COMMUNICATING USER RESEARCH FINDINGS THROUGH DESIGN ARTIFACTS: THE CASE OF SHUTTLE BUS DRIVERS

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

AYÇA KINIK

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF DOCTOR OF PHILOSOPHY
IN
INDUSTRIAL DESIGN

JANUARY 2024

Approval of the thesis:

COMMUNICATING USER RESEARCH FINDINGS THROUGH DESIGN ARTIFACTS: THE CASE OF SHUTTLE BUS DRIVERS

submitted by **AYÇA KINIK** in partial fulfillment of the requirements for the degree of **Doctor of Philosophy** i**n Industrial Design, Middle East Technical University** by,

Prof. Dr. Halil Kalıpçılar
Dean, Graduate School of **Natural and Applied Sciences** _____

Prof. Dr. Gülay Hasdoğan
Head of the Department, **Industrial Design** _____

Prof. Dr. Gülay Hasdoğan
Supervisor, **Industrial Design, METU** _____

Examining Committee Members:

Assoc. Prof. Dr. Fatma Korkut
Industrial Design, METU _____

Prof. Dr. Gülay Hasdoğan
Industrial Design, METU _____

Assist. Prof. Dr. Ali Berkman
Industrial Design, TOBB ETU _____

Assoc. Prof. Dr. Naz A.G.Z. Börekçi
Industrial Design, METU _____

Assist. Prof. Dr. Sedef Süner Pla Cerda
Industrial Design, TEDU _____

Date: 26.01.2024

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last name: Ayça, Kınık

Signature:

ABSTRACT

COMMUNICATING USER RESEARCH FINDINGS THROUGH DESIGN ARTIFACTS: THE CASE OF SHUTTLE BUS DRIVERS

Kınık, Ayça
Doctor of Philosophy, Industrial Design
Supervisor: Prof. Dr. Gülay Hasdoğan

January 2024, 402 pages

This study focuses on the design, prototyping, and utilization of an online, interactive communication tool to communicate user research findings to designers. The user research was conducted with shuttle bus drivers, utilizing interviews, field observations, and eye-tracking recordings to collect data. The design process involved the creation of design artifacts such as personas, eye-tracking videos, and a driver experience map, as well as a workshop protocol for problem identification. The study's main outcomes are a generative model for driver experience dimensions and insights for designing and utilizing online and interactive user research communication tools. The study utilizes data-driven personas, naturalistic driving videos, and a user journey map to identify design problems. It was found to be immersive, providing empathy for users, facilitating information navigation, and enabling contextual understanding and user comparison.

Keywords: Research Communication Tool, Research through Design, Design Problem Identification, User Experience, Bus Drivers

ÖZ

KULLANICI ARAŞTIRMA BULGULARININ TASARIM SÜRECİ ÇIKTILARI YOLUYLA AKTARILMASI: SERVİS OTOBÜSÜ SÜRÜCÜLERİ ŞÖRNEĞİ

Kınık, Ayça
Doktora, Endüstri Ürünleri Tasarımı
Tez Yöneticisi: Prof. Dr. Gülay Hasdoğan

Ocak 2024, 402 sayfa

Bu çalışma, kullanıcı araştırma bulgularını tasarımcılara iletmek için çevrimiçi etkileşimli bir iletişim aracının tasarımı, prototipleştirilmesi, ve kullanılmasına odaklanmaktadır. Kullanıcı araştırması, servis şoförleri ile gerçekleştirilmiş olup, veri toplamak için mülakatlar, saha gözlemleri ve göz takibi videoları kullanılmıştır. Araştırma süreci, personalar, göz takibi videoları ve kullanıcı deneyim haritası gibi çıktılarının yanı sıra tasarım problemlerinin tanımlanması için bir çalıştay protokolü üretmiştir. Çalışmanın ana çıktıları, sürücü deneyimi boyutları için yaratıcı bir model ve çevrimiçi etkileşimli kullanıcı araştırma iletişim araçlarının tasarımı ve kullanımına yönelik içgörülerdir. Çalışmada tasarım sorunlarını belirlenmesi için veri odaklı personalar, doğal ortamdaki sürüş videoları ve kullanıcı deneyim haritası kullanılmaktadır. Tasarlanan iletişim aracının, katılımcıların kullanıcılarla empati kurmasına yardımcı olduğu, aradıkları bilgiye ulaşmalarını kolaylaştırdığı ve kullanıcıların bağlamı hakkında kapsamlı bilgi verdiği gözlemlenmiştir.

Anahtar Kelimeler: Arastırma İletişim Aracı, Tasarım Yoluyla Araştırma, Tasarım Problemi Tanımlama, Kullanıcı Deneyimi, Otobüs Şoförleri

To my family

ACKNOWLEDGMENTS

Working on this thesis was a demanding journey that left a profound mark on me both personally and professionally. I'd like to thank my supervisor, Prof. Dr. Gülay Hasdoğan, for guiding, challenging, and allowing me to explore my intellectual curiosities with great patience. Beyond her role as my thesis supervisor, she provided personal connection and emotional support during challenging times. I am grateful for the critical yet friendly guidance and encouragement provided by my thesis monitoring committee members, Assist. Prof. Dr. Ali Berkman and Assoc. Prof. Dr. Naz A.G.Z. Börekçi. I'm also grateful for the constructive feedback and support of the jury members, Assoc. Prof. Dr. Fatma Korkut and Assist. Prof. Dr. Sedef Süner Pla Cerda.

I'd like to thank Prof. Dr. Kürşat Çağıltay, Dr. Serkan Alkan, Mehmet Dönmez, and METU Computer Education and Instructional Technology Department for lending the eye tracking device as well as granting access to and providing training for the analysis software.

The bus drivers and professional designers who participated in this study generously shared their thoughts and patiently responded to my inquiries, which enabled me to understand their experiences and perspectives profoundly.

Ilpo Koskinen generously provided detailed responses to my inquiries about the data analysis. His graciousness in taking the time to help a Ph.D. student he didn't know left me deeply appreciative.

Mustafa Hasdoğan, who has been a patient teacher, supportive colleague, and close friend since our time at Atılım University, helped me handle problems with the video files for this study. Rodrigo Esparza Parga provided essential support with his friendship, humor, and philosophical outlook on life. Dear Laura alleviated much of the stress burden during this process through our therapy sessions. I extend my

thanks to my colleagues at Tec de Monterrey, Luis Miguel Gutierrez, and Emmanuel González, for welcoming me into their team and for their flexibility and understanding as I completed this study.

My family provided their unwavering support throughout this journey. My mother has been a fundamental pillar of my vitality and resilience, empowering me with the courage to pursue what drives and inspires me in life. For the past two years, my family has shouldered the immense responsibility of not only providing encouragement, love, and protection but also supporting my entire livelihood, enabling me to devote my full attention to this study. Their love, support, and devotion are beyond any measure, without which this work would not be possible. I'm grateful for your existence, my dear mom, dad, brother, sister, and my little girls, Zeyno and Tarçın.

TABLE OF CONTENTS

ABSTRACT v

ÖZ vi

ACKNOWLEDGMENTS viii

TABLE OF CONTENTS x

LIST OF TABLES xvi

LIST OF FIGURES xvii

1 INTRODUCTION 1

1.1 Problem Background and Research Approach 3

1.2 Aim of the Study 6

1.3 Research Questions 7

1.4 Structure of the Thesis 8

2 EXPLORING AND COMMUNICATING USER EXPERIENCES 11

2.1 Integration of User Knowledge into Design 11

2.1.1 From Ergonomics to Participatory Design 11

2.1.2 The Age of Computers and Human-Centered Turn 14

2.1.3 Summary 17

2.2 Selecting User Research Methods 18

2.2.1 Type of Understanding 19

2.2.2 Type of User Presence 21

2.2.3 Design Process Activities 23

2.2.4 Origins of Methods 30

2.2.5 Type of Data 30

2.2.6 The Context of Product Use 31
2.3 Communicating User Research 32
2.4 Discussions About User Research and Design 34
3 RESEARCH THROUGH DESIGN 37
3.1 Roles of RtD Artifacts 39
3.2 RtD Knowledge 42
3.2.1 Design Patterns 43
3.2.2 Ultimate Particulars 46
3.2.3 Theory on design vs. Theory for design 48
3.2.4 Implicit Artifact Knowledge vs. Annotated Portfolios 49
3.2.5 Conceptual Constructs 51
3.2.6 Intermediate-level Knowledge and Strong Concepts 52
3.2.7 Bridging Concepts 55
3.2.8 Critique of Design Artifacts 57
3.2.9 Domain Theories 60
3.3 Chapter Discussion 61
4 METHODOLOGY 63
4.1 Data Collection and Analysis Methods 65
4.1.1 Data Collection 67
4.1.2 Participants 69
4.1.3 Data Analysis 73
4.2 Procedure of Study 88
4.2.1 Phase 1: Exploring the Bus Design Practice 89
4.2.2 Phase 2: Driver Data Collection and Creation of Design Artifacts 91

4.2.3 Phase 3: Identifying Design Improvements with Designers 94
4.3 Ethical Considerations and Limitations: 99
4.4 Roles of the Author 99
5 DESIGN PROCESS AND ARTIFACTS 101
5.1 Design Iterations 101
5.1.1 Version 1: Designing face-to-face Workshops pre-COVID-19 102
5.1.2 Version 2: Remote and Online Workshops 121
5.1.3 Pilot Workshops 140
5.2 Main Artifacts of the Final Version 157
5.2.1 Final Driver Experience Map 157
5.2.2 Final Driver Frames 161
5.2.3 Final Driving Videos 170
5.3 Complementary Artifacts of the Final Version 173
5.3.1 Miro Boards 173
5.3.2 Miro Board Navigation and Text 173
6 UTILIZATION AND ASSESSMENT OF THE WORKSHOP FRAMEWORK 179
6.1 Driver Experience Map 180
6.1.1 Driver Experience Map-Based Problem Observations 180
6.1.2 Utilization of Driver Experience Map 181
6.1.3 Assessment of Driver Experience Map 183
6.2 Personas 185
6.2.1 Persona-based problem observations 186
6.2.2 Utilization of Personas 189

6.2.3 Assessment of Persona Content and Design 194
6.3 Videos 199
6.3.1 Utilization of Videos 200
6.3.2 Assessment of Videos 257
6.3.3 Utilization and Assessment of Video Representations and Campus Map 266
6.4 Other Evaluations 270
6.4.1 Design and Content Improvements: 271
6.4.2 Impact on the Design Process 273
6.4.3 Comparisons with Other Sectors 274
6.4.4 Bus Manufacturing Business 275
6.4.5 Problematization of Observations 277
7 DISCUSSION AND CONCLUSIONS 281
7.1 Generative Model of Driver Experience Dimensions 284
7.2 Concluding Remarks About the Workshop Framework 290
7.2.1 Appraised qualities of the workshop framework 291
7.2.2 Improvement Areas 295
7.2.3 Limitations of the Workshops 297
7.3 Limitations & Challenges 298
7.3.1 Generalization 298
7.3.2 Researcher as a detached observer 299
7.3.3 Failed Attempts 300
7.4 Further Studies 302
REFERENCES 303

A. Mapping the Driver Cabin 317
B. Semi structured interview guide 321
C. Remarks From Driver Encounters 324
D. Eye Tracking Analysis Problem for Dingin 4 Video 328
E. Eye Tracking Recordings 332
F. Videos and Participants 333
G. Final Design Artifacts for Individual Participants 335
H. Final Design Artifacts for Driving Videos 337
I. Workshop Questions (Turkish) 339
J. Workshop Questions (English) 340
K. Problems Related to Products and Systems 341
L. Problems Related to Unmet Driver Needs 342
M. Problems Related to the Actions of the Traffic Actors 343
N. 1FA Synopses 345
O. 2MeK Synopses 351
P. 3SG Synopses 356
Q. 4CB Synopses 362
R. 5FuA Synopses 367
S. 6EC Synopses 371
T. 7IT Synopses 378
U. 8OB Synopses 382
V. 9MuK Synopses 390
W. 10KU Synopses 394
X. Consent Form for Driver Data collection 398

Y. Consent Form for Workshop Participants.....400

Z. Ethics Committee Approval for Driver Data Collection 401

AA. Ethics Committee Approval for Designer Data Collection 402

CURRICULUM VITAE.....403

LIST OF TABLES

TABLES

Table 1 Driver participants' information....70
Table 2 Designer participants' information....72
Table 3 Phases of the study and research methods....89
Table 4 Clip 1 events and annotations....107
Table 5 Clip 2 events and annotations....109
Table 6 Clip 3 events and annotations....112
Table 7 Clip 4 events and annotations....113
Table 8 Events in the Bıçkın 1 clip (extended version of the former Clip 3)....131
Table 9 Events in the Bıçkın 3 clip (extended version of the former Clip 2)....133
Table 10 Persona names and number of clips for Pilot studies....134
Table 11 Problem type examples identified by pilot 1 participant....141
Table 12 Design decisions following Pilot 1 workshop....143
Table 13 Driver personas and number of drivers....166
Table 14 Curation problems for Dingin 3 video....261

LIST OF FIGURES

FIGURES

Figure 1: Definition of Operationalization of User Research 7
Figure 2 Levels of Need Expression by Sanders (1992)..... 20
Figure 3 Different levels of needs in relation to user research methods by Sleeswijk Visser et al. (2005)..... 21
Figure 4 Design research phases (Hanington, 2007) 25
Figure 5 Phases of design process and corresponding methods (Squires & Byrne, 2002) 26
Figure 6 Product development stages and research methods (Rohrer, 2022)..... 26
Figure 7 Design process phases and research methods (Farrell, 2017) 27
Figure 8 Double diamond process and research methods (Gama et al., 2022)..... 28
Figure 9 Stanford Design School design thinking process and user involvement strategies (Schmarzo, 2017)..... 29
Figure 10 User research methods based on their domain origins (Hanington, 2003) 30
Figure 11 The categorization of user research methods by Rohrer (2022)..... 32
Figure 12 Model of ways to achieve effective user research communication (Töre Yargın, 2013). 34
Figure 13 Alexander's pattern number 204 (Alexander, 1977)..... 43
Figure 14 A pre-pattern from Chung et al. (2004)..... 45
Figure 15 From universal to ultimate particular by Nelson & Stolterman (2012).. 46
Figure 16 Design as a compound inquiry (Nelson & Stolterman, 2012)..... 47
Figure 17 A sketch of an annotated portfolio from Gaver (2012) 50
Figure 18 RtD process model proposed by Stolterman & Wiberg (2010) 52
Figure 19 Landscape of intermediate-level knowledge by Höök & Löwgren (2012) 54
Figure 20 Comparison of bridging concepts, conceptual constructs, and strong concepts (Dalsgaard & Dindler, 2014) 56

Figure 21 The knowledge range between general theories and particular design instances (Dalsgaard & Dindler, 2014) 57
Figure 22 "Menstruation Machine" by Sputniko! As cited in Bardzell et al. (2015) 58
Figure 23 Timeline for data collection and construction. 64
Figure 24 Notebooks used for handwritten notes throughout the study. 65
Figure 25 Photo depicting a part of the literature analysis conducted by writing on a whiteboard in September 2018. 66
Figure 26 Areas in the human visual field (Bergstrom & Schall, 2014) 68
Figure 27 Representations of the eye movements on eye tracking videos. 69
Figure 28 An example of mind mapping with ConceptDraw for bus manufacturer meetings. 78
Figure 29 An example of analysis with physical sticky notes for grouping driver problems. 79
Figure 30 Updating and rearranging problem codes on Miro with the information from the workshop analysis. 79
Figure 31 Heat map for 1 minute of reversing (Dingin 4 video) 80
Figure 32 Gaze plots for the 26-second portion of reversing the vehicle (Dingin 4 video) 81
Figure 33 Photo depicting a part of bus driver problem analysis conducted by writing on sticky notes. 82
Figure 34 An example of video analysis notes. 83
Figure 35 Chronological notes in relation to campus landmarks for the recording number 022. 85
Figure 36 Analyzing different road geometries on campus. 85
Figure 37 Curating the clips with video editing software, iMovie. 86
Figure 38 Writing synopses from transcriptions. 87
Figure 39 Codes from the first analysis attempt of raw transcriptions. 95
Figure 40 Screenshot from the third version of MAXQDA coding. 96
Figure 41 Clip 1 Screenshot: Reversing maneuver at the fuel station. 107

Figure 42 Clip 2 Screenshot: Two buses on a narrow road. 108
Figure 43 Clip 2 Screenshot: The oncoming bus enters a space. The ego driver glances at the front wheel of the oncoming bus to foresee its maneuver, hence the other driver's intention. 110
Figure 44 Clip 3 Screenshot: Attempting to turn the air conditioning on. 111
Figure 45 Clip 4 Screenshot: Checking Mirrors 112
Figure 46 Clip 4 Screenshot: Merging onto the main road. 115
Figure 47 Version 1: Home Screen 116
Figure 48 Version 1: Event Type Screen 117
Figure 49 Version 1: Video Player Screen 118
Figure 50 Miro Frame for Miro Tutorial 123
Figure 51 Miro Frame for Automation Levels and Exemplary Features 124
Figure 52 Miro frame for campus shuttle facts. 126
Figure 53 First and updated problem categories. 127
Figure 54 Problem group visualizations. 128
Figure 55 Persona brainstorming. 129
Figure 56 Initial visual design of personas and driver frames. 130
Figure 57 Experience map example (Gibbons, 2017) 136
Figure 58 Customer Journey Map example (Gibbons, 2017) 136
Figure 59 Empathy map example (Gibbons, 2017) 137
Figure 60 Initial driver experience map design. 139
Figure 61 Some problems identified by Pilot 1 participant. 142
Figure 62 Redesigned driver frames filled by the p2AK before the workshop 145
Figure 63 Driver experience map notes by p3MD. 149
Figure 64 p3MD notes for İhtiyar videos. 149
Figure 65: An example of a filled-out worst-case scenario template by p3MD. 150
Figure 66 Prioritized problems and some solution suggestions from p3MD. 152
Figure 67 Design iteration of the driver experience map for the Pilot 4 workshop. 154
Figure 68 Design iteration of the main Miro board for the pilot 4 workshop. 155

Figure 69 Numbered notes of p4TC for the driver experience map and Bıçkın videos. 156
Figure 70 Driver Experience Map 159
Figure 71 Problematic situation exemplar from the Driver Experience Map 161
Figure 72 Driver Frame Exemplar 163
Figure 73 Persona Exemplar (Bıçkın) 166
Figure 74 Positive skills and negative behaviors segments in personas. 168
Figure 75 Map key on the corner of the campus map. 169
Figure 76 Video representations on the campus map for the Bıçkın 7 video. 169
Figure 77 List of final videos. 170
Figure 78 Video player and notetaking on videos (participant screen) 172
Figure 79 Video notes on account owner's screen. 172
Figure 80 Miro introduction. 175
Figure 81 A spatial cue and descriptive text on the Miro board dedicated to the videos. 176
Figure 82 The descriptive text for interacting with video representations. 176
Figure 83 The descriptive text for notetaking on videos. 177
Figure 84 Rare event examples from the driver experience map. 185
Figure 85 Uyanık (Sly) Persona 186
Figure 86 Persona characteristics information. 193
Figure 87 Labeling attitudes in personas. 197
Figure 88 Persona skills and behaviors sections. 198
Figure 89 Şakacı, not yielding to a pedestrian in a visually challenging situation. 203
Figure 90 Bezgin makes a hand gesture, indicating he wouldn't stop (Bezgin 1). 204
Figure 91 Bıçkın tries to avoid collusion. 205
Figure 92 Uyumlu warns the passengers before closing the doors (Uyumlu 3). 207
Figure 93 Şakacı tells passengers that he will take a break. 208
Figure 94 Bıçkın shouts at another driver (Dingin) waiting outside. 208
Figure 95 A sequence from Dingin 5 video. 210

Figure 96 İhtiyar taking over a loaded tractor in video 2. 212
Figure 97 A passenger asks about the bus route before boarding (Uyanık 2). 213
Figure 98 Uyumlu calls out to the passenger (Uyumlu 5). 213
Figure 99 Şakacı honks the horn to a pedestrian during a right turn. 215
Figure 100 Passenger crowd in Uyumlu 2 video. 217
Figure 101 Passenger crowd and mirror obstruction in Bezgin 1 video. 218
Figure 102 Uyumlu checks passengers after passing over a speed bump. 219
Figure 103 Uyumlu's head posture while looking at the top interior mirror. 220
Figure 104 Gaze pattern on the passenger's feet in Dingin 3 video. 222
Figure 105 Bezgin checks the pedestrian at the bus stop (Bezgin 2 video). 223
Figure 106 Bezgin ignores a pedestrian at the bus stop (Bezgin 3 video). 224
Figure 107 Şakacı looks at the wheels of the car. 225
Figure 108 Screen on the left obstructs the road view while turning left (Bezgin 2) 226
Figure 109 Mirror on the middle-right obstructs the road view while turning right (Dingin 3) 226
Figure 110 Encounter with a runner in Uyanık 1 video. 228
Figure 111 Screenshot locations of the left turn (Uyumlu 5) 229
Figure 112 Gaze interpretations of Uyumlu during a left turn. 230
Figure 113 Passenger passing in front of the bus (Dingin 6) 232
Figure 114 Şakacı leaves the bus bay. 233
Figure 115 Screenshots from leaving the bus bay. 234
Figure 116 Pedestrian waiting on the road in Uyumlu 3 video. 235
Figure 117 Uyanık turns right at one of the major turnabouts on campus (Uyanık 4) 236
Figure 118 Interpretations of Uyanık's gaze movements during the right turn. ... 238
Figure 119 Bıçkın tries to adjust the air conditioner while maneuvering (Bıçkın 1) 241
Figure 120 Şakacı gets on the bus (Şakacı 1). 242
Figure 121 Şakacı makes a video call while maneuvering (Şakacı 1). 244

Figure 122 Dingin searches for the route sign (Dingin 5).....246
Figure 123 İhtiyar rotates the route sign during a right turn (İhtiyar 2). 248
Figure 124 A white bus violating red light in Şakacı 4 video. 250
Figure 125 Gaze interpretations of Şakacı while he gives way to other road users (Şakacı 2).....255
Figure 126 Gaze indicator disappearing behind the logo in consecutive video frames. 260
Figure 127 Dingin 3 video curation problems.....262
Figure 128 Şakacı talks to someone on the sidewalk in Şakacı 3 video. 265
Figure 129 Video Representations on the campus map. 266
Figure 130 Selected Frames from Bıçkın 7 GIF 268
Figure 131 Dimensions of Bus Driver Experience.....286

CHAPTER 1

INTRODUCTION

It is commonly recognized that understanding users holds essential significance in design practice. However, the growing complexity of both product development processes and products presents challenges in understanding users' experiences with the products.

The growing complexity of processes for product development refers to the diverse configurations of project teams and multistakeholder projects in which designers take part. Depending on the team configuration, designers may conduct user research or dedicated user researchers may do it. While the involvement of designers in user research allows them to get immersed in the design context, gain an in-depth understanding of users, and develop empathy, this may not be feasible for all projects or all designers in the team. This is the situation in many product development companies that establish dedicated departments for user research or seek user research assistance from outsourcing parties. Consequently, this introduces challenges in sharing user knowledge with designers, which is one of the two main concerns of this study.

The growing complexity of products refers to an increasing interconnection, transformation, and intertwining of digital and physical products, systems, and services into each other. While this complexity applies to all products, systems, and services, the author has focused on exploring and communicating the experience of shuttle bus drivers. This decision is inspired by the author's previous experience as one of the designers in a multistakeholder healthcare project, where she encountered firsthand the challenges of incorporating the knowledge from the user research conducted by dedicated user researchers into that design project.

The project included designing a diagnostic and interventional system comprising various elements distributed across multiple locations, rotating and moving mechanical parts, on-screen interfaces, physical controls, audio-visual warnings, and images. It served different user groups, including nurses, technicians, and surgeons. The system referred to in this project included people, technology, and their surrounding social and organizational contexts. Therefore, interactions occur between medical equipment, diagnostic tools, electronic health records, patients, healthcare providers, and policymakers.

These complex interactions find expression in diverse contexts, including transportation systems such as bus systems. Exemplifying this notion, a bus system epitomizes the convergence of individuals (passengers, drivers, pedestrians, other vehicle drivers), technology (vehicles, route maps, and ticketing and monitoring systems), and the socio-organizational structures governing transportation operations and policies. Such systems are identified as socio-technical systems and are characterized by their complexity that arises from the interdependencies and relationships between the different elements of the system, such as goals, people, culture, technology, infrastructure, and processes (Davis et al., 2014). As a result, changes in one part of the system can have far-reaching effects on other parts, making these systems challenging to analyze, understand, and design. Consequently, a holistic approach is recommended for addressing these challenges of designing socio-technical systems (Aylward et al., 2021).

Analogous to healthcare systems, bus systems embody the multifaceted nature of socio-technical systems, wherein technical components intermingle with social elements to deliver a service to users. These interactions within the bus transport system affect bus drivers' working experiences. Following this line of thought, exploring in which ways design interventions may improve their experience is the second main concern of this study.

1.1 Problem Background and Research Approach

Against this backdrop, this study takes on an explorative approach to inquiring into these two main concerns: exploring bus drivers' working experiences and structuring the user knowledge for communicating with designers. The explorative approach is characterized as "the ability to cope with unknowns" and "is typical for researchers exploring uncharted territory, working at the fringes, or in the overlap of multiple concerns" (Stappers, 2007, p. 86). While the two concerns of this study may not reside at the fringes of design research, its novelty arises from the inquiry into the overlap of these concerns by facilitating designing as a way of inquiry.

Previous research has shed light on some aspects of the first concern of the study, bus driver working experiences. For instance, inner-city public bus drivers commonly suffer from work-related stress (Useche et al., 2017) and poor occupational conditions and health (Jones et al., 2014). Bergomi et al. (2017) note that bus drivers encounter stressors associated with their work, including demanding job requirements and limited control over their working conditions, along with contextual stressors concerning their role within the organization and interactions with coworkers and supervisors. These stressors are exacerbated by some bus driver personality characteristics such as impulsiveness (Bergomi et al., 2017). Additionally, Salmon et al. (2011) pointed out that some bus driver tasks, which are among the significant aspects of the driver experience, induce distracted driving, an issue that has not been extensively explored. Distraction and inattention are among the most prevalent risks to driving safety (Regan & Hallett, 2011) and are not only relevant to bus driving. However, bus driver tasks such as answering passenger questions, picking up and dropping the passengers at the bus stops, managing passenger aggression, and communicating with the task operation center increase the likelihood of driver distraction and contribute to long-term fatigue (Salmon et al., 2011). In addition, maneuvering a big vehicle, such as a bus, and negotiating the road interactions with other road users might well induce undesirable experiences, driver fatigue, and safety risks.

The second concern of the study, communicating user knowledge, has also been addressed by researchers such as Sleeswijk Visser (2009) and Töre Yargın (2013) in their doctoral dissertation studies. For her thesis, Sleeswijk Visser (2009) designed tools for communicating rich user experience data to practicing designers by drawing on her previous experience as a designer and design researcher. She conducted several studies on different topics in which she designed tools for communicating knowledge about the daily lives of different user groups. For instance, in one study, she focused on the morning rituals of families, and in another, she explored the shaving experiences of men. Similarly, she focused on different aspects of communication tools in different studies, such as the interactivity of the tools or their capacity for enabling interpretation for the participants (designers and design students). In the end, she developed a framework for *successful* communication of user knowledge as well as the descriptions of the qualities, mechanisms, and operational means to achieve it.

Töre Yargın (2013), on the other hand, interviewed designers from different sectors, such as transportation or medical product design, to identify designers' articulated expectations (self-reported psychological constructs) from the user research information systems from the *effective* communication perspective. In the end, she developed a model for effective communication of user knowledge that is based on the designers' psychological constructs she identified through the interviews, as well as the strategies and guidelines for facilitating the model.

Sleeswijk Visser (2009) notes that user research communication needs to enhance *empathy* to enable designers to form a deep understanding of users, support *engagement* that leads to designers' commitment to utilizing the information, and provide *inspiration* to facilitate creating product ideas. Töre Yargın (2013) explains the *qualities of user information* and the *dimensions of delivery methods* of an information system designed to communicate user knowledge effectively. In addition, she also explains the *parameters for effectiveness* that the study

recommends considering while designing and developing information systems (see 2.3 for more).

The approach of this study towards its second concern, that is the communication of user knowledge, has similarities with Sleeswijk Visser's (2009) dissertation in the sense that the author of this thesis also designed artifacts to communicate user knowledge, asked designer participants to utilize them, and interpreted their utilization and assessment of the artifacts. To design the artifacts, the author draws on her previous experience as a designer and design researcher, as well as the communication qualities defined by Sleeswijk Visser (2009) and the communication model developed by Töre Yargın (2013). This means that the author of this thesis put the knowledge about user research communication to use while designing a novel workshop framework. Therefore, this study does not aim to establish another model for user research communication but to design a user research communication workshop, explore how designers utilize and assess it, and glean insights into its design process, utility, and improvement areas. These insights are aimed to help design user research communication workshops for sociotechnical systems.

The exploration of the second concern of the study, communicating user knowledge is inquired by research through design (RtD) approach. Research through design (RtD) is a research approach that combines design practice and scholarly inquiry, using the act of designing and the creation of design artifacts to generate knowledge and address wicked problems (Zimmerman et al., 2007). RtD is considered to have the potential to be one of the most important contributions of design researchers to the larger research community (Zimmerman et al., 2010). While RtD is widely recognized as emphasizing unique contributions that design can make to research endeavors, it is not always addressed using this particular terminology (Godin & Zahedi, 2014; Stappers & Giaccardi, 2017). Among others, terms such as *design research through practice* (Koskinen et al., 2011), *constructive design research* (Koskinen et al., 2011; Wensveen, 2018), *interaction*

design research (Fallman, 2008; Höök & Löwgren, 2012), *practice-based design research* (Vaughan, 2017), *experimental design research* (Brandt & Binder, 2007), and *research-oriented design* (Fallman, 2003) are being used to indicate the "designerly ways of doing research" (Stappers & Giaccardi, 2017).

Inquiring the communication of user knowledge by RtD is parallel to Sleeswijk Visser's (2009) approach in her dissertation, however, different from that study, the author of this study focuses on a single topic: the experiences of shuttle bus drivers. Focusing on a single topic enables a thorough examination of the topic and triangulation of the knowledge about bus driver experiences. Triangulation includes the knowledge from the literature review of bus driver problems, field observations of the author, and designer participants' interpretation of the information delivered via workshops. This, in return, leads to the development of a model of driver experience.

1.2 Aim of the Study

This study aims to support design practice with the knowledge gained through operationalizing user research from the field. Operationalization entails conducting user research, designing a workshop framework with the user research findings, and facilitating the framework (Figure 1). The study constructs two types of knowledge. One is the generative model of the dimensions of bus driver experience, which provides insights into the effects of system interactions on driver experiences. This model can be facilitated for idea generation for a variety of projects within socio-technical systems. The other is providing insights into understanding users and communicating knowledge to the product development process.

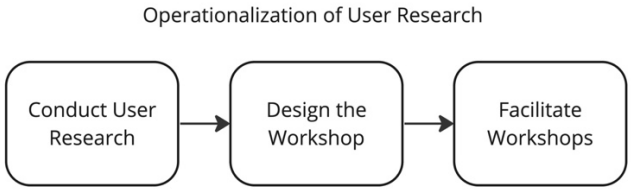


Figure 1: Definition of Operationalization of User Research

This aim is inquired through three phases. The first is to select and explore the case, the second is to collect user data and design a user research communication workshop framework for the case, and the third is to conduct workshops with the tool to explore its utilization on framing design problems.

The insights generated in this study are gleaned from a combination of field research involving different stakeholders and the design and implementation of a workshop framework, which was subsequently utilized by design professionals. By integrating user research, design practices, and human-centric perspectives in an iterative process, this study inquires about practical solutions and insights that advance the field of bus system design and contribute to the broader goal of enhancing the communication of user experiences with designers.

This study, centered around a single case, aims to thoroughly examine its details, fostering a nuanced understanding rather than prioritizing the generalization of the knowledge constructed through the study. However, documentation of the explication of the case and the process are provided to support the replicability of the study and its applicability to other types of cases.

1.3 Research Questions

The research questions for this study are formulated to initiate an explorative inquiry into the two main concerns explained above. These concerns are (a) communication of user research findings about a selected case (METU shuttle bus system) and (b) exploration of design improvements related to the experience of a

selected user group (bus drivers) within a socio-technical technical system. Therefore, the research questions are formulated as the following:

1. What are the safety and comfort problems that shuttle bus drivers experience during their daily routines and driving, and how might these problems be addressed?
2. How might the user research findings be structured to help practicing designers discover design opportunities for safety and comfort problems?

1.4 Structure of the Thesis

Chapter 2 reviews the literature about exploring and communicating user experiences. Different types of methods enable access to different aspects of user experiences. In addition, employing methods during different phases of a project or for different project purposes enables the project team to utilize different aspects of user knowledge. This chapter explains the integration of user knowledge in design conceptually and historically and presents a categorization of user research methods. In addition, the chapter presents a user research communication model that informed the design of the workshop throughout the second phase of this study. The chapter closes with a discussion about how this study defines products and the integration of user knowledge into designing them.

Chapter 3 reviews the literature concerning knowledge construction through the research through design (RtD) approach, exploring its potential contributions and setting realistic expectations. The first part of the chapter describes the roles of the artifacts in knowledge construction in RtD, while the second part outlines nine types of knowledge deemed as RtD's contributions by leading researchers in the field. Given that RtD distinguishes itself from design practice through its emphasis on knowledge construction, conveying the insights garnered through RtD alongside the artifacts produced becomes essential. Thus, establishing an understanding of

the various forms of knowledge construction from the literature is recognized as critical.

Chapter 4 presents the methodology and procedure of the study. It begins by describing the data collection and analysis methods and continues with explanations of the study phases, ethical considerations, and the roles undertaken by the author.

Chapter 5 presents the design process and the artifacts of the workshop framework developed through the research through design (RtD) approach.

Chapter 6 presents the insights from utilization and the assessment of the workshop framework.

Chapter 7 discusses the findings considering the literature about research through design knowledge construction and presents conclusions for the study.

CHAPTER 2

EXPLORING AND COMMUNICATING USER EXPERIENCES

This chapter reports the author's efforts to build an understanding of the integration of user knowledge in design, categorization of user research methods, and communication of user research findings to inform method selection and their implications for the study.

2.1 Integration of User Knowledge into Design

2.1.1 From Ergonomics to Participatory Design

Integration of user knowledge into the design of products can be traced back to physical and cognitive ergonomics studies for military purposes during the world wars. Operationalization of ergonomics for commercial product design is frequently attributed to Henry Dreyfus, an industrial designer and the author of the 1960 book The Measurement of Man. By providing detailed measurements of people, he aimed to guide the design of the products to suit their users. Even though the design has always been implicitly focused on its users, the commercial success of his approach of fitting the product to people instead of expecting people to fit it indicates an explicit shift towards focusing on people for product development.

In the 1960s, parallel to the operationalization of ergonomics in design, the Design Methods movement emerged as a response to the increasing complexity and perceived limitations of design practice. It sought to develop systematic and structured methods for designing products, systems, and processes and address the challenges of complexity and uncertainty in the design process by introducing

scientific and analytical methods (Cross, 1984). In the post-war era, available production methods increased, and designers had to deal with more than selecting the right materials and exploring aesthetic improvements. Designers were expected to respond to subtle user needs and market demands and incorporate various knowledge domains into design thinking (Archer, 1965). According to Bonsiepe (2007), the need to respond to the complexity and aspiration for becoming a respected and recognized discipline helped to have structured methodologies to be accepted enthusiastically. The movement's main concern was improving the design process, decision-making, and knowledge management. In addition to rational and prescriptive methods for designing, the design methods movement assumed a three-stage linear design process of analysis-synthesis-evaluation (Cross, 1984). The main source of user knowledge in this period was still ergonomics (Tore Yargın, 2013).

In the 1970s, the design methods movement lost its popularity for the lack of recognition of the creative process and its inability to respond the “wicked” or ill-structured” problems(Cross, 1984). Increasing complexity brought about social problems in the design, which rendered design problems to be characterized as “wicked problems” (Rittel & Webber, 1984). Wicked problems are real-world problems, such as the problem of poverty, and include social interactions, which makes it hard to handle with rational methods. According to Rittel & Webber (1984), defining the problem is the main problem with wicked problems because solutions differ wildly depending on how the problem is framed. By scrutinizing the notion of wicked problems, Simon (1984) argued that even well-defined problems might not be as well-defined as Rittel & Webber (1984) posited, therefore, broadened the domain of wicked problems. Moreover, Thomas & Carroll (1984) dismissed the prevalence of the type of problems and assumed that any problem could be perceived as a design problem; by doing this, they emphasized the importance of the way of looking at a problem instead of the problem itself. The attempts to define the problems and the ensuing difficulty in handling these problems with rational methods forced the design methods movement to evolve

into a second generation of methods involving other stakeholders' participation in the projects (Broadbent, 1984). Despite the criticism about the design methods movement, it had procedural contributions to user interface design, design of information systems, knowledge management, and computerization of the design process design (Broadbent, 2002).

Advancements of personal computers for non-expert users around the 1970s brought about the need for a deeper understanding of the people (Giacomin, 2014; Ritter et al., 2014). This gave rise to participatory design and the employment of ethnographers for design projects (Koskinen et al., 2011). Participatory design was a response to the advent of computers in the workplace and the workers' hesitation about losing control over their work (Kensing & Blomberg, 1998) with an attempt to democratize workspace decisions and empower workers (Ehn, 1993). Participatory design is an approach to design that emphasizes the involvement of end-users or stakeholders in the design process. This approach recognizes that users have valuable knowledge and expertise that can inform the design of products or services. It is grounded in the belief that those affected by design should have a say in how it is created (Dourish, 2006). User knowledge is central to participatory design, as it allows designers to understand better the users' needs, preferences, and behaviors, leading to more effective and usable products or services (Sanders & Stappers, 2008). Even though participatory design has its roots in political and social movements, particularly in Scandinavia, it lost its political ideology when it spread to software development and design industries in the United States. Its lasting contribution to design research is collaborative work with the stakeholders and using mock-ups in the collaborative work (Koskinen et al., 2011).

A parallel development to the design methods movement in the1970s was the software crisis characterized by a significant increase in project costs, late deliveries, and poor quality of software products (Naur & Randell, 1969). The reasons for the crisis were considered poor project management, limited education capacity for the software developers, the absence of a well-defined software development process, and the need for more understanding of the users (Jefsioutine

& Knight, 2006). The impact of the software crisis on software development was significant. One of the consequences was moving away from the linear waterfall software development process towards the iterative agile process (Jefsioutine & Knight, 2006). The other consequence was the increased involvement of social scientists in product development to understand the needs and requirements of users. Ethnographers played a critical role in understanding user behavior, culture, and preferences. Employing ethnographers became common practice in product development to identify user needs and ensure that software products met user requirements (Hughes et al., 1995). Identification of the software crisis and integration of ethnographic methods into the design process to mitigate the crisis originated from the military software products and disseminated to other areas such as design for office work, air and transportation control rooms, and police work (Hughes et al., 1995).

To summarize, both the nature of the design process and the nature of operationalized user knowledge have transformed during this period. Both design and software development domains abandoned linear processes in favor of iterative and participatory processes. In addition to the physical, cognitive, and organizational ergonomics knowledge, social aspects of human-machine interactions and user needs came to the forefront instead of the technology-centered product development mindset, manifested by integrating social scientists into the design and development teams. At this point, products' hardware and software aspects still had separate and clear boundaries, which gradually dissolved.

2.1.2 The Age of Computers and Human-Centered Turn

Building on the learnings of the 1970s, the 1980s marked the emergence of HCI, usability, and interaction design disciplines. In addition, human-centered design, participatory design, and deep understanding of the users became more prominent in the design industry. Pertinent to the pervasiveness of software technologies, daily life products have later turned into connected systems. This made it hard to

consider the products' hardware and software aspects separately as the products' definitions, use context, and the situation of the users have changed. Furthermore, some products no longer existed as independent objects but as a point of delivery for services formerly performed by humans, such as automated teller machines (Heskett, 2005). Therefore, new ways of identification of design problems and new processes and methods for handling problems and innovations have ensued accordingly.

In the 1980s, Human-Computer Interaction (HCI) emerged as a computer science specialty, building on the knowledge base of cognitive sciences. Due to the increased use of microcomputers in the 1980s, usage scenarios and user types of computers expanded. Non-expert users, such as librarians, business executive assistants, bank clerks, etc., started using computers for different purposes. Subsequently, usability became a major problem (Shackel, 1997). The concept of usability encompasses both a quality attribute for evaluating ease of use and the methods employed for such assessment (Nielsen, 2012). Even though the earlier conceptions of usability which refers to the ease of use and learnability of software products (Shackel, 1997), recently it encompasses five essential components: learnability, which measures initial task ease; efficiency, assessing task speed; memorability, gauging reusability after a break; errors, evaluating mistake occurrence and recovery; and satisfaction, capturing overall user contentment and enjoyment (Nielsen, 2012). According to Koskinen et al. (2011), usability gained swift acceptance primarily due to its natural alignment with the established principles of ergonomics, a scientific and systematic field.

In contrast to the cognitive roots of HCI, the epistemology of HCI remarkably changed in the late 1980s by assimilating concepts from ethnomethodology along with the activity theory and distributed cognition (Carroll, 2010). Field studies replaced laboratory user studies, and collaborative interactions gained prominence over the single user in front of a PC situation. HCI later started to rely on social, cognitive, and computing sciences, with a heavy emphasis on design research, pragmatics, and aesthetics (Carroll, 2010).

Lucy Suchman and her colleagues at Xerox Palo Alto Research Center (PARC) advanced ethnographic research in software design in the late 1980s by studying human behavior around computers in the workplace (Otto & Smith, 2013). Plans and Situated Action (Suchman, 1987, as cited in Otto & Smith, 2013) was one of the first studies focusing on human-computer interactions by dealing with the relationships between design and anthropology. Suchman constructed workflows, plans, and situated action through extensive ethnographic research and demonstrated how cultural concepts influenced the design.

The ethnographically informed work of the Xerox PARC influenced an area known as computer-supported cooperative work (CSCW) (Koskinen et al., 2011; Otto & Smith, 2013). CSCW emerged in the 1980s and focused on how computers could be used to support collaborative work between individuals and groups. Researchers of CSCW applications (or, in other terms, "groupware" such as videoconferencing systems, collaborative authorship applications, etc.) explored how computer systems could be designed to facilitate communication and collaboration between users and how technology could be used to support distributed work (Grudin, 1994). According to Grudin (1988), CSCW applications commonly failed despite the significant investments made for their development. One of the reasons he put forward is the lack of understanding of the behaviors of groups and organizations and differences of individuals in natural settings; he suggested the contextual research of Whiteside, Bennett, and Holtzblatt (1987; as cited in Grudin, 1988) to understand the natural human behavior comprehensively.

Parallel to the developments of computer technologies, new journals of design research emerged throughout the 1980s into the 1990s for the development, articulation, and communication of design knowledge (Cross, 2007). According to one of the prominent design researchers, Nigel Cross (2007), design knowledge resides in three sources, namely people, processes, and products. People refer to studying designers and other people to understand designerly ways of knowing; processes refer to the study of design practices and processes to develop design methods and tools; products refer to the "study of the form and configuration of

artifacts" for understanding the embodied form, material, and finishing knowledge of the existing products for future reference (Cross, 2007, p48). His argument around design research does not refer to the integration of user knowledge into design.

Integration of ergonomics into the design is the root of human-centered design; however, the user-centered turn of the design profession happened in the 1990s (Koskinen, 2011). By the 2000s, the focus of the design was shifted from the sensory qualities of the physical products to the range of experiences the product enables for its users (Redström, 2005).

2.1.3 Summary

Even though the design discipline is inherently human-centered, designers have typically relied on their own intuition to address concerns about how an end user might interpret, interact with, and respond to designed artifacts (Strickler, 1999). Explicit efforts for the integration of human knowledge into the design can be marked by the integration of ergonomics knowledge. The integration of user knowledge into the design discipline has evolved through the influence of design practice, design research, developments in computer technologies, and other human research domains such as marketing, psychology, cognitive sciences, anthropology, and sociology. The recognition of user-centered design approaches in design practice, the establishment of design research as a field, the advancements in computer technologies, and different approaches to understanding human cognition and conduct have collectively driven the understanding and utilization of user perspectives in designing more user-centric solutions. This integration continues to evolve, with ongoing research and technological innovations further enriching the collaboration between designers and users for successful design outcomes.

Similar historical and theoretical accounts of transitions regarding the integration of user knowledge to design can be found in Chapter 3 of Melican's dissertation

(Melican, 2000), Sleeswijk Visser's dissertation (Sleeswijk Visser, 2009), and Chapter 2 of Töre Yargın's dissertation (Töre Yargın, 2013); this study focuses on the user experience research for the purposes of designing products and services.

2.2 Selecting User Research Methods

There is a vast array of methods and hybrid practices for understanding users, and the selection of user research methods depends on the project's goals, constraints, and flexibilities. For instance, a project that aims to improve the driving and work experience of bus drivers by identifying disruptive design opportunities without a restriction on the type of product would necessitate different kinds of user research methods than a project that aims to evaluate the usability of a new speedometer that is designed to motivate drivers to adhere to speed limits. This study is positioned similarly to the first type, therefore inquiring about the wider context of the users. Consequently, an attempt was made to comprehend different types of user research methods to guide the method selection.

Categorizing user research methods into discrete groups is challenging because the methods are influenced by developments in various research and practice domains, as previously stated. In addition, methods are modified by practitioners to achieve project goals therefore, there are many names for "idiosyncratic adaptations of standard methods" (Melican, 2000). For example, observing user behaviors in their natural environment can be called design ethnography, rapid ethnography, guerilla ethnography, shadowing, fly-on-the-wall, etc. Furthermore, practitioners may be unwilling to share the details of their methods for competitive advantage (Karat, 1996).

However, categorization can provide several advantages, including facilitating communication and collaboration among researchers, enabling the selection of appropriate methods for specific research questions, and providing a framework for

evaluating and comparing research results. For this reason, this section attempts to build a categorization to select appropriate methods for the rest of the study.

2.2.1 Type of Understanding

User research methods can be grouped based on the type of user understanding they provide. The type of understanding can be conceptual/procedural (Melican, 2000), attitudinal/behavioral (Martin & Hanington, 2012; Rohrer, 2022), and say/do/make (Sanders, 2001; Sleeswijk Visser et al., 2005).

Melican (2000) identifies two analytical perspectives, conceptual and procedural, that implicate selecting appropriate user research methods. By adopting a *conceptual* perspective, the researcher is set to inquire about users' beliefs, attitudes, motivations, and expectations by, i.e. interviewing them. By adopting a *procedural* perspective, the researcher is set to inquire about actions, reactions, and interactions of the user in a particular context by, i.e., observing them.

Some researchers and practitioners, including Martin & Hanington (2012) and Rohrer (2022), have differentiated between attitudinal and behavioral research methods reminiscent of the conceptual and procedural analytical perspectives of (Melican, 2000). *Attitudinal* methods refer to what people say, and *behavioral* methods refer to what people do. Some attitudinal methods are interviews, surveys, and focus groups; some behavioral methods are A/B testing and eye-tracking. Usability studies and field research, the two most common user research methods, are located between the two ends of this categorization, meaning that they reveal both attitudinal and behavioral knowledge (Rohrer, 2022).

In addition to the dichotomy of what users say versus what users do, Sanders (2001) introduces the notion of knowledge that can be gained from inquiring about what users make. According to Sanders (1992), attitudinal and behavioral methods have limited utility for discovering tacit and latent user needs. She structures levels of expression of user needs (Figure 2) and recommends a design research

framework to access what users say, do, and make simultaneously (Sanders, 2001). *Make* methods are a creative pursuit of user experiences, and they blur the distinction between research and design (Sanders, 1992). Building on levels of need expression, Sleeswijk Visser et al. (2005) identify user research techniques for accessing different need levels (Figure 3). According to their model, what people say reveals the explicit needs of the users and can be accessed with the help of interviews. What people do reveals observable needs and can be accessed by observations. What people know, feel, and dream reveals the deepest level of knowledge, tacit and latent user needs, and can only be accessed by generative methods. (See 2.2.3)

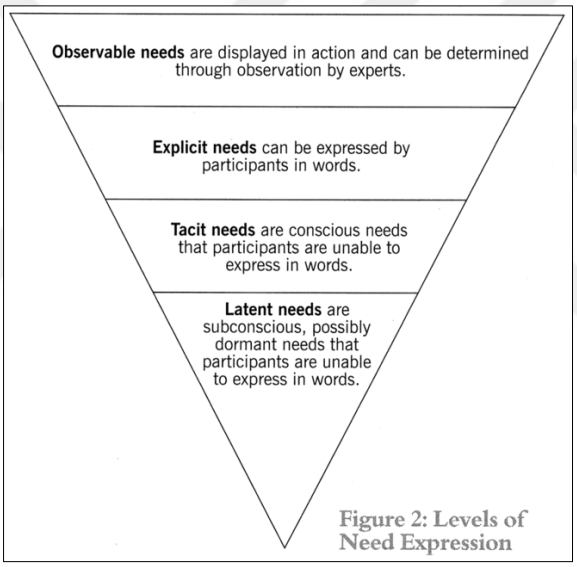


Figure 2 Levels of Need Expression by Sanders (1992)

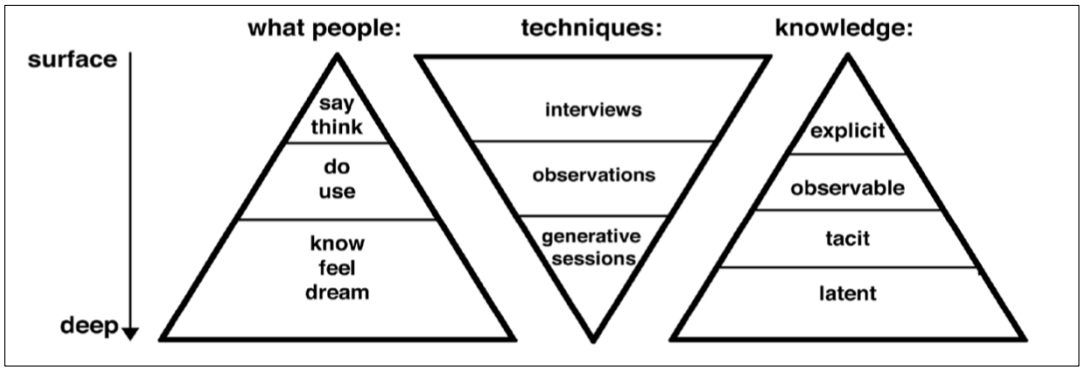


Figure 3 Different levels of needs in relation to user research methods by Sleeswijk Visser et al. (2005)

In a similar creative vein, a well-known design consultancy, IDEO, provides a set of methods for inquiring and incorporating user knowledge into design. Ask methods include engaging with users by asking them questions or by asking them to complete some tasks such as card sorting or keeping a photo journal. Look methods include observing people and their activities to focus on what users do rather than what they say. Try methods include creating simulations of user experiences, such as role-playing, for empathizing with users or prototyping design concepts for evaluation of the user experience. Learn methods are for analyzing the collected data to identify emerging themes and gleaning insights about the user experience.

2.2.2 Type of User Presence

Incorporating user knowledge into the design can be categorized based on the type of user presence in the project. Even though involving users in projects is generally considered direct contact with users (Kujala, 2003), projects may require a different type of user presence because of the lack of access to users, the danger posed to users, and time or other project restrictions, etc... as a result, user presence can be direct or indirect. Direct presence can be in the form of interviews, observations, usability testing, etc., for the specific purposes of a project. Indirect presence can incorporate previous user knowledge, approximations, or interpretations into the

project through expert reviews, user models, guidelines, standards, and analysis of the data traces users left behind.

Melican (2000) named types of direct user presence as the mode of data collection and identified three modes of data collection: observing, listening and discussing, and participating. According to him, there is an assumed range of positions of privilege in different modes. Observational user research tends to privilege the researcher, whereas participatory research privileges the user (Melican, 2000).

Martin & Hanington (2012) defined a range of direct and indirect user presence as participatory, observational, self-reporting, or expert review methods. Direct presence methods are categorized as participatory, observational, and self-reporting. Users are directly present in direct presence methods by creating artifacts, answering questions, or being the subject of observations. Some participatory methods are design workshops with users and collages users created. Some observational methods include a variety of field studies. Some self-reporting methods are interviews, photo studies, semantic differential, cognitive mapping, and cultural probes. Indirect presence methods are expert reviews and secondary research. Some expert review methods are ergonomic analysis, cognitive walkthrough, and heuristic analysis. Secondary research involves consulting previous user research (Martin & Hanington, 2012). Some methods, such as usability tests, card sorting, think-aloud protocol, and the Wizard of Oz technique, can be both observational and self-reporting.

In addition, Hasdoğan (1996) explained the role of user models in integrating user knowledge to design with both direct and indirect user presence. By conducting a field study with the designers in the UK, she categorizes user models utilized by designers as *empirical*, *experimental*, and scenario-based. Empirical models are based on collected data assumed to represent the user population of the product of interest. They include all the published material, tools, and software available to designers. Examples of empirical models include tabular information, templates, and anthropometric recommendations. The user presence in empirical models is

indirect for the specific projects. Experimental models refer to the evaluation of prototypes with users with direct user involvement or through the design team's experience with the user population. Evaluation can either be done with representative users or the designers acting out users' usage. Scenario-based models are based on storylines relating to users, usage, and the context of the product. Scenario building is argued to be the core activity in the design process and is done instinctively as part of design practice. Designers empathize with the users and write stories about how the design would be used; hence the user presence is indirect.

Another type of indirect user presence is cognitive models that are utilized for predicting user performance for novel screen-based product interactions. These models enable designers to consider the consequences of design choices and establish potential design approaches before receiving direct user feedback on a design. It is crucial that these models are based on prior analysis of users to ensure a certain level of confidence in their ability to represent users' cognitive processes and interactions accurately (User Experience Professionals Association, n.d.). However, Jorritsma et al. (2015) evaluated three well-known cognitive models, KLM (keystroke-level model), GOMS (goals, operators, methods, selection rules), and CogTool. They concluded that these models are not reliable tools on which to base a decision between multiple interface alternatives. In addition, according to Rogers (2004, as cited in Stolterman, 2008), almost none of the designers who evaluated the usefulness of methods for improving their practice reported using predictive methods, such as GOMS.

2.2.3 Design Process Activities

Activities within the design process refer to the aims towards which the user research knowledge is utilized. User research may be utilized to discover design opportunities, empathize with the users, define the project scope, and develop and evaluate design concepts. These activities can be mapped to the different phases of

the design process, such as opportunity identification is more likely to happen early in the design process, or the need for evaluating design concepts may seem more prevalent later in the process. However, there are two pitfalls to be mindful of in this conception. Firstly, the phrase “design process” implies a unity that does not exist in practice, and there are several design processes that may be applied to the vast array of design projects (Heskett, 2005). Secondly, even though the aims of different user research methods differ, methods can be applied differently to adjust to different aims. Furthermore, design processes are cyclical and iterative, and the need for different activities, i.e., opportunity identification or evaluation, may occur at any given time in the process. Therefore, categorizing user research methods based on the phases of the design process is prone to making false distinctions (Hanington, 2003). However, with these pitfalls in mind, this categorization has utility in deciding when the methods can be utilized, evidenced by his agreement with the phase-based categorization in their infamous book “Universal Methods of Design” (Martin & Hanington, 2012).

Research conducted during the initial stages of a design process is commonly referred to as generative, formative, or discovery research, distinct from evaluative or summative research, a type of research conducted in the later stages of a process (Hanington, 2003). Later, he increases the granularity of formative versus summative dichotomy and identifies a three-phase process as exploratory, generative, and evaluative (Hanington, 2007). Exploratory research involves conducting user and product studies to establish a knowledge base and develop empathy with users and products, especially when operating in unfamiliar domains. Generative research is a more targeted endeavor aimed at gaining a profound understanding of user needs and desires, as well as fostering concept development through participatory design activities. Evaluative research combines established methods to assess emerging design concepts in relation to user expectations. It is important to note that the sequence of research does not necessarily restrict the use of specific methods to particular phases. Instead, methods can be flexibly employed across different stages of research and design. Additionally, Figure 4 illustrates that

the research phases often overlap in terms of timing and methods rather than having distinct starting and ending points.

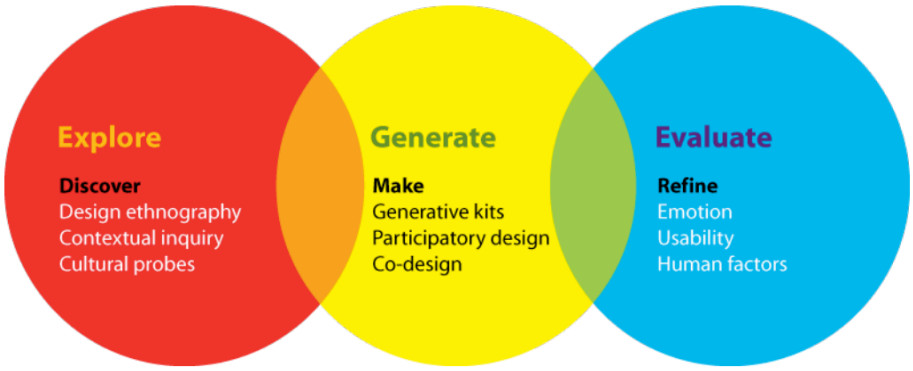


Figure 4 Design research phases (Hanington, 2007)

User models also play an important role throughout the design process for the integration of user knowledge (Hasdoğan, 1996). Empirical models can provide designers with data and information about the user population at the early stages of the design process. Experimental models can be used to test and evaluate design concepts with live users. Scenario-based models can help designers anticipate and plan for different usage scenarios, and user needs throughout the design process.

Squires & Byrne (2002) identify a three-phase process as discovery, definition, and evaluation. They identify sets of data collection and data analysis methods for each phase (Figure 5).

	Discovery	Definition	Evaluation
Data collection	• Contextual observation (tours, maps, inventories) • Focus groups • Open-ended interviews • Participant observation (active or passive) • Videography • Tracking	• Contextual observation (tours) • Directed and semi-structured interviews • Free-lists, ratings, rankings, definitions, explanations • Role-playing • Scenarios • Displacement research	• [Testing with] Product simulations • Usability tests • Surveys
Data analysis	• Categorical matrices • Time series analysis • Network mapping • Content analysis (text, audio, and video) • Semiotic analysis	• Categorical matrices • Concept mapping (multidimensional scaling and property fitting) • Activity flow diagramming • Decision modeling	• Standard inferential statistics • Scaling (Guttman, multidimensional scaling)

Figure 5 Phases of design process and corresponding methods (Squires & Byrne, 2002)

Rohrer (2022) from the Nielsen Norman Group combines the discovery and definition phases into a "strategize" phase and adds a "design" phase. In this categorization, users are included in some creative activities, such as participatory design and card sorting (Figure 6). His three-phase process of "strategize, design, launch & assess" is mapped to generative, formative, and summative research activities, respectively (Rohrer, 2022).

Product-Development Stage		
Strategize	Design	Launch & Assess
Research goal: Find new directions and opportunities	**Research goal:** Improve usability of design	**Research goal:** Measure product performance against itself or its competition
Generative research methods	Formative research methods	Summative research methods
Example methods		
Field studies, diary studies, interviews, surveys, participatory design, concept testing	Card sorting, tree testing, usability testing, remote testing (moderated and unmoderated)	Usability benchmarking, unmoderated UX testing, A/B testing, clickstream / analytics, surveys

Figure 6 Product development stages and research methods (Rohrer, 2022)

Farrell (2017) from the Nielsen Norman Group defines a four-phase process consisting of "discover, explore, test, and listen" (Figure 7). While this process includes the user in some creative activities, such as card sorting, users are

involved early in the process as subjects of inquiry to discover their problems and at various phases of the process as prototype evaluators.

Discover	• Field study • Diary study • User interview • Stakeholder interview • Requirements & constraints gathering
Explore	• Competitive analysis • Design review • Persona building • Task analysis • Journey mapping • Prototype feedback & testing (clickable or paper prototypes) • Write user stories • Card sorting
Test	• Qualitative usability testing (in-person or remote) • Benchmark testing • Accessibility evaluation
Listen	• Survey • Analytics review • Search-log analysis • Usability-bug review • Frequently-asked-questions (FAQ) review

Figure 7 Design process phases and research methods (Farrell, 2017)

The Design Council defines a four-phase double-diamond process of “discover, define, develop, and deliver” (Ball, 2019). Building on the double diamond process, Gama et al. (2022) inquire about the design methods used by software development teams. According to them, software development teams without a formal design background are familiar with and integrating user knowledge by

utilizing user research methods such as interviews, card sorting, Wizard of Oz, and user testing (Figure 8).

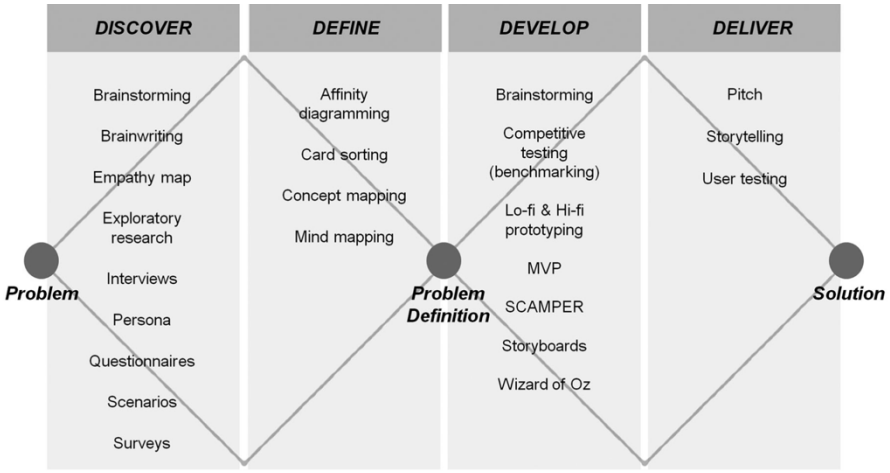


Figure 8 Double diamond process and research methods (Gama et al., 2022)

Stanford dschool defines a five-phase design thinking process consisting of "empathize, define, ideate, prototype, test." Design thinking is a human-centered and iterative process that starts with empathizing with the users, continues with defining problems, ideating on possible solutions, prototyping selected solutions, and testing the solutions. Even though these phases indicate an overall time dimension of a project, they are modes of thinking which occur iteratively. Since this process does not predicate any specific user research methods for its phases, and its emphasis is on user involvement and iteration, user knowledge can be incorporated with various methods throughout the process, as exemplified in Figure 9.

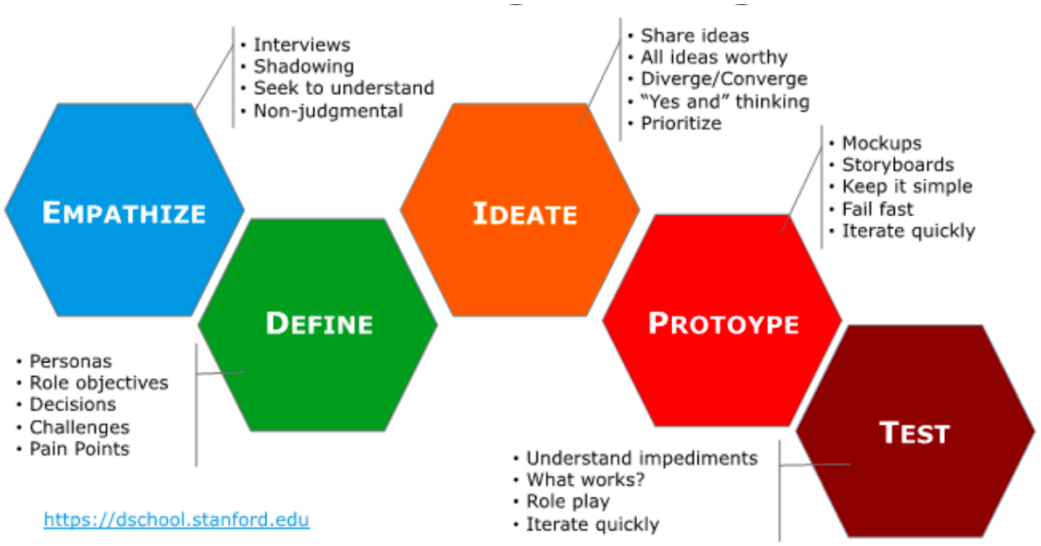


Figure 9 Stanford Design School design thinking process and user involvement strategies (Schmarzo, 2017)

Martin & Hanington (2012) define a five-phase process. The first phase, known as "planning, scoping, and definition," involves the exploration and establishment of project parameters. In the second phase, "exploration, synthesis, and design implications," immersive research and design ethnography are conducted, leading to implications that inform the design process. The third phase, "concept generation and early prototype iteration," encompasses participatory and generative design activities. In the fourth phase, "evaluation, refinement, and production," iterative testing and feedback are utilized to refine the design. Finally, the fifth phase, "launch and monitor," entails conducting quality assurance testing to ensure the design's readiness for the market and public use, as well as ongoing review and analysis for necessary adjustments. Not all methods in the book are user research methods per se; however, as the authors are proponents of human-centered design, all phases include methods enabling the integration of user knowledge directly or indirectly.

2.2.4 Origins of Methods

As mentioned before, the categorization of user research methods according to the phases of the design process can lead to false distinctions (Hanington, 2003). For this reason, Hanington (2003) categorizes user research methods based on their origins. According to this categorization, user research methods can be within a spectrum of traditional, adapted, or innovative. Traditional methods tend to be quantitative, whereas innovative methods tend to be more qualitative (Figure 10).

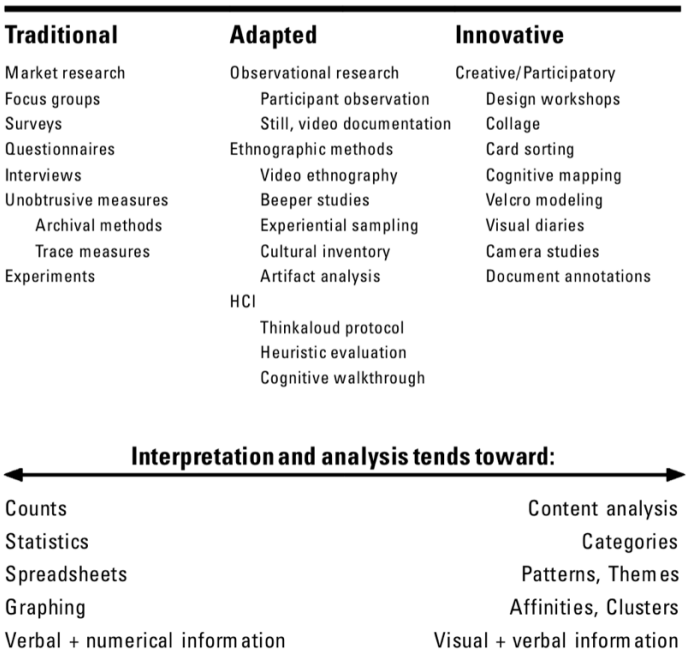


Figure 10 User research methods based on their domain origins (Hanington, 2003)

2.2.5 Type of Data

One of the key distinctions between user research methods is the qualitative and quantitative distinction which refers to the type of data the methods produce. Qualitative data refers to non-numerical data that is collected through methods such as interviews, observations, and open-ended questions. This type of data is often used to gain a deeper understanding of individuals' experiences and perceptions. Quantitative data refers to numerical data that can be measured or counted. It is

often collected through structured methods such as surveys or experiments and is analyzed using statistical methods. This type of data is often used to test hypotheses or to identify patterns and relationships among variables. One of the key differences between qualitative and quantitative methods is the role of the researcher; in quantitative research, the researcher and the research instruments are detached, whereas, in qualitative research, the researcher is the research instrument (Tracy, 2020). Since in qualitative research, the observations are registered and analyzed through the researcher's perspective, self-reflexivity about one's goals, tendencies, biases, and awareness about the possible effects of context on research findings becomes critically important.

On the other hand, qualitative user research has been acknowledged as a driving force behind innovative designs (Holtzblatt & Holtzblatt, 2014). Qualitative research has also been stressed as necessary for empathizing with users and inspiring designers to create more useful and enjoyable products (Fulton Suri, 2003; Kouprie & Sleeswijk Visser, 2009; Mattelmäki & Battarbee, 2002). As a result, designers tend to rely on qualitative observational methods that allow them to delve deep into their subjects and gain an understanding of how users perform their activities and how environmental factors come into play (Norman, 2013).

2.2.6 The Context of Product Use

While categorizing the user research methods, Rohrer (2022) distinguishes four types of the context of product use: natural, scripted, limited, and decontextualized (Figure 11). The goal of studying the natural use of a product is to minimize the impact of the study on user behavior or attitudes, allowing for a closer approximation of reality. However, this approach may result in reduced control over the topics studied. Conversely, scripted usage is employed to focus on specific aspects of the product, such as a newly redesigned feature of a known product. The degree of scripting may vary depending on the research objectives. Methods that suggest limited product use allow studying a specific or abstracted aspect of the

product experience. An example of limited use is card sorting the information architecture of a digital product. The type of studies where the product is not used are conducted to study user attitudes instead of usage or usability. Some examples are studying attitudes toward the brand or discovering the aesthetic attributes of a product.

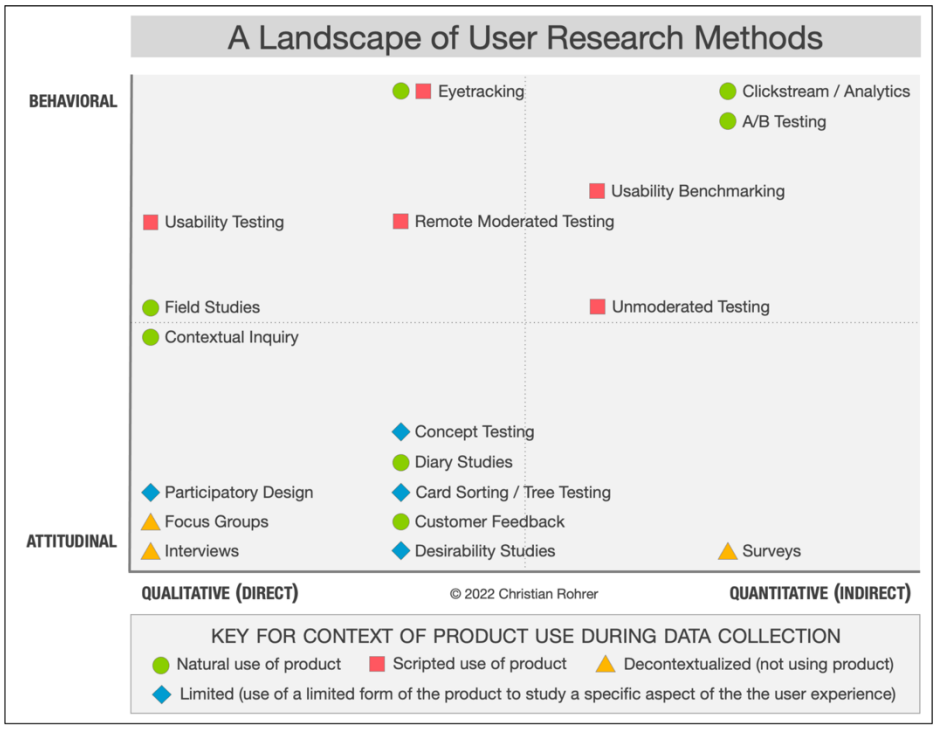


Figure 11 The categorization of user research methods by Rohrer (2022)

2.3 Communicating User Research

According to Töre Yargın (2013), a crucial decision for the communication of user research revolves around determining the extent of the designer's engagement with the observation and interpretation phases of user research. In her model of ways to achieve effective communication (Figure 12), designers can be excluded from or included in this observation and interpretation process. The exclusion of designers from this process refers to the situation where user research is conducted by other stakeholders instead of designers, such as outsourcing companies or dedicated user

research professionals within the same company. Even though the exclusion is not preferred by some of the designers, it might be the case when an outside opinion is deemed necessary or due to the division of labor. In the case of designer exclusion, prioritized findings, accompanied by statistical significance indicators, hold persuasive value for rationalizing choices to managerial stakeholders, as they can inform investment decisions. Likewise, design recommendations or illustrative cases in presenting findings serve as concrete evidence, enhancing the shareability of results with managers seeking empirical support. Therefore, the findings from the exclusion case act as the justification for design decisions while presenting to other project stakeholders.

On the other hand, the immersion of the designer in the observation and interpretation phases of user research inspires designers by enhancing empathy towards users. In the case of immersion, representativeness and interpretability of the way of communication come to the forefront. Information, in this case, needs to be multidimensional, in-depth, and credible and persuasive for designers. Immersion can be achieved by direct involvement of the designers in the observation and interpretation phases or by providing raw and qualitative data to designers, such as video recordings and transcriptions of user research.

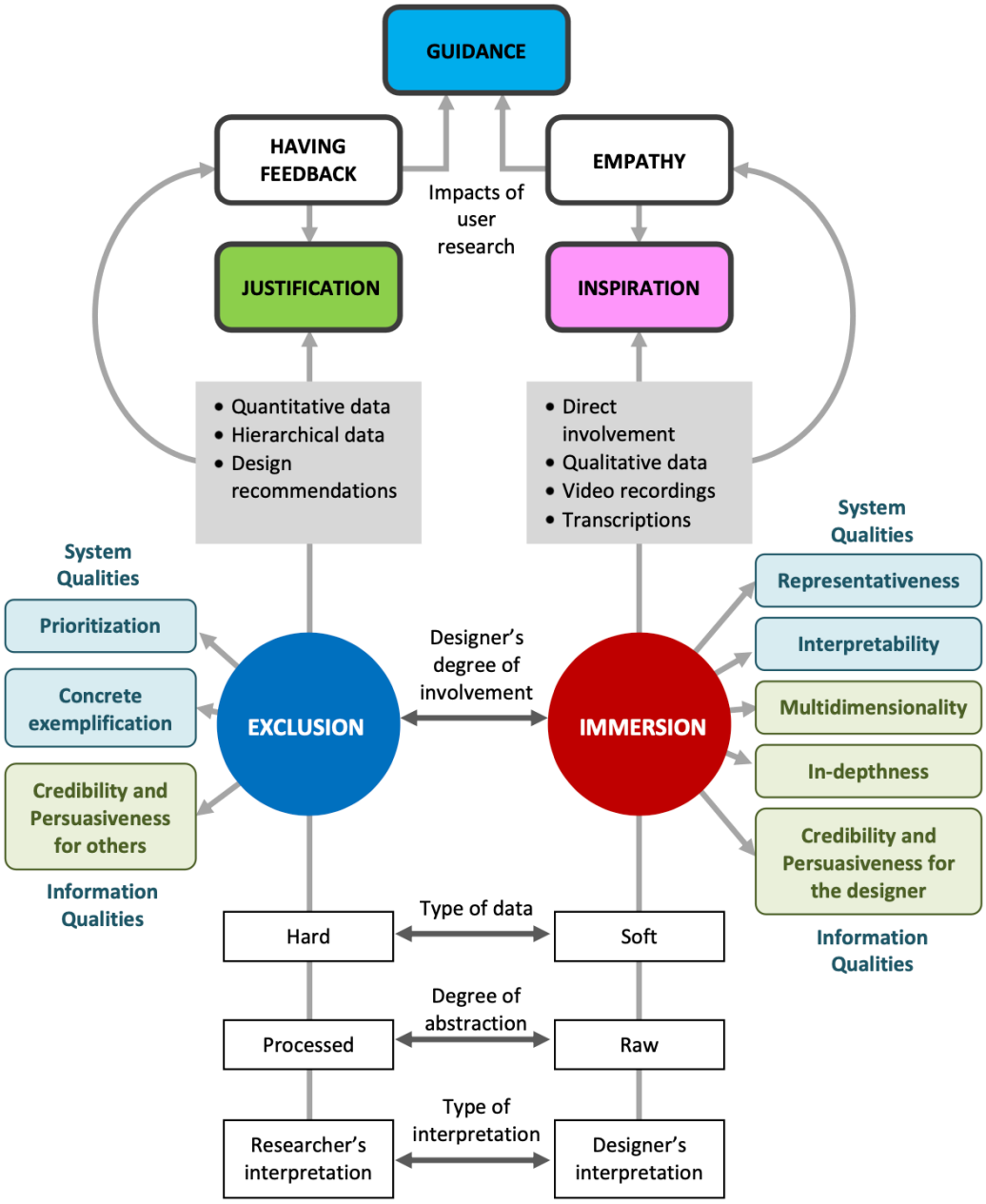


Figure 12 Model of ways to achieve effective user research communication (Töre Yargın, 2013).

2.4 Discussions About User Research and Design

This thesis follows Margolin's definition of the product (1997), considering both the material (hardware or physical products) and immaterial (software, graphical

user interfaces, tasks, etc.) elements as products. It also adopts Heskett's (2005) characterization of a design approach, which incorporates user behavior, connects hardware and software, and serves as strategic planning in designing complex systems.

By transcending the boundaries between hardware and software aspects of products and embracing a design approach that strategically addresses user needs, this chapter defines user research as a type of design research that historically emerged from the synergistic interactions between developments in the design, social, psychological, and cognitive domains, alongside technological advancements.

This thesis also recognizes innovative methods and empathy as essential sources for integrating user information into the design process. Innovative methods encompass not only established approaches like co-creation workshops, prototyping, and design thinking but also creative uses of traditional and adapted methods. Creative use of observational and ethnographic methods, artifact analysis, and other unobtrusive techniques can also serve as valuable sources of user knowledge. These approaches help uncover insights that traditional user research methods may overlook, leading to a more comprehensive understanding of user needs and preferences.

Moreover, empathy plays a crucial role in understanding and connecting with users on a deeper level. By empathizing with users and gaining a profound understanding of their motivations, needs, and aspirations, designers can develop user-centered solutions that resonate with users and enhance their overall experience. This emphasis on empathy aligns with the evolving nature of user research, which has shifted from a primary focus on improving the design process and defining design problems to encompassing a broader range of human experiences influenced by needs, emotions, and situational factors. This evolution reflects a deeper understanding of the importance of considering user perspectives in design.

CHAPTER 3

RESEARCH THROUGH DESIGN

As explained in the introduction chapter, research through design (RtD) is an approach to scholarly inquiry employing the process of designing and the development of design artifacts to produce insights and navigate "wicked problems" (Zimmerman et al., 2007). RtD is employed for designing a user research communication workshop in phase two of this study. The designed workshop was facilitated by design professionals in phase three of this study to construct knowledge about its utility. Literature about the knowledge construction in RtD informed the workshop's design and analysis process and the conclusions about the designed workshop. This chapter reviews the literature about knowledge construction in RtD to enable this purpose.

Since Frayling (1993) introduced the term, RtD has gained popularity in different fields, such as design (Boon et al., 2020; Godin & Zahedi, 2014), human-computer interaction (Zimmerman et al., 2007) and education (Edelson, 2002). This popularity, when combined with its flexible approach to knowledge inquiry, has opened up a wide variety of discussions concerning disparate aspects of RtD. The lack of a coherent understanding of RtD renders it problematic in terms of positioning it within the wider research community (Boon et al., 2020; Gaver, 2012; Godin & Zahedi, 2014; Koskinen et al., 2011; Stappers & Giaccardi, 2017; Zimmerman et al., 2007). For instance, Zimmerman et al. (2010) point out the expectations of HCI professionals from RtD and call for methodological and theoretical developments to become a more formalized research approach and permeate science-oriented domains such as HCI. Gaver (2012), on the other hand, suggests that the push to formalize RtD may be driven by particular ontological politics or power dynamics that prioritize scientific inquiry as the dominant or authoritative mode of knowledge production, therefore, encourages mindfulness

about such expectations as it may stifle the essence of RtD by robbing it of its prospects of rich knowledge contributions and challenging the status quo thinking. Discussing ontological politics, Forlizzi et al. (2011) highlight the frustration faced by design researchers, as they often encounter a lack of recognition and funding, which can be viewed as an outcome of ontological politics. The varying perspectives on rigor and quality between computer and social scientists and design researchers may result in favoring certain research approaches and methodologies, influencing the allocation of resources and opportunities within the research community. Finally, Stappers (2013) highlights the significance of aligning the role of RtD artifacts with well-established research methods, particularly in fields like psychology, to strategically enhance the likelihood of publishing research outcomes (on page 41). This expectation of alignment can be seen as a manifestation of ontological politics.

In an effort to position RtD within the wider research community, RtD is distinguished from research in natural sciences and/or research in humanities. Development of design knowledge is fundamentally different from scientific knowledge or knowledge about human behavior, which results in a lack of recognition of rigor and quality of RtD (Forlizzi et al., 2011). According to Bardzell et al. (2015), as opposed to the research in natural sciences, the purpose of RtD is not to introduce new factual information about the world but rather to enhance our ability to perceive and interpret the world more profoundly, similar to humanities. On the other hand, RtD aims to reach a future preferred state (Zimmerman & Forlizzi, 2008) as opposed to discovering the current states in natural sciences and humanities. In RtD, the creation of artifacts serves as a way to explore and understand alternative futures, uncover human needs and desires, and facilitate new insights (Zimmerman et al., 2007). RtD allows researchers to approach messy situations with unclear or even conflicting agendas, which are not well suited to other methods of inquiry (Zimmerman et al., 2007, 2010). As a result, RtD incorporates designerly ways of knowing, enabling exploratory inquiries while providing a viable alternative to “the rigid knowledge claims and

methods of science or the self-contained textuality of the humanities" (Brandt & Binder, 2007, p. 2).

In the following sections, aspects of RtD, such as artifacts and knowledge construction, will be explored. The relationships between the different aspects are intertwined; therefore, discussing them separately, such as discussing artifacts without touching upon knowledge or quality, is difficult (Boon et al., 2020). For descriptive purposes, these aspects are discussed separately, but it is crucial to acknowledge their interconnected nature, as they collectively contribute to the impact of RtD projects.

3.1 Roles of RtD Artifacts

Designing and prototyping the artifacts such as products, systems, space, or media play a central role in knowledge production in RtD; however, the act of designing and the roles of designed artifacts in RtD are distinguished from the design practice and commercial products (Koskinen et al., 2011). Transforming RtD artifacts into commercial products necessitates substantial resources from major global corporations, a feat that lies beyond the means of most researchers. Evaluating RtD solely based on its capacity to yield commercial products is unjust, particularly when dealing with "wicked problems" that extend beyond conventional solutions (Koskinen et al., 2011). According to Bardzell et al. (2015), a successful RtD artifact is a tool that assists in navigating and elucidating a perplexing problem space that aims to shed light on the intricate nuances of the design problem. The Artifact helps demarcate boundaries and articulate complexities within the problem space, providing meaningful understanding without enforcing rigid solutions. In addition, according to Fallman (2003), artifacts in RtD are designed to generate knowledge; therefore, the emphasis is on the generated knowledge instead of the final artifact. According to Stappers (2013), RtD prototypes can assume diverse roles, including confronting existing theories, confronting the world, stimulating

discussions and reflections, effecting changes in the world, and testing theoretical propositions. The principles behind each role are explained as follows:

1. **Confronting existing theories:**

Prototypes confront theories by moving beyond abstract concepts and translating theories into practical applications. Building a prototype demands engaging with real-world complexities resulting in complete solutions that satisfy multiple theories simultaneously. Additionally, prototypes in RtD encourage the integration of theories from various fields, as a single phenomenon in the world becomes the carrier for multiple perspectives and descriptions. By bridging the gap between theory and practice, prototypes facilitate the creation of cross-disciplinary links (Stappers, 2013).

2. **Confronting the world**

This principle involves moving from theoretical propositions to practical realization. While the previous function may occur before the prototype is functional, this function aligns with the essential tenets of empirical research; irrespective of the theoretical claims about the prototype's characteristics, this function demands that researchers make concrete decisions for the realization and testing of the prototype. This transition from abstract theory to concrete instantiation reveals intricate details and nuances that often remain unaddressed in the realm of experimental literature (Stappers, 2013).

3. **Stimulating discussions and reflections**

Unlike the previous principles that can be pursued by researchers working in solitude or within a studio setting, evoking discussion and reflection involve engaging with other minds and eliciting collective responses. Interactive and participatory engagement with prototypes fosters a dynamic exchange of ideas, knowledge, and perspectives among researchers and stakeholders. Consequently, this role concerns not only the generation or validation of the knowledge but also the communication of it (Stappers, 2013).

4. **Influencing changes in the world**

At its core, this principle revolves around the transformative potential of prototypes in envisioning and exploring possible futures and aligns closely with action research approaches. By introducing prototypes as interventions or as vehicles for effecting change and improvement in specific domains, researchers can better comprehend the dynamics of change in existing practices and environments (Stappers, 2013).

5. **Testing theoretical propositions**

This principle aligns with the traditional experimental approach in which the prototype acts as the embodiment of a hypothesis and designing acts as producing stimuli for an experiment. By creating prototypes that represent and realize the proposed theories, researchers can conduct empirical investigations to validate or challenge their assumptions. This principle is particularly compatible with well-established research methods in fields like psychology, making it easier to publish research outcomes (Stappers, 2013).

6. **Prototypes as the carriers of knowledge**

Stappers (2013) acknowledges the notion of prototypes as carriers of knowledge. However, he emphasizes that prototypes do not inherently make scientific statements on their own. Their ability to convey knowledge depends on how they are framed within existing knowledge and interpreted in a specific context. For prototypes to effectively communicate knowledge, researchers must explicitly clarify the interpretative process and the underlying knowledge framework. This notion seems to build on his expectations of scientific knowledge construction from RtD.

Conversely, Gaver (2012) emphasizes the irreducibility of prototypes by building on Nelson & Stolterman's (2012) notion of "ultimate particulars" (See 3.2). Gaver (2012) highlights that prototypes are vital for design theory because artifacts embody the numerous decisions made by designers with a level of specificity and

detail that would be challenging or even impossible to achieve through written or diagrammatic descriptions. In a similar vein, according to Stolterman & Wiberg (2010), certain knowledge transcends the confines of traditional textual or other formats of research outcomes in design; instead, it necessitates embodiment in artifacts. These artifacts assume a pivotal role in theorization, acting as vessels for knowledge that can be materialized only as emergent characteristics of the entirety of the artifact. With an emphasis on the irreducibility of RtD artifacts, Gaver (2012) and Stolterman & Wiberg (2010) seem to be challenging the notion of the primacy of knowledge over artifacts in RtD, as suggested by Stappers (2013) and Fallman (2003). That being said, Gaver (2012) proposes the use of annotated portfolios (See 3.2) in RtD to offer explanations of design choices, decision-making, and theoretical considerations, enriching artifact presentations and enhancing knowledge communication. However, annotated portfolios serve to complement the artifacts, providing support without replacing the knowledge they embody.

3.2 RtD Knowledge

RtD, as an inquiry revolving around designing products, services, environments, or systems, yields implicit knowledge that primarily resides within the resulting artifact (Stolterman & Wiberg, 2010; Zimmerman et al., 2010). In addition, Forlizzi et al. (2009) identify RtD knowledge as knowledge gained through designerly activities to improve design practice. Consequently, many researchers view design methods as the most prominent outcome of RtD; therefore, it is argued that its full potential for greater impact remains untapped (Zimmerman et al., 2010). RtD generates various types of design knowledge, encompassing conceptual frameworks, guiding philosophies for design, and supportive methods to facilitate these frameworks and guiding philosophies. RtD can also lead to new perspectives for framing problems that propose preferred states for the situation at hand and new

product forms that broaden the design space (Forlizzi et al., 2009). Some forms of and models for knowledge construction in the literature are explained as follows.

3.2.1 Design Patterns

The notion of pattern language was initially developed in architecture and urban planning by Christopher Alexander (1977). A pattern language consists of design patterns that describe specific problems, their contexts, and proven solutions, making it a versatile tool for guiding the design process. He provides 253 patterns to guide the design of towns, buildings, and constructions. An example of a building pattern is “secret place (Pattern 204).” Secret place suggests creating a small, locked, and secret place in the home to fulfill the human need for privacy and intimacy. This hidden space allows individuals to keep precious belongings and memories, only revealing them selectively to trusted individuals, adding a sense of mystery and personal connection to the home (Figure 13).

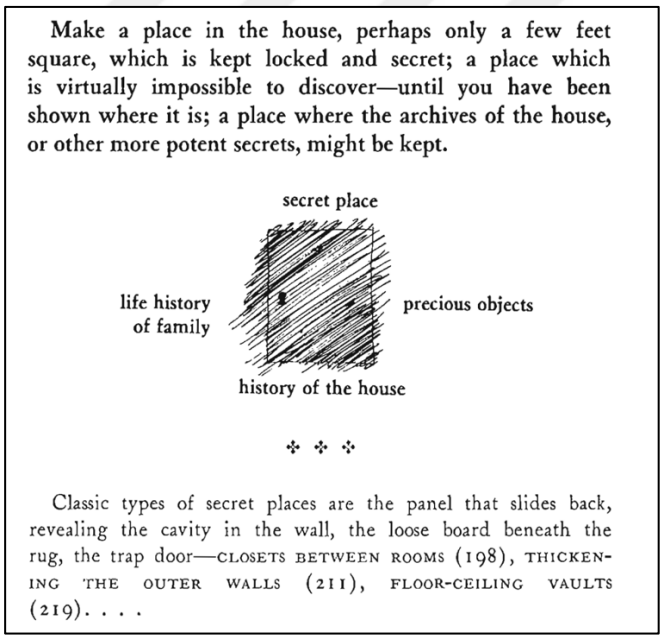


Figure 13 Alexander's pattern number 204 (Alexander, 1977)

Pattern languages have found applications in other domains, including user experience design. In their work about communicating user research findings to

designers, Chung et al. (2004) define design patterns as “a format for capturing and sharing design knowledge” (p.1) and introduce the concept of pre-patterns for guiding design. Unlike fully developed patterns, pre-patterns (Figure 14) serve as initial design concepts that can potentially evolve into comprehensive patterns within a pattern language. Zimmerman et al. (2007) highlight the significance of pre-patterns by indicating their potential as plausible outcomes of RtD.

D5 • SERENDIPITY IN EXPLORATION



Figure 1. Design for serendipity when users want to be spontaneous.

• BACKGROUND

An example of KEEPING USERS IN CONTROL (D4), serendipity in exploration is often used in touring and guidance applications, where services like USER-CREATED CONTENT (B4), and FIND A FRIEND (B6) can enhance such services.

• PROBLEM

Some people enjoy directed tours, but others like to just explore freely. Applications that are constrained to pre-determined courses may make people feel that they are not in control and end up being frustrated.

• SOLUTION

Design your applications to be flexible and controllable. Allow users to be spontaneous in their decisions. They may sometimes wish to end up in a specific location but want to be flexible in the path they take to get there.

For example, rather than providing an omniscient overhead map, a conceptual design called the (De)Tour Guide lets people discover districts and landmarks "only upon approach, as if by chance." It also lets people "get lost on purpose, or to follow the idiosyncratic paths of unusual strangers."

Another way of designing for serendipity is to empower users with USER-CREATED CONTENT (B4). Rather than being just consumers of content, they can also be creators of TOPICAL INFORMATION (B2).

• REFERENCES

Kaasinen, E. (2003). "User needs for location-aware mobile services." *Personal Ubiquitous Computing* **7**: 70–79.

Figure 14 A pre-pattern from Chung et al. (2004)

3.2.2 Ultimate Particulars

Ultimate particular is a design concept that refers to the outcome of design, which is the convergence of individual judgments, intentions, and actions of the designer manifested in a specific and concrete form (Nelson & Stolterman, 2012). Ultimate particular stands in contrast to abstract universal truths (Figure 15) and is considered a valid knowledge outcome of RtD (Gaver, 2012; Zimmerman & Forlizzi, 2008).

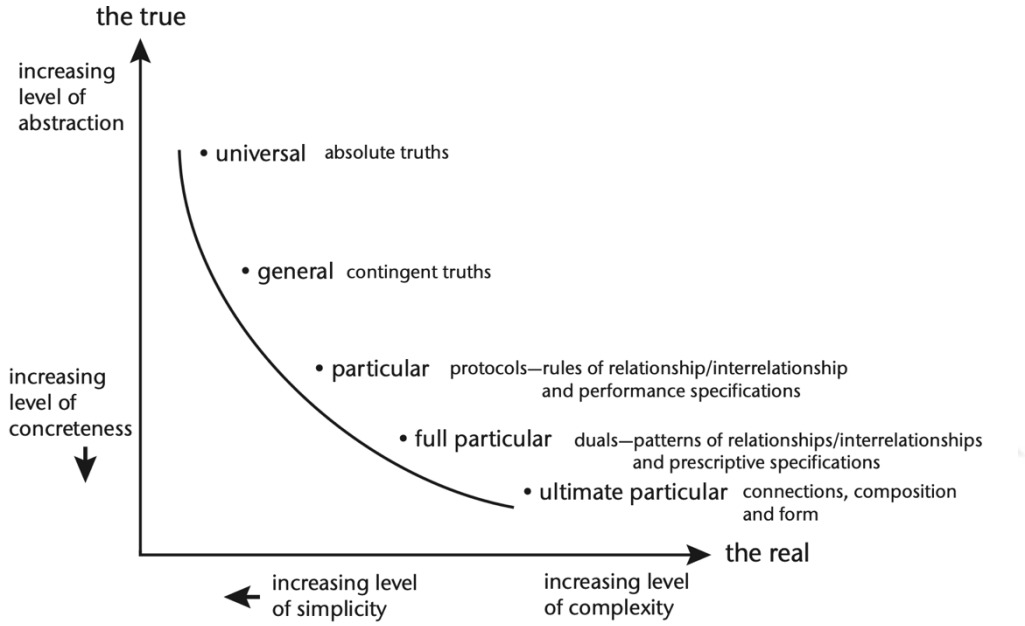


Figure 15 From universal to ultimate particular by Nelson & Stolterman (2012)

According to Nelson & Stolterman (2012), there are different cultures of inquiry and action, such as science, art, and religion, that lead to knowledge. They consider design as a new culture of inquiry and action. In an attempt to distinguish the knowledge and actions produced by design from the other cultures, they identify three modes of inquiry, namely the inquiry of *the real*, *the true*, and *the ideal,* and identify that design is a compound of three modes of inquiry (Figure 16).

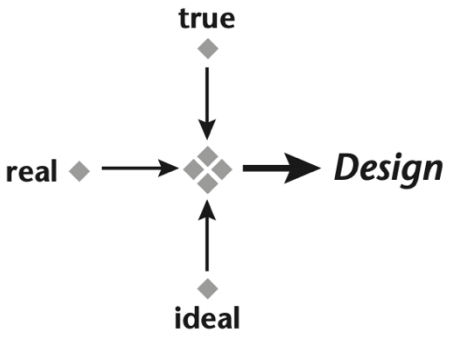


Figure 16 Design as a compound inquiry (Nelson & Stolterman, 2012)

The true originates from accurate descriptions and controlled observation, while the real results from specific actions, judgments, and intentions. The distinction between what is true and what is real is illustrated through examples: a painting by Cézanne is real, while the atomic weight of copper is true; an experience is real, but a scientific theory is true; an organization is real, but a proven principle or law is true. Decision-making and actions in design must encompass both the true and the real for effective outcomes, necessitating a balance rather than a compromise. The inquiry of the ideal, on the other hand, pertains to the exploration of norms and values, often concerning how the world "ought" to be based on any idealistic system such as religion. The ideal manifests itself as the desirable outcome in design, which cannot be fully realized in reality. However, reasonable approximations of the design ideal, that is, the desirable outcome, can be achieved. Thus, design involves striving to create the closest possible approximations to these ideals.

The mode of inquiry known as "the true," which is aligned with the scientific culture of inquiry and action, is often advocated as the superior mode, regardless of the contexts or requirements (Nelson & Stolterman, 2012). However, in human endeavors, optimal choices and suitable actions stem from a blend of modes beyond “the true.” Neglecting this can result in becoming stuck in unproductive cycles of excessive analysis and fixation on values in some contexts. In light of this situation, design decisions and actions that are founded not just on “the true” but

also on “the real” and “the ideal” are valid forms of inquiry (Nelson & Stolterman, 2012), and ultimate particulars have “the same dignity and importance as truth in science” (Stolterman, 2008, p. 59).

3.2.3 Theory on design vs. Theory for design

Zimmerman et al. (2010) conducted a study that is a combination of a literature review, interviews with 12 leading design researchers, and the examination of RtD examples. As a result, they identified knowledge types produced with RtD as *theory on design* and *theory for design.* Theory on design emerges from studying the design process, creating knowledge about how and why people design, aiming to comprehend the fundamental aspects of human design activity rather than directly enhancing design practice. In a similar vein, Donald Schön’s work on reflective practice aligns with this notion of theory on design due to its multifaceted contributions. Schön's exploration of how designers acquire insights from their actions and design artifacts, utilizing reflection-in-action and reflection-on-action to refine their methods, mirrors the essence of theory on design (Zimmerman et al., 2010). Schön’s framework not only fosters a profound understanding of the intricacies of design as a human endeavor but also underscores the significance of tacit knowledge, intuition, and artistic expression in the design realm. Additionally, Schön's perspective challenges the prevailing view of design as a linear, analytical problem-solving procedure. Instead, it introduces an alternative paradigm that characterizes design as a dynamic discourse with the contextual milieu. Furthermore, Schön's work contributes substantially to the development of a design epistemology, tailoring a theory of knowledge specifically suited to the distinctive demands of the design field (Zimmerman et al., 2010).

On the other hand, theory for design involves developing knowledge to improve design practice. This kind of theory takes several forms: conceptual frameworks, which often take the form of applying knowledge from the human science disciplines and applying it to design; guiding philosophies, which take the form of

sensitizing concepts to help direct designers and researchers in solving design problems; implications for design that result from inquiry into wicked problems; and design implications and design patterns, arising from the analysis of designed artifacts (Zimmerman et al., 2010). As described above, Alexander's(1977) design patterns fit in the definition of theory for design that is produced with RtD.

3.2.4 Implicit Artifact Knowledge vs. Annotated Portfolios

As mentioned before on page 42, Gaver (2012) suggests accompanying RtD artifacts with annotations as a way of enriching the presentation of irreducible knowledge of RtD artifacts since the fundamental achievement of RtD is regarded as these artifacts. The significance of RtD lies in its ability to generate novel realities in the form of artifacts, with its theory serving as annotations. In Gaver's (2012) exploration of implicit theories embodied in objects, four distinct types come to light. The first type encompasses *philosophical theories*, delving into the fundamental values and principles that designs should serve. The second type, *functional theories*, revolves around the practical aspects of design, investigating how intended values and principles are achieved through interactions with the artifact, focusing on functionality and usability. *Social theories*, the third type, consider the characteristics and behaviors of the artifact's users, understanding the social context and its impact on design. Finally, *aesthetic theories*, the fourth type, pertain to the form and appearance of the designed object, ensuring its alignment with the intended context and aesthetics. Collectively, these implicit theories shape the meaning, functionality, user experience, and aesthetics of the design, enriching the overall understanding of the artifact's role and significance.

Annotated portfolios (Figure 17), on the other hand, share similarities with Alexander's (1977) design patterns as they present textual knowledge about designed artifacts. However, annotated portfolios diverge by deliberately avoiding the generalization of principles; instead, they maintain the particularity of the artifacts while expressing connecting and differentiating ideas between different

artifacts. Combining designs with annotations facilitates a better understanding of the conceptual aspects of designs while also linking them to specific design manifestations, thereby providing a solid foundation and definition for theoretical concepts (Gaver, 2012). In addition, Gaver suggests that the knowledge produced with research through design is provisional, contingent, and aspirational. This means that the knowledge is temporary and subject to change, dependent on other future events or unforeseen causes, and based on imagined or desired realities. In other words, the knowledge produced through research through design is not fixed or definite but rather is constantly evolving and adapting to new circumstances and aspirations. This reflects the nature of design as a creative and generative process that is always in flux and open to new possibilities. The knowledge produced with research through design is not only descriptive or explanatory but also creative and visionary. It is not only useful or practical but also inspiring and provocative. In other words, the knowledge produced with research through design is not only about "what is" but also about "what if."



Figure 17 A sketch of an annotated portfolio from Gaver (2012)

3.2.5 Conceptual Constructs

According to Stolterman & Wiberg (2010), conceptual constructs are abstract ideas or mental models that represent a phenomenon or combination of theories in human-computer interactions. They are more specific and focused than general concepts such as user experience, interaction, or usability, and they integrate individual theoretical concepts into new combinations that reflect earlier findings and new insights. Similar to intermediate-level knowledge below, they mediate between practical design guidelines that emerged from hands-on design activities and grand theories imported from social or behavioral sciences.

Conceptual constructs are manifested in artifacts, and the artifacts serve as real-world representations of the conceptual constructs, allowing researchers to investigate and understand the practical implications of these abstract ideas. Some examples of conceptual constructs include *Tangible user interfaces* (*TUIs*), *Embodied Interaction*, and *Social Computing*. TUIs refer to a new way of designing and interacting with digital information. The key feature of TUIs is that they allow users to manipulate digital information through physical actions, such as grasping, moving, or rotating objects, rather than through traditional input methods like keyboards or mice. This creates a more direct and intuitive connection between the user and the digital information, making it easier for users to understand and interact with complex data. Embodied interaction refers to the idea that interaction with digital information is not just a cognitive activity but also involves the body and the physical environment. It is manifested in artifacts such as gesture-based interfaces and augmented reality systems that allow users to interact with digital information in a more natural and intuitive way. Social computing refers to the use of computational systems to support social interactions and collaboration. It is manifested in artifacts such as social networking platforms, collaborative editing tools, and online communities that enable users to connect, communicate, and collaborate with others.

To develop conceptual constructs, Stolterman & Wiberg (2010) propose an RtD process model (Figure 18) that consists of two cycles: the theory-oriented cycle and the design-centered cycle. In the theory-oriented cycle, the researcher starts with a theoretical idea or concept related to interaction and then designs and creates an artifact that embodies and manifests this concept in a concrete design. In the design-centered cycle, the researcher starts with a use situation or a user problem and then conducts user studies, literature reviews, or scenario analysis to understand the situation and the user needs. Based on this understanding, the researcher designs and creates a novel artifact that addresses the situation and the user needs. The researcher can move back and forth between these two cycles, depending on the research question, purpose, and outcome. Both cycles involve internal and external critique, meaning that the researcher has to reflect on their own assumptions, choices, and results and seek feedback from other researchers, users, or stakeholders. Both cycles also involve contextualization, which means that the researcher has to situate their research within the existing body of knowledge and practice in the field of interaction design.

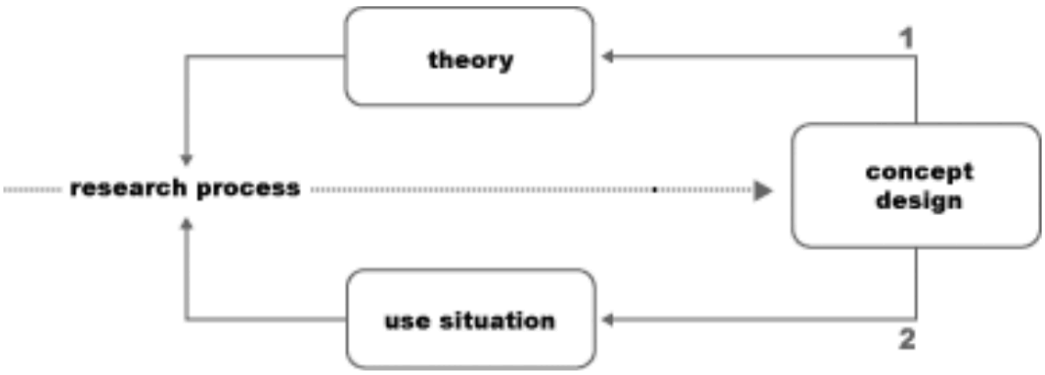


Figure 18 RtD process model proposed by Stolterman & Wiberg (2010)

3.2.6 Intermediate-level Knowledge and Strong Concepts

In examining RtD knowledge, Höök & Löwgren (2012) observe that knowledge construction primarily revolves around designing innovative interactions and

evaluating them through empirical user studies. This approach serves dual objectives: presenting specific examples of innovative designs and contributing to a broader comprehension of human-computer interaction. Consequently, RtD predominantly generates knowledge at the levels of individual cases and general theories. According to Höök & Löwgren (2012), RtD also offers opportunities for the construction of knowledge that falls between these levels. This intermediate-level knowledge, which is more abstract than individual cases but does not seek the generality of a theory, is referred to as intermediate-level knowledge. They illustrate this concept by presenting an abstraction continuum for RtD knowledge, positioning particular instances and abstract theories at two extremes, with intermediate-level knowledge residing in between (Figure 19). Within this intermediate space, they identify generative and evaluative types of knowledge. Generative intermediate-level knowledge, such as design patterns, guidelines, annotated portfolios, methods, and tools, plays a direct role in creating new designs, whereas evaluative intermediate-level knowledge, such as experiential qualities, design heuristics, and criticism, helps to evaluate new designs. The notions of generative and evaluative modes are presented as an analytical distinction; their boundaries are indistinct in practice. For example, certain qualities used for design evaluation can also inspire ideas and direct the design process or vice versa (Hagen, 2011, as cited in Höök & Löwgren, 2012).

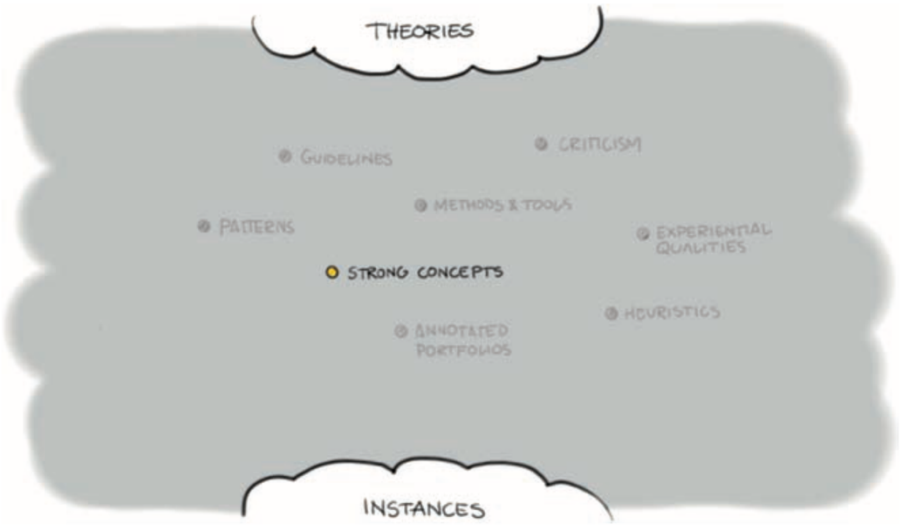


Figure 19 Landscape of intermediate-level knowledge by Höök & Löwgren (2012)

Generative knowledge, as discussed by Lichtenstein (2000) in his reflection on Don Schön's research, emerges and evolves through active engagement with complex situations and ongoing processes of reflection-in-action. The generative knowledge framework encourages practitioners to continually reshape their understanding and practice in response to uncertainties, value conflicts, and novel phenomena. Rather than viewing knowledge as separate from action, this approach recognizes that meaningful understanding is intimately tied to the unfolding process of engaging with the world. By reflecting on their experiences and surfacing implicit understandings, practitioners can generate new insights and adapt their approaches to address emerging challenges and opportunities.

In addition to describing generative intermediate-level knowledge, Höök & Löwgren (2012) also introduce another type of generative intermediate-level knowledge named “strong concepts,” which are characterized by their focus on interactive aspects of designs rather than their static appearance. These concepts are a part of the human-technology interface in the form of design elements of the artifacts that denote usage patterns and behaviors that emerge over time. Furthermore, strong concepts encapsulate core design ideas that hold potential applicability across diverse use situations and even across various application

domains. Operating at an abstraction level above particular instances, they can be flexibly utilized in different ways during concept design or design detailing. For example, *social navigation* is a strong concept in interaction design that involves making decisions based on the choices and actions of others in similar situations. Instances of social navigation include anonymous recommender systems such as product reviews of purchasers on e-commerce websites, digital footprints users left in virtual information spaces such as likes, comments, and shares on social media platforms, and location-sharing features of online maps to share one's location and navigate the physical world (Höök & Löwgren, 2012). Through social navigation, users leverage the experiences and decisions of others to inform their own choices and interactions, creating an interactive and social approach to decision-making.

3.2.7 Bridging Concepts

Bridging concepts is a particular form of intermediary knowledge that claims accountability to both theory and practice and is composed of three constituents: a theoretical grounding, a series of design articulations, and a set of exemplars. (Dalsgaard & Dindler, 2014). A theoretical grounding is the foundation of a bridging concept based on one or more existing theories (e.g., pragmatist philosophy) or frameworks (e.g., Deweyan notion of conflict) that inform and inspire the concept. It provides the rationale and the context for the concept, as well as its potential implications and applications. A series of design articulations are "the parameters that are important in expressing the qualities of a concept" (Krogh & Petersen, 2009, as cited in Dalsgaard & Dindler, 2014, p. 1638). They help designers understand and manipulate the concept, as well as evaluate its effectiveness and suitability for different situations and purposes. A set of exemplars are concrete instances that illustrate how a bridging concept can be realized in practice. Exemplars show the range and diversity of the concept, as well as its strengths and limitations. They also serve as sources of inspiration and

evaluation for designers who wish to employ or develop the concept further (Dalsgaard & Dindler, 2014).

According to Dalsgaard & Dindler (2014), bridging concepts facilitate bidirectional exchange between theory and practice, contrasting conceptual constructs (Stolterman & Wiberg, 2010), and strong concepts (Höök & Löwgren, 2012) (Figure 20). Bridging concepts can emerge from both theory and practice, often through continuous explorations. Unlike strong concepts by Höök & Löwgren (2012), which primarily draw knowledge from particular design instances, bridging concepts bridge the theory-practice gap by being rooted in both realms. While similar to Stolterman & Wiberg's (2010) conceptual constructs, bridging concepts diverge in their dual focus on inspiring design practice while advancing theoretical understanding. The label "bridging" signifies their role in linking theory with design practice, grounding them in real-world issues while also incorporating theory. Bridging concepts, despite being akin to conceptual constructs and strong concepts, is considered to occupy a complementary niche between theories and particular design instances, expanding the spectrum of intermediary knowledge (Figure 21).

	Conceptual constructs	Strong concepts	Bridging concepts
Primary origins	Theory	Design cases	Inspired by exemplars as well as theory
Primary intent	Theoretical advancements	Informing design practice	Facilitating exchange between theory and practice

Figure 20 Comparison of bridging concepts, conceptual constructs, and strong concepts (Dalsgaard & Dindler, 2014)

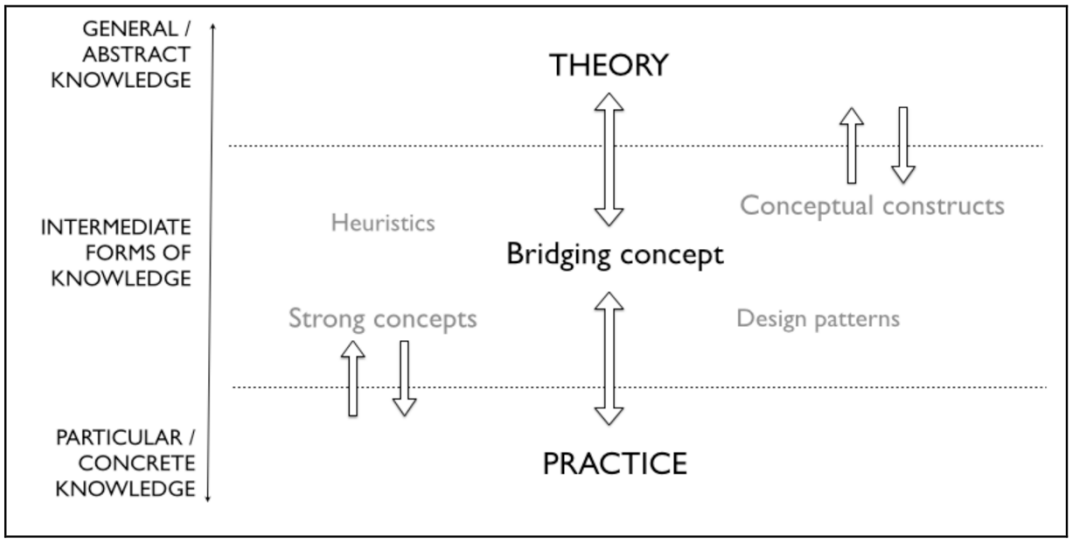


Figure 21 The knowledge range between general theories and particular design instances (Dalsgaard & Dindler, 2014)

3.2.8 Critique of Design Artifacts

In Forlizzi et al.'s (2011) perspective, criticism plays a vital role in various knowledge domains, including design. It involves expert-subjective interpretations, classifications, and evaluations based on informed and rigorous reasoning. As criticism relies on disciplinary subjectivity, which is domain-specific and experienced, it is typically not integrated into scientific epistemologies, which prioritize objectivity and neutrality. Forlizzi et al. (2011) suggest that embracing the subjectivity of criticism can be advantageous in describing decisions and judgments made throughout the RtD process, hence supporting knowledge construction via RtD.

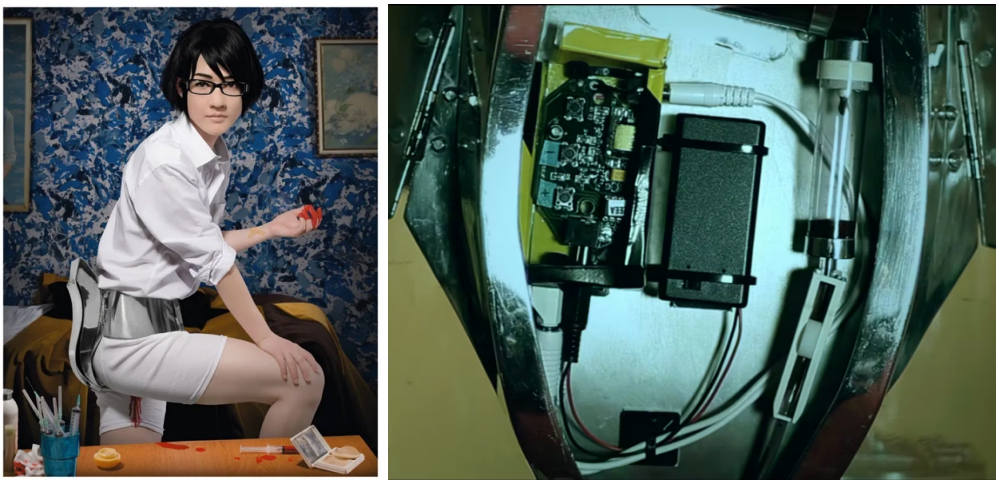


Figure 22 "Menstruation Machine" by Sputniko! As cited in Bardzell et al. (2015)

Bardzell et al. (2015) exemplify the construction of RtD knowledge through criticism by providing a critical analysis of a design fiction project named Menstruation Machine (MM) (Figure 22). Created by Sputniko! as an MFA graduation project from the Royal College of Art, the device is a metal chastity belt-like apparatus that simulates menstruation for its wearer. Accompanied by a 3-minute music video and a designer statement, the project challenges conventional perceptions of gender, examines the cultural significance of menstruation, and delves into the desire to experience different perspectives.

Bardzell et al. (2015) first discuss the functionalist interpretation of MM and its limitations. The functionalist interpretation suggests that the device helps men empathize with women concerning menstruation and, in turn, questions its ability and limitations to simulate the real experience of menstruating for men. The functionalist reading of electronic devices also suggests that they are primarily functional, solve problems, reinforce social norms such as gender, and do not offer cultural commentary. This is a very limiting view of an artifact's power, and if we aim for RtD to have an impact on the research community, the community will need to improve its approach collectively. Bardzell et al. (2015) exemplify this improvement by explicating how MM proposes alternative understandings of menstruation, hence produces knowledge. The authors identify some knowledge

claims that MM embodies, such as *menstruation as a design material*, *a desirable experience* that *can be simulated with a device*, *a physiological event*, and *a gendered phenomenon*. The authors glean these propositions either directly from the designer's statement and video or by explicating project artifacts. For instance, the designer explicitly states that she wanted to illustrate how technology does not necessarily evolve fairly and contrasts the approval processes of drugs for birth control versus erectile dysfunction. Therefore, part of the design's impact is that it normalizes a sexually marginalized position and encourages designers to imagine design problem spaces from the perspective of those who are sexually or otherwise marginalized. The authors frame this statement as a proposition: *Technological innovation is regressively gendered*. They conclude that MM is a complex and polysemous object that offers multiple perspectives and interpretations for design research. Therefore, it is a missed opportunity in terms of knowledge construction via RtD to evaluate MM on the grounds of its functionality.

Regarding criticism's role in RtD knowledge construction, Bardzell et al. (2015) titled their article on the subject "immodest proposals" that refers to Swift's satirical essay "A Modest Proposal." The essay suggested eating poor children as a solution to the poverty and overpopulation problems in Ireland and aimed to ridicule the English government and elites for their indifference and rationalism regarding Irish suffering (Kuiper et al., 2023). "A modest proposal" now signifies audacious suggestions to provoke reactions or reveal hypocrisy. These notions underscore how particular approaches to improving society, without scrutinizing the power dynamics underlying its injustices, contributed in tandem with those injustices to the resultant suffering (Weber, 2020). By referring to Swift, Bardzell et al. (2015) emphasize the importance of investigating the relationships among technology, design, gender, taboo, and the body, without oversimplifying these matters into universal theories, prescriptive design implications, or rigid dogmas and advocate that the exploration process of relationships, rather than seeking universal truths, is, in itself, a valid form of knowledge construction via RtD.

3.2.9 Domain Theories

Edelson (2002) presents the types of RtD knowledge by scaffolding the development of an educational software tool named the "Progress Portfolio." Although he focuses on advancing the educational research domain rather than RtD knowledge construction, his explorations bridge these realms. The Progress Portfolio enables students to capture and store their learning process while conducting and managing data-rich research by using computers. This tool facilitates reflection on students' own scientific inquiry over extended periods.

The RtD team observed students, prototyped an initial design, observed the use of the prototype in the classroom, and used their observations to refine the design of the tool and to revise the curricula for this specific learning environment. Edelson (2002) further embarks on a reflective analysis of accumulated data and design experiences, culminating in overarching theories that can be acquired through engaging in designerly activities as a research approach. These types of knowledge include *domain theories*, *design frameworks*, and *design methodologies*.

Domain theories entail descriptive abstractions of a part of problem analysis of the specific design case, which, in Edelson's (2002) case, is capturing and managing students' own learning process on computers. Such theories encompass diverse aspects, ranging from the dynamics of learners and teachers to the influences of learning environments. Domain theories bifurcate into *context theories*, illuminating challenges and prospects within specific design contexts, and *outcomes theories*, which characterize sets of results tied to specific interventions. An example of a context theory is Soloway, Guzdial, and Hay's (1994, as cited in Edelson, 2002) domain theory, which describes the specific challenges of designing software for learners. Their theory of *learner-centered design* describes three issues that software for learners must address. These are the need to motivate learners, the need to adapt to changes in learners as they learn, and the need to accommodate the inevitable diversity among learners. An example of an outcome theory is the *model of reflective inquiry*, which is based on the design and

evaluation of the Progress Portfolio and refers to the desired outcome, that is, the metacognitive strategies students must adopt by utilizing the Progress Portfolio. According to him, the metacognitive strategies, such as monitoring and capturing their learning progress and communicating the results as well as their progress to others, are the components of reflective inquiry.

3.3 Chapter Discussion

RtD offers the possibility to inquire into complex situations and uncover insights that may elude other research approaches. Furthermore, RtD enables researchers to bridge the gap between theory and practice by integrating theoretical knowledge with practical design interventions. The utilization of RtD in this study was motivated by its capacity to navigate complex challanges in the realm of user research communication challenges that might have remained unexplored without the direct engagement in designing a user research communication workshop using real-life data collected beforehand.

The discussion surrounding RtD's application underscores its potential to transcend disciplinary boundaries. As mentioned at the beginning of the chapter, RtD has garnered attention across various domains, including design, human-computer interaction, and education. However, the lack of a unified understanding of RtD poses challenges in positioning it within the broader research landscape. While some advocate for formalizing RtD to enhance its credibility and impact, others caution against diluting its essence through rigid standardization. The tensions in defining RtD are further compounded by ontological politics and varying perspectives on rigor and quality across disciplines. Design researchers may sometimes encounter challenges related to recognition and funding, which can reflect broader power dynamics within the research community. Moreover, the divergence in expectations between design and scientific fields underscores the need for a nuanced approach to evaluating RtD's contributions. Positioning RtD in relation to traditional research paradigms underscores its distinctiveness as a

knowledge-generating process. Unlike scientific inquiry, RtD prioritizes the exploration of preferred alternative futures and the creation of knowledge through design process. The artifacts produced in RtD serve as probes for uncovering latent needs and desires, facilitating novel insights that may elude conventional methodologies.

In addition to informing the design and analysis of the user research communication workshop in this study and advocating for the legitimacy of the designerly ways of knowledge inquiry, the RtD literature review in this chapter also shaped the study's understanding of the possible conclusions that could be drawn. As explained in Chapter 7, the discussion regarding the types of knowledge contributions of the study references the various types of RtD knowledge expounded upon in this chapter.

CHAPTER 4

METHODOLOGY

The methodology chapter presents the approach employed in this study, which utilizes field research and research through design to explore bus driver needs and communicate the findings to practicing designers. The study encompasses two primary objectives pursued in parallel. Firstly, it aims to identify safety and comfort improvements from the perspective of bus drivers, defined as the dimensions of driver experience. Secondly, it focuses on creating a research communication workshop framework to convey user research findings and explore its utilization in helping designers identify improvement opportunities.

To achieve these objectives, the study was executed in three phases. The initial phase involved conducting exploratory research at a bus manufacturer in Turkey to gain insights into the context. The second phase encompassed field research with bus drivers, along with the development of design artifacts and a workshop procedure designed to communicate the research findings. Finally, the third phase comprised discovery workshops with designers, where the design artifacts and workshop procedure developed in the second phase were utilized to explore improvement opportunities.

This chapter provides an account of the methodological characterization, techniques, and timeline of the study. Additionally, it presents an overview of the three phases of the study and describes the data collection and analysis methods utilized to gather and analyze the qualitative data. By presenting the details of its methodology, this study aims documenting a systematic approach to achieving its objectives, thereby contributing to the advancement of knowledge in the field. See Figure 23 for an overview of the process.

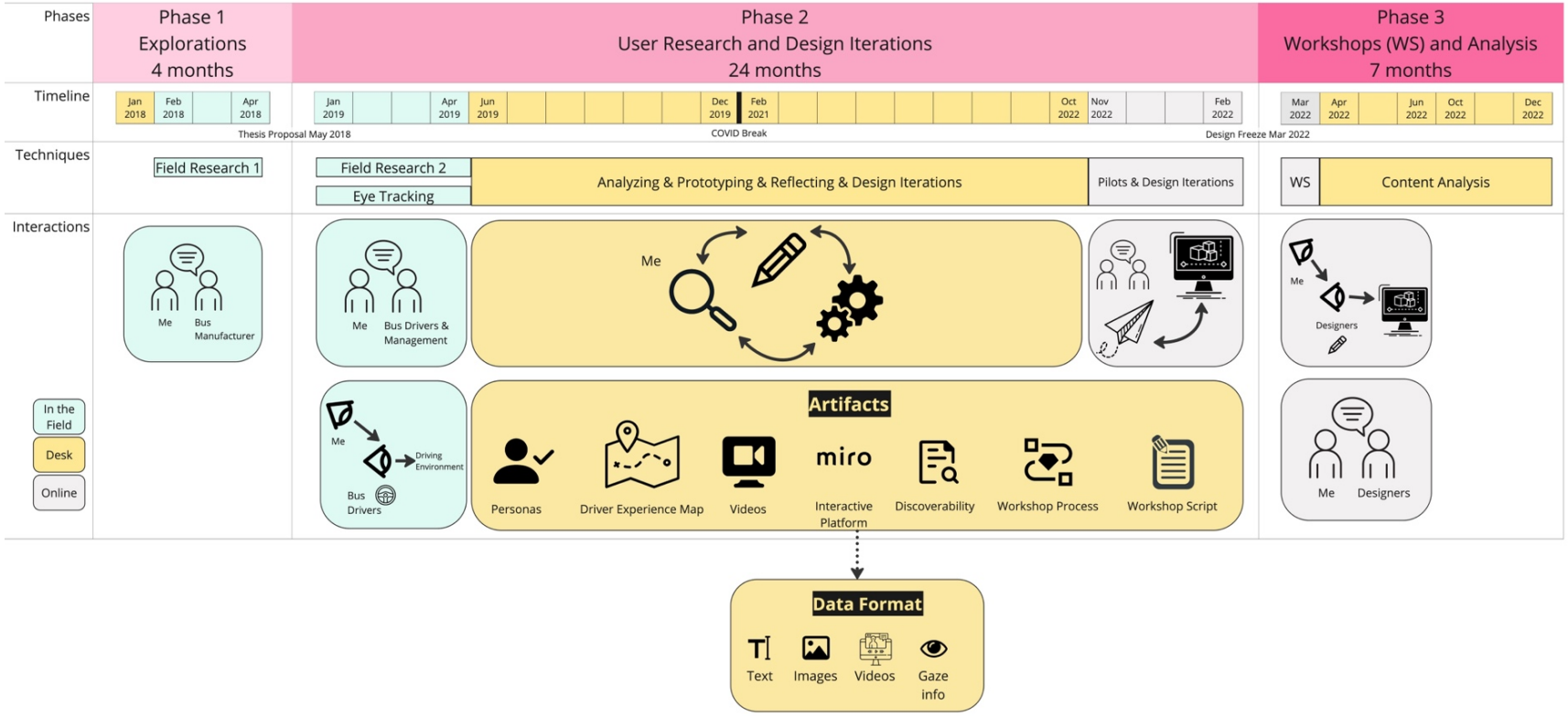


Figure 23 Timeline for data collection and construction.

4.1 Data Collection and Analysis Methods

Data collection methods include literature review and qualitative techniques such as interviews, meetings, observations, and eye-tacking video recordings. Data were collected as audio recordings, video recordings, photographs, and handwritten memos on notebooks. These notebooks were also utilized for data analysis. A total of around 1500 pages were handwritten in 8 notebooks from 2018 to the end of 2023 (Figure 24).



Figure 24 Notebooks used for handwritten notes throughout the study.

Some software, such as MS Excel, Miro, and MAXQDA, as well as some traditional methods, such as notetaking on notebooks, whiteboards, and sticky notes, were utilized for analysis and visualization of the analysis. For instance, Figure 25 depicts a part of the analysis conducted on the literature about driver models and experience to decide on the type of driver data to collect and the type of information content to deliver via workshops.

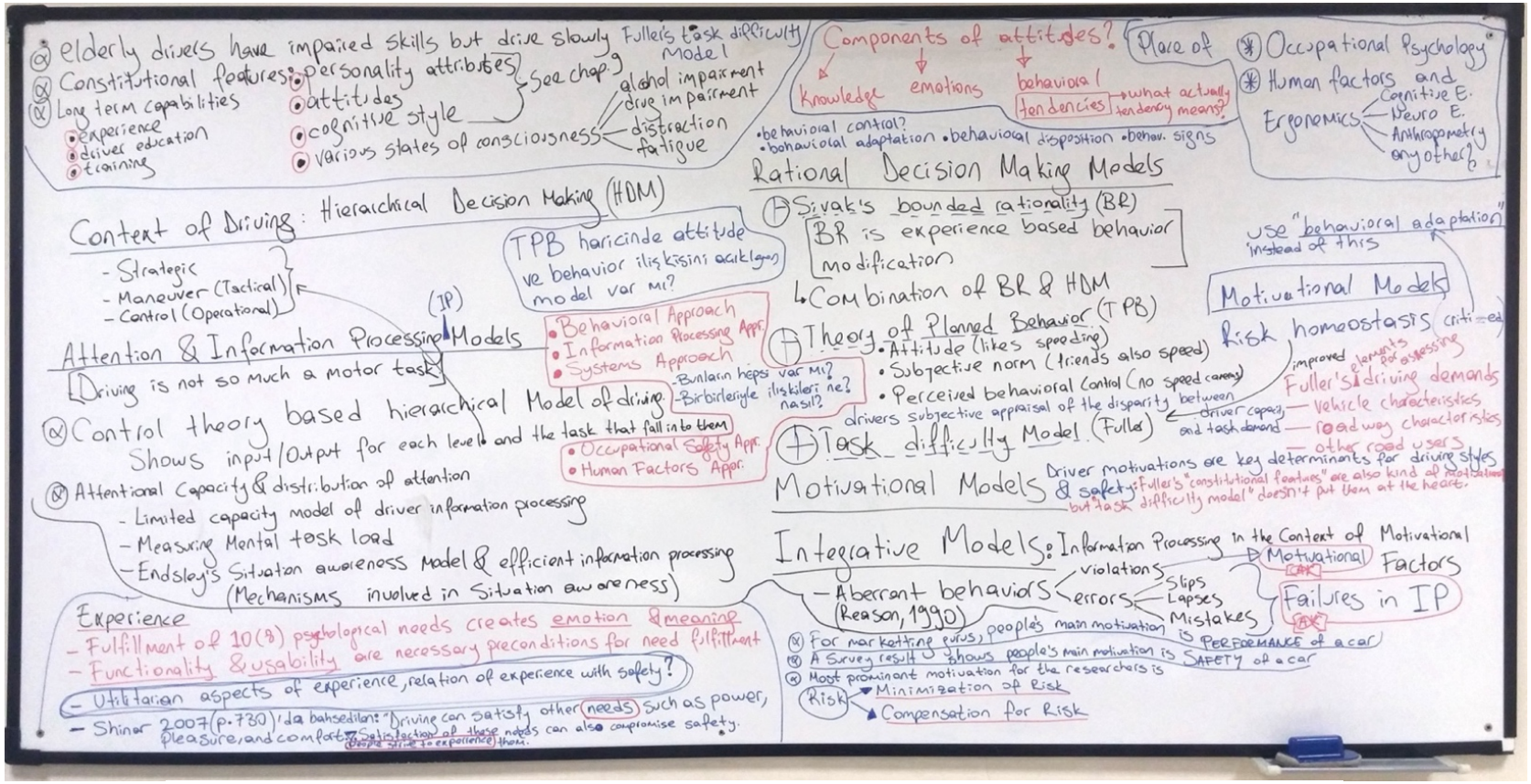


Figure 25 Photo depicting a part of the literature analysis conducted by writing on a whiteboard in September 2018.

4.1.1 Data Collection

Field research and workshops were facilitated to collect data from the bus manufacturer, bus drivers, and designers. Field research involves visits to a bus manufacturer and the campus directorate of transportation premises, as well as observing bus trips. The bus manufacturer visits comprise the first phase of the study and are explained in section 4.2.1. This was the discovery phase that included the exploration of the bus design process in a local manufacturing company. Visits to the university campus directorate of transport are part of phase two of the study and are explained in 4.2.2. These visits included observations, conversations, and eye-tracking recordings of the bus trips.

Eye tracking data from the drivers was collected with a wearable Tobii Pro Glasses 2 device during their driving. The device measures two fundamental eye movements: saccades and fixations. Fixations are the stationary periods that last between 50 – 600 milliseconds during which the information intake occurs. Saccades are the sudden movements of the eyes between fixations that typically last between 20 - 40 milliseconds (Bergstrom & Schall, 2014). When the eyes are fixated, the vision is divided into three regions, namely central or foveal, parafoveal, and peripheral (Figure 26). Foveal vision is defined as the narrow area where the visual acuity is at its highest, meaning the visual information collected in this area is clear. In parafoveal and peripheral areas, the visual acuity is low, and the vision contains much less information about the area.



Figure 26 Areas in the human visual field (Bergstrom & Schall, 2014)

While the nature of eye movements and eye tracking research is beyond the scope of this study, it can be summarized that saccades carry the foveal area on certain areas in the environment where the fixations occur to collect visual data. The representations of these movements in the eye-tracking videos consist of a moving circle on the locations of fixations, followed by jagged lines tracing saccades, as in Figure 27. This figure is extracted from the Uyumlu 3 video, where the driver scans the road junction to monitor oncoming traffic before merging onto the main road. The workshop participants were informed that the circle signifies the driver's gaze without specifying saccades and fixations, a deliberate choice to maintain simplicity. Moreover, interpreting the circle and lines was considered by the author to be quite intuitive.

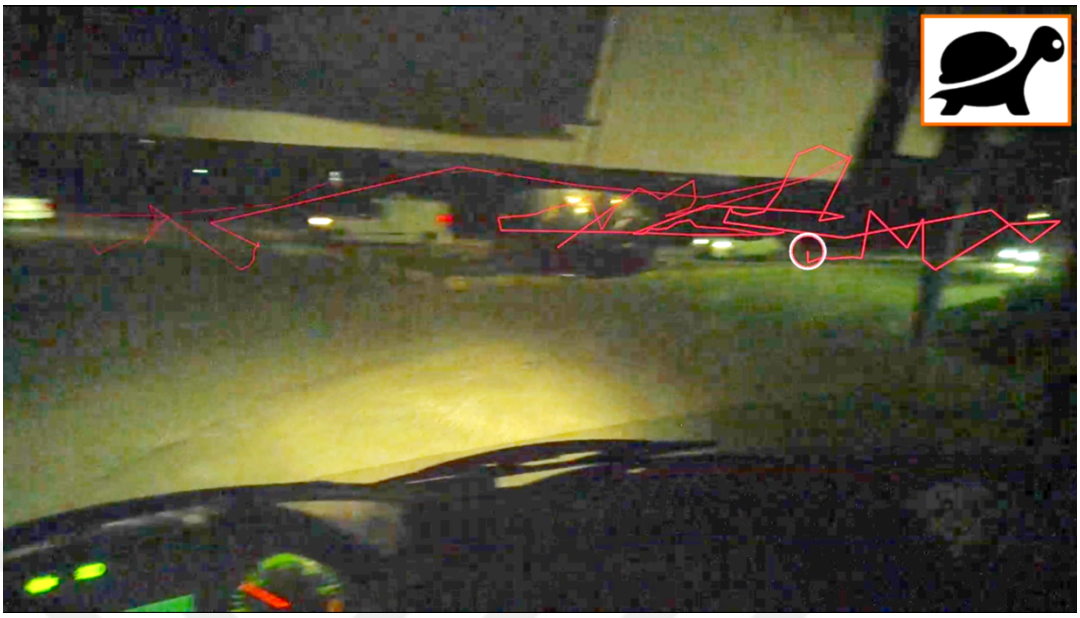


Figure 27 Representations of the eye movements on eye tracking videos.

The creative workshops are also conducted with professional designers to collect data. Designers were personally invited through LinkedIn. Conducting workshops is the third phase of the study and is presented in 4.2.3. Furthermore, since the workshop artifacts and the procedure are conceptualized as a framework and are among the study's outcomes, the details of the design process and final artifacts are presented in CHAPTER 5. The information about driver participants and designer participants is explained below.

4.1.2 Participants

Drivers

As mentioned, the campus directorate of transport was visited to gather data about the bus driver problems. The exact number of drivers is challenging to determine because the author visited the premises eleven times, where multiple encounters with drivers occurred at the resting area of the directorate's premises. During these visits, spontaneous gatherings or conversations took place, with drivers coming

together to engage with the author, even when the visit was originally planned for eye-tracking recordings.

For instance, at the beginning of this field study, an informational meeting was organized, attracting approximately 25-30 drivers. During discussions, occasional disagreements arose. Subsequently, some drivers left, while a subgroup of 10-15 drivers convened separately to discuss the contentious issues between driver groups and management. In this ensuing discussion, one driver expressed significant distress when addressing the disagreements. The author adapted to the situation to maintain the established rapport and avoid disrupting the authenticity of drivers sharing their experiences.

In addition to these encounters where the number of participants was unclear, driving videos were recorded with an eye-tracking device. Eleven drivers agreed to participate, but one of them (Dingin 1) was called back to the directorate premises via a phone call only seven minutes after starting the journey. The other driver who replaced Dingin 1, who also aligns with the Dingin persona and is designated Dingin 2, completed the journey. Table 1 below shows the driver codes and their corresponding recordings.

Table 1 Driver participants' information

#	**Driver Code**	**Date**	**Day**	**Hour**	**# Laps**	**Recording Length**
1	İhtiyar	Jan 2019	Tue	14:14	2	01:12
2	Şakacı	Jan 2019	Tue	15:47	2	01:25
3	Bezgin	Feb 2019	Fri	13:04	1	00:38
4	Uyanık 1	Mar 2019	Sat	16:05	2	01:38
5	Uyanık 2	Mar 2019	Sun	15:46	2	01:27
6	Uyumlu	Mar 2019	Sun	17:45	2	01:48
7	Dingin 1	Mar 2019	Mon	08:26	0.25	00:07
8	Dingin 2	Mar 2019	Mon	08:35	0,75	00:35
9	Dingin 3	Mar 2019	Mon	10:17	2	01:23
10	Bıçkın 1	Mar 2019	Tue	08:59	1	00:24
11	Bıçkın 2	Apr 2019	Wed	12:49	2	01:23

Designers

The participants of the workshops are considered to be future users of the user research communication framework developed in this study. The participant selection process involved a purposeful sampling approach, aligning with the recommendations of Koskinen (2003). 15 professional designers were invited to participate in the study, of which 10 agreed to participate. Primary participants, comprising three current designers from bus manufacturing companies, were invited based on their direct involvement in bus design. This group was presumed to possess a heightened interest in understanding the user experiences of bus drivers, given their current roles, aligning with Koskinen's emphasis on studying experts when seeking in-depth insights into a user group. Secondary participants, four designers who had previously engaged in bus design projects but had since transitioned to different professional domains, were included to provide varied perspectives, in line with Koskinen's suggestion of exploring secondary user groups for insights into future product generations. While their interest in bus drivers might not be as immediate, their experiences in diverse fields, such as designing other vehicles or healthcare systems, were expected to contribute insights beyond the core bus design domain. Deviant participants, three designers with backgrounds in design research, user research, and user experience design but without direct involvement in bus design, were chosen to bring their varied expertise to the study, echoing Koskinen's recommendation of including deviant cases to introduce novel viewpoints that might not be readily apparent within the primary and secondary participant groups. The categorization of participants into primary, secondary, and deviant groups was guided by their potential interest in understanding the experiences of bus drivers, ensuring a multifaceted exploration of user perspectives in line with empathic design principles. Participants' information can be seen in Table 2. The information about the number of years of experience in the table (YoX) was collected from their LinkedIn profiles. Participants 1FA and 8OB found time to view all videos corresponding to their selected three personas before the workshop. This explains the numbers within the

parentheses, denoting 16 and 15 videos, respectively. For detailed information on the participants' individual video viewing preferences, including the specific videos and their viewing sequence, please see Appendix F.

Table 2 Designer participants' information

Code	**Category**	**Experience**	**YoX**	**Workshop Date**	**Workshop Length**	**# of Videos**
1FA	Secondary	Mobility designer focusing on physical products, a driving enthusiast, research experience about bus drivers.	20	14, 15 Mar	01:54	5 (16)
2MeK	Deviant	Ph.D. researcher with user research experience in various types of products.	10	15 Mar	02:06	4
3SG	Primary	Design office manager at a bus company.	15	17 Mar	02:12	5
4CB	Secondary	Senior product designer experienced in professional healthcare systems, previous bus design experience, focuses on regenerative design	20	21 Mar	01:34	5
5FuA	Primary	Design manager at a bus company.	18	21 Mar	02: 10	3
6EC	Deviant	UX designer with a design Ph.D., works at a marketing data technologies company.	13	22 Mar	01:39	4
7IT	Secondary	Design manager at a military vehicle company, with previous experience in the design of public transportation vehicles.	21	22 Mar	01:24	3
8OB	Secondary	Design and trim manager at a military vehicle company, previous experience in the design of public transportation vehicles, focuses on ergonomics.	19	23 Mar	01:37	4 (15)
9MuK	Deviant	UX designer at a major social media platform, a graphic design background, user research experience for digital products.	24	15, 23 Mar	01:19	4
10KU	Primary	Junior designer at a bus company.	1,5	24 Mar	01:57	4

4.1.3 Data Analysis

Koskinen (2015) examined how design researchers analyze data and make sense of their findings and identified four analytic cultures—statistical, interpretive, explication, and art and design-based.

Statistical culture builds on the sciences and uses quantitative methods, such as experiments and surveys, to test hypotheses and measure outcomes. This is considered common in engineering and psychology-oriented fields of design research (Koskinen, 2015). The statistical culture might be needed when there is a need to quantify user behaviors or preferences or when working in fields that require numerical data, such as justifying design decisions to other product development stakeholders such as project managers. The role of theory is more pronounced in this culture than in other cultures, as researchers rely on theory in formulating research questions, planning data gathering, analyzing data, and prototyping.

Interpretive culture builds on the social sciences and uses qualitative methods, such as ethnography and interviews, to understand meanings and contexts (Koskinen, 2015). It is associated with user-centered and participatory design research and could help understand user experiences, emotions, or cultural contexts in depth. Writing down observations on Post-it notes and clustering them, which is also known as *affinity walls* or *affinity diagramming*, can be considered in line with this culture (Koskinen, 2015). Affinity diagramming is an inductive activity, meaning that rather than categorizing notes into predefined groups, the process begins from the ground up. It involves clustering specific details into groups, which then form the basis for identifying general and overarching themes (Martin & Hanington, 2012). One of the significant issues about interpretively analyzing design research is attributed to the lack of analytic skills of the designers that are gained by repeated immersion of the anthropologists in the fieldwork and their extensive education for developing analytical prowess (Jordan and Yamauchi 2008, as cited in Koskinen, 2015). That being said, Koskinen seems to argue that

designers possess the sensitivity that allows them to observe and interpret the world around them. He provides an example from one of IDEO's projects with a swimwear company in Brazil that illustrates how designers, despite lacking a foundation in anthropological theory and designing for a context that is distinct from the designers' own European background, were able to derive meaning from their observations and create a product successfully. He apparently advocates recognizing the analytical skills that designers bring to the table, even if those skills differ from traditional anthropological approaches.

Explication culture refers to a thorough inspection of the meaning in artifacts, often drawing on theories from linguistics or semiotics (Koskinen, 2015). While data collection within the explication culture differs from fieldwork, it also follows a ground-up approach, as does the interpretive culture. This refers to initiating the analysis by closely examining specific details of an artifact and then progressively synthesizing them to gain a deeper understanding of its overall structure and significance. This culture uses textual and visual analysis methods to examine meanings and structures, and it might be most useful when analyzing historical trends, aesthetic qualities, or theoretical concepts in design (Koskinen, 2015). Koskinen observes the challenge in describing the process of explication and offers an illustrative example for clarification. For instance, to understand the careers of figures like Frank Lloyd Wright or Ettore Sottsass through an explication culture of analysis, a researcher must explore multiple archives, engage in discussions with their family, friends, and contemporaries, delve into the study of design culture and its dynamics during their respective eras, and contextualize their work into a framework. Within interpretive and explication cultures, theory serves as a repository of precedents and a sensitizing framework that incorporates analysis with creativity (Koskinen, 2015).

Art and design-based culture builds on contemporary art and design practices (Koskinen, 2015). Unlike other cultures that draw from research world practices, this culture builds on the creativity found in the art and design realm. Some researchers within this culture may deliberately distance themselves from scientific

methodologies. Researchers collect materials about the subject of analysis, get familiar with the materials by browsing, organizing, and reading them, create mood boards and collages with the material, and identify themes for design. This process can aim for analysis or design. According to him, this culture provides insights into the working methods of designers and design researchers and enhances our understanding of their creative steps. However, he notes that a potential pitfall in this approach is the risk of overly praising creative work while overlooking the importance of rigorous research (Koskinen, 2015). The art and design culture encourages the exploration of innovative, challenging, or critical perspectives on design. In art and design-based work, research builds on exemplars rather than theory; however, there is often a lot of theoretical and philosophical depth behind the surface. In a sense, this culture has parallels with research through design (RtD) as knowledge inquiry, which was explored in CHAPTER 3.

Koskinen considers this classification significant, recognizing analysis as crucial yet underemphasized in the design research literature. He believes that these four cultures encompass a wide variety of possibilities, and they can exist at the same time. However, the classification is not intended to be definitive. Nevertheless, by drawing parallels to analysis cultures in sciences, social sciences, the humanities, and design, this categorization provides guidance for developing analysis approaches for this study.

While this study primarily aligns with the interpretive culture outlined above, a combination of approaches is employed for analyzing diverse data sources by incorporating elements from interpretive, explication, and design-based cultures. Data from the interviews, meetings, and observations was analyzed in line with the inductive culture while comparing the analysis results with the relevant literature, while eye-tracking videos and observations about driver personalities were explicated and designed into specific clips for different personas. Workshops, on the other hand, were analyzed by devising an interpretive approach informed by insights from an email exchange with Koskinen. In this correspondence, Koskinen

suggested generating synopses from transcription data, influencing the formulation of workshop analysis.

Analysis of Audio Recordings

Meetings at the bus manufacturer facilities and meetings, as well as the interviews and other encounters with the drivers at the university directorate of transportation, were transcribed. This data was analyzed by writing down the remarks of the transcriptions, coding them, grouping the codes, and preparing affinity diagrams and mind maps with physical sticky notes, prints of the transcriptions, or software such as ConceptDraw and Miro.

An example of a mind map that was prepared for one of the meetings at the bus manufacturer facilities and created with ConceptDraw can be seen in Figure 28. These meetings occurred in Phase 1 of the study, which aimed to explore manufacturer challenges, their design processes, and the possibility of a thesis collaboration (see Phase 1: Exploring the Bus Design Practice section for more information). Figure 28 presents a summary of the previous meetings, showing the main themes and possible stakeholders to consult in case of a thesis collaboration. Among the possibilities that emerged from the negotiations between the author and the manufacturer about the extent of the study, the manufacturer showed interest in some possibilities, such as automatizing some bus driver tasks. These possibilities were presented in the "definition and extent of real problems" group in the figure. Among the problem areas and solutions identified by the author from the literature, the manufacturer showed interest in issues such as drivers turning off warning sounds due to finding them annoying. These problem areas were presented in the "exemplary problems and countermeasures" group in the figure.

In addition, the figure also displays a disagreement about the outcome of the study, revealed by mind mapping. Even though the author was interested in conducting user research and communicating the findings to designers from the outset of the

study, she did not exclude the possibility of creating bus design proposals as the outcome. Throughout the meetings, the author realized that while supporting the idea of conducting user research, the manufacturer preferred receiving bus design proposals at the end of the study. This meant that the author would focus less on the communication of user research findings and more on the design of a bus. The design of a user research communication tool was still possible at this point. However, the tool was preferred to support making value decisions rather than facilitating empathy with the bus drivers. After presenting the author's understanding derived from the meetings using the provided image, negotiations about the collaboration gained clarity. After presenting the contents of Figure 28, the person responsible for the collaboration projects noted that they consider designing a user research communication tool to be foundational research. However, they expressed interest in collaboration if the study's outcome involved design proposals. In response, the author chose to pursue the study independently, prioritizing a more explorative approach with a focus on communicating user research. This analysis via mind mapping helped structure the bus manufacturer meetings and marked the initiation of defining bus driver problem groups.

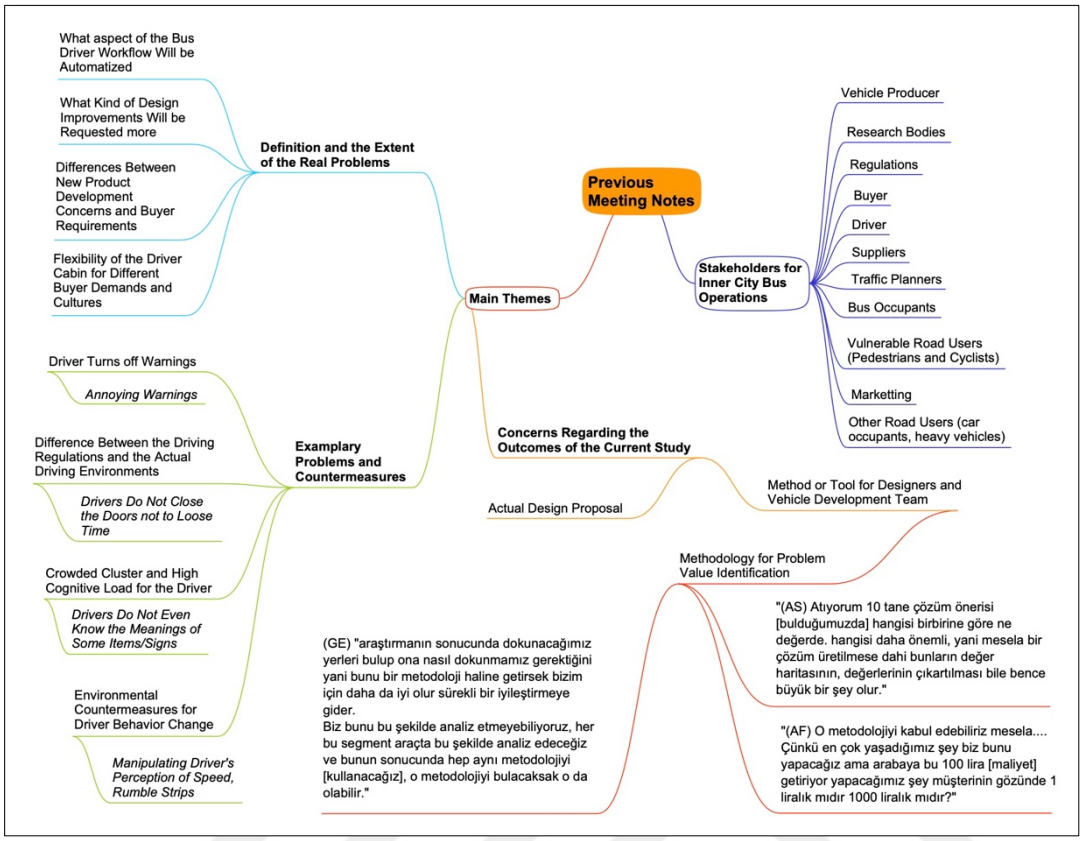


Figure 28 An example of mind mapping with ConceptDraw for bus manufacturer meetings.

Building on the previous analysis with mind mapping (Figure 28), driver problem groups were further refined by affinity diagramming the field data by using physical Post-it notes (Figure 29) and Miro (Figure 30). This iteration of analysis started by noting down remarks (see Appendix C) from driver encounters, continued by noting the themes from the remarks and the literature on Post-it notes, and arranging them a couple of times to define driver problem groups (see Updating Problem Groups section in Chapter 5). These problem groups were updated and rearranged several more times (i.e., Figure 30) with the help of workshop analysis. Iterative affinity diagramming of the literature, data from bus manufacturer meetings, field data, and workshop data eventually became the Generative Model of Driver Experience Dimensions explained in the last chapter.



Figure 29 An example of analysis with physical sticky notes for grouping driver problems.



Figure 30 Updating and rearranging problem codes on Miro with the information from the workshop analysis.

Analysis of Eye Tracking Videos

Eye tracking data was collected using the mobile Tobii Pro Glasses 2 device, which records both the environmental video and eye movements. Tobii Pro Lab analysis software was explored for creating data visualizations, including heat maps (Figure 31) and gaze plots (Figure 32) for presentation to workshop participants. Heat maps visualize the total duration of the user's gaze on certain areas of the scene with designated colors, whereas gaze plots show the chronological order of fixations with numbers and the duration of fixations with the radius of fixation circles. Although eye tracking primarily served as an observational technique, the potential for generating data visualizations for significant events was considered beneficial for designers. However, challenges such as environmental lighting and reflections, lengthy recording durations, and the author’s limited expertise in this field precluded realizing this possibility. Consequently, eye-tracking recordings were utilized only as video clips.

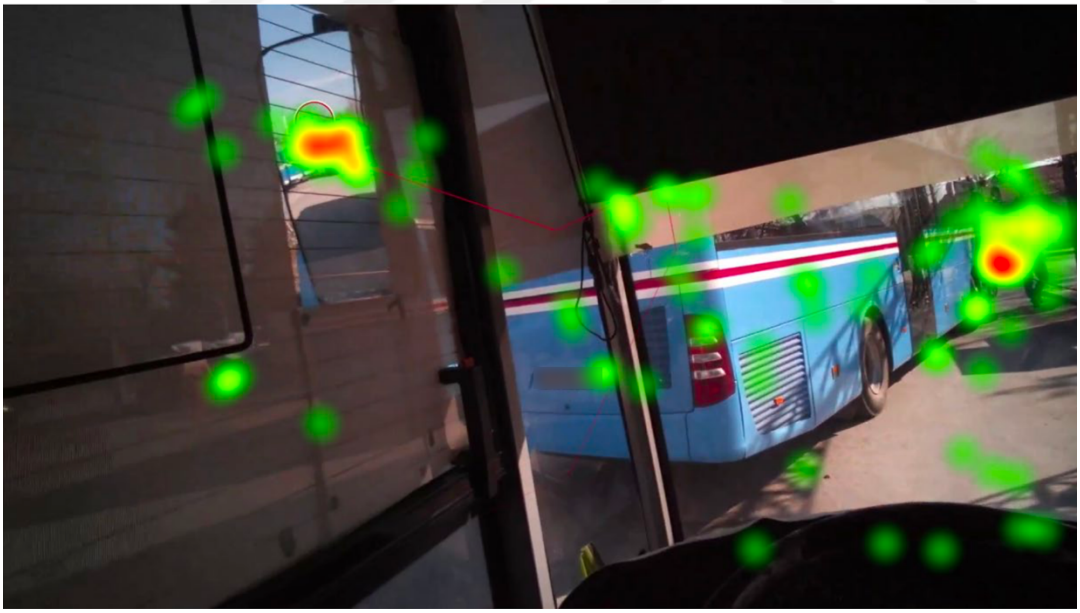


Figure 31 Heat map for 1 minute of reversing (Dingin 4 video)



Figure 32 Gaze plots for the 26-second portion of reversing the vehicle (Dingin 4 video)

After the failed attempt at traditional eye tracking analysis, all recordings were exported as videos featuring the gaze indicator illustrating drivers' eye movements. These videos underwent analysis to identify and compare significant events while concurrently curating video clips from selected segments to construct a coherent trip narrative. While on the bus during recordings, the author engaged in tasks such as calibrating the eye-tracking device, changing its battery and memory cards, monitoring the recording software for malfunctions, and observing the trips. Throughout this involvement, the author spotted and made notes of a set of significant events for later consideration. Furthermore, multiple viewings of the videos were undertaken to regain familiarity with the video content. Attempts were made to extract all significant events from the recordings with Adobe Premiere Pro software considering the initial driver problem groups (Figure 33).

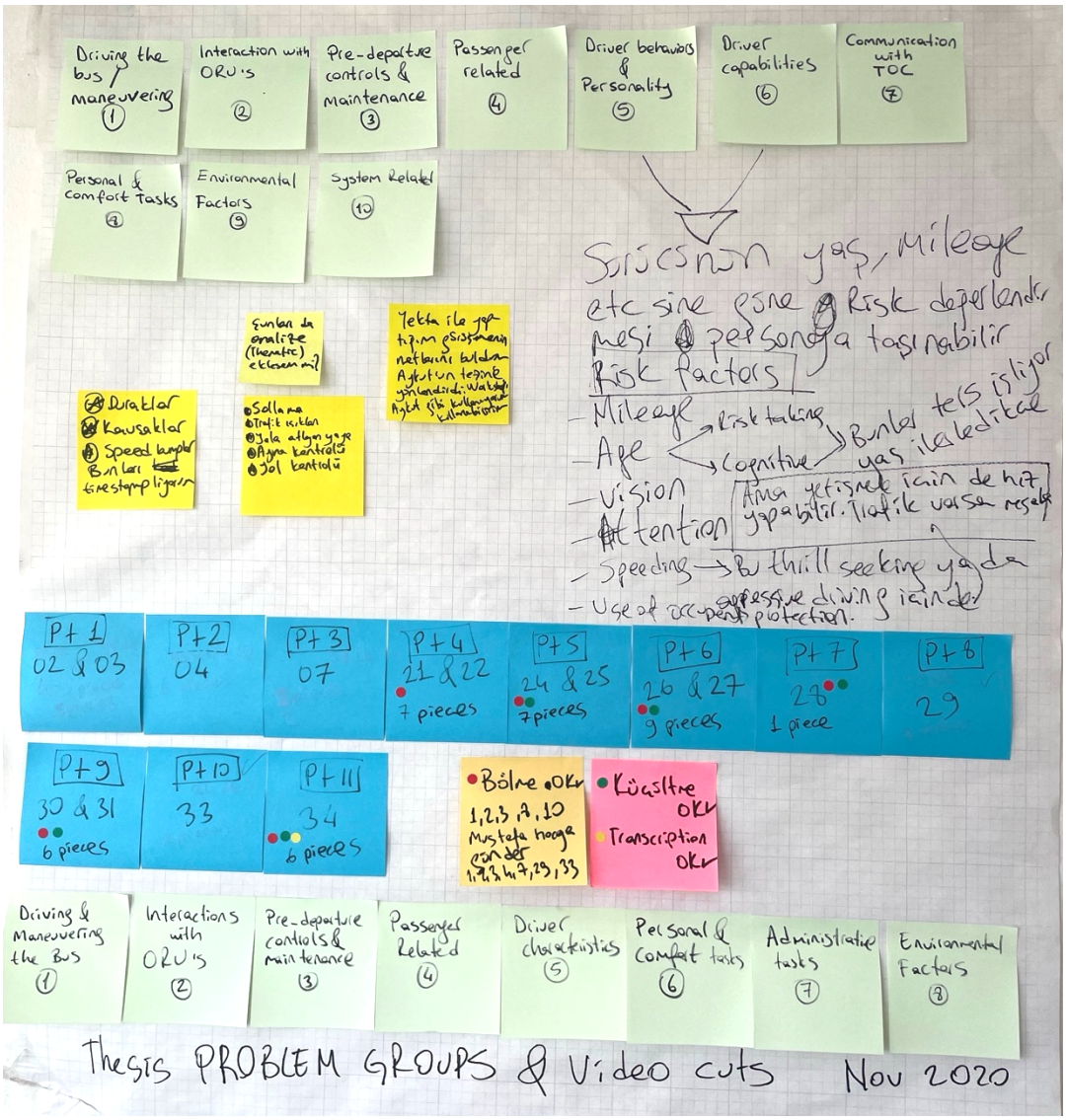


Figure 33 Photo depicting a part of bus driver problem analysis conducted by writing on sticky notes.

However, the video files proved excessively large, surpassing the capabilities of the computer in use for video editing, disrupting the synchronization between the sound and the video. At this point, the author sought help from a colleague, Mustafa Hasdoğan, in synchronizing the sound and video and reducing the size of the videos. Following the preparation of shorter videos with synchronized sound by utilizing a lighter software (Loiloscope), a couple of significant events were selected to start curating trial video clips (see Chapter 5 below for details). After

working on trial video clips, initial personas were created based on some drivers with distinctive characteristics (see Incorporating Personas in Chapter 5 for details). One of the personas was named “İhtiyar” (the old man) to anonymize the driver’s real name. His advanced age, shorter stature, the sound of his labored breathing, wiser demeanor, and trouble while using some of the features of the new buses inspired this name. Another persona was named “Bıçkın” (Fierce) due to the driver’s intense reaction toward perceived unfair work distribution and neglect from the management (see Driver Personas section in Chapter 5 for the author’s associated characteristics with each persona). After designing some driver personas, their recordings were analyzed to identify significant events. This analysis was in the form of taking notes for each recording about the problematic and interesting events in the recordings. For instance, Figure 34 displays some notes about the selection process from Bıçkın recordings.

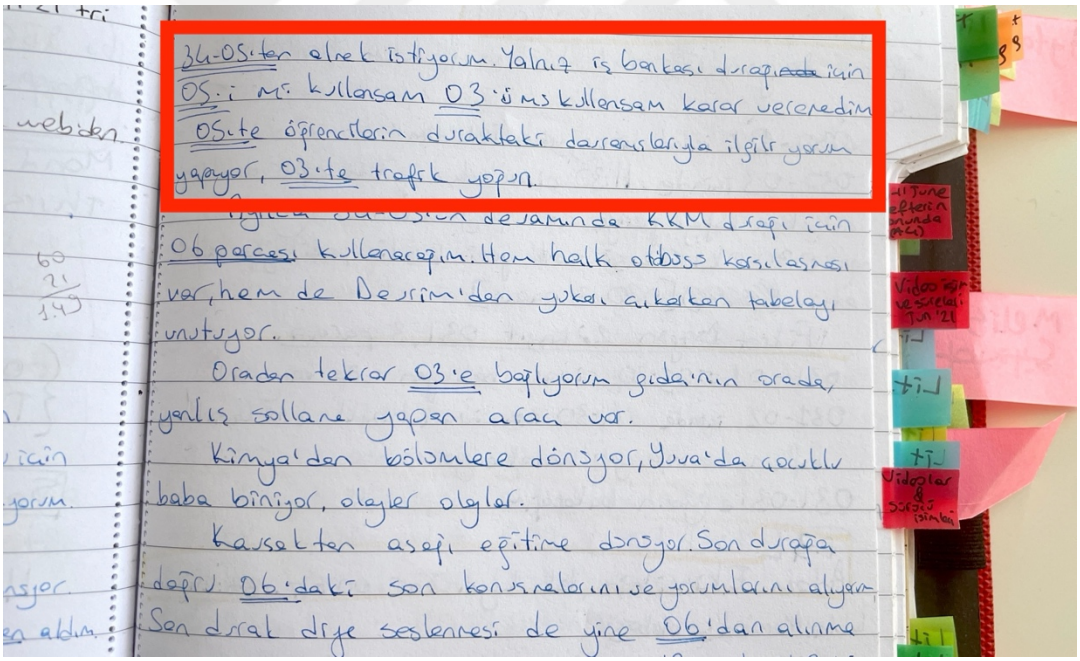


Figure 34 An example of video analysis notes.

This image shows an example of the author’s notes about selecting events from the video recordings. The note features the code of the video (i.e., 34-03 or 34-05), the event (approaching a bus stop), and the reason for selection (heavy traffic). For

instance, the driver in the video passed a specific bus stop (İş Bankası stop) twice, and a decision needed to be made about which one to select for the curated clip. While the driver was passing this bus stop for the first time, the traffic was heavy, and the driver had to perform a combination of mirror and road checks while departing from the bus stop. The gaze information in this event was deemed significant as it might inspire the design of driving assistance features. On the other hand, when the driver passed the same bus stop the next time, a passenger was waiting, and the driver honked the horn. When the author asked why, he said, "The student at the bus stop seemed preoccupied and did not notice the bus – perhaps he was thinking about his classes – so I wanted to help him notice the bus." This event is deemed significant as it shows a driver interpreting the intentions of a passenger by looking at their body posture and empathizing with the passenger. Ultimately, the second event was selected as it was found more noteworthy, and there were several other events featuring driver gaze behaviors while departing from the bus stop and in heavy traffic.

Other ways of video analysis included chronologically writing down the events in relation to the campus landmarks and highlighting the interesting events, as in Figure 35, and analyzing different road geometries by drawing them and comparing the necessary maneuvers as well as the directions of the traffic, as in Figure 36. Moreover, cutting the whole recordings and preparing short video clips that maintain the narrative coherence while resembling the actual trips with the help of a video editing software, iMovie (Figure 37) also served as the analysis of the videos as it required constant comparison and selection of the video events.

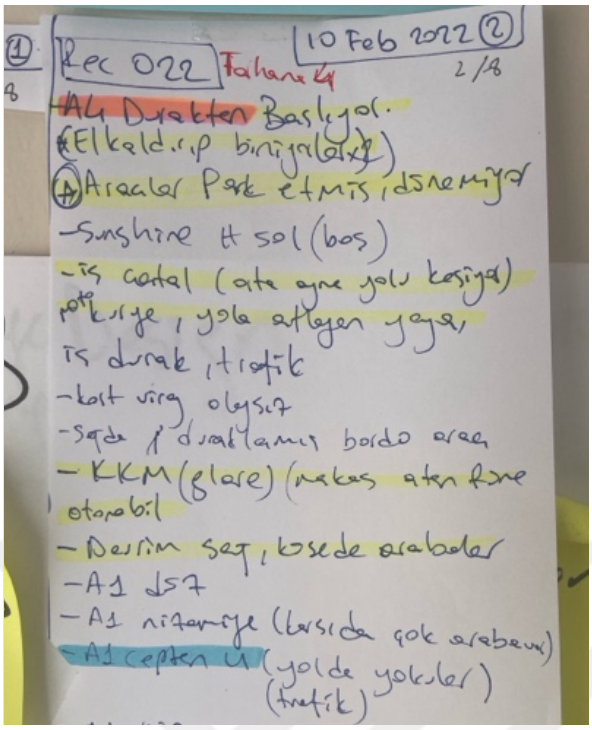


Figure 35 Chronological notes in relation to campus landmarks for the recording number 022.

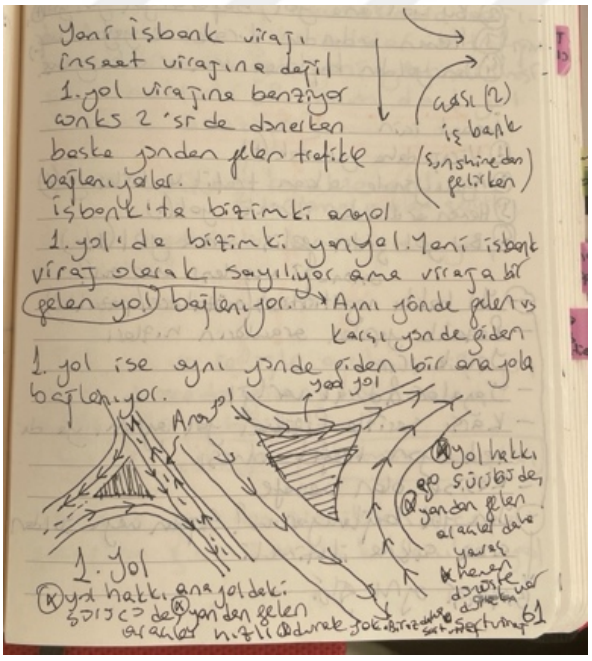


Figure 36 Analyzing different road geometries on campus.

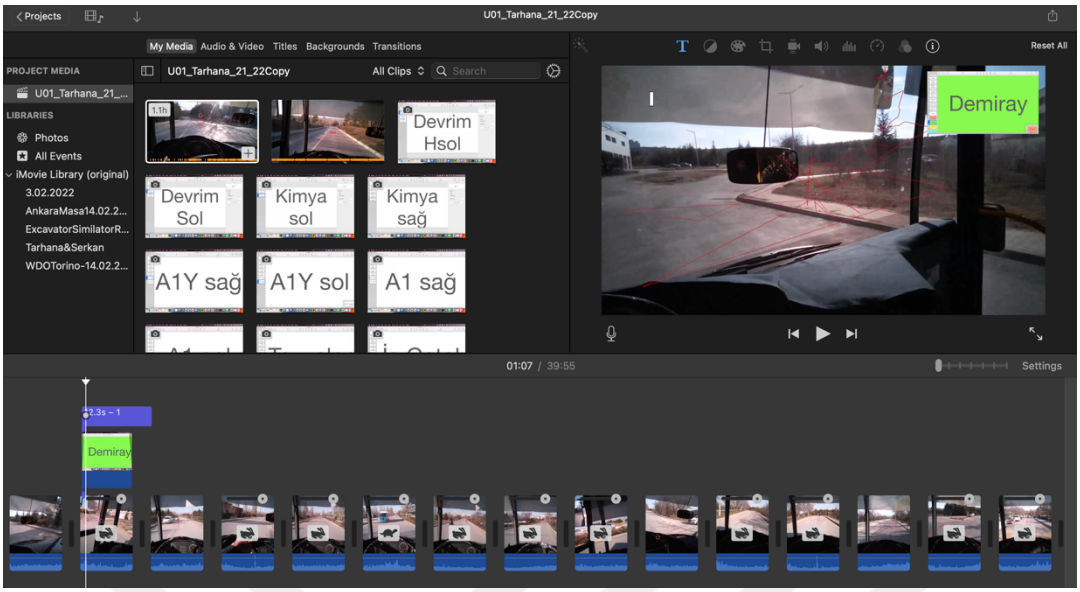


Figure 37 Curating the clips with video editing software, iMovie.

Referring to the categorization by Koskinen (2015), the analysis of videos was an interpretation and explication process of the driving videos. In addition, the curation of the clips from the entire recordings resembles the design culture of analysis in Koskinen's terms.

Analysis of Workshops

The analysis of the workshops included two steps. One is writing synopses from verbatim transcriptions, and two is coding and grouping them. The timestamped verbatim transcription of each workshop was saved into separate MS Word files. Each transcription was divided into parts labeled as the phase of the workshop. These phases included introductory questions, comments about the driver experience map, the names of the videos and the personas the participant selected and commented on, and post-workshop questions. Each part that belongs to different phases was then divided into utterances and converted to separate synopses. These synopses are written to (a) capture the core meanings in each utterance, (b) remove the repetitions, filler words, and brand names, (c) convert split sentences or the sentences that were left unfinished into coherent sentences,

(d) add the participant's non-verbal expressions to reveal the tacit meanings that are not evident in the plain transcription text, and (e) create a summary of the utterance. For instance, Figure 38 displays an example of conversion from transcription to synopsis from a participant's utterance.

Transcription

[00:09:01.03] SG: a need for a more personal relaxation space. AK: why? [00:09:19.17] SG: these guys… they already see thousands of people throughout the day while working. They interact with thousands of people, and they are exposed to the stress of thousands of people. The same applies in traffic as well. Therefore, they need isolated spaces where they can rest physically and mentally [00:09:43.26] SG: these guys are driving heavy vehicles in the same sitting position for hours. In fact, they are in a position similar to heavy labor. Therefore, they need to get rid of their physical fatigue. [00:10:00.21] SG: not only for their own needs but also for the safety of the people traveling in the vehicles they use, it is an important factor. Both mentally and physically, [00:10:12.10] SG: maybe they need psychological support at intervals they need, both mentally and physically, and they need to rest at necessary intervals.

Synopsis

6. They need a more personal relaxation space than they currently have to be able to rest mentally and physically. Both for their own needs and for traffic safety. They are in a position similar to heavy labor. SGp2

Figure 38 Writing synopses from transcriptions.

In this example, the participant was prompted to discuss key issues identified from the driver experience map before viewing any videos. In this utterance, which was extracted from a longer answer, the participant talks about his observations on resting facilities for drivers. The participant outlined various reasons supporting the need for a dedicated resting area, likening bus driving to heavy labor. Subsequently, the participant proposed potential solutions and highlighted potential adverse outcomes if the identified problem remains unaddressed. The synopsis in Figure 38 established the main points of the utterance while omitting details.

Each synopsis is labeled with a number indicating its chronological order within the workshop session. The number 6 at the beginning of the synopsis in Figure 38 indicates the chronological order of this particular synopsis for participant 3SG.

Each synopsis also includes a label at the end, corresponding to the original transcription's page. The label SGp2 at the end of the synopsis in Figure 38 shows that this synopsis is written with the data on the second page of raw transcription of the participant 3SG. Moreover, raw transcriptions are timestamped, aligning with the corresponding video minutes of the workshop recordings. This ensures the traceability of the author's interpretations during synopsis writing to the video recordings of the workshops, facilitating the evaluation of the analysis.

All transcriptions, totaling 95,684 words of verbatim text (see Appendix F for details), were distilled and rewritten into 718 synopses. Writing synopses in this way established the analysis structure by facilitating the explication and interpretation of the transcriptions. The synopses from all participants were then imported into an analysis software (MAXQDA) for coding. After several coding iterations, the analysis focused on how participants defined driver needs and how they utilized the workshop framework. In addition, the participants' answers to post-workshop questions (Appendices 0 and J) gauged participants' assessments of the workshop framework. This particular synopsis in Figure 38 includes information about driver needs and links this identification to one of the workshop artifacts, the driver experience map. These synopses, labeled with corresponding MAXQDA locations matching their chronological order numbers, were used in writing CHAPTER 6. They are provided in the appendices (N, O, P, Q, R, S, T, U, V, W) in their original language for reference.

4.2 Procedure of Study

The study was executed in three phases (Table 3). The first phase involves exploratory research at a bus manufacturer in Turkiye. The second phase encompasses field research with bus drivers and developing design artifacts for communicating the findings. The third phase includes discovery workshops with designers, facilitating the design artifacts developed in phase two.

Table 3 Phases of the study and research methods

	Phase 1	**Phase 2**	**Phase 3**
Field Research	At the bus manufacturer	At the METU Directorate of Transportation	-
Eye Tracking	-	With bus drivers	-
Online workshops	-	-	With design professionals

4.2.1 Phase 1: Exploring the Bus Design Practice

The initial phase of this study consisted of conducting a literature review about traffic safety and bus driver problems and exploratory research at the premises of a prominent bus manufacturer in Turkey. This exploratory research included a series of meetings, interviews, and observations at the factory facilities, as well as an analysis of audio recordings of the meetings and discussions. The primary objective of this phase was to comprehend the safety and contextual factors that affect traffic, driving, and bus manufacturing, establish connections with industry practices, explore potential collaboration opportunities, and set the stage for subsequent phases of the study.

Given the study's emphasis on communicating user research findings in corporate environments, collaboration with an industry partner was sought to enhance practical relevance. To facilitate this collaboration, presentation materials were prepared, incorporating relevant literature on traffic and bus driving safety. These materials were presented in a series of meetings with the key personnel from the bus manufacturer, including the design manager, the R&D manager, two designers, two engineers, a representative from the funding department, and a manufacturing technician.

The initial informal contact with the company was made at a trade fair held in Ankara. Subsequently, three visits to the manufacturing facilities were conducted on February 7th, March 7th, and April 11th, 2018. Each visit involved spending the

entire workday at the factory, engaging with key stakeholders, and immersing myself in the bus design practice. A focused literature review started one month before visits and lasted for approximately four months.

Data collection methods in this phase included meetings, interviews, and observations conducted at the factory facilities. A total of 5 hours and 52 minutes of audio recordings were made and transcribed. While the meetings of the first visit were fully transcribed, the following visits were transcribed selectively. For the first meeting, a presentation was prepared to show bus driver problems from the literature and possible outcomes if the collaboration turns into a funded one. This presentation initiated discussions about the manufacturer's interests and acceptable outcomes of a funded collaboration. These discussions were fully transcribed with Inqscribe software to identify possible misunderstandings and establish alignment between the manufacturer and the author. After making the misalignments visible, the following meetings were selectively transcribed to maintain alignment. In addition to analyzing traffic and bus driving safety literature and the meeting transcriptions, the contents of some tender and bus documents were also analyzed to prepare a map of the bus cabin (Appendix A) and gain insights into design constraints and bus specifications.

This phase laid a foundation for the study by conducting comprehensive exploratory research and analyzing relevant literature. Engagements with the bus manufacturer and analysis of collected data provided insights into the bus design practice. Although the collaboration did not progress as a funded project (see Analysis of Audio Recordings section for reasons and Failed Attempts section for reflections), the findings guided subsequent phases and shaped the scope of the research.

The analysis results were used to triangulate literature findings, design artifacts for communication of research findings, and as codes for workshop analysis. Additionally, two designers from the company participated in the third phase of the study, actively engaging with the developed artifacts and providing feedback.

However, due to the lack of funding, an eye-tracking device from the university was utilized within the campus, as it was not permitted to be taken off-campus. Consequently, the study was confined to the buses on campus, restricting the scope of data collection and analysis.

Constructed artifacts include a presentation for the bus manufacturer, which includes initial affinity maps of problem groups and possible project directions and a map of the bus controls inside the cabin. The artifacts were designed with Adobe InDesign, Photoshop, and ConceptDraw Office Mindmap.

4.2.2 Phase 2: Driver Data Collection and Creation of Design Artifacts

This phase involved collecting driver data through semi-structured interviews, observations, and eye tracking using Tobii Pro glasses 2. Following the driver data analysis, it also included the creation of design artifacts using various software tools.

The purpose of this phase was to gain a comprehensive understanding of the bus driver experience and context. The data collection aimed to observe the work environment, tasks, and relationships of bus drivers, while the design artifacts aimed to communicate the research findings effectively.

The initial meeting with the Transportation Directorate manager took place in October 2018. The data collection occurred between January and April 2019 after obtaining approval from the METU Human Research Ethics Committee. Facilities were visited 11 times during this period for interviewing and observing the drivers and recording eye-tracking videos. The visits were distributed among weekdays, weekends, daytime, and night shifts, each lasting between a half-day and a full day.

Some visits involved meeting only 2 or 3 drivers who preferred not to engage in public conversation. The author attempted semi-structured contextual interviews with two drivers, but these attempts were unsuccessful (see 7.3.3 about the failed attempts and Appendix B for the interview guide). Eight of these meetings were

audio recorded for transcription and analysis, accumulating to 8 hours and 34 minutes. For the spontaneous conversations with the drivers where audio recording was not feasible, the author took voice or written notes to document the discussed problems afterward. These problems are transformed into a list that is explained in Chapter 5 below.

Participants of the field data collection included bus drivers, administrative staff, and the manager from the METU Directorate of Transportation. Their involvement provided insights into the bus driver experience and context. Additionally, a psychologist, a professional driver, a design professional, a design master's student, and a design Ph.D. researcher individually participated in the pilot problem identification workshops, which were used for iterating the design of the artifacts and the procedure.

In the second phase, three types of data were collected and analyzed. Firstly, data were collected from drivers and the directorate of transportation employees in the field, which involved semi-structured interviews and observations. Secondly, eye-tracking recordings were made while driving by using Tobii Pro glasses 2. Thirdly, videos of the pilot workshops were recorded for design iterations, which involved problem identification activities and evaluation of the workshop artifacts and the procedure. The combination of field and driver data collection and data from the pilot workshops aimed at a holistic exploration of the challenges faced by bus drivers and the iterative refinement of the design artifacts.

During the interviews and observations, audio recordings were made, and photographs were taken to provide contextual information for the observations. Interviews and observations produced 08 hours and 34 minutes of audio recordings. The analysis involved selectively transcribing, affinity diagramming, and triangulating with existing literature to identify problem groups. These groups were used for designing the artifacts and as provisional codes for workshop analysis in the subsequent phase.

Tobii Studio software was initially used to analyze the eye-tracking recordings and generate heatmaps and gaze plots of critical driving situations. However, due to challenging lighting conditions in the natural environment, the software inaccurately mapped the gaze onto the external image of the bus cabin in some parts of the recordings (Appendix C). As a result, this analysis method was abandoned, and the eye-tracking recordings were converted into videos with a gaze indicator for qualitative video analysis. The total duration of the eye-tracking videos was 17 hours and 36 minutes.

The third type of data collection was from five pilot workshop participants, which involved conducting workshops with participants and analyzing their usability feedback about the artifacts and the procedure. The shortest workshop took 1 hour and 19 minutes, and the longest took 1 hour and 53 minutes. The total duration of pilot workshop recordings was 7 hours and 56 minutes. Workshops were video recorded, selectively transcribed, and analyzed with affinity diagramming. The design of the artifacts and procedure was iterated after each pilot workshop.

The analysis of field research and eye-tracking videos informed creating design artifacts. The artifacts and the workshop procedure were designed to convey the research findings and address the identified driver problems. The design of the artifacts and procedure underwent iterations guided by the analysis of pilot workshops, resulting in creating an interactive prototype and a refined procedure.

Constructed artifacts include driver personas, video clips, Vimeo and YouTube databases, GIFs, maps for the video clips, driver experience map, interactive Miro Boards, and the final workshop procedure script. Design of the artifacts is done with Tobii Studio, Adobe packages (XD, InDesign, Illustrator, Premiere Pro, Photoshop), Miro, Vimeo, YouTube, and iMovie.

4.2.3 Phase 3: Identifying Design Improvements with Designers

This phase involved inviting design professionals and conducting ten problem-identification workshops. The activities included preparing invitation materials, contacting design professionals through LinkedIn and/or direct communication, arranging workshop dates, and conducting and analyzing the workshops.

The purpose of this phase was to identify improvement opportunities for METU shuttle bus operations, focusing on enhancing the driver experience. This phase served as a consolidation and triangulation of the previous phases, further refining the understanding of bus driver problems. It also helped identify case-specific issues and dimensions related to the bus driver experience. Additionally, it served as an evaluation of the workshop artifacts and the procedure itself.

The workshops were conducted between March 14th and March 24th, 2022, after obtaining approval from the METU Human Research Ethics Committee. The analysis phase extended for approximately six months, concluding at the end of December 2022.

Data were collected through the administration of the workshop procedure conducted on Zoom, with each workshop being video recorded. The workshop procedure consisted of two parts. In the first part, participants identified design problems by evaluating the driver experience map. The second part involved participants selecting personas and watching video clips of significant events. While watching the clips, participants were asked to think aloud, sharing their thoughts, questions, and insights. After each video clip, participants were prompted with the question, "What do you think the driver needs here?" to stimulate discussions and gain insights into how the participants frame the problems and relate to the drivers. In addition, participants were asked about their previous experiences before the workshops and their opinions after the workshops. Pre-workshop questions were structured to understand participants' previous experiences facilitating user research, public transportation use, and transportation

design. Post-workshop interviews aimed to gather feedback on the artifacts and workshop procedure while highlighting differences between the problems identified through the driver experience map and the videos (see Appendix 0 for workshop questions in Turkish and Appendix J for their English translations).

The duration of each workshop ranged from 1 hour and 19 minutes to 2 hours and 12 minutes, resulting in a total recording duration of 17 hours and 52 minutes. These recordings were transcribed verbatim, including the annotations about the participants' emotional reactions interpreted from their intonation and gestures, and subsequently analyzed. This analysis started with coding the verbatim transcriptions in MS Excel. However, this trial yielded an abundance of codes (Figure 39) about various aspects of the workshop and prevented the author from forming a coherent understanding of the workshops since the sequence of participant utterances was of significance.

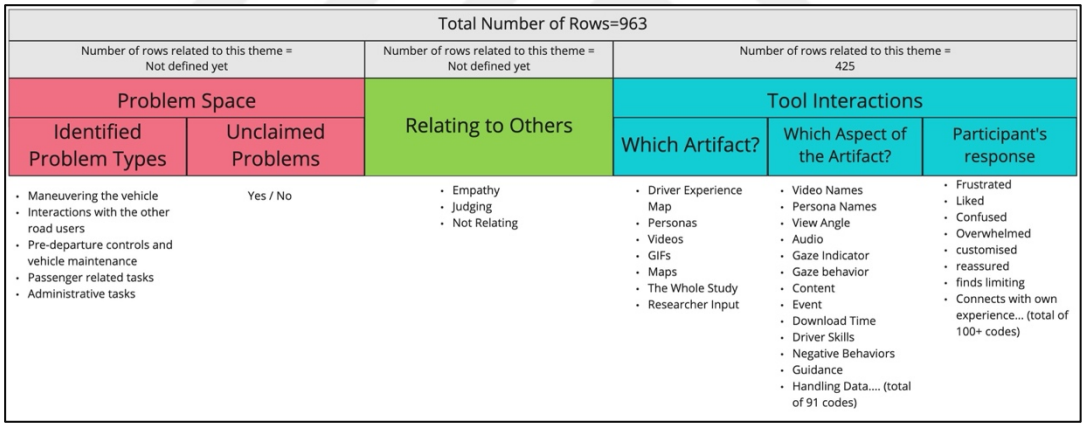


Figure 39 Codes from the first analysis attempt of raw transcriptions.

In order to overcome the difficulty of forming a coherent understanding, the author wrote the whole workshop transcriptions in her own words while maintaining the meaning of the participant utterances. This started by dividing the transcriptions into narrative groups that resemble the workshop phases, such as pre-workshop questions, driver experience map comments, comments about specific videos and personas, and post-workshop questions. Later, the author divided the narrative groups into smaller chunks of utterances and wrote synopses for each chunk, as

explained in the Analysis of Workshops section. Synopses of each participant were organized in separate MS Word documents and imported to MAXQDA for coding. Since coding trials of the raw transcriptions with MS Excel, writing the synopses, and taking handwritten notes enabled the author to form an understanding, the author defined different coding schemes to evaluate their suitability to the synopses. An example of these coding schemes can be seen in Figure 40. All aspects of the workshop were considered in the initial iterations of coding schemes, including driver problems, participant evaluations of workshop artifacts, and participants' engagement with the workshop content. However, the coding process became increasingly complex after analyzing data from just two participants, prompting the author to introduce numerous additional codes to the initial scheme.

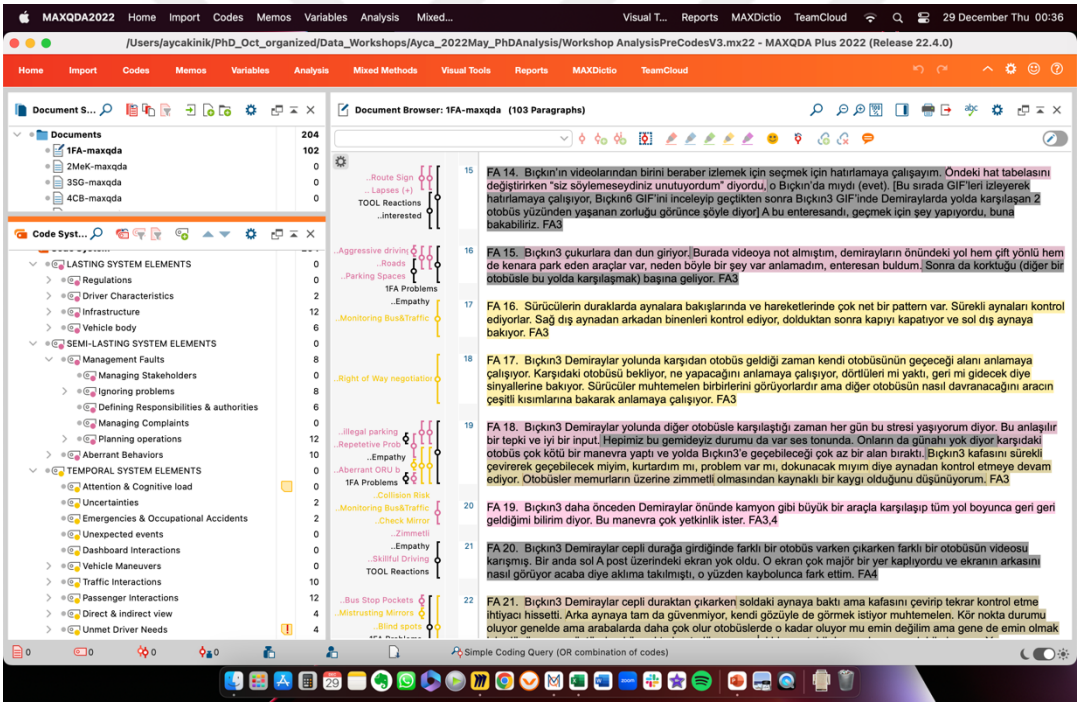


Figure 40 Screenshot from the third version of MAXQDA coding.

To address the challenge of managing a large number of codes and avoiding analysis paralysis resulting from numerous approaches to analysis, the author returned to handwritten notes and subsequently split the analysis of the synopses into two distinct parts. The first part focused on how participants defined driver

problems during the workshops, while the second part examined participants' utilization of the workshop and their assessments of its utility.

For the first part of the synopsis analysis concerning the driver problems, MAXQDA codes were transferred to Miro and underwent multiple rearrangements. Throughout this process, comparisons were made with bus driver issues identified through literature review, field research observations, and workshop synopsis files. This comparison with different data sources resulted in modifying the problem categorization. While the initial categorization was focused on the bus driver tasks, as this categorization was based on the literature, the subsequent categorizations included participants' particular problem identifications. In addition, participants sometimes focused on solution ideas without referring to any problem or as a response to a combination of several problems, which was also included in the subsequent categorizations.

In the subsequent problem categorization, the identified issues were classified into three categories: problems related to the products (Appendix K), unmet driver needs (Appendix L), and undesirable actions of traffic actors (Appendix M). An attempt to visualize this categorization involved incorporating bus driver tasks, such as "approaching the bus stop," and solution ideas proposed by participants, such as "implementing a communication system between drivers, managers, and passengers." This process resulted in the refinement of the model of the driver experience by eliminating overlapping problem groups (see 7.1). This model also enabled the visualization of interactions among different categorization elements, such as the relationship between driver needs and organizational culture, as identified by participants.

The second part of the synopsis analysis focused on examining how participants *utilized* and *assessed* the workshop. To accomplish this, participant utterances were categorized into four groups: those concerning the driver experience map, personas, videos, and other evaluations. Participant responses to the post-workshop questions and any spontaneous utterances specifically addressing participant

preferences about the workshop are categorized as *assessments*. On the other hand, participants' engagement with different artifacts, such as personas or the driver experience map, as well as their varied ways of utilizing different artifacts, such as identifying a task sequence from gaze information, are grouped as *utilizations*. Upon deciding to divide the synopsis analysis into two parts, MAXQDA was utilized to group the synopses, select the relevant ones for direct quotation, and ensure the inclusion of all necessary synopses. Simultaneously, handwritten notes were taken to support the analysis and its integration into the thesis writing process.

The outcome of the phase encompassed two key aspects. Firstly, it involved the identification of problem areas to improve the bus driver experience. Secondly, it encompassed the evaluation of the artifacts and the procedure used in the study. Through the execution and analysis of workshops, a triangulation of bus driver problems was achieved, leading to a holistic understanding of the dimensions encompassing bus driver experience and areas for potential enhancements. Notably, design professionals encountered moments of hesitation when confronted with some problems and their corresponding design ideas, consequently highlighting the barriers that impeded the improvement. Furthermore, observing and analyzing the interactions between design professionals and the final versions of the artifacts and workshop procedures provided insights into further development of the artifacts and the procedure and potential alternative applications.

Pre-workshop interviews highlighted the influence of designers' previous experiences on their problem focus, emphasizing the importance of involving stakeholders with diverse backgrounds in the project. These interviews underscored how individual perspectives and expertise shaped problem understanding and guided the approach to addressing challenges. When combined with workshop observations, post-workshop interviews served as a platform for participants to express their insights and evaluations. These interviews provided participants’ reflections on their experiences with the artifacts and the workshop procedure, allowing for a comprehensive understanding of their perspectives and feedback.

4.3 Ethical Considerations and Limitations:

Ethical considerations are paramount in this study. Informed consent is obtained from all participants, and anonymity and confidentiality are maintained during data collection and storage. Ethical committee approval was obtained before both the driver data collection and designer data collection to ensure compliance with ethical standards.

Besides the ethical considerations, it is important to acknowledge the limitations and delimitations of this study. As a result of being a case study, contextual constraints of the case may have impacted the research outcomes. However, the study provides insights into the dimensions of bus driver experience and recommendations for communicating user research findings in multistakeholder projects for developing products within sociotechnical systems that combine physical and screen interactions and are operated by professional users.

4.4 Roles of the Author

During the course of this study, the author assumed four different roles. The first role involved assuming the responsibilities of a user researcher, entailing the exploration and examination of bus driver experiences and perspectives. The second role involved the design of the workshop artifacts and the workshop procedure. Acting as a workshop facilitator, the author guided the workshop sessions according to a semi-structured script while actively listening to participants, posing clarifying questions, and responding to inquiries from design professionals. This approach fostered an interactive environment conducive to participant engagement and collaboration. Lastly, the author undertook the role of a project manager, encompassing tasks such as stakeholder management, ensuring effective communication, scheduling and organizing project-related meetings, and making decisions regarding the study's direction following each phase.

CHAPTER 5

DESIGN PROCESS AND ARTIFACTS

Building on the issues around the communication of user research (see Chapter 2 Section 3), this chapter explains the design iterations of the user research communication tool and the aspects of the final prototype that was utilized via the problem identification workshops. The following guidelines were identified to direct the design of the tool.

- Facilitate empathy with users, immerse designers into the holistic and naturalistic experience of the users, and engage designers with findings to counterbalance the overwhelming amount of data.
- Communicate task-related issues as well as the issues that are related to universal human needs; highlight the issues that affect road traffic safety, occupational safety, and users' comfort.
- Design a variety of research artifacts to communicate all eye-tracking, observational, and literature insights gleaned from the literature review about traffic safety and user research.
- Design the tool for corporate or interdisciplinary project settings where user researchers and designers have different roles and where the product team members mostly don't have direct contact with the users.
- Design the tool as a database so that the research findings can be revisited for future projects and can be accessed by different team members on demand.

5.1 Design Iterations

This section documents the six main design iterations carried out during the research through design (RtD) phase of the Ph.D. study. Initially, the tool was

planned for face-to-face workshops, but due to the COVID-19 pandemic, it had to be redesigned as a remote tool after the first version. The design process of Version 1 and Version 2 constituted the majority of the time invested in the RtD phase, with Version 1 taking seven months to develop and Version 2 taking nine months. Between the design of Version 1 and Version 2, there was a COVID-19 pause that lasted approximately one year. During the COVID-19 outbreak, while serving as a visiting professor of industrial design at Tec de Monterrey, the author utilized Miro as an institutionally provided tool for remote collaboration in designing and delivering classes. In these online classes using Miro, various approaches were tried to guide students in integrating user research findings into their design projects. Drawing upon familiarity with the platform's capabilities, the decision was made to construct the tool on Miro. The explorations for the classes also informed the ways of conducting shorter workshops and the utilization of different design artifacts, such as personas and journey maps in this study. Version 2.0, which was design on Miro, was then implemented in the first pilot workshop, and the outcomes from this workshop informed the design iterations for the Pilot 2, 3, 4, and the final version, which were developed over a span of four months.

5.1.1 Version 1: Designing face-to-face Workshops pre-COVID-19

The first version of the workshop includes a digital interactive tool to view driving videos, card sets for probing the design thinking process, and a workshop procedure that consists of five design thinking phases. The primary focus of this version was placed on the exploration of eye-tracking videos' potential as a central component of the tool to provide immersive and contextual information for user research communication. Computational challenges were encountered due to the size of these videos, and synchronization issues were identified during initial attempts using Adobe Premiere Pro. To address these challenges, Loiloscope software was employed, enabling easy video resolution reduction and the creation of fifteen-minute clips, thereby resolving the computational issues and facilitating

smoother video handling. The design process of Version 1 enabled the achievement of the following milestones.

Identification of Problem Groups

The identification of problem groups played a pivotal role in this phase. It involved the adaptation of ten problem groups by drawing upon the works of Salmon, Young, & Regan (2011), Shinar (2007), and Öz, Özkan, & Lajunen (2010), which encompassed various facets of bus driver tasks, traffic safety risks, and risky driving behaviors associated with stress reactions. To consolidate these insights and incorporate them with observations made during the driver data collection phase, an affinity diagramming approach was employed. This process facilitated the categorization of issues into specific problem groups, thus providing a framework for analysis and video analysis. Below is a list of these problem groups, along with exemplary events illustrating their significance:

1. *Driving the bus / Maneuvering:* Encompasses tasks such as high or low-speed steering, speed adjustment, maneuvering around obstacles or turnabouts, approaching bus stops, reversing, and parking.
2. *Interactions with Other Road Users (ORUs):* ORUs include pedestrians, cyclists, and other vehicles. This problem group addresses the challenges of understanding the intentions of ORUs and responding appropriately, such as pedestrians suddenly entering the vehicle's path or waiting for other vehicles at turnabouts.
3. *Pre-departure Controls and Maintenance:* Involves checking engine, fuel, and brake indicator lights/displays, inspecting the interior and exterior of the bus for cleaning or maintenance needs, or locating items left behind by passengers.
4. *Passenger-Related Tasks:* Encompasses tasks like assisting passengers boarding or disembarking, responding to passenger queries, and providing directives when passengers obstruct the driver's view.

5. *Driver Behaviors and Personality:* Encompasses factors such as annual driving distance (mileage), previous accident involvement, personality traits (e.g., thrill-seeking tendencies or aversion to driving), and violations related to speed, use of occupant protection, and aggressive driving.
6. *Driver Capabilities:* Addresses aspects like anthropometry and biomechanics of sitting/driving posture and reach, sensory capacity and limitations, cognitive abilities, distractions, inattention, fatigue, emerging health issues, and the challenges associated with younger novice drivers or older drivers.
7. *Communication with the Task Operation Center (TOC):* Involves receiving calls from the TOC, informing the TOC about unexpected situations like accidents or traffic congestion that disrupt the original route schedule, and managing shifts efficiently.
8. *Personal and Comfort Tasks:* Encompasses activities like arranging personal belongings in the vehicle (e.g., jacket, phone, tissue papers), adjusting music or radio settings, controlling air conditioning, and managing incoming personal calls or messages.
9. *Environmental Factors:* Considers variables such as weather and light conditions, road surface conditions (e.g., wet, icy, potholes), road geometry, and natural disasters that can impact the driving experience.
10. *System-Related Issues:* Addresses concerns like shift arrangements, locating the bus's previous parking spot, ensuring equitable distribution of shifts, fostering cooperation and communication with managers and other connected departments, examining the safety culture within the organization or country, and identifying recreational areas for eating, resting, and socializing between driving shifts.

Trial Video Clips

Four trial video clips, each ranging from 25 seconds to 1 minute and 29 seconds, were created and annotated. This section describes trial clips and their annotation in order to identify annotation types and a strategy for video clip preparation.

Preparations of video clips yielded four types of annotations: speech translations, time and pace annotations, descriptors, and event codes. Below, detailed reflections on each annotation type are provided.

Descriptors: These constitute annotations that include the author's interpretations of drivers' feelings, intentions, and significant events, presented in an omniscient narration style. This narration style offers an in-depth exploration of characters' inner worlds, but some readers may find it less immersive because they are not directly experiencing events through a character's perspective (Abbott, 2008). Additionally, descriptors like "driver notices the gas pump connection" introduce the author's interpretations of the driver's gaze location, which, while realistic, limit participants' opportunities to form their interpretations, hence potentially reducing engagement and diverting their focus from observing the actual events in the videos.

Speech Translations: One aspect of the video annotations was the inclusion of direct Turkish-to-English translations of the conversations within the videos. These translations aimed to emphasize conversations relevant to the events in the selected videos and to engage English-speaking participants in the study. However, translating certain Turkish expressions, like "her gün bu stresi yaşamak zorundayız yani!" which can be translated as, "We have to live with this stress every day, you know!" posed a challenge. This expression, conveying driver frustration and irony, implies that the stress is unjustly imposed on them daily due to decision-makers' lack of concern. The implied meaning stems from a previous conversation with the driver, which is not

recorded on the video. An accurate translation is time-consuming and requires professional services, given the nuanced cultural context, which the author couldn't fully capture within this study's timeframes for the entirety of the videos.

Time and Pace Annotations: These refer to the inclusion of timers and fast-forward icons in the selected sections of the videos. Timers mark the events where the duration of the tasks is deemed important by the drivers or the author. These annotations highlight any disproportionate task durations, potentially influencing decision-makers and inspiring alternative design solutions. While task completion time is a frequently used metric in usability evaluations and observing disproportionately long task completion times can be inspiring, videos are not focused on usability assessment. Instead, the aim is to guide designers to discover a variety of problems. Including the timers, which provide granular information about task durations, may inadvertently suggest a usability evaluation focus that goes beyond the study's intended scope. Fast-forward icons, on the other hand, aimed to maintain narrative coherence while preventing viewer boredom and time consumption during user research immersion. While this practice enhances video narration's coherence and viewing duration, it may cause confusion when the driver's gaze moves rapidly across the viewing area.

Event Codes: Event codes help structure video problems, integrate literature and observation knowledge, and direct participants' attention to particular events. However, as a single event in the video may encompass multiple codes, a decision must be made between including all codes and risking screen overcrowding or selecting the most significant codes for the author, potentially constraining participant interpretation. Furthermore, coding each event is a time-intensive process.

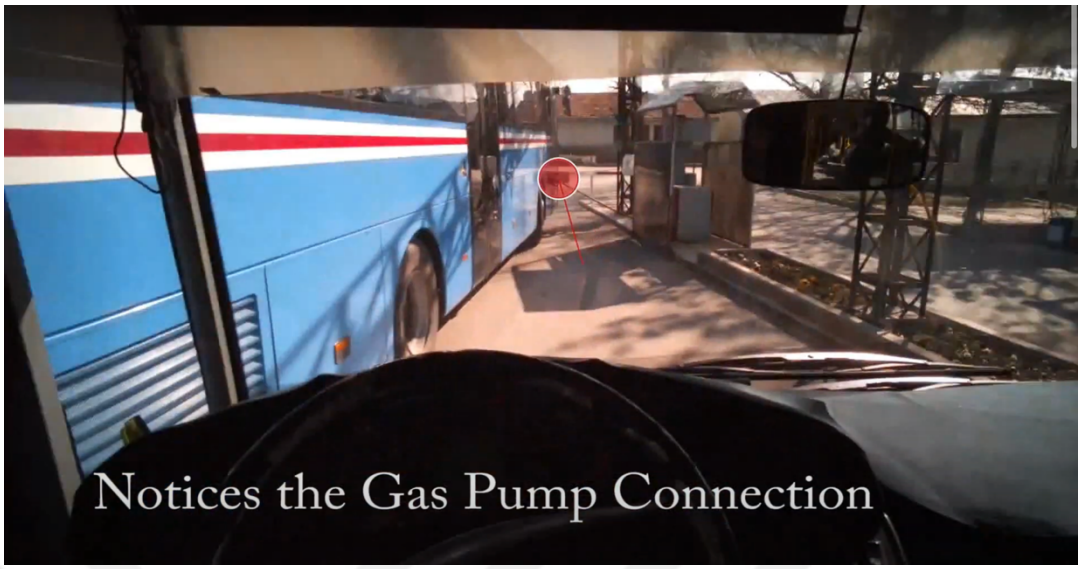


Figure 41 Clip 1 Screenshot: Reversing maneuver at the fuel station.

Clip 1 presents a challenging reversing maneuver at the fuel station where another bus is parked that obstructs the road for the ego bus (Figure 41). The video does not have any conversation and captures a 32-second sequence of maneuvers and glances. Therefore, the only annotations are descriptors such as "right mirror check." Descriptors of this clip include the conduct of the driver as well as the author's interpretation of the ego driver's glances. The events and annotations of the clip are as follows (Table 4).

Table 4 Clip 1 events and annotations.

#	**Event**	**Annotation**	**Annotation Type**
1	The driver initiates the shift but encounters an obstacle as another bus is parked in front.	Has to start the shift but a bus parked in front	Descriptor
2	The driver switches to reverse gear, indicating the intention to navigate the obstacle.	Switches to reverse gear	Descriptor
3	Left and right mirror checks are performed to assess the surroundings.	Left mirror check, Right mirror check	Descriptor
4	The driver notices that the other bus is connected to the gas pump, introducing an additional complexity (Figure 41).	Notices the gas pump connection	Descriptor
5	The engine is started, and the driver checks the relevant indicator.	Starts the engine and checks the indicator	Descriptor

Table 4 Clip 1 events and annotations (cont'd).

6	The driver rechecks the gas pump connection of the other bus to ensure safe maneuvering.	Observes the gas pump connection	Descriptor
7	Just before commencing the maneuver, the ego driver notices a pedestrian emerging in close proximity. The driver waits for the pedestrian to move to a safe spot before proceeding.	Checks the pedestrian	Descriptor
8	The driver initiates the reverse maneuver, conducting several right and left mirror checks and monitoring the immediate environment to ensure a safe and precise maneuver.	Right mirror check, Checks the pedestrian, Left mirror check, Checks the pedestrian, Right mirror check	Descriptor

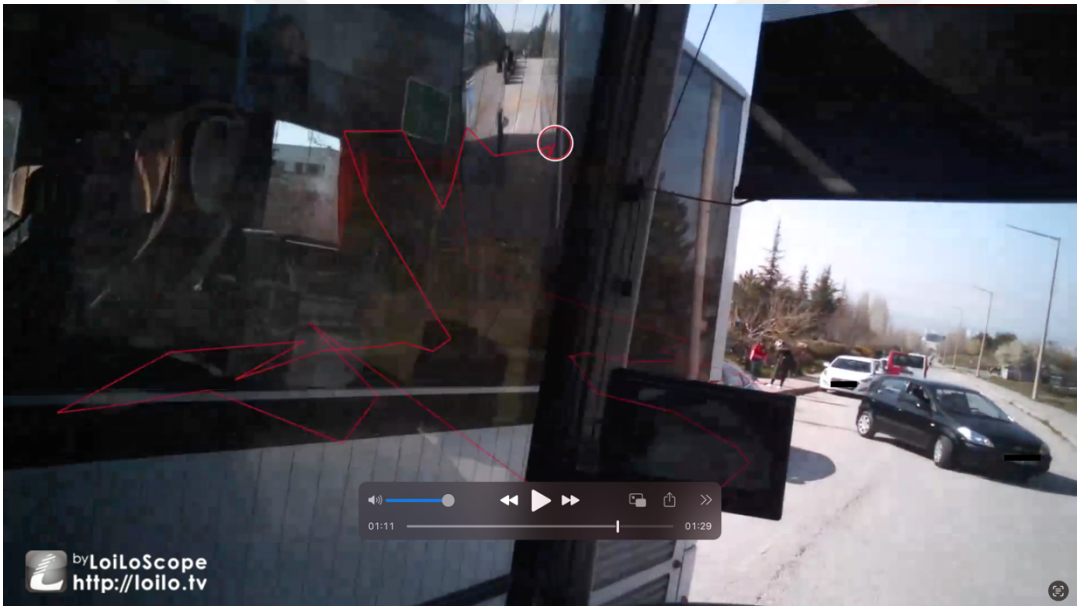


Figure 42 Clip 2 Screenshot: Two buses on a narrow road.

Clip 2 depicts two buses on a narrow road attempting to pass each other without colliding (Figure 42). Meanwhile, the ego driver conveys his frustration and annoyance through his speech. This clip is annotated with speech translations in addition to descriptors such as "driver notices the oncoming bus" or "driver sounds frustrated." Descriptors of this clip include the emotions of the ego driver as different languages may convey emotions differently, and English-speaking viewers might not fully grasp the driver's emotional state. After this clip was

prepared, it was realized that additional annotations were needed for the driver's gaze (Figure 43) and the sped-up portions of the clip. The events and annotations of this 1-minute and 29-second clip are as follows (Table 5).

Table 5 Clip 2 events and annotations.

	Event	**Annotation**	**Annotation Type**
1	The ego driver is navigating a narrow, two-lane, undivided road with oncoming traffic. Parking is prohibited on this narrow road, but vehicles are parked on the left-hand side, which is designated for oncoming traffic. The ego driver notices another bus approaching from the opposite direction.	He sees the bus coming from the opposite direction	Descriptor
2	Ego driver continues driving and begins to speak in frustration. The frustration arises because two buses from opposite directions are forced onto a single lane due to illegally parked vehicles, and they will have to pass each other side by side.	-Now look at this! -The real surprise is here! -The real problem is here, unfortunately	Speech Translation
		He sounds frustrated	Descriptor
3	Both buses continue to advance towards each other. However, the bus from the opposite direction finds a gap among the parked cars and attempts to enter that space to provide as much room as possible for the ego bus. The ego driver glances at the front wheel of the oncoming bus to foresee its maneuver, hence the other driver's intention (Figure 43). Ego driver continues speaking.	-I don't know who will give the way to the other -My fears came true -We feel this stress everyday	Speech Translation
		He sounds annoyed	Descriptor
		The glance of the ego driver could be annotated as IRU (interaction with other road users)	*Event code*
4	As the ego bus continues forward, ego driver's glance moves to the back of the other bus, noticing another car approaching from behind the oncoming bus. The approaching car moves in reverse and maneuvers into a gap among the parked cars, allowing the ego bus to pass.	NA	NA
		The glance of the ego driver could be annotated as IRU (interaction with other road users)	*Event code*
5	The ego bus proceeds slowly, continuously checking the left and right mirrors as the maneuver takes considerable time. This portion of the video has been sped up to prevent viewer boredom.	NA	NA
		[Sped up portion could be annotated with a fast forward icon]	*[Time and Pace]*

Table 5 Clip 2 events and annotations (cont'd).

6	After successfully passing each other without collision, and commencing the drive, the ego driver talks in annoyance	-It's like threading a needle -We passed safely but it was hard	Speech Translation
		He sounds annoyed	Descriptor



Figure 43 Clip 2 Screenshot: The oncoming bus enters a space. The ego driver glances at the front wheel of the oncoming bus to foresee its maneuver, hence the other driver's intention.

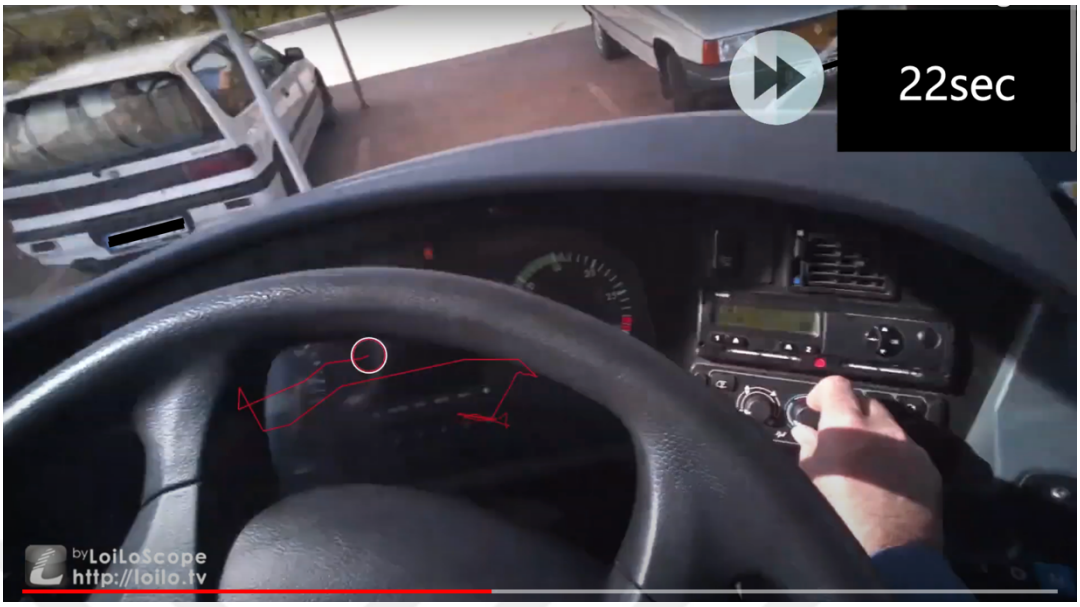


Figure 44 Clip 3 Screenshot: Attempting to turn the air conditioning on.

Clip 3 portrays a 25-second segment capturing the initial moments of the departure (Figure 44). Within this clip, the ego driver attempts to turn on the air conditioner, although their intent remains implicit, as no verbal communication is evident in the video. The video shows the driver engaging with various controls and scrutinizing a display for an extended duration before initiating the drive. To prevent viewer boredom, a portion of the video has been accelerated. The annotations of this clip include a timer, a fast-forward icon highlighting the accelerated segment, and descriptors. These descriptors aim to elucidate the ego driver's intentions, which are not visually apparent in the video. The events and annotations of this 1-minute and 29-second clip are as follows (Table 6).

Table 6 Clip 3 events and annotations.

	Event	**Annotation**	**Annotation Type**
1	The ego driver tries to turn on the air conditioning.	Tries to turn on air conditioning	Descriptor
		Timer display “1 sec”	Time and Pace
2	The ego driver glance moves between display and controls for an extended period of time to understand if the air conditioning has started. This portion of the video has been sped up to prevent viewer boredom.	Timer display counts up to “45 sec”	Time and Pace
		Fast forward icon	Time and Pace
3	The ego driver gives up on turning on the air conditioning and checks his phone and the right mirror.	Gives up without turning on	Descriptor

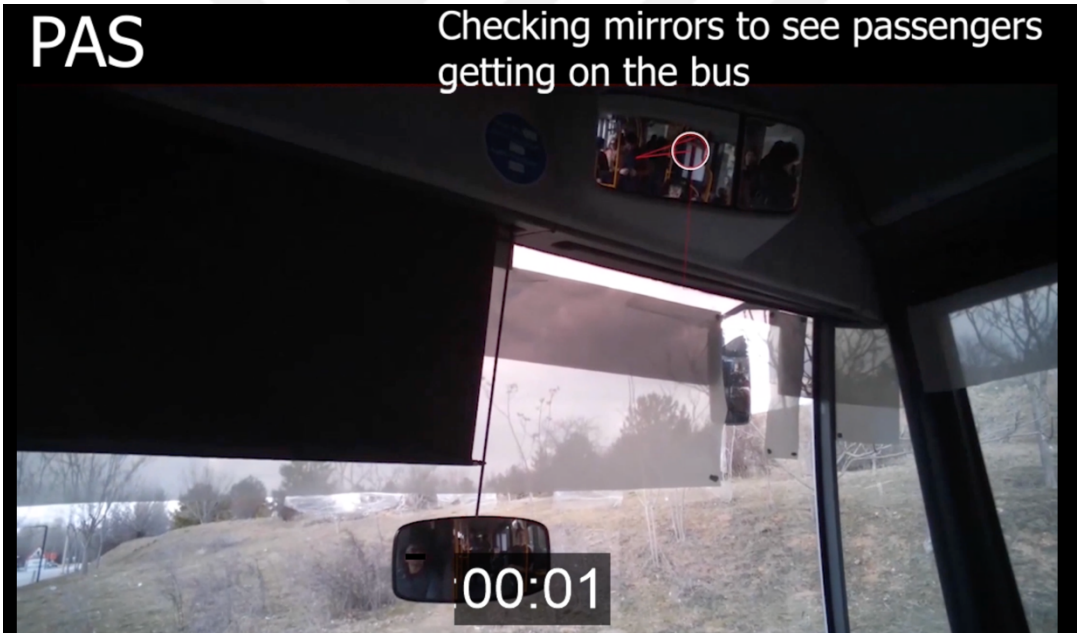


Figure 45 Clip 4 Screenshot: Checking Mirrors

Clip 4 illustrates the ego bus pulling into a dedicated bus bay, picking up passengers, and then departing from the bay onto the main road (Figure 45). In this 1-minute and 5-second clip, the annotations include translated conversations, descriptors, a timer, and event codes. One descriptor type of this clip is the intentions of the ego driver, such as “turns back to check the mirror blind spot.”

Another descriptor type depicts the source of a phone ring tone as “his phone rings.” Clip 4 includes a timer for displaying the duration of passenger boarding, but this segment is presented at its natural, unaltered speed. This decision is based on two considerations. Firstly, the duration of passenger boarding was relatively short, and speeding up this segment would have resulted in a loss of video coherence. Secondly, bus stops are positioned in close proximity to each other to enhance the passenger experience. However, this proximity can sometimes lead to driver frustration, as passengers may take their time boarding or disembarking, prompting drivers to feel restless and impatient. Consequently, the intention behind presenting the full, unaltered duration of the boarding process is to provide viewers with an authentic depiction of this regular aspect of a driver's experience. In addition to other types of annotations, clip 4 employs event codes such as “MAN” for the maneuvering situation, “PER” for personal and comfort tasks, and “PAS” for passenger-related tasks. These codes correspond to identified problem groups, serve the purpose of directing viewers' attention to particular situations, and provide informative cues regarding potential problems from the literature. The events and annotations of this clip are as follows (Table 7).

Table 7 Clip 4 events and annotations.

#	Event	Annotation	Annotation T.
1	The ego driver approaches the dedicated bus bay and notices a pedestrian jumping onto the road, as well as a vehicle illegally parked on the left side of the road where the pedestrian jumped.	IRU *(interaction with other road users)* + Notices the pedestrian and the car	Event Code + Descriptor
2	The ego driver takes several glances at the pedestrian and the parked vehicle to assess the situation. Concerned about the parked car potentially cutting in front of the bus, the driver observes their movements.	IRU + Notices the pedestrian and the car	Event Code + Descriptor
		White car is parking in the wrong direction, catches his attention [*blinking text with a red highlight]*	Descriptor
3	After determining that the car is indeed parked and the pedestrian will safely cross the road, the ego driver begins looking into the bus bay, preparing for a right turn to enter it.	MAN *[maneuvering the bus]* + Approaches to the bus stop	Event Code + Descriptor

Table 7 Clip 4 events and annotations (cont'd).

4	There are 18 people waiting at the bus stop. One pedestrian is sitting on the curb with their legs on the road, while another is passing in front of the bus.	MAN + Approaches to the bus stop	Event Code + Descriptor
		18 passengers waiting. No one wants to get off *[orange highlighted text]*	Descriptor
5	The ego driver checks the pedestrians to ensure safe passage for the walking pedestrian and to avoid hitting the seated one. The driver also decides where to stop for the waiting passengers.	NA *[The glance of the ego driver could be annotated]*	NA *[Event Code]*
6	The ego driver checks the right interior mirror, right outer mirror, and middle mirror on the windshield to confirm that all passengers have boarded safely (Figure 45).	PAS *[passenger related tasks]* + Checking mirrors to see passengers getting on the bus	Event code + Descriptor
7	Since the bus is not very crowded, no passengers are disembarking, and none of the boarding passengers have special needs that would extend the boarding time, the process goes smoothly, taking only 16 seconds. The ego driver closes the door and proceeds to merge back onto the main road.	PAS + Checking mirrors to see passengers getting on the bus	Event code + Descriptor
		Passengers get on and get off through the same doors, at the same time	Descriptor
		Timer display counts up to "00:16"	Time and Pace
8	An oncoming vehicle approaches and the ego driver checks the far end of the oncoming road on the right side to assess the traffic situation.	MAN + Checks the road	Event Code + Descriptor
9	The ego driver checks the left outside mirror to determine if the lane the ego bus will merge into is clear. Although no vehicles are visible in the left mirror, the driver continues to turn their head to check the mirror's blind spot before initiating the merge. The ego driver's notices a vehicle and decides to wait while his phone begins to ring (Figure 46).	MAN + Turns back to see the mirror blind spot *[red highlighted text]*	Event Code + Descriptor
		PER *[personal and comfort tasks]* + His phone rings [*blinking text with a red highlight]*	Event Code + Descriptor
10	Sounding nervous about answering the call, the ego driver turns his head asks the author if he can take the call, but then ignores the call.	- Can I take the call? - (researcher) Sure	Speech Translation
		Phone ring stops	Descriptor
11	The ego driver checks the road once more and proceeds to merge	MAN + Drives out of the bus stop	Event Code + Descriptor



Figure 46 Clip 4 Screenshot: Merging onto the main road.

Interactive Digital Tool

An interactive digital tool developed using Adobe XD comprises four essential screens. These screens include the home screen, video player screen, event screen, and basket screen. The home screen serves as the entry point, featuring a campus map housing video clips recorded at various campus locations (Figure 47). The thumbnails of these clips are taken from one of the significant moments of the clip and positioned on the map, reflecting their actual recording locations. Displaying video locations is relevant as different campus areas exhibit varying traffic conditions and road geometries, influencing driving maneuvers and driver's interactions with road users and passengers.

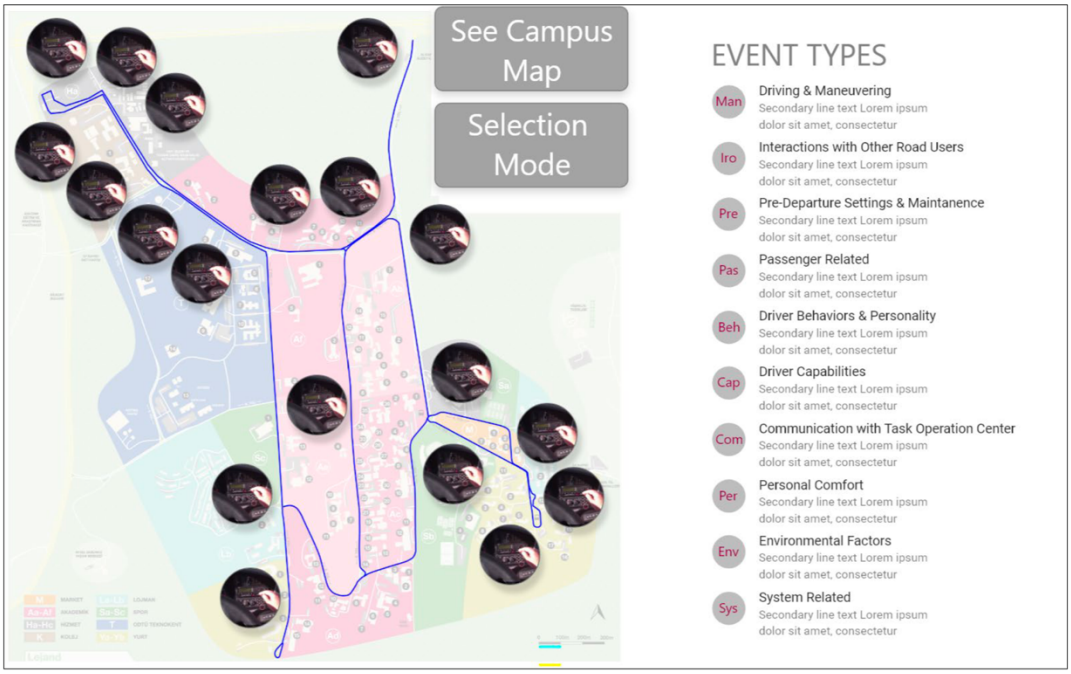


Figure 47 Version 1: Home Screen

The home screen also provides access to a complete list of event types, each coded with labels such as MAN (maneuvering), PAS (passenger-related tasks), and PER (personal and comfort tasks). Clicking on these icons navigates users to the event-type screen (Figure 48), which contains descriptions of each event type and showcases exemplary vehicle automation features through animated GIFs sourced from NHTSA (2019). These pages aim to assist participants in interpreting videos, framing problems, and incorporating automation technologies.

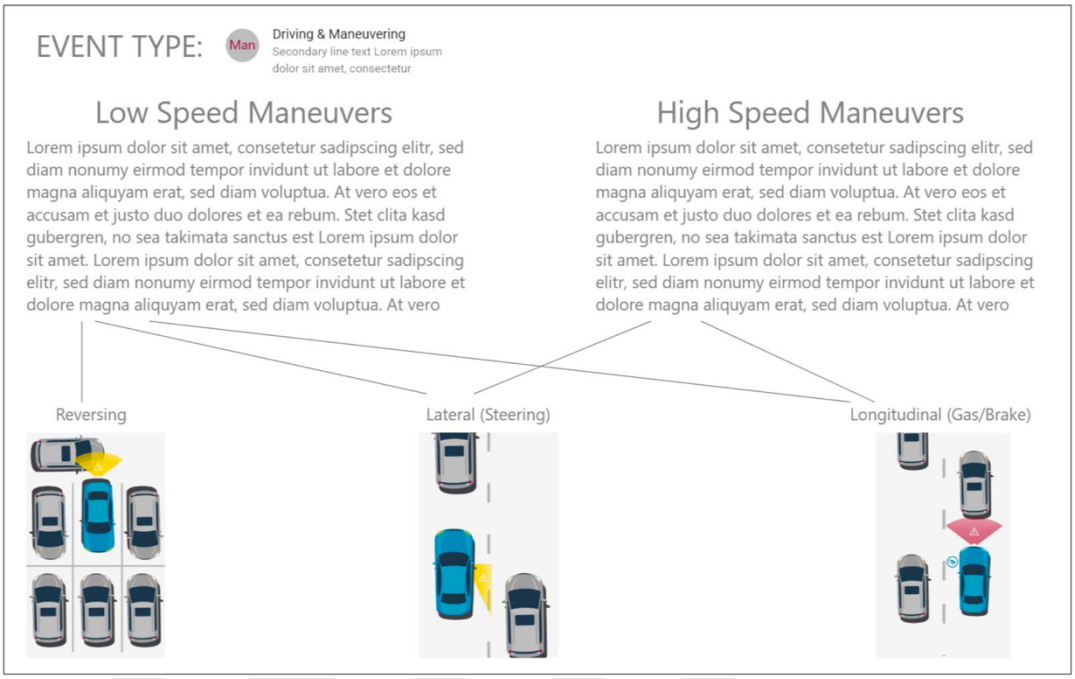


Figure 48 Version 1: Event Type Screen

Upon selecting a video thumbnail, the video player screen opens (Figure 49), offering playback controls, including play, pause, and volume adjustment, along with the option to add videos to the basket. This screen enables participants to watch the video, review associated event types, and add the clip to their basket for ideation purposes. The basket screen contains selected video clips for use in the ideation phase and subsequent design stages.

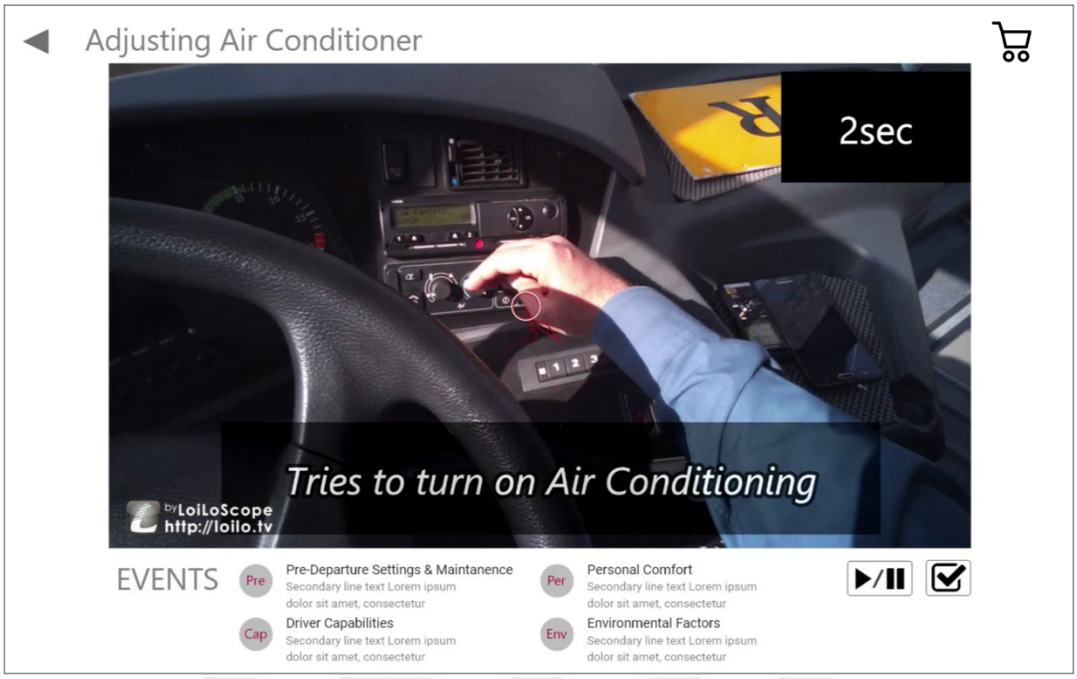


Figure 49 Version 1: Video Player Screen

Workshop Plan

A provisional workshop plan was drafted to identify how participants would engage with the digital tool, the extent of their engagement, and the topics of information that would be provided in addition to the digital tool. Additional information topics were included with the aim of enhancing participants' understanding, decision-making, and creative ideation throughout the workshop steps. User research knowledge can be of utility throughout the whole design process for various stakeholders, including designers, engineers, and other decision-makers within an industry setting. For this reason, a five-step design thinking process, similar to a real-life project, was planned to be employed. The design thinking process helps teams address uncertainty by providing a structured approach that allows for gradual framing and exploration of design problems and opportunities. It enables rapid validation of assumptions, learning from failures, and iterative refinement, all of which contribute to reducing uncertainty and enhancing the overall quality of the final design solutions.

However, it became apparent that completing all five steps of the design-thinking process could take up more than what is possible within the scope of this thesis. In a similar way, Sleeswijk Visser (2009) examines the effects of sharing raw user research data with designers in design workshops resembling the design thinking process for her dissertation study. Her research reveals that conducting both user research data immersion and ideation within a single workshop limits user research immersion. Consequently, she proposes dividing workshops into two separate sessions for each purpose.

Additionally, the coronavirus pandemic necessitated remote workshops with shorter workshop durations. Hence, for version 2, the decision was made to focus on the empathy phase to reduce online duration and improve the focus of the study. This abrupt change of plans also removed the possibility of testing version 1 with participants. Therefore, design decisions for version 2 were derived by reflecting on version 1 and the process as explained below.

Reflecting on Version 1 and the Process

The design of version 1 marks the initial steps taken in leveraging eye-tracking videos to provide immersive and contextual information to the participants. In addition, the design process laid the foundation for categorizing bus-driving problems, exploring various video editing and prototyping tools, and ways of annotating videos.

One of the key challenges of this iteration was striking a balance between comprehensiveness and manageability of the extent of the study. The initial design of the tool and the workshop process aimed to incorporate a wide range of video annotations and external knowledge topics to support the whole design process. However, as the study progressed, the need to streamline the tool became more evident, and the workshop's scope was refined to focus on the empathy phase.

Reflecting on Problem areas for bus driving:

The author identified problem groups through literature and field research, deciding to integrate them into the workshop framework for a more comprehensive understanding of bus driving challenges. This enriches participants' experiences, capturing diverse and abstract aspects not easily visible in video clips but crucial to the driver's experience. Contextual information also enhances empathy with drivers.

While integrating problem groups into this study is useful, a decision was made to alter the form of integration. Initially, this information was annotated on the videos with codes, such as 'MAN' for driving and maneuvering problems, but this was later abandoned as they cluttered the screen. Additionally, comprehending and remembering the three-letter acronyms of the problems was deemed difficult. As a result, these codes were removed from the videos and presented separately in the second version with the help of graphics.

Reflecting on Interactive Tool

Building a prototype helped assess the limitations of prototyping tools and the author’s own capabilities within the time constraints of the thesis. As the videos play a central role in this tool, the large file size of the videos posed challenges to embedding multiple video clips in an Adobe XD prototype. In addition, transitioning to online workshops necessitated an online repository for the videos such as YouTube or Vimeo that would seamlessly integrate into Miro.

Reflecting on Annotations

Annotating the videos proved to be exceedingly time-consuming. Annotating four clips with a total duration of 3 minutes and 31 seconds took a couple of weeks. Considering the total duration of the final clips, which amounted to 2 hours, 14 minutes, and 11 seconds, annotating them was not feasible for this study. In addition, translating daily conversations from Turkish to English while accurately conveying cultural nuances was beyond the thesis's scope and the author's capacity.

Furthermore, there was also a risk that the annotations would diminish the immersive quality of the first-person perspective videos. As a result, the decision was made to discontinue annotating the videos except for the fast-forward icons and continue with Turkish-speaking participants.

5.1.2 Version 2: Remote and Online Workshops

The second version was implemented on the online platform called Miro. Miro serves as an infinite digital whiteboard, accommodating text, images, videos, and external video platform links, such as Vimeo. The tool's accessibility extends to anyone with an internet connection, irrespective of account ownership or familiarity with the platform.

This transition brought about significant adjustments to the tool's design and the workshop framework. Unlike Version 1, in which face-to-face workshops relied on in-person presentations and prompts, Version 2.0 demanded a shift toward asynchronous participant activities, recognizing the limitations of extended online engagement. As a result, the need arose to condense and visualize the presentation material and integrate it directly into the tool.

Two areas of the tool underwent updates to adapt to the online environment. These included the reorganization and visualization of problem groups and a complete overhaul of the workshop process. Furthermore, building on the progress from the earlier version, the driver experience map and driver personas were integrated, and a curated selection of video clips was introduced. This section reports the design and evaluation processes that shaped Version 2.0.

Organizing the Miro Board with Complementary Information

Transitioning to Miro brought about some opportunities as it has internal visualization features and allowed prototyping a range of interactivity with various

media types without any knowledge of coding. Boards are the foundational elements in Miro, serving as digital canvases for creating and organizing content collaboratively. Frames, on the other hand, provide a means to create separate sections or containers within a board, enhancing organization and clarity, particularly in complex projects. This study leveraged a range of features, including frames and boards for organizing a wide variety of media, embedding animated GIFs and videos on boards and frames, creating interactive links between boards, frames, and external web pages, and utilizing pan navigation for board exploration by clicking and dragging.

The main artifacts of version 2 are problem groups, driver personas, driving videos, and the driver experience map, as explained in the following sections. In addition to the main artifacts, complementary information is also included to provide contextual understanding. There are three complementary information frames that include Miro introduction, vehicle automation, and METU shuttle facts. In the Miro introduction frame (Figure 50), participants are guided on the basic operations within Miro. It explains how to select, copy, zoom in and out, undo actions, and other basic functions. Below this guidance, an interactive area is provided where participants can practice these features, helping them become familiar with Miro's user interface and functionality.

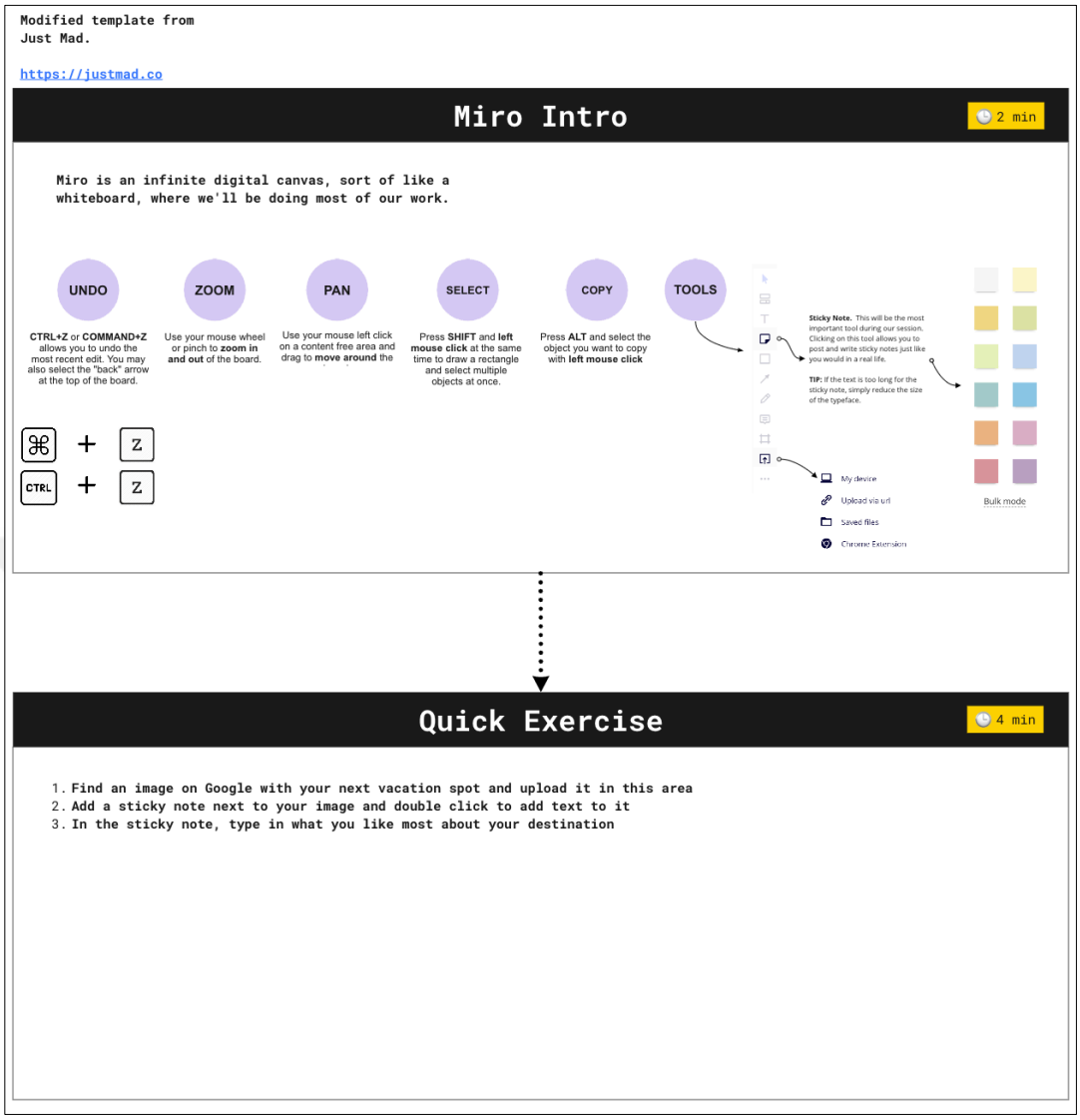


Figure 50 Miro Frame for Miro Tutorial

The second frame aims to inform participants about the scope of the study with regard to vehicle automation levels. It provides visualizations and explanations about six levels of vehicle automation defined by the Society of Automotive Engineers (SAE, 2016), spanning from level zero to level five. Levels four and five, known as high automation and full automation, respectively, are outside the scope of this study, as presented in Figure 51. Examples are illustrated using animated GIFs sourced from the National Highway Traffic Safety Administration's website to enhance the understanding of automation features (NHTSA, 2020).

These examples encompass three types of automation features. Warning features offer alerts and notifications to assist the driver in decision-making. Intervention features like emergency braking briefly intervene in specific situations, such as when a pedestrian appears unexpectedly in front of the vehicle, to enhance safety. In the third type, the automation system temporarily takes control of the vehicle. An example is traffic jam assist, which is designed to aid the driver in stop-and-go traffic situations. When activated, it takes control of certain driving tasks, such as maintaining a safe following distance, centering the vehicle in its lane, and controlling acceleration and braking. However, up to level four, the driver retains responsibility for the vehicle's operation and is, therefore, required to monitor the driving at all times. This distinction sets lower automation levels apart from higher levels, where the vehicle assumes a greater responsibility.

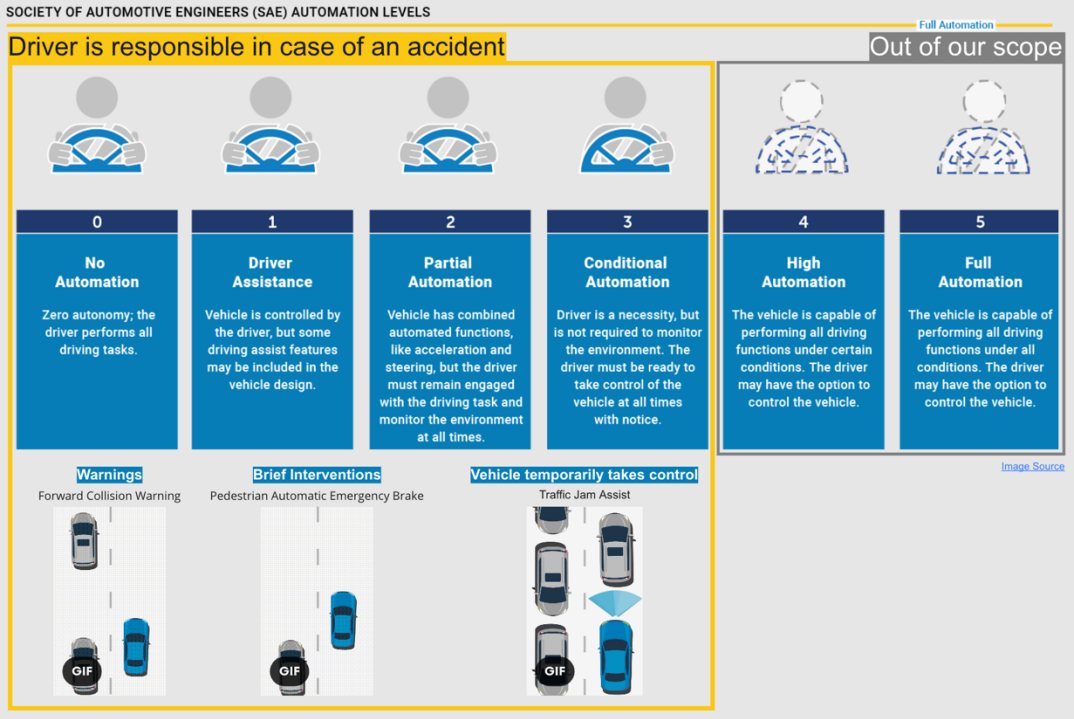


Figure 51 Miro Frame for Automation Levels and Exemplary Features

The third frame is crafted to incorporate some findings from field research and interview that the main artifacts were not able to capture (Figure 52). It provides a visual guide to METU Shuttle routes, using simplified route drawings to prepare

participants for the driver frames containing video clips. The text on the frame provides information about various aspects of METU Shuttle operations. These aspects include different routes, negative driver experiences due to the power dynamics regarding different employment types, drivers' preferences for specific bus types, and considerations regarding passenger accessibility and bus ergonomics.



Figure 52 Miro frame for campus shuttle facts.

Updating Problem Groups

The previously identified problem groups were restructured into two categories: task-related risk groups and driver and environmental risks. Task-related risk groups encompassed maneuvering the bus, interactions with other road users (ORUs), pre-departure controls and maintenance, passenger-related tasks, personal and comfort tasks, and administrative tasks. Driver and environmental risks are driver characteristics and environmental factors. The initial and updated problem categories are presented in Figure 53. Subsequently, each risk group underwent visualization through the manipulation and combination of royalty-free vector graphics sourced from www.freepik.com (Figure 54).

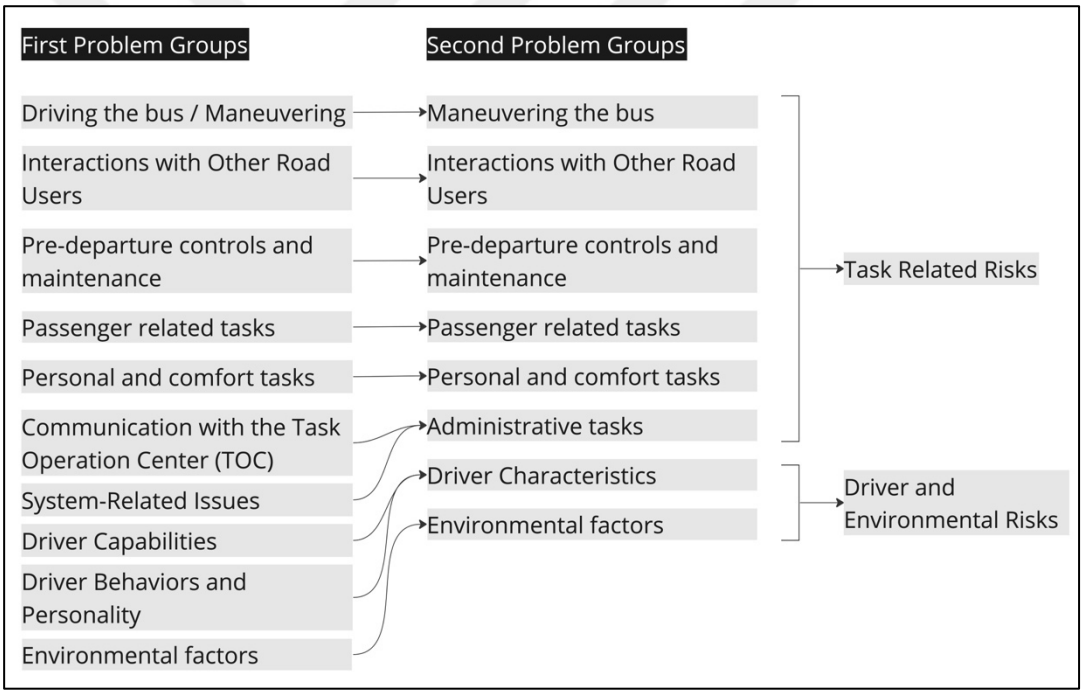


Figure 53 First and updated problem categories.

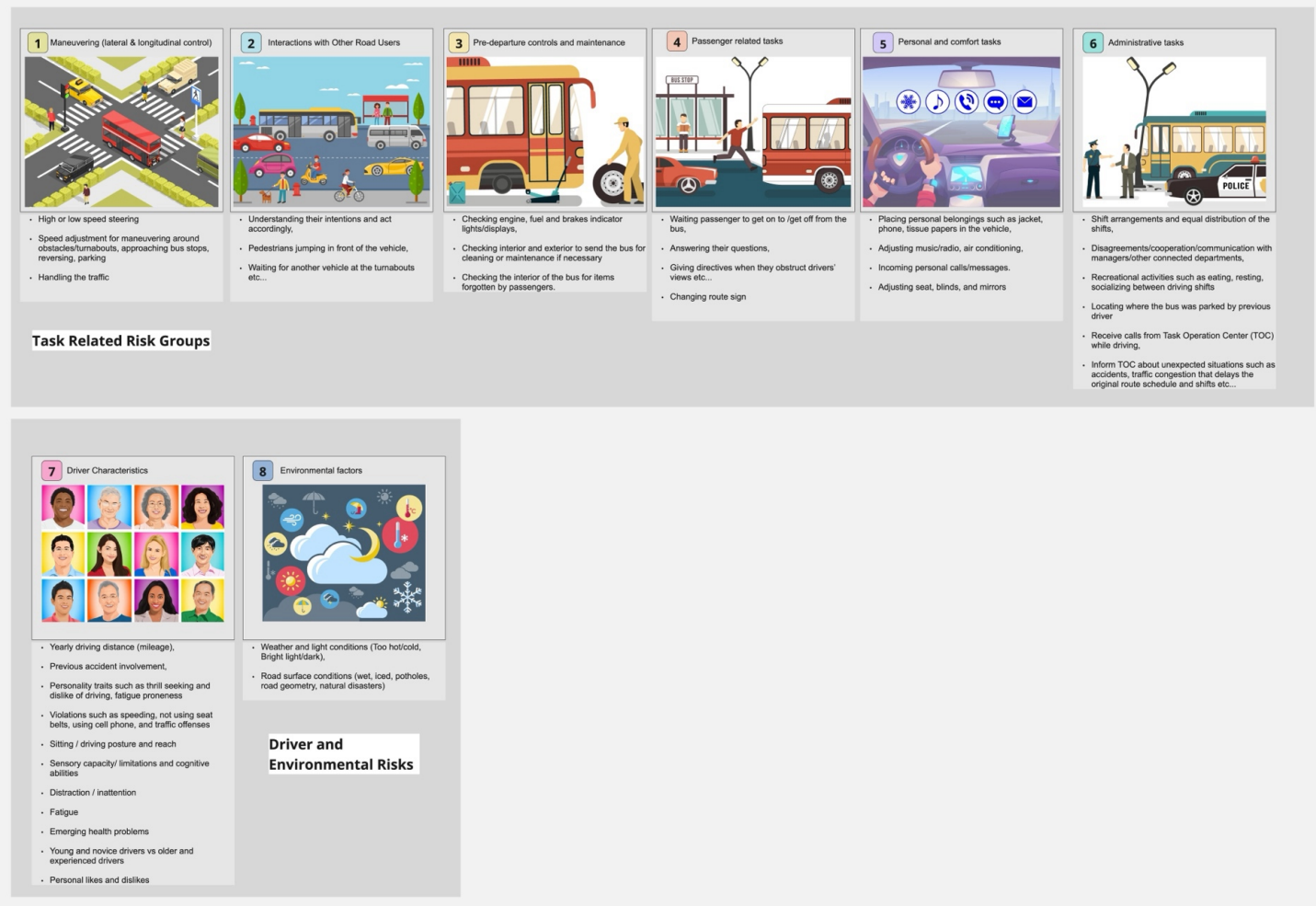


Figure 54 Problem group visualizations.

Incorporating Personas

Personas are representations of potential users that serve as archetypal figures to guide design decisions. A well-rounded persona typically includes several key elements, including the individual's name, age, gender, and a visually informative image supplemented with contextual background information (Interaction Design Foundation, 2020). According to this definition, it is advised to document the persona's experience and relevant skills in the specific domain related to the product or service under development. Moreover, providing a contextual description of how the persona might engage with the product or service, taking into account factors like their willingness to use, usage frequency, and preferred device, is essential. Finally, articulating the persona's goals, attitudes, and concerns when using the product or service is also encouraged. In line with these recommendations, a list of characteristics that could be relevant for a professional bus driver was brainstormed (Figure 55). These characteristics are informed by traffic safety literature and include negative driver behaviors, driver skills, driver health conditions, and driver attitudes.

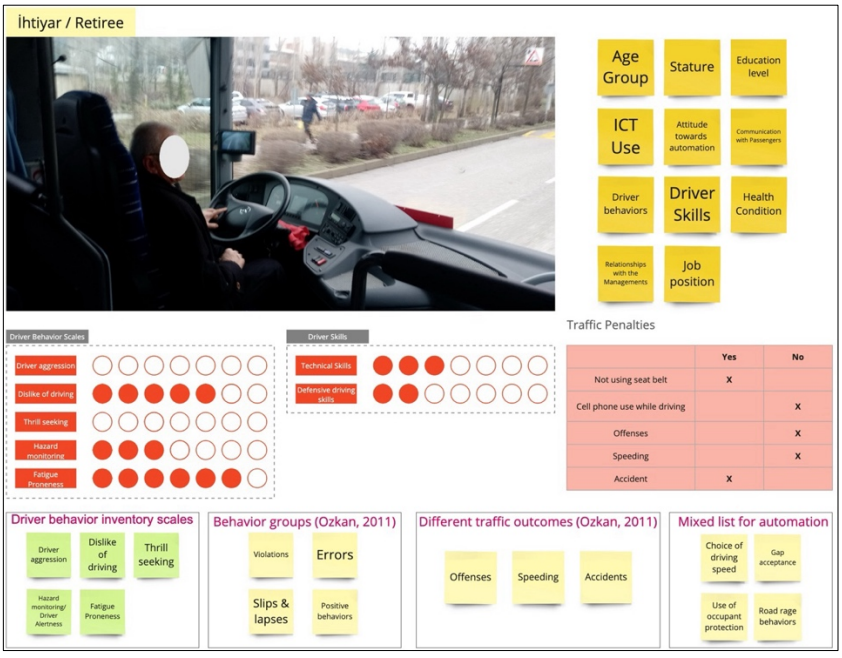


Figure 55 Persona brainstorming.

Four provisional personas were created for the pilot studies. With the integration of personas, a decision was made to establish a direct connection between the personas and video clips. This linkage was visually communicated through the design of driver frames within the Miro platform. In addition to personas and video clips, each driver frame includes a campus map with colored lines denoting the specific locations where each video clip was originally recorded on campus. This approach aims to provide a comprehensive understanding of the driver's experience within the context of the recorded sessions by creating a narrative that resonates with the authentic experiences of the driver. The preliminary visual design of driver frames can be seen in Figure 56. The final versions of personas and driver frames will be explained on page 161.

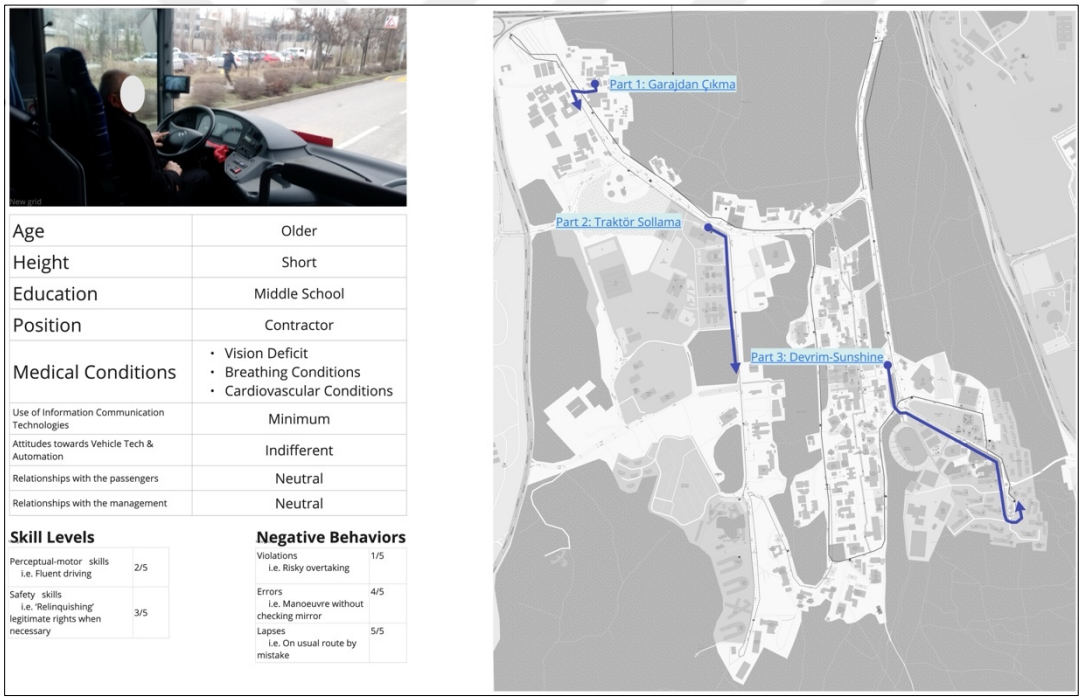


Figure 56 Initial visual design of personas and driver frames.

Curating new video clips

As previously mentioned, preparing trial video clips revealed the challenges of annotating the videos. These challenges included the time-consuming nature of

annotating even very short video clips, such as 25 seconds, and the negative impact of English translations and on-screen annotations on the immersive quality of the videos. Furthermore, the decision was made to link personas with the drivers and present the videos as a narration of drivers' real-life shifts. Therefore, the choice was made to restructure the video clips from the presentations of singular events into narrations of a driver's entire shift with only pace annotations. As an example, Clip 2 and Clip 3, previously described in the trial video clips section above, can be provided. In Clip 2, the driver had to pass through a narrow road alongside an oncoming bus. In Clip 3, the driver attempted to activate the bus's air conditioning for about 45 seconds but ultimately gave up. Both of these clips were from the same driver, Driver 11. With the integration of personas, a Turkish name, “bıçkın,” roughly meaning "angry" in English, was assigned to this driver, and these two clips were expanded to include a larger number of incidents. The order of the clips was also adjusted to accurately reflect the campus's layout and the chronological sequence of events during that particular shift. The previous Clip 2 was extended from 1 minute and 29 seconds to 3 minutes, and the previous Clip 3 was extended from 25 seconds to 4 minutes and 24 seconds. The details of the events contained within these clips can be seen in Table 8 and Table 9. A total of 15 clips were curated for four personas. See Table 10 for the persona names and number of clips.

Table 8 Events in the Bıçkın 1 clip (extended version of the former Clip 3).

#	Event	Event Type	Annotation
1	The ego driver stands inside the bus and tries to hang his jacket on a hanger located high on the right B-pillar, requiring a stretch and potentially causing discomfort.	Personal Comfort, Pre-departure Preparations	NA
2	He sits in the driver's seat, gazing around the driver's cabin. When asked by the author, he explains that he checks fuel and AdBlue levels, etc., to ensure the bus is ready for the shift.	Pre-departure Preparations	NA

Table 8 Events in the Bıçkın 1clip (extended version of the former Clip 3) (cont'd).

3	He attempts to turn on the air conditioner but eventually gives up without success. This portion is sped up. (See Table 6 for event details)	Personal Comfort, Pre-departure Preparations, Driver's Knowledge of Vehicle Features	Fast forward icon
4	He stands up from his seat to place the route sign in front of the windshield. Drivers commonly forget to change the sign, leading to passenger inquiries, which in return frustrates drivers. At times, drivers attempt to change the sign while driving, which poses a risk of losing control of the bus. Although this driver remembered to change the sign this time, he forgot while returning to the garage.	Pre-departure Preparations, Passenger Related Tasks	NA
5	The ego driver reverses the bus while checking the right and left mirrors. The video is sped up until he begins talking about his lack of trust in reverse cameras. He emphasizes that reversing is the riskiest maneuver and relies on mirrors instead of reverse cameras to mitigate this risk. He makes extra turns around the roundabout to navigate around an illegally parked car obstructing his path.	Maneuvering, Driver Attitude Towards Vehicle Technologies, Interactions with Other Road Users	Fast forward icon
6	A passenger requests the driver to turn on the air conditioning. The ego driver attempts to adjust it once more while driving on a narrow, curved road. He expresses frustration due to his inability to turn it on. The video shows that the driver is unable to monitor the road during this interaction.	Passenger Queries, Maneuvering, Driver's Knowledge of Vehicle Features	NA
7	While the ego driver is still trying to adjust the air conditioning, a pedestrian suddenly jumps in front of the bus, coming very close to a potential collision. The driver honks the horn and voices his frustration. He complains about pedestrians wearing headphones and ignoring traffic. He suggests this behavior is because pedestrians are aware of campus regulations that require motor vehicles to yield to them, which they tend to exploit.	Interactions with Other Road Users, Administrative issues	NA

Table 8 Events in the Bıçkın 1clip (extended version of the former Clip 3) (cont'd).

8	The ego bus arrives at the first bus stop and waits for the scheduled departure time. The driver checks his phone multiple times to ensure an on-time departure. This portion of the video is sped up. Once the time arrives, the ego driver begins driving on a narrow and curvy road and complains about the lack of concern of the management regarding the road design.	Pre-departure Preparations, Maneuvering, Administrative issues	Fast forward icon

Table 9 Events in the Bıçkın 3 clip (extended version of the former Clip 2)

#	**Event**	**Event Type**	**Annotation**
1	The ego driver proceeds along a narrow road obstructed by illegally parked cars. This road leads to a U-turn, which is a necessary part of the route as it marks one of its corner ends. The driver expresses frustration about the challenges posed by these parked cars to bus drivers and notes his relief that there's no oncoming vehicle at this moment. He continues with the U-turn, a time-consuming maneuver; therefore, this portion is sped up.	Interactions with Other Road Users, Maneuvering,	Fast forward icon
2	The driver prepares to leave after successfully completing the U-turn and picking up passengers from a bus stop. As he scans the road's far end for safe maneuvering, he spots another approaching bus. Remarkably, this occurs on the same narrow road where he expressed relief at not encountering oncoming traffic earlier. It's as if he foresaw this scenario, or it's a common occurrence.	Interactions with Other Road Users, Maneuvering,	NA
3	In a narrow road with parked cars, two buses approach each other, leading to frustration for the ego driver as they both must squeeze onto a single lane (see Clip 2 event details in Table 5). Throughout this maneuver, the ego driver continuously checks the right and left mirrors and monitors the surroundings, causing the video view to shift dramatically. This segment is maintained at real speed to avoid viewer discomfort, unlike the earlier Clip 2. Ultimately, the two buses successfully pass each other without a collision, but the ego driver expresses annoyance.	Interactions with Other Road Users, Maneuvering,	NA

Table 9 Events in the Bıçkın 3 clip (extended version of the former Clip 2) (cont'd)

4	As the ego driver continues driving to a bus bay to collect passengers, he emphasizes the challenging nature of the situation, having to face another bus head-on on a narrow road. He's relieved that this time, there aren't many vehicles behind the other bus. He recalls a previous instance where he had to drive backwards for the entire distance of that road due to a traffic jam behind the oncoming bus.	Interactions with Other Road Users, Maneuvering, Passenger Related Tasks	NA
5	He waits at the bus stop for the embarking passengers. He checks the right mirror to make sure everyone is embarked. After leaving the bus stop and departing from the bus bay, he checks the left mirror to assess traffic in the same direction as the bus. In addition, he turns his head to check the mirror's blind spot.	Passenger Related Tasks, Maneuvering	NA

Table 10 Persona names and number of clips for Pilot studies

Persona name	Bıçkın	İhtiyar	Bezgin	Uysal
Number of Clips	7	3	4	1

Incorporating Driver Experience Map:

Gibbons (2017) describes different types of user experience maps and outlines a decision framework that guides their creation. According to this definition, different types of UX maps, including experience maps, customer or user journey maps, and empathy maps, complement each other for providing insights into user experiences. Experience maps provide an overview of an entire end-to-end journey, encompassing the steps to achieve a goal (Figure 57). Similar to customer journey maps, experience maps also organize phases, actions, thoughts, and emotions in separate sections. However, while customer journey maps (Figure 58) focus on specific customer interactions related to a particular product or service, experience maps offer a broader perspective and do not tie to any specific offering. They are designed to understand general human behavior and serve as a baseline for

understanding user experience, making them suitable for consolidating diverse experiences into a single visualization. Furthermore, empathy maps help understand a particular type of user. They are divided into four quadrants - Says, Thinks, Feels, and Does - to externalize user knowledge and create a shared understanding (Figure 59). Empathy maps are particularly useful at the beginning of the design process or when categorizing research notes from user interviews.

Before embarking on any type of UX mapping, three decisions must be made (Gibbons, 2017). The first decision is choosing between mapping the current state or a future desired state. Current state maps are ideal for identifying and documenting current problems and pain points, while future state maps envision an ideal state for a user or experience, offering a benchmark for improvement. The second decision is selecting between hypothesis and research-based mapping. Hypothesis maps are based on accumulated team knowledge, help identify research gaps, and serve as a first step towards creating a higher-fidelity, research-based map. Research maps are based on collected user data and deliver more robust insights. The last decision is the level of map visualization detail, determining whether it should be low-fidelity or high-fidelity. Low-fidelity maps, often created informally with tools like sticky notes, encourage collaboration and revisions, making them suitable for initial project stages. High-fidelity maps, on the other hand, are polished and designed for sharing across teams to provide clarity.

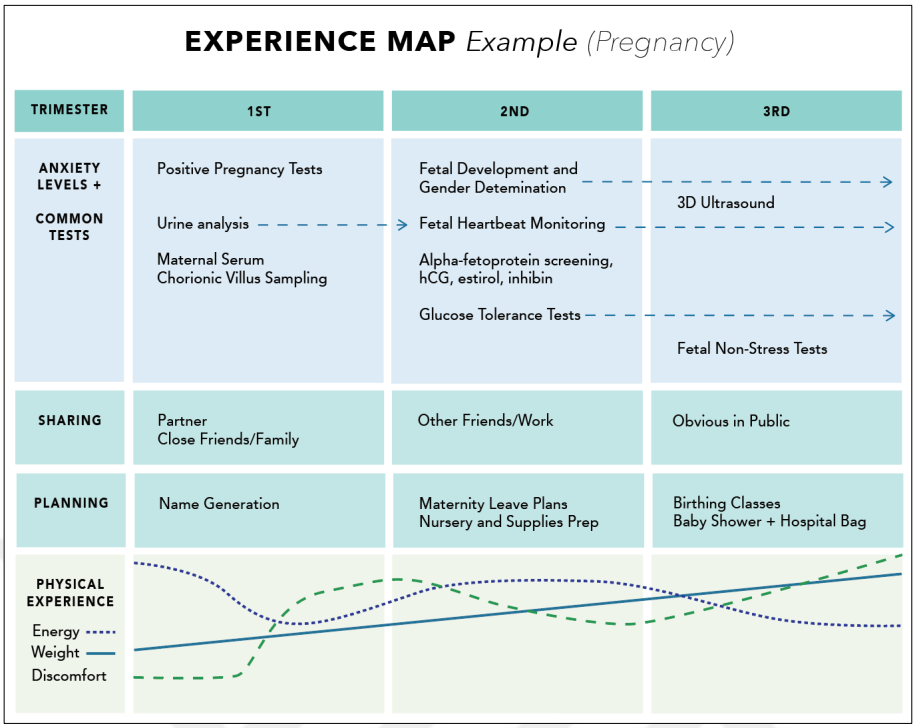


Figure 57 Experience map example (Gibbons, 2017)

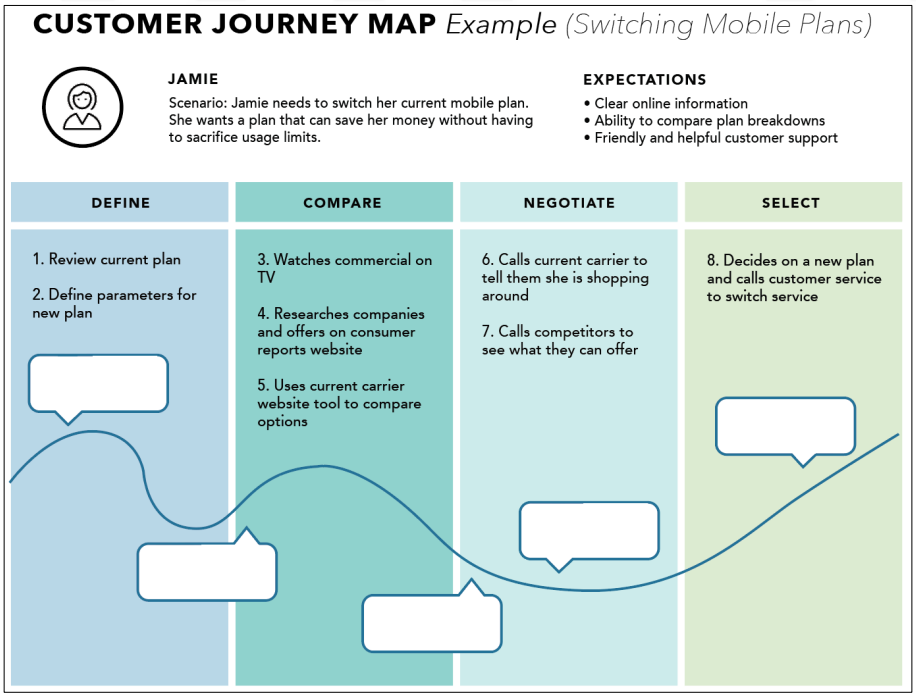


Figure 58 Customer Journey Map example (Gibbons, 2017)

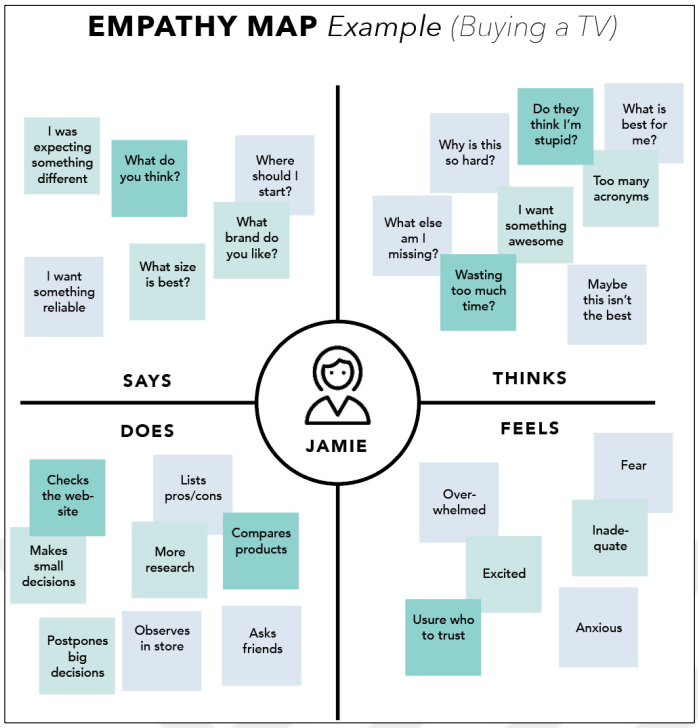


Figure 59 Empathy map example (Gibbons, 2017)

In line with these recommendations, an initial driver experience map was designed and integrated into the tool (Figure 60). This experience map portrays different stages of a shift, including pre-departure, driving, lunch break, and evening break. Each stage consists of multiple steps, totaling 16 steps. These steps are accompanied by descriptive text, photographs, event locations, and both positive and negative experiences. The content in this map aligns with field research observations and interview findings that video clips alone couldn't capture. This map closely resembles a current state and research-based experience map as it captures the driver's current shift experience, focusing on the driver's journey during the shift without specific reference to products like buses.

The driver experience map is aimed to be a high-fidelity research artifact to be shared with the team as the presentation of research outcomes; therefore, participants were not specifically asked to interact with this map. However, both the design of the map and how participants were expected to interact with it are iterated according to the pilot workshop observations. Pilot workshop observations

are explained starting on page 140, and the final version of the driver experience map is presented on page 157. The final version became a combination of an experience map (Figure 57) and an empathy map (Figure 59), as it describes the driver's actions, interactions, and internal dialogues, indicating his thoughts and feelings utilizing a first-person narrative style (see section 5.2.1 below).

Stages	1: Pre-departure							2: Driving
Steps	Arrives at recreation room, has a short chat with his friends	Checks the monthly shift table for his working hours	Walks through the area to find the bus	Identifies the number plate that is assigned to him	Checks the fuel level and estimates that will not be enough for his shift	Drives to the nearby fuel station	Makes back and forth maneuvers to get out of the fuel station	Starts the ring tour. Notices a garbage bin is obstructing the road.
Image								
Touchpoint	Recreation room, tables & chairs	Small printed monthly schedule paper & announcement board	Garage area	Number plates of the buses	Dashboard of he bus	Fuel station area & registering notebook	Controls, mirrors & windows of the bus	Controls and doors of the bus & garbage bin
Gain	Socializing with friends							
Pain	Resting on uncomfortable chairs	Finding name and number plate	Locating the bus	Finding number plate	Guessing the need for fuel refill	Registering km of the vehicle and the amount of fuel	Performing a number of forward & reverse maneuvers while checking the mirrors	Leaving the bus and pushing the bin

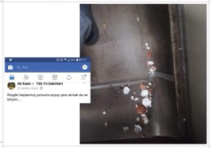
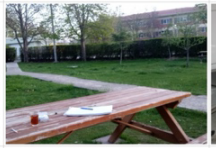
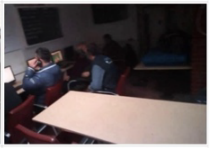
Stages	3: Lunch Break			2: Driving		5: Evening Break		
Steps	After the ring, walks inside the bus to check for left belongings, sees the eggshells on the ground	Cooks his lunch in the oven in the pergola area since his ring ends after the driver cafeteria was closed.	Heads to recreation room to eat his lunch and to have some tea	Starts the ring tour. Parked cars obstruct the road, he can't find its driver so everyone leaves the bus.	Passengers waiting in the following stops checks the ring bus on the app, issue a complaint for the late ring bus.	After the ring, he takes a short break before preparing the dinner.	Prepares the dinner for himself and his colleagues.	Plays some computer game before going to sleep on the foam mattress placed on the table
Image								
Touchpoint	"Car Wash" area & broom	Pergola area & kitchen utensils	Recreation room, tables, chairs & kitchen utensils	Controls and doors of the bus	Web page, phone & email	Garden furniture & kitchen utensils	Kitchen area and utensils & ingredient packages brought from home	Desktop computers, table & foam mattress
Gain						Resting in the garden		
Pain	Sweeping the interior before the next shift	Planning for the meal	Resting in a noisy room	Evacuating the bus and returning garage	Deviating from the schedule, explaining the situation to management		Planning for the meal	Sleeping on the table

Figure 60 Initial driver experience map design.

5.1.3 Pilot Workshops

Version 2 of the workshop framework was iteratively developed and evaluated through pilot workshops. Various components of Version 2 have been presented in earlier sections. For the complete set of Miro artifacts, please refer to Appendices 0 and 0. Following the last pilot workshop, the final iteration was completed. These final Miro artifacts are presented in the section 5.2. Four personas and 15 video clips were created for the pilot workshops. The workshops were designed for individual participants to avoid the influence of group dynamics on the workshop outcomes. Participants were informed that both the author and they were collaborating on a design project. The author assumed the role of a user researcher and, in this capacity, shared research findings with the participants, encouraging them to identify problems. This approach was chosen to focus participants on the evaluation of the communication of findings, foster a shared sense of purpose and cooperation between the participant and the author, and ensure they did not feel like they were being evaluated.

Pilot 1 Workshop

Pilot 1 participant, p1EO, was a design Ph.D. researcher with experience in field research and had previously designed a project related to public buses. He is an aficionado of automobiles and driving and is also knowledgeable about the METU shuttles. These familiarities allowed for an investigation into whether there were knowledge inconsistencies and the fine-tuning of the workshop framework.

Workshop procedure: One week before the synchronous workshop, the participant was provided with a link to the videos and instructed to review the video clips. During the Zoom session for the synchronous workshop, presentations on problem groups, vehicle automation examples, various METU shuttle-related facts and figures, and the driver experience map were delivered, consuming a total of 55 minutes. Subsequently, the participant was allocated a 30-minute independent

offline period to compile a list of design problems they considered significant and wished to ideate on for the future. The participant compiled a problem list (Figure 61) and explained each problem. The total duration of the workshop was 1 hour and 49 minutes, including the independent offline period.

Participant Reflection and Problem Identification: Before explaining the problem list, the participant reflected on the term “problem” and its wide-ranging interpretations; he noted that the dataset encompassed various problem types. These problems included events beyond the driver's control, infrastructural issues, and bus design-related problems. The participant suspected some of these issues might extend beyond the study's intended scope but opted to include them in the list as he would like to use them for ideation (Table 11). During the workshop, problems were intentionally solicited without specific constraints, fostering the exploration of a wide array of challenges within the socio-technical shuttle bus system. In this context, it's not uncommon for different problems to overlap, and addressing a core issue may necessitate consideration of various aspects of the system, aspects presented in the bus driving problem groups. The workshop ended with post-session questions about the participant’s evaluation of the workshop framework.

Table 11 Problem type examples identified by pilot 1 participant.

Problem	Type
Pedestrians suddenly jump in front of the bus as they exploit the pass priority that is granted by the university management.	An event beyond the driver's control
The narrow road where buses make a U-turn at gate A2.	Infrastructural problem
Lack of hierarchical organization of rarely-used and frequently-used features on the bus dashboard.	Bus design-related problem

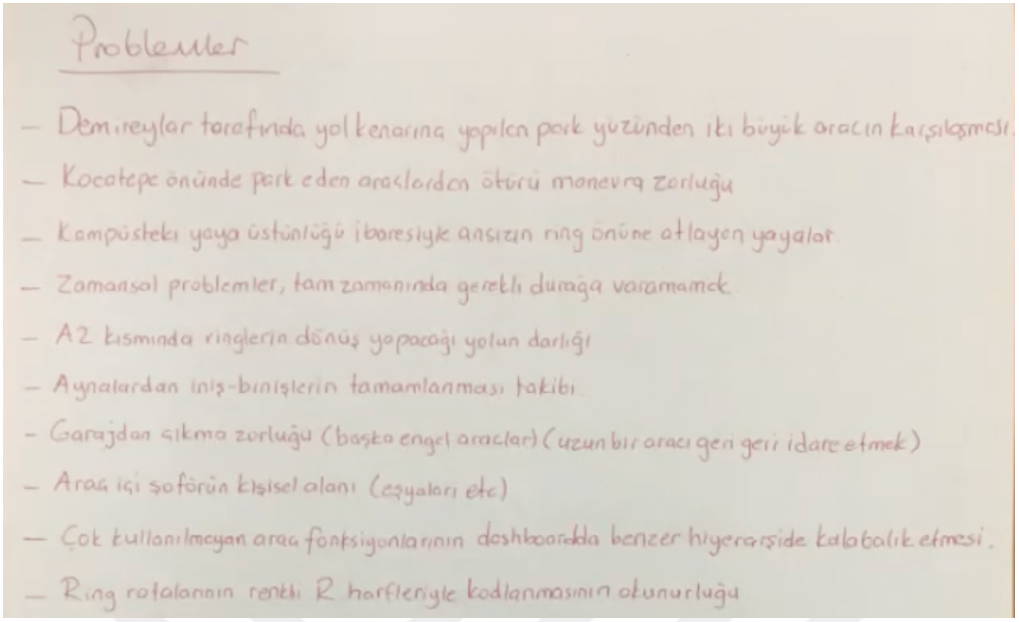


Figure 61 Some problems identified by Pilot 1 participant.

Outcomes and Design Decisions: The absence of references to any artifacts or the gaze movements of the drivers in the problem list may be attributed to the fact that the participant composed it one week after viewing the videos and listening to 55 minutes of various presentations. It is highly likely that the participant had forgotten the details of the content during the intervening time and that the lengthy presentations further contributed to his distraction. In order to facilitate a higher level of focus on the videos, to ensure that participants examined complementary information before watching the videos, and to reduce the duration of the presentations, the decision was made to implement the following changes for subsequent pilot workshops (Table 12).

Table 12 Design decisions following Pilot 1 workshop.

#	What	Why	How
1	Guide participants to focus more on the videos	To explore the relationship between videos and problem identification	By planning pilot workshops that solely focus on the videos and enabling participants to take notes for each video separately
2	Ensure that participants examined complementary information in the artifacts before watching the videos.	To enhance contextual understanding for the participants who are not familiar with METU shuttles	By separating complementary information and videos onto different Miro boards, and by conducting an initial Zoom meeting to present the complementary information
3	Reduce the duration of the presentations	To reduce the synchronous duration and enhance the extent of participant engagement	By removing the frames for problem groups and vehicle automation examples from Miro

Pilot 2 Workshop

The video interactions were redesigned based on the first decision in Table 12. The design update for pilot 2 workshops is explained below. The impact of these design changes was assessed through two individual Pilot 2 workshops involving two participants who share a passion for driving. One participant p2AK, was a psychologist with experience in occupational safety, while the other, p2MM was a professional driver. It was anticipated that, due to their professions requiring a focus on safety and their personal interest in driving, these participants would readily identify safety issues in the videos.

Workshop procedure: The same workshop procedure was applied for both participants, which was as follows: The first session began with an explanation of the workshop's objectives and instructions on interacting with the videos and taking notes within the Miro platform. Subsequently, the participants were given links to the respective Miro boards designed for each persona. They were instructed to watch the videos and take notes regarding any problems they identified during the viewing. The following week, another meeting was arranged for workshops about

discussing the noted problems. The workshop with the psychologist participant, p2AK, lasted 1 hour and 22 minutes, and the one with the professional driver, p2MM, lasted 1 hour and 31 minutes.

Given the primary emphasis on video notetaking for pilot two workshops, the frames containing the driver experience map and METU shuttle facts were not shared with the participants; only updated driver frames were shared with them. In the initial version of Pilot 1, the initial driver frames (Figure 56) displayed the names of the videos, which were linked to Vimeo. In this iteration, videos were embedded directly into the Miro boards to provide an easier watching experience and maintain a connection between the maps, personas, and videos (Figure 62). These embedded videos can be viewed on Miro or can be opened in a new window. The decision to embed videos resulted in an increase in the size of the Miro boards. To accommodate this, individual boards were created for each driver persona.

Participant Reflections and Problem Identifications: Both workshop participants provided detailed accounts of the video events, evidenced by their notes and their explanations of these notes. They identified both the problems and the good practices of the drivers. Moreover, participants' assessment of video events addressed the driving frame as a whole. This means that they not only identified the problems but also created a whole picture of a driver in their minds, combining the persona characteristics and an overall evaluation of the driving videos. Participants combined the driver personas and the videos and perceived a driver frame as a holistic representation of a real driver and his behavior patterns. While interpreting video events, they even referred to the types of employment contracts of the personas. An example of this is a comment of the psychologist participant, p2AK, about İhtiyar persona. The participant inferred that being a full-time (memur) employee, İhtiyar seems to be waiting for his retirement, but he has to wait for his child to graduate from the university so İhtiyar can afford the child's education expenses. As a result, p2AK interpreted that İhtiyar is driving in an exhausted way. Moreover, both participants referred to drivers in the videos by the name of the personas and compared different personas' driving abilities. This

understanding is presented through participants' identification of behavioral patterns such as "Even though Bıçkın may be breaking traffic rules, I prefer being a passenger in his vehicle over İhtiyar's."

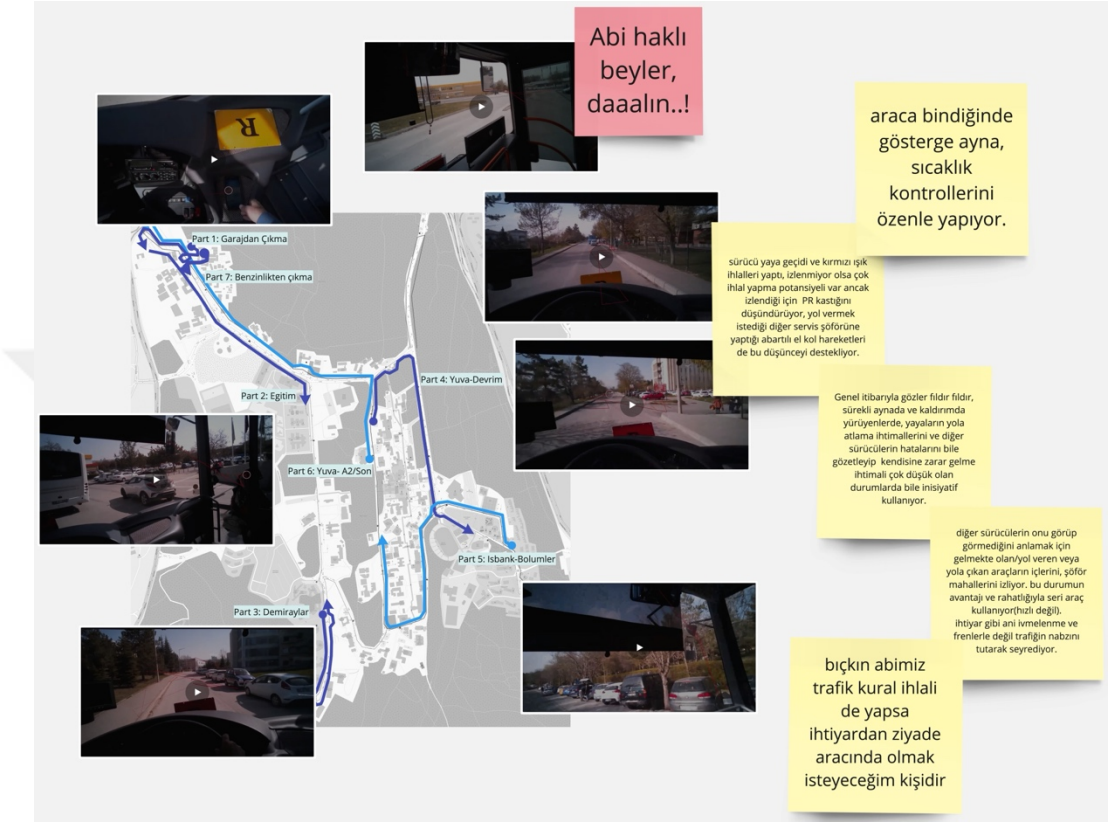


Figure 62 Redesigned driver frames filled by the p2AK before the workshop

Professional driver participant, p2MM, provided comments on the videos akin to a sports expert narrating a match, analyzing each move and strategy of the drivers. He embellished his narration with personal memories from his professional driving experiences, drawing parallels between those events and the video. In response to queries about potential solutions, both participants suggested ideas encompassing various dimensions of the shuttle bus system. These proposals spanned improvements in bus design, enhancements to infrastructure, and the implementation of driver performance evaluation and monitoring systems.

Finally, participants highlighted a gaze pattern observed in the video events. This pattern involved the driver directing his gaze toward the faces of other drivers in

traffic. Participants emphasized that they engage in this behavior to discern the intentions of fellow drivers, such as determining if the other driver intends to yield the right of way. Additionally, they mentioned using this gaze pattern to establish eye contact and ascertain the direction in which the other driver is looking to ensure the other driver notices them.

Outcomes and Design Decisions:

In the first pilot workshop, the participant viewed all the videos beforehand but documented the identified problems after attending additional presentations during the workshop. Note-taking during video observation naturally led to more detailed problem descriptions during the second version of the workshops. In addition, utilizing Miro for embedding videos offered the advantage of presenting a cohesive view of all videos, associated notes, and their respective locations, fostering a comprehensive understanding. However, this approach had drawbacks. Firstly, it led to an excessively large Miro board due to the size of the videos, necessitating the allocation of each driver frame onto different boards. Secondly, limitations in interaction were observed with the embedded videos on Miro. Specifically, positioning the seek bar at a precise point proved to be challenging. Additionally, when the video was paused for notetaking, a significant issue arose—the seek bar automatically returned to the beginning of the video. This particular drawback hindered smooth navigation and usability while watching the videos. Despite these challenges, it was not considered a priority problem for the next pilot, as an alternative solution involving opening the videos in a new window still provided more precise control over video playback. Consequently, the participant of the next pilot workshop was advised to open videos in a new window until the author figures out a solution.

The participants of the pilot 2 version of the workshops made detailed comments on the driver personalities, considered them realistic by comparing the real drivers they know, and internalized the reality of the driver personas to the extent that participants proposed their own versions of persona names. As a result, Asabi was

renamed as Bıçkın following p2AK’s suggestion, and Kalender was renamed as Uyumlu following both p2AK’s and p2MM’s suggestions. In addition, the difference in engagement with the driver personalities between the participants of version two and version one is attributed to the fact that the videos were rewatched together during the workshops. In version one, the participant watched the videos before the workshops, and the author only asked the participant to note the problems during the workshop. In the second version, participants were asked to show the video part in which their observation occurred. The first version limited the author's opportunity to observe participant engagement with the videos.

In addition, problem identification prompts were also different in the second version of the pilot workshops. Instead of asking only about the observed problems, turning off the camera to give time to the participant to note the problems and presenting the problem list afterward, participants were encouraged to elaborate by asking to show the associated video parts, as explained above and by asking questions such as “How can we design the bus to prevent this problem?” or “What can be done to improve the driver's comfort and safety in general?” This approach naturally opened up conversations and discussions between the participants and the author, improving the comprehension of the reasoning behind the problem framing and improvement suggestions.

Furthermore, adjustments were made to the problem identification prompts and workshop procedures for the second version of the pilot workshops. Unlike the first iteration, participants in the second round were instructed to write down their problem observations while watching the videos, eliminating the need for dedicated note-taking time during the workshop. The questions were also modified, shifting from a simple inquiry about observed problems to inquiries such as 'How can we design the bus to prevent this problem?' and 'What measures can enhance the driver's overall comfort and safety?' Additionally, participants were prompted to highlight identified problems by showcasing the associated video parts, introducing a visual dimension to the discussion. This approach facilitated dynamic conversations between participants and the author, encouraging detailed insights

and improving overall comprehension of the reasoning behind problem framing and improvement suggestions.

However, a critical point was raised by p2AK that influenced the formulation of prompts and the approach to problem identification. He noted that, with this study, strategic problems were more likely to be identified rather than issues solely related to bus design. This emphasized the notion that the design of the bus is only one component of the system, and there are limitations to what can be achieved through redesigning it. This insight underlined the need of the formulation of prompts that did not exclusively focus on bus design but rather on the overall bus driver experience. Consequently, alternative prompts were explored to uncover different dimensions as explained below. While exploration of alternative prompts was crucial for problem identification, another factor contributing to this critical feedback could be attributed to the participants' non-designer backgrounds. Although the pilot sessions with driving enthusiasts were beneficial in focusing on video events, and improving workshop facilitation and the prompts, exploring the insights of a designer through another pilot was deemed necessary before introducing substantial changes to the artifact design.

Pilot 3 Workshop

Workshop procedure: Following the Pilot 2 workshops, the decision was made to update the problem identification prompts without making substantial design changes and to conduct the workshop with a designer participant (p3MD, a female designer with four years of experience). Additionally, in the Pilot 2 workshops, only the links to the videos were sent, omitting the Miro board containing the driver experience. For pilot 3, the Miro board was reintroduced, and the participant was instructed to take notes on problems both in the driver experience map (Figure 63) and in the videos. This marked the first instance of requesting the participant to take notes on the problems presented in the driver experience map, aiming to enhance participant engagement with the artifact. Two sessions were conducted. In

the initial session, the driver experience map was presented, and details about the study, Miro usage, and participant expectations were explained. After a week, the second session was held, during which the participant discussed the identified problems and proposed solutions. The workshop concluded with creating worst-case scenarios and prioritizing problems, as explained below. The first meeting lasted 27 minutes, and the workshop itself took 1 hour and 27 minutes.



Figure 63 Driver experience map notes by p3MD.

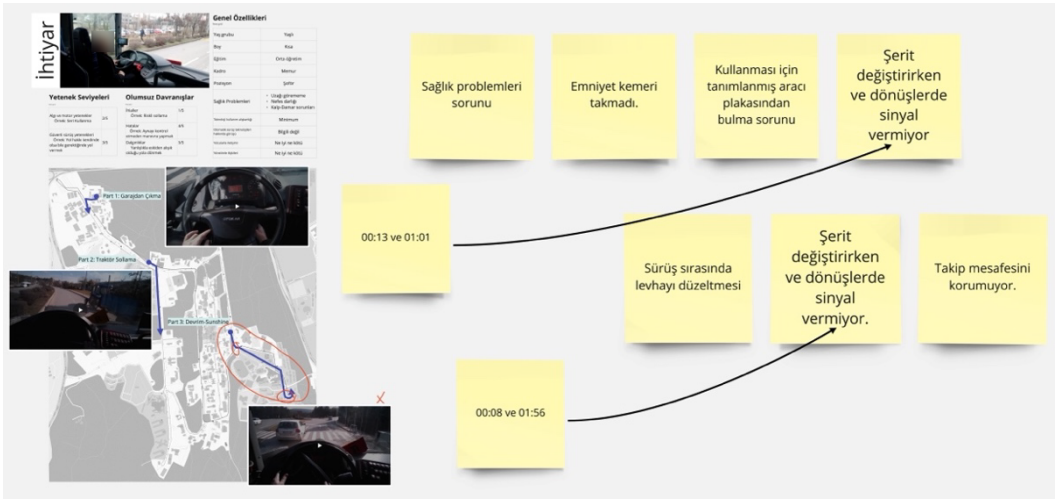


Figure 64 p3MD notes for İhtiyar videos.

Outcomes and Design Decisions: This participant also took notes for the videos (Figure 64); however, unlike previous participants, p3MD was instructed to

document the approximate timestamp of the events in the video, aiming to make it easier to identify specific video segments during the workshop. This adjustment was also anticipated to enhance participant engagement with the video events. After discussing the participant's problem observations from the driver experience map and the videos, an alternative prompt was introduced to increase engagement with the video events further. The participant was tasked with constructing worst-case scenarios using the problems identified from both the driver experience map and the videos. To formulate the scenario, the participant was guided to list actions, individuals involved, location, time, and possible interactions (Figure 65). The intention was to encourage the generation of diverse scenario alternatives that transcend the limitations of the video events and incorporate the participant's imagination and experience.



Figure 65: An example of a filled-out worst-case scenario template by p3MD.

An example of a completed worst-case scenario template is illustrated in Figure 65. The worst-case scenarios referred to the health issues presented in the persona artifact, driver behaviors observed in the videos, and cognitive decline associated with the advanced age of the İhtiyar persona. These scenarios included concerns about the driver forgetting to signal, becoming involved in a collision while executing a turn, or experiencing health complications such as asthma or a heart attack. She suggested implementing a blind-spot warning and a health-tracking system in response to these scenarios. While engaging in a realistic contemplation of potential worst-case scenarios, the participant appeared uneasy when discussing these situations and exercised restraint in elaborating on them. This hesitancy can be ascribed to the severity of potential outcomes linked with worst-case scenarios. The act of observing real people in authentic life situations might have induced a heightened sense of empathy in the participant towards the individuals in the videos. This empathy might have reached a level, where engaging in discussions about the events that result in severe consequences required a considerable degree of dissociation from reality, forcing her to mentally distance herself from the real-life implications of the scenarios, potentially leading to feelings of inappropriateness and awkwardness.



Figure 66 Prioritized problems and some solution suggestions from p3MD.

In addition to worst-case scenarios, a Miro frame was introduced to organize problems and solution suggestions into ‘must-have’ and ‘good-to-have’ sections at the end of the workshop (Figure 66). P3MD placed most of the problems and suggestions in the ‘must-have’ section and positioned several of them in between these two sections. Reflecting on the additional prompts implemented for the pilot 3 workshop, it became apparent that notetaking during the session consumed a significant amount of the workshop duration. Due to the participant's reluctance to write, the author assumed the responsibility of taking notes while she spoke. Furthermore, the participant's comments on the problems in the videos, notes on the worst-case scenario template, and the problem prioritization board reiterated the same issues and solutions. Consequently, a decision was made to eliminate the problem prioritization frame from the workshop to reduce its duration, eliminate redundancy, and shift the focus towards conversation instead of notetaking. At this

point, the decision was made to retain the questions for creating the worst-case scenario without presenting it as a worst case. Additionally, a choice was made to iterate the design of the artifacts and add explanatory text to the Miro boards, eliminating the need for an initial meeting where the aim of the study and driver experience map was presented. Consequently, the design of the experience map and the design of the Miro boards were iterated to convey information comprehensively without the need for a presentation, as explained below. At this stage, videos were still embedded in the Miro Boards as a more optimal solution had not been identified, and P3MD did not give any feedback about the embedded videos on the Miro boards.

Pilot 4 Workshop

Design Iteration: Before the Pilot 4 workshop, several design changes were implemented. Firstly, the design of the driver experience map was refined. Secondly, the visual and layout design of the boards and personas underwent refinement. Thirdly, textual explanations were incorporated to eliminate the necessity of the initial meeting. The initial driver experience map featured 16 steps; however, 6 of these steps, which were already covered in the videos and included details about the rest area, were omitted to streamline the data. Additionally, the text on the map was enhanced to provide more detailed information about the events. The first-person narrative style was adopted to offer insights into the thoughts and feelings of the driver (Figure 67).

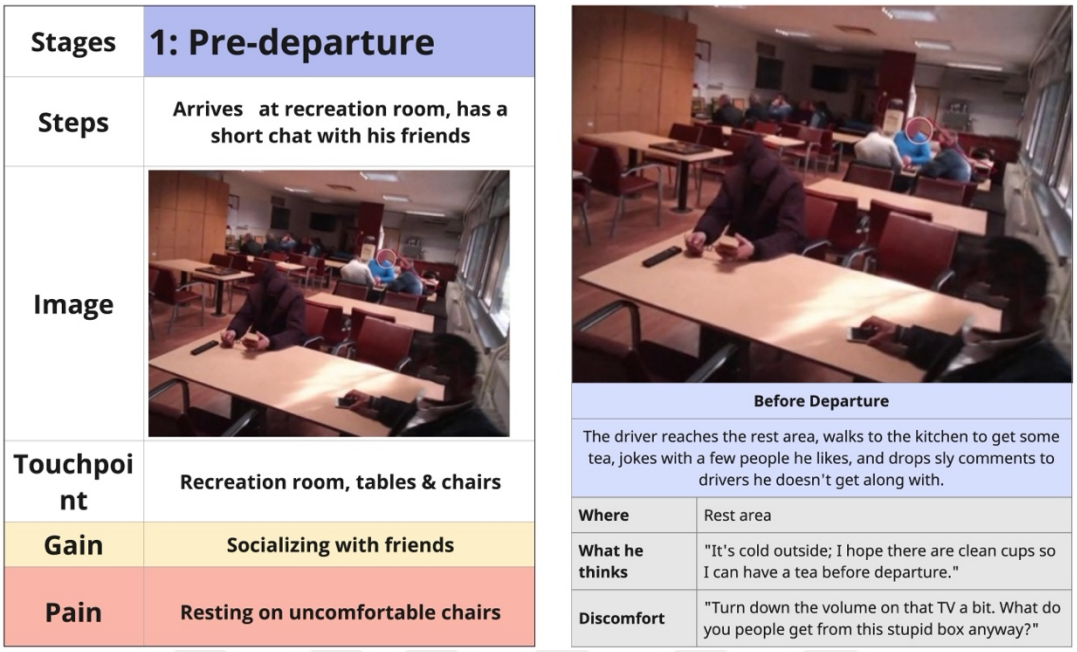


Figure 67 Design iteration of the driver experience map for the Pilot 4 workshop.

Changes in the visual design and layout of the Miro boards encompassed the arrangement of colors and layout to emphasize the artifacts and descriptive text. Speech boxes were introduced at specific points on the Miro boards to elucidate the process and participant expectations (Figure 68). Furthermore, details about the expectations for each step were placed on the left side of each artifact (explained in section 5.3.2). Visual sections were created to group relevant information in driver personas, facilitating participant comprehension and aiding memory retention of the information (refer to Driver Personas below).

During the workshop, the participant, p4TC, discussed the problems observed from the map and the videos. However, after the workshop, when queried about generating worst-case scenarios, he essentially reiterated the same problems observed, thereby prolonging the workshop without contributing additional information. While these worst-case scenarios could serve as valuable input for subsequent phases in a real-life project, such considerations fall beyond the scope of this study. Consequently, the decision was made to eliminate the process of building worst-case scenarios altogether, aiming to reduce the workshop duration.



Figure 68 Design iteration of the main Miro board for the pilot 4 workshop.

While building worst-case scenarios were removed from this study after the pilot 4 workshop, two participants from the main workshops, 8OB and 9MuK, who are experienced in working with user research data, emphasized the significance of integrating the research findings into subsequent stages of real-life projects. 9MuK further suggested planning activities, such as design sprints, to ensure the seamless incorporation of research findings into product development (see 6.4.2). The author interprets 9MuK's suggestion for additional activities as being akin to what was attempted with the worst-case scenarios.

Finally, p4TC numbered his notes for specific artifacts (Figure 69). The numbers in the driver experience map notes represent the steps, while those next to the videos represent the video numbers. Moreover, he highlighted the challenges of taking notes away from the artifacts and watching embedded videos. In response, a decision was made to incorporate note-taking sections on each step of the driver experience map (see 5.2.1). Additionally, an alternative way to embed videos into the Miro boards was found, enabling direct notetaking on the videos (5.2.3). The final version of the artifacts is explained in the next section.



Figure 69 Numbered notes of p4TC for the driver experience map and Bıçkın videos.

5.2 Main Artifacts of the Final Version

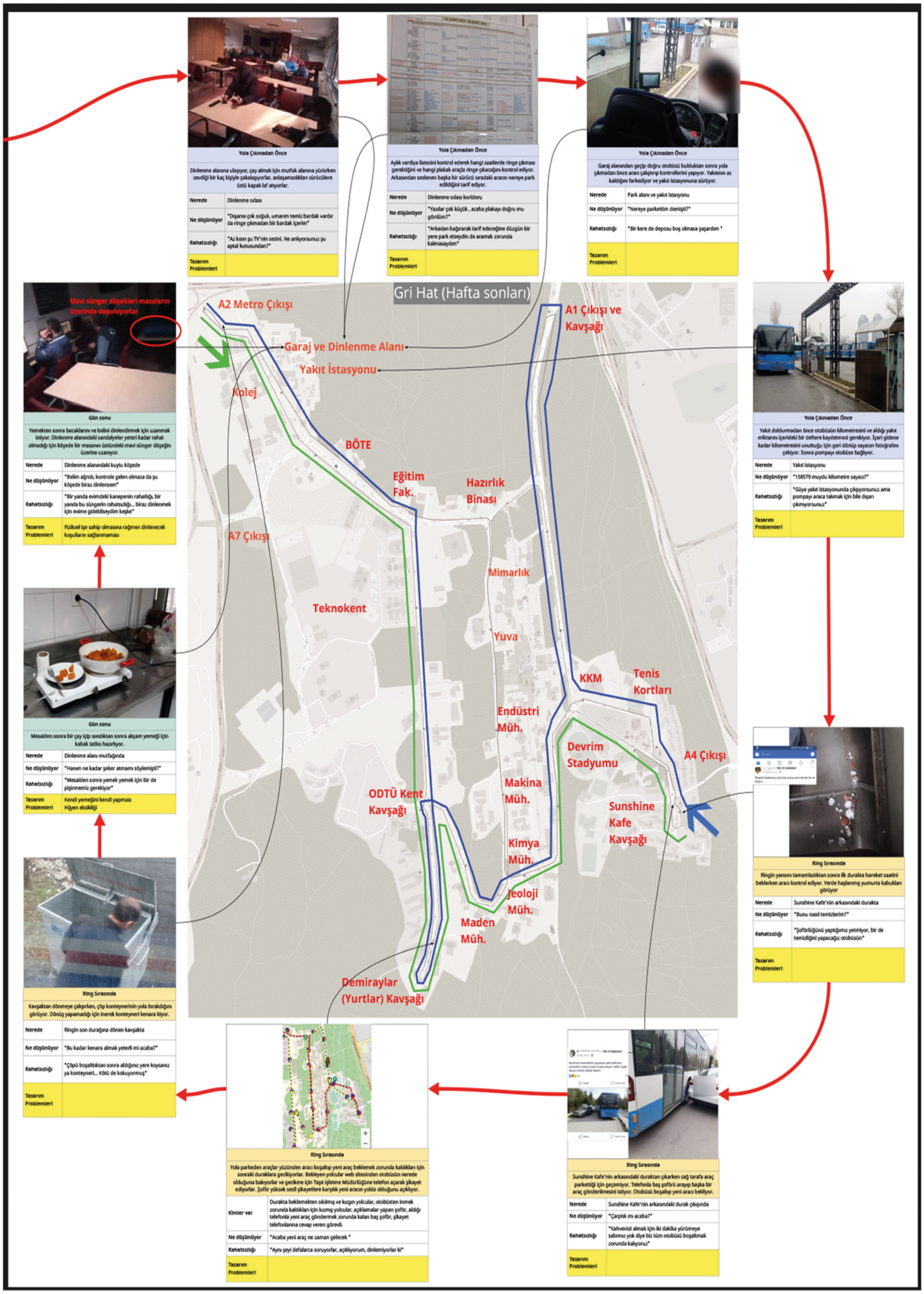
This section describes the final version of artifacts and the workshop procedure designed for communicating user research findings.

5.2.1 Final Driver Experience Map

The Driver Experience Map (Figure 70) on the Miro board illustrates ten problematic situations identified through interviews and observations at the Transportation Directorate facilities. These situations were identified through field research but not adequately conveyed through the driving videos. Each problematic situation has a photo depicting the context and five information boxes (Figure 71). The first information box explains the observation phase, such as before departure, while driving, and at the end of the day. The following boxes explain the event and indicate its location. In addition, the driver's thoughts and feelings were written in a first-person narrative style to enhance empathy.

Each situation on the map includes a yellow comment box, allowing participants to contribute their solution ideas. Before the workshops, participants were requested to review the problematic situations and provide solutions within the designated comment boxes. This approach served two purposes. Firstly, it helped streamline the workshop process by minimizing the time required for participants to complete the boxes during the sessions. Secondly, it enabled participants to familiarize themselves with the extensive workshop data beforehand, facilitating a deeper engagement with the material during the workshops. By incorporating the drivers' perspectives, thoughts, and feelings, as well as inviting participant input through the comment boxes, the map served as a means of eliciting insights and generating potential solutions to the identified problems.

Figure70 Driver Experience Map





Before Departure	
He walks through the garage area to find the bus assigned to him. After finding it, he starts the vehicle and performs the necessary checks. He notices that the fuel is running low, therefore, drives toward the fuel station.	
Location	Park area and fuel station
What he thinks	"Where did the previous driver say he parked it?"
What he says	“I would be surprised if the fuel tank wasn't empty for once."
Design Problems	

Figure 71 Problematic situation exemplar from the Driver Experience Map

5.2.2 Final Driver Frames

Driver frames on the Miro board are designated sections connecting information about driver personas and driving videos (Figure 72). Each driver frame includes elements such as the driver persona itself, the total duration of associated video clips, names and preview GIFs of the video clips, and colored lines indicating the locations of each video clip. This arrangement is aimed for a visually organized representation of the driver's characteristics and the corresponding video content. Driver frames and their elements serve as mnemonic cues for the content that helps memory retention.

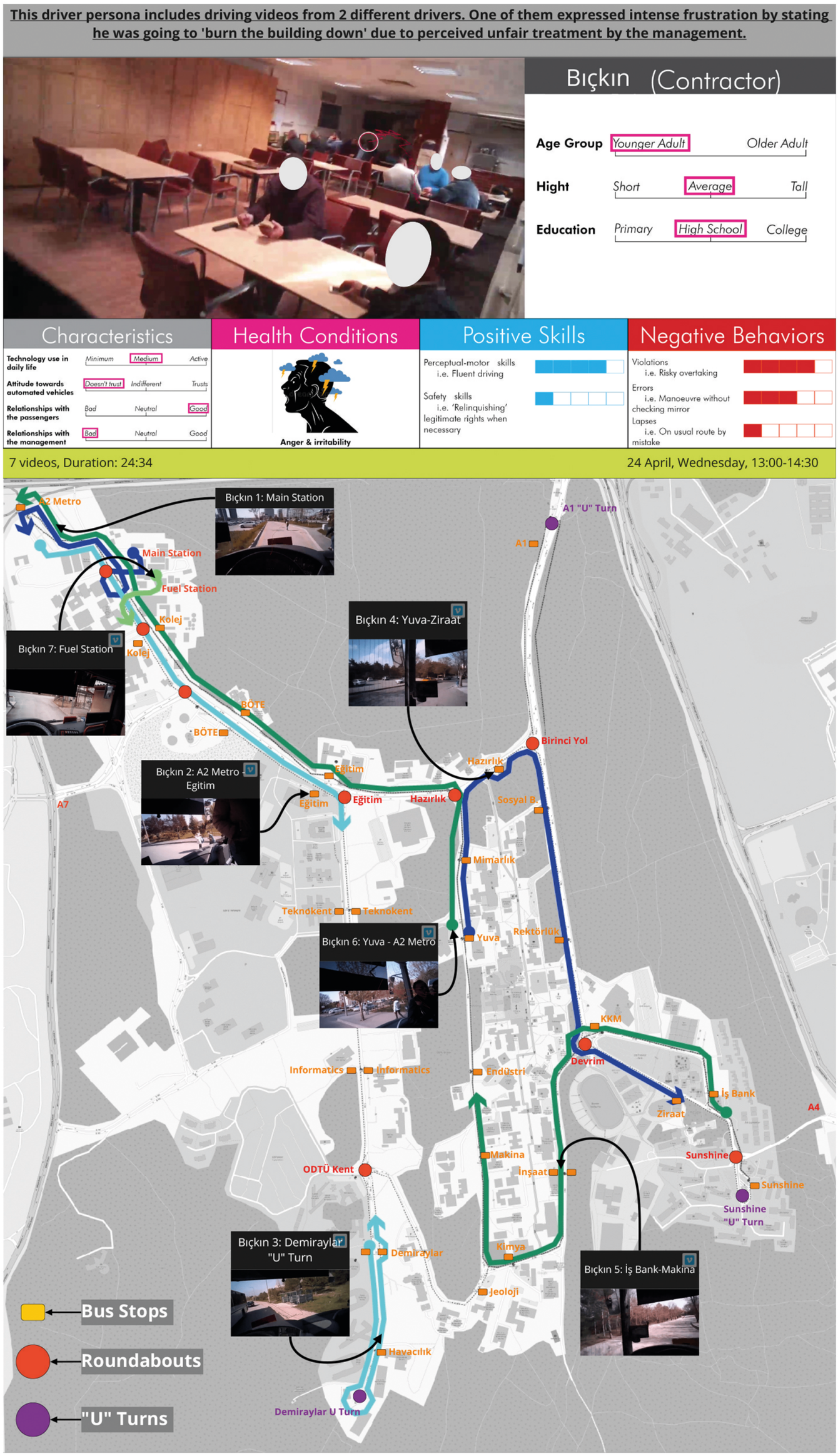


Figure72 Driver Frame Exemplar

Driver Personas

Seven driver personas were created from eleven drivers' eye-tracking recordings. Grouping was based on drivers' perceived similarities and their routes during recordings. Each persona had six information areas and a contextual photo of the driver (Figure 73). Information areas were 1) Persona stereotypical name and employment type, 2) Basic demographics, 3) Attitudes and professional relationships, 4) Health conditions, 5) Positive driving skills, and 6) Negative driving behaviors. Stereotypical names of the personas and the assigned number of drivers can be seen in Table 13.

- Bıçkın (Fierce): Known for their fierce and explosive tendencies, which may make them appear volatile and challenging to handle when their principles are challenged.
- Bezgin (Grizzled): Reflects a world-weary outlook, a nonchalant approach, and a sense of being somewhat jaded by their experiences.
- Dingin (Chilled): Characterized by their calm and collected approach to life, radiating tranquility and composure.
- İhtiyar (Old Man): Embodies traditional wisdom yet may find themselves grappling with the complexities of modern life and technology.
- Şakacı (Joker): Brings humor and light-heartedness to situations to create a jovial atmosphere. However, this inclination to prioritize humor over serious matters might come across as disruptive.
- Uyanık (Sneaky): Known for their alert and crafty nature, they are often seen as resourceful and sly individuals.
- Uyumlu (Easygoing): Often maintains a calm and cooperative demeanor, which can sometimes be perceived as complacency and a lack of a strong drive.

Table 13 Driver personas and number of drivers

Driver Persona	Fierce	Grizzled	Chilled	Old Man	Jokester	Sneaky	Easy Going	Total:7
# of drivers	2	1	3	1	1	2	1	Total: 11

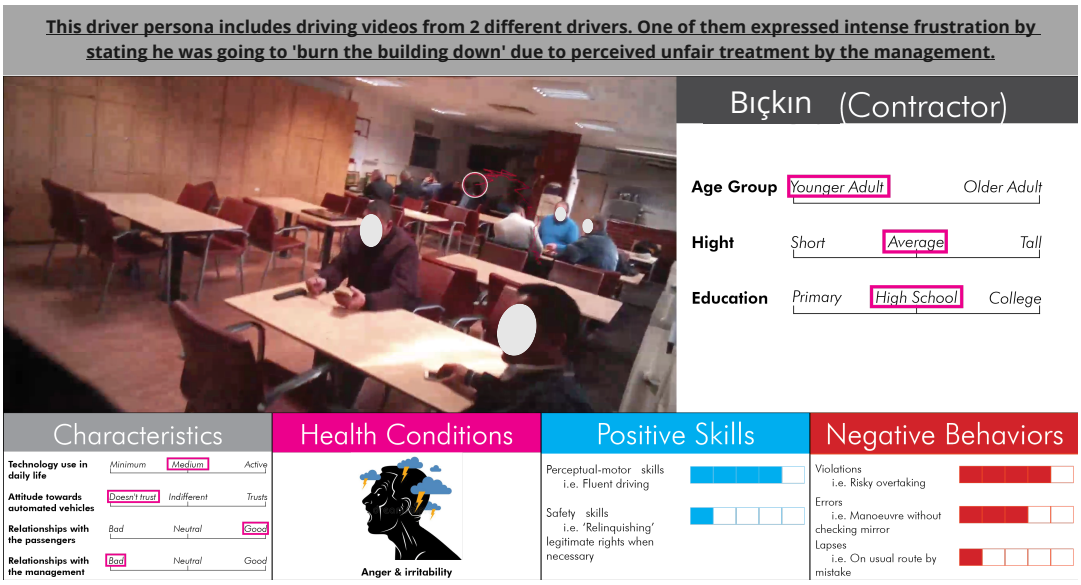


Figure 73 Persona Exemplar (Bıçkın)

1) Stereotypical persona names and employment types: Personas were assigned stereotypical names such as Fierce, Grizzled, Old Man, etc., to make them memorable. The names were also selected for signaling certain types of traffic conduct, such as traffic rage, memory lapses, and mistakes. Employment types were employee and contractor, which indicates different pay ranges, legal employment rights, and social status in the workplace.

2) Basic demographics: Demographic information, which is considered one of the default persona information, includes the age, height, and education level of the drivers. It was also provided to signal the increased statistical traffic risks. Older drivers have reduced dexterity and cognitive agility, which has the potential for increasing response times for emerging traffic risks, and younger drivers are more

prone to risky traffic conduct such as thrill-seeking and aggressive driving (Shinar, 2007). The height of the drivers may have an impact on the ergonomics of the bus cabin and road vision. Education level is indicated as a proxy for users' knowledge, preferences, and behavioral patterns.

3) Attitudes and professional relationships: This section includes the persona's attitude toward driving technologies, technology in general, and relationships with the passengers and the management. Attitude toward technology is indicated as a proxy for perceived usefulness, which is one of the fundamental indicators of technology acceptance (F. D. Davis, 1989). Lack of trust in vehicle technologies specifically may result in not utilizing helpful technological features, whereas trusting too much in them may result in external locus of control, which means giving up safety responsibility to technological features, which is dangerous in semi-autonomous driving (Heikoop et al., 2016).

4) Health conditions: Bus drivers frequently have occupational health issues such as musculoskeletal and circulatory problems from sitting for extended periods of time and in a constantly vibrating environment, respiratory problems because of being exposed to exhaust gases, and various stress-related problems because of road negotiations in the traffic and handling passengers (Johansson et al., 1998; Kompier, 1996; Lewis & Johnson, 2012; Useche et al., 2017). While health conditions information was not specifically collected from the drivers, many reported their health problems and that several drivers were on medical leave during the field research. Despite its somewhat speculative nature, it is realistic and placed to emphasize the prevalence of health issues in the bus-driving occupation.

5&6) Positive driving skills and Negative driving behaviors: In traffic psychology, driver factors such as behaviors, skills, certain personality traits, and psychological indicators play a significant role in traffic crashes (Sümer & Özkan, 2002). While cognitive-motor skills and safe driving skills of drivers reduce the safety risks, negative driver behaviors such as violations, errors, and slips and lapses pose safety risks in traffic (Sümer & Özkan, 2002). Drawing inspiration from traffic

psychology, this study incorporated segments for ‘positive skills’ and ‘negative behaviors’ into the driver personas (Figure 74). Each persona is equipped with scales for positive skills, such as perceptual motor skills and safety skills, as well as negative behaviors, including violations, errors, and lapses. These attributes are scaled from 1 to 5, providing specific skill and behavior characteristics to the personas. While these behaviors and skills are typically measured using normalized psychological scales, such as the Driver Behavior Questionnaire (Sümer & Özkan, 2002), the author assigned the scores without applying any normalized scales in this study. This approach was adopted to facilitate discussions about the drivers’ psychological dimensions in the context of product, system, and service design for bus transportation.

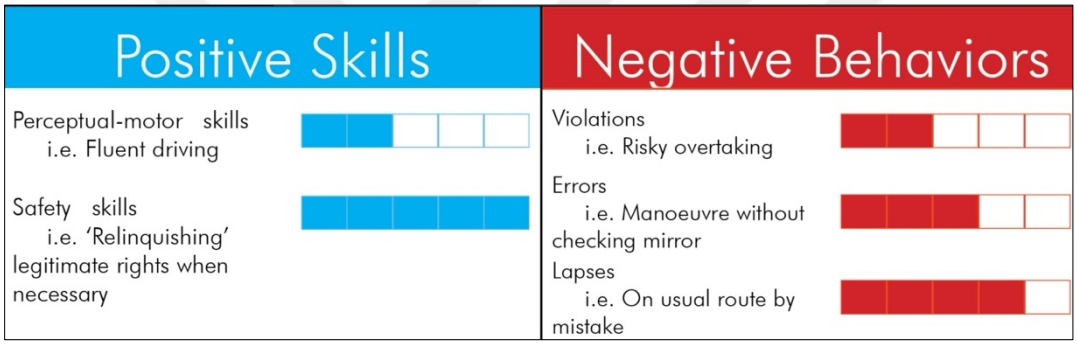


Figure 74 Positive skills and negative behaviors segments in personas.

Video Representations and Campus Maps

Each driver frame features a campus map below the driver persona. This map shows some main road features, such as the bus stops, roundabouts, and location of U-turns, represented with orange rectangles, red circles, and purple circles, respectively (Figure 75). Textual information on the map includes bus stop names, displayed in orange, and landmarks such as “fuel station,” in red. The campus map serves as a backdrop for presenting the videos while providing a spatial context.

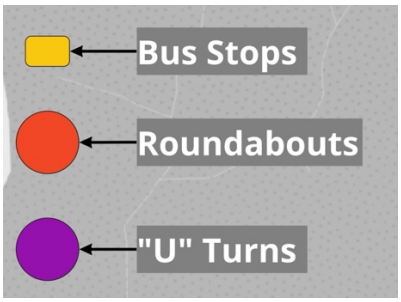


Figure 75 Map key on the corner of the campus map.

Video representations on the map include video names that are linked to the external videos on Vimeo, preview GIFs, and colored lines to indicate the route in which the eye-tracking videos were recorded. Representations aimed to serve as mnemonic cues to enhance designers' engagement, memory retention, and effective utilization of the video clips during the workshop sessions.

For instance, in Figure 76, the text “Bıçkın 7: Fuel Station” is the name of the 7th video of Bıçkın persona and is linked to the video uploaded on Vimeo. The light green line indicates the route for the Bıçkın 7 video, which starts from the fuel station and ends around the bus tops named “Kolej.” Clicking the image below the video name plays the selected 6-second portion of the Bıçkın 7 video.

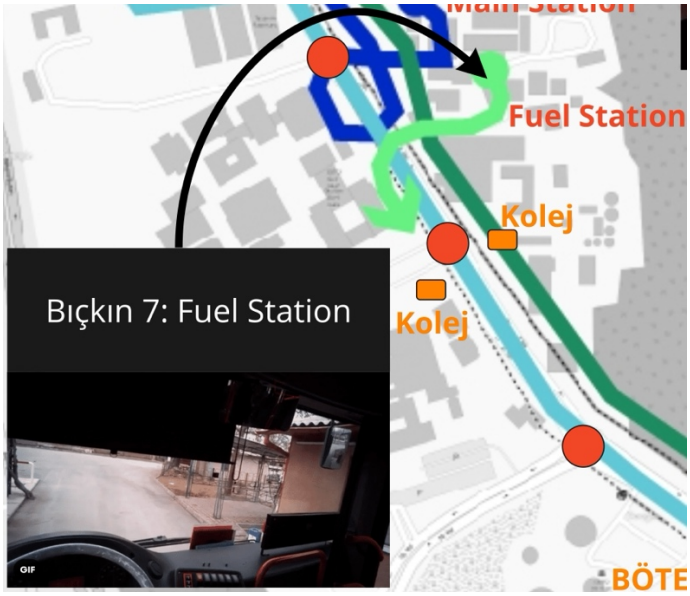


Figure 76 Video representations on the campus map for the Bıçkın 7 video.

5.2.3 Final Driving Videos

There are a total of 36 final video clips for seven personas. The length of the clips varies from 1 minute and 12 seconds to 5 minutes and 20 seconds. The list of the video clips can be seen in Figure 77.

#	Name	Duration	#	Name	Duration
1	Bezgin 1: ODTÜ Kent - Demiraylar	04:43	19	İhtiyar 1: Garajdan Çıkma	02:45
2	Bezgin 2: UçanKaçan-Devrim	05:20	20	İhtiyar 2: Traktör Sollama	01:18
3	Bezgin 3: Sunshine - Kimya	04:02	21	İhtiyar 3: Devrim - Sunshine	02:38
4	Bezgin 4: Eğitim-Mendil	04:13	22	Şakacı 1: Garajdan çıkma	02:41
5	Bıçkın 1: Garajdan Çıkma	04:24	23	Şakacı 2: Hazırlık-Devrim	03:31
6	Bıçkın 2: Metro - Egitim	04:05	24	Şakacı 3: Sunshine Mola - Devrim	03:11
7	Bıçkın 3: Demiraylar "U" Dönüş	03:00	25	Şakacı 4: Son duraktan garaja dönüş	03:12
8	Bıçkın 4: Yuva-Çarşı	03:09	26	Uyanık 1: Başlangıç - İnşaat	04:28
9	Bıçkın 5: İşbank-Bölümler	03:35	27	Uyanık 2: Ziraat Durağı - Sunshine - KKM	04:35
10	Bıçkın 6: Yuva - Son durak	05:09	28	Uyanık 3: KKM Durak - A1 Nizamiye	03:17
11	Bıçkın 7: Yakıt İstasyonundan Çıkma	01:12	29	Uyanık 4: Birinci Yol Kavşağı - Kimya Kavşağı	02:58
12	Dingin 1: Garajdan Çıkarken Arkadaşlara Sitem	04:15	30	Uyanık 5: ODTÜ Kent-Demiray	03:27
13	Dingin 2: Otobüsü Devraldıktan Sonra - 1. Yol Kavşağı	03:49	31	Uyanık 6: RingSonu- Garaj	04:19
14	Dingin 3: Birinci Yol Kavşağı - Ring Sonu	04:46	32	Uyumlu 1: Metro-Demiray	04:08
15	Dingin 4: Yakıt İstasyonu - Levha Arama	03:49	33	Uyumlu 2: ODTÜ Kent - KKM	03:57
16	Dingin 5: Metro- Tampon Çarpma	03:47	34	Uyumlu 3: A1-ODTÜ Kent	04:01
17	Dingin 6: Teknokent - Bölümler	03:55	35	Uyumlu 4: ODTÜ Kent - Demiray - Metro	04:34
18	Dingin 7: Rektörlük - Ring Sonu	03:58	36	Uyumlu 5: Garaja Dönüş	04:00

Figure 77 List of final videos.

The videos cover a range of events, including approaching and departing from bus stops, turning at road junctions, negotiating the right of way, taking over other vehicles, driving in the night, passenger embarkment and disembarkment, driver preparations for departure, and traffic conflicts. Common themes include traffic interactions, difficult maneuvers, and other routine activities of the driver, such as communicating with the passengers.

Since the video content is sourced directly from drivers who were grouped as driver personas, the depicted events in the videos were limited to those that naturally occurred during the recordings. However, with 11 recorded drivers and a cumulative recording duration of 17 hours and 36 minutes, the videos ended up offering a comprehensive insight into diverse driver experiences. Following the analysis and editing process, the 36 final videos have a total duration of 2 hours and 14 minutes, with a file size of 8.38 GB. Videos are stored on the author's Vimeo account with a Pro membership. This membership facilitates larger uploads, provides advanced privacy settings and a notetaking interface for the videos (Figure 78).

To preserve the privacy of the videos, they are hidden on Vimeo, accessible only through the buttons on the Miro board. While driver identities are anonymized by grouping them into personas, license plates of other vehicles, and the voices and faces of people in the videos remain visible. This necessitated hiding the videos on Vimeo due to their sensitive nature. However, clicking the video button on the Miro board opens the video in a web browser, revealing the copiable video link, prompting the need to caution participants against copying or sharing data to maintain privacy. This precaution may be particularly crucial in corporate settings where controlling stakeholders' access to video data is more challenging.

The video note-taking interface is a Vimeo feature where the participant and account owner's screens differ. The author configured the participant with minimal playback controls, as depicted in Figure 78 compared to Figure 79. Participant screen includes standard controls for play/pause, sound, speed adjustments, and full

screen. In addition to these controls, the screen allows timestamped notetaking during video playback. Clicking anywhere on the video screen pauses the video, opens a note-taking interface, and creates a timestamp (Figure 78). Pressing the add button places the note on the right side of the video, displaying the participant-provided name (Figure 79). Despite the author's preference for restricted visibility, these names and notes are visible to all participants due to Vimeo's settings.

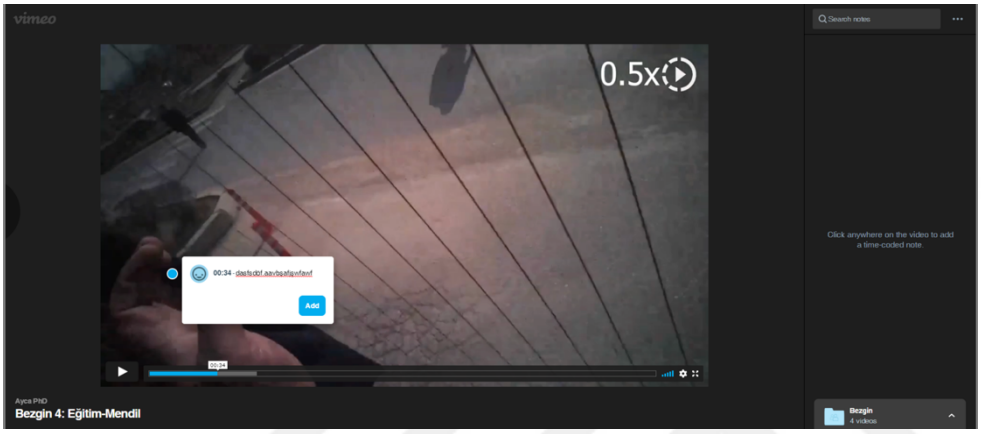


Figure 78 Video player and notetaking on videos (participant screen)

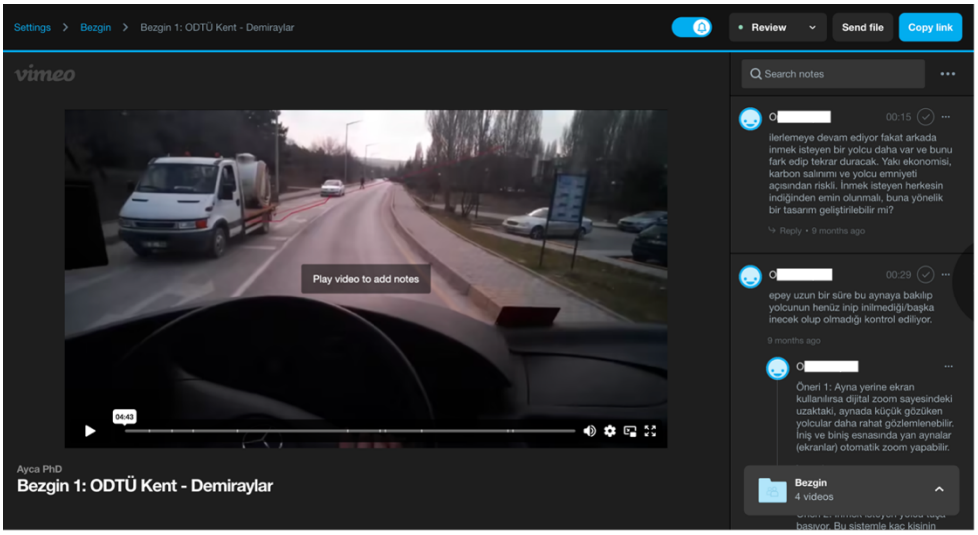


Figure 79 Video notes on account owner's screen.

5.3 Complementary Artifacts of the Final Version

Complementary artifacts do not contain information about the user research with bus drivers, but they are necessary to facilitate remote and online workshops, enabling asynchronous work. This requires the artifacts to feature brief and clear explanations, enabling participants to use them without a preliminary meeting about the aim of the study and how to utilize the artifacts.

5.3.1 Miro Boards

Two Miro boards were designed to communicate the research findings. The first Miro board served as an introductory platform, providing information on the study itself, instructions on Miro board navigation and manipulation, as well as introducing the driver personas and prominently featuring the driver experience map. Each workshop participant received a replicated copy of this board specifically assigned to them. This approach ensured that every participant had their designated board with editable access, allowing them to contribute directly by filling out the comment boxes within the driver experience map.

A section on this replicated board was interlinked with the second Miro board. The second Miro board was the same for all participants and was designed to facilitate the exploration of video content, with detailed instructions on video previewing and note-taking. It comprised seven driver frames, each representing a driver persona and a total of 36 associated video clips. The video clips were uploaded to Vimeo, and the corresponding links were assigned to the video names on campus maps.

5.3.2 Miro Board Navigation and Text

Navigation refers to the methods and mechanisms by which users move through and interact with a digital product or system. It encompasses the user interface

elements, such as menus, links, buttons, and controls, that allow users to navigate between different sections, screens, or content areas. Navigation systems provide the means for users to find and access the information they seek.

Since Miro provides an infinite canvas where users can place and organize content spatially on the board, the navigation strategy can be called "Board Navigation." This includes navigating the boards by panning (scrolling) and zooming in or out with the help of input devices such as a computer mouse, trackpad, or touch-enabled devices to view and interact with different content sections. Therefore, participants can navigate the boards to locate specific content or areas of interest without the need for menus, buttons, or any other interface elements.

For this study, both of the Miro boards follow a right-to-left flow guided by descriptive text and arrows. The descriptive text includes an introduction to Miro, a description of the study, participant consent approval, spatial cues for workshop steps, and instructions about each step of the workshop.

While Miro boards can be navigated simply using input devices, since there are two Miro boards for each participant, the first boards, assigned to individual participants, is linked to the second Miro board, which is used by all participants. Additionally, video representations on the campus map are linked to individual videos uploaded on Vimeo. These links enable participants to jump to new web browser windows, providing a more structured navigation experience.

The first board begins with a ‘start here’ text and descriptions about how to use Miro (Figure 80). The workshop process was divided into steps, and spatial cues were created for each step to help participants orient themselves and navigate to specific areas. These cues were designed as large speech bubbles, ensuring readability even when zoomed out (see Figure 81 for an example).



Figure 80 Miro introduction.

Each step includes descriptive text below the spatial cue. An example of a spatial cue and descriptive text can be found in the following figures taken from the second Miro board dedicated to the driving videos (Figure 81, Figure 82, Figure 83). Figure 81 displays the zoomed-out view of the descriptions. It features a spatial cue in the form of a yellow-colored speech bubble and bullet pointed descriptions about how the participants are expected to interact with the video content. It provides clarification that the red circle on the videos is an indicator of the drivers' gaze. The text in Figure 82 details the process of playing the GIFs and accessing the video links. Text in Figure 83 explains how to take timestamped notes on the videos and the procedure for canceling notes in the event of an error.

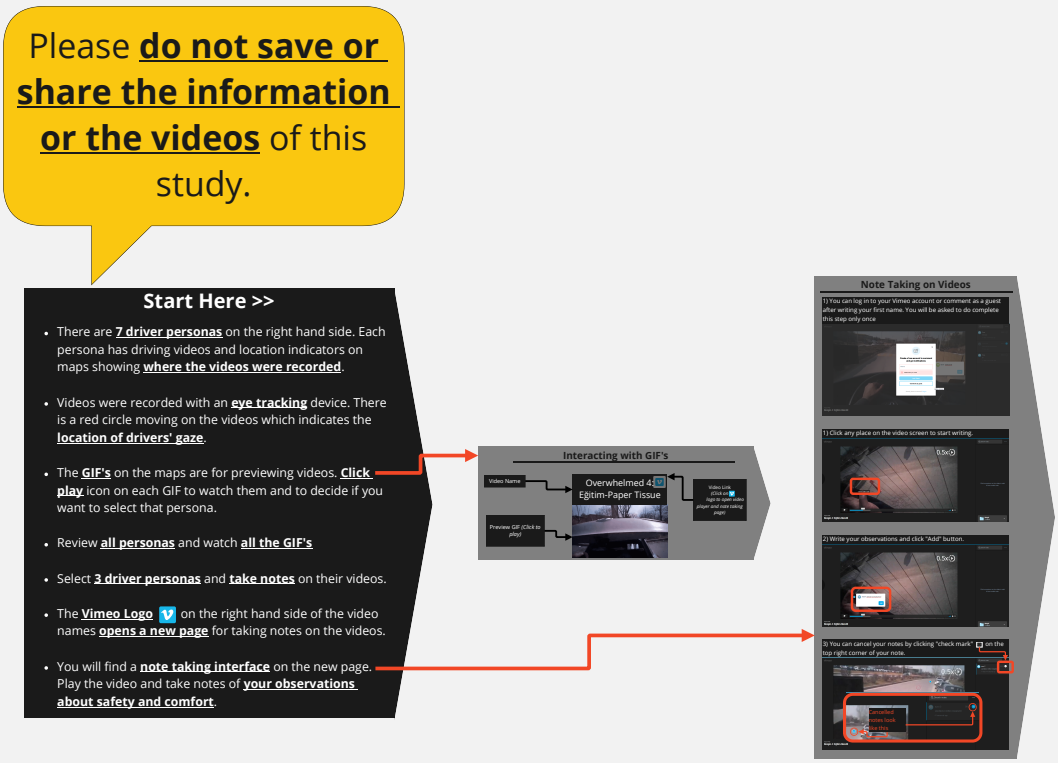


Figure 81 A spatial cue and descriptive text on the Miro board dedicated to the videos.

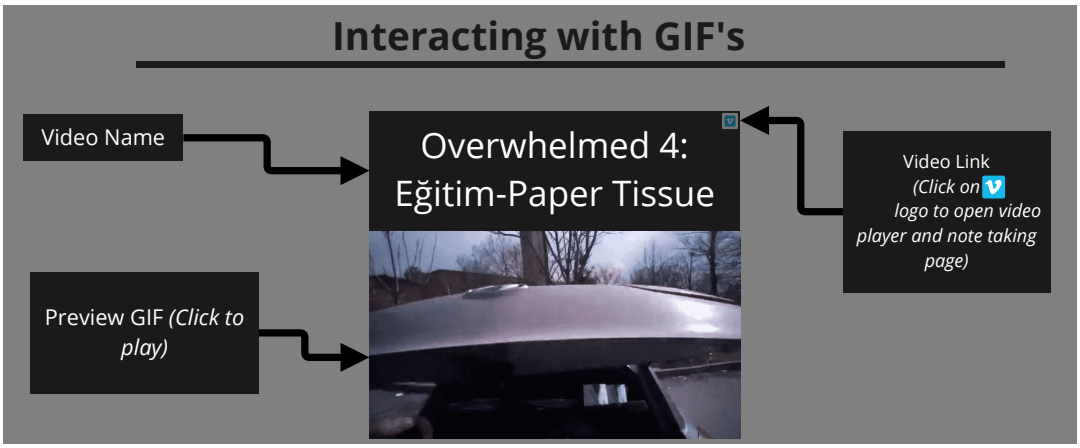


Figure 82 The descriptive text for interacting with video representations.

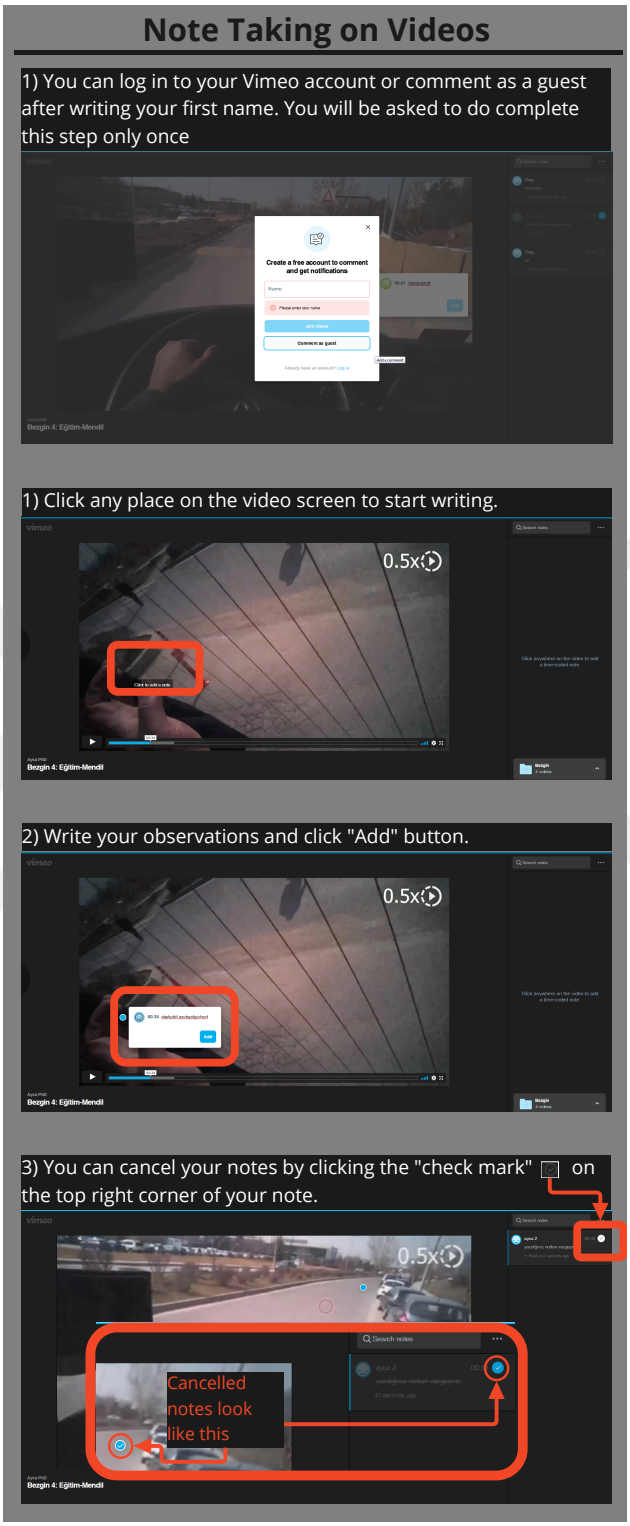


Figure 83 The descriptive text for notetaking on videos.

CHAPTER 6

UTILIZATION AND ASSESSMENT OF THE WORKSHOP FRAMEWORK

Participant designers were asked to identify comfort and safety problems and driver needs by utilizing the workshop framework. They were provided with the links to the workshop artifacts to get acquainted with before the workshops. At the beginning of the workshops, participants were asked about their driving experience, user research affiliation, and experiences about being passengers of public buses. During the workshops, they were asked to talk about their observations about the driver experience map, select and watch driving videos, comment on the videos with regard to driver safety and comfort needs, and prioritize all the problems at the end of the workshops. They were also asked open-ended questions to evaluate the workshop framework at the end of the workshops. This chapter reports the ways of utilization of the workshop framework and participants' assessment of the workshop framework.

While it is impossible to clearly discern which observations are derived from which artifacts due to the rich information content and holistic nature of the workshop framework, the participant utterances related to specific information areas communicated through different artifacts are traced back in the transcripts, and the artifact contents. In addition, at the end of each workshop, participants were asked about their opinions regarding different artifacts of the framework and the whole process. These comments are then consolidated into a holistic assessment of the artifacts and the framework and are reported under this section. This section is divided into three sub-sections: driver experience map, driver frames, and other comments.

As some participants, such as 2MeK, 4CB, and 5FuA, put it, the driver experience map provided an overview of the context, whereas driver frames, which are

artifacts that consist of driver personas and driving videos, provided the immersive details of the problems. Driving videos are the conceptual combination of the actual video clips and the representations of the videos on the campus map. These representations include the location of the video, video naming, and the Thumbnail GIFs. Participants commented on elements of the driver frames separately, as well as the relationships of the elements. These comments are reported in the following two subsections titled accordingly. The last subsection, titled "Other Comments," includes participants' overall evaluations of the framework.

6.1 Driver Experience Map

The driver experience map is designed as a tool to convey insights derived from interviews and field observations that may not be evident in the videos. It encompassed various contextual elements, including aspects of shuttle bus operations, driver resting areas, the fuel station, and more.

6.1.1 Driver Experience Map-Based Problem Observations

Participant observations within the driver experience map shed light on systemic challenges faced by shuttle bus drivers, such as parking violations, lack of support for the well-being and professional development of the drivers, and concerns about better organization and delegation of driver tasks. Moreover, the participants highlight operational hurdles like efficient fuel management, strategies for coping with route disruptions, and effectively handling disruptive passenger behaviors. Additionally, interactions with the driver experience map revealed the need for designing better information communication mediums about the shift organization for drivers, and shuttle routes and real-time bus locations for passengers.

6.1.2 Utilization of Driver Experience Map

While the majority of participants found the contextual data in the driver experience map as of utility for gaining insights, one secondary participant who is a military vehicle designer with a focus on ergonomics (8OB) and one deviant participant who is a UX designer at a social media platform (9MuK) expressed their preference for prioritizing watching videos and refused to interact with the experience map. Their choice to focus on video content seems to stem from limitations in the time available for their engagement and the appeal of the novelty of eye-tracking videos. Moreover, the fact that they are not directly interested nor involved in projects for bus drivers might have affected this disinterest in learning more about the shuttle bus context. On the other hand, a primary participant's comment about the experience map, who is equally intrigued by the eye-tracking videos and works as a design manager for a bus company, demonstrates the utility of the map:

> Driver experience map provided clear information about where and what the user was thinking and feeling, contributing to a better understanding of the problems. It also enabled me to make comments on the topic without even watching the videos. (5FuA Position: 48)

The participant, 5FuA, found particular intrigue in identifying an issue from the driver experience map. This issue involves drivers not recalling the location of their vehicles when moving from the rest area to the bus. He emphasized the significance of this problem, noting that in their company, specializing in fleet sales, a fleet might comprise 100-120 vehicles, totaling 400-500 when combined with existing ones. The uniform corporate graphics on these vehicles make them visually indistinguishable. Recognizing the difficulty for drivers in locating their assigned vehicles, particularly in large garages, he noted the potential for a simple, practical, and cost-effective solution by utilizing smartphones. He suggested that addressing this issue could not only enhance driver satisfaction but also prove to be a valuable investment for management (5FuA, Pos. 8).

In addition, the driver experience map transcends its initial supplementary role, as pointed out by a deviant participant who is a Ph.D. researcher focusing on user research (2MeK). This participant envisions the map as the central piece for integrating video observations, ideation, and sketches throughout the entire design process. To illustrate this, the participant described a preferred usage scenario involving capturing screenshots from the videos, enriching the map with detailed depictions of events like the movement and location of objects, and eschewing the need for constant video reference:

> If there was something in the video that caught my interest, I would take a screenshot and place it on the experience map. So, for example, instead of just noting that there's a dog passing the road, I would prefer to take a screenshot that shows the specifics of its movement and location. Therefore, I would turn to the videos only when I needed them. (2MeK Position: 74)

This dual functionality of the experience map, serving as both a problem-identification tool and a platform for ideation, underscores the map's versatility and potential as a template for mobility-related projects. Additionally, this approach emphasizes the map's potential self-sufficiency in portraying the driver's journey by relating the events to the campus map and enabling participant-generated ideas. In a similar vein, a secondary participant who was a designer at a healthcare company and worked on a bus project before (4CB) expressed a preference for the circular layout of the experience map around the campus map, citing its clarity and step-by-step approach in contrast to the conventional linear formats found in healthcare projects she participated, which tend to be overwhelming and disorienting due to their extended and monotonous nature. By favoring the circular design format, this participant not only highlights its suitability for diverse contexts but also reinforces the idea of concluding the user journey at its starting point (4CB Position: 55).

6.1.3 Assessment of Driver Experience Map

The first-person narrative style of the driver experience map was appraised for humanizing the driver and enabling empathy by a secondary participant with a previous bus design experience (7IT). Insights into the drivers' thoughts and emotions in the form of internal dialogues are found more effective in portraying the character of the drivers compared to the accompanying photographs (7IT Position: 53). Similarly, another secondary participant with a previous bus design experience (1FA) shared his thoughts about the empathy-inducing quality of the driver experience map with an emotional expression:

> I didn't put myself in the driver's shoes while watching the videos, but I did when filling out the driver experience map. Especially lying on the table struck me; I thought it was very unfair. It's sad that there are no proper rest areas. (1FA Position: 77)

Two primary participants, 3SG and 10KU, both designers at bus companies, raised concerns about the severity of events depicted in the driver experience map. Participant 10KU expressed skepticism regarding the relevance of these events to METU drivers, suggesting they might not occur on the campus (10KU, Pos. 57). Similarly, participant 3SG noted both overlaps and discrepancies between experience map observations and video footage. He observed that the experience map events portrayed a more stressful environment reminiscent of public transport services in crowded cities, while the videos depicted a calmer traffic situation. It's worth noting that the experience map events were collected from the campus, facilitating the interviews conducted with the drivers and reviewing social media posts from METU students. Interviews provide access to drivers' knowledge and memories over an extended timeframe, and social media posts provide visual evidence for some rare events. Given the infrequency of these events, capturing them on video is unlikely, which potentially explains the disbelief of the participants and the disparities between the experience map and video events.

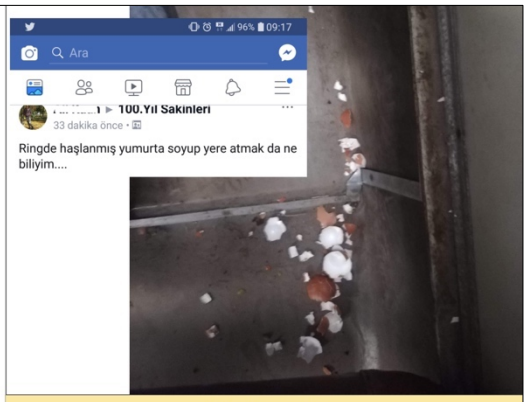
Regarding rare events, two participants tended to justify design opportunities with the frequency of events in the driver experience map. One deviant participant (6EC), who holds a design Ph.D. and works as a UX designer at a marketing data technologies company, highlighted the importance of the problem frequencies for opportunity identification. The participant emphasized that the driver experience map provided qualitative data, offering a detailed insight into peak problems from the driver's perspective. However, he also mentioned the need to complement this qualitative data with quantitative data in order to make sound judgments (6EC Position: 7-8). Similarly, another secondary participant with previous bus design experience said:

> I saw in the driver experience map that some passengers left eggshells on the bus, which is an interesting problem, but I don't think it happens repeatedly. Therefore, I wouldn't focus on it. (1FA Position: 11)

In line with the concerns about event frequencies, it is crucial to focus on the problems that align with the level of effort that is invested in incremental product improvements within for-profit companies to achieve a substantial return on investment. However, as this study is a knowledge construction endeavor that focuses on improving the driver experience rather than developing any specific products, rare events such as eggshells and cooking were also included to explore the extent of the driver experience (Figure 84). This approach also aligns with the design thinking practices for innovative product development.



Gün sonu	
Mesaiden sonra bir çay içip ısındıktan sonra akşam yemeği için kabak tatlısı hazırlıyor.	
Nerede	Dinlenme alanı mutfağında
Ne düşünüyor	"Hanım ne kadar şeker atmamı söylemişti?"
Rahatsızlığı	"Mesaiden sonra yemek yemek için bir de pişirmemiz gerekiyor"
Tasarım Problemleri	



Ring Sırasında	
Ringin yarısını tamamladıktan sonra ilk durakta hareket saatini beklerken aracı kontrol ediyor. Yerde haşlanmış yumurta kabukları görüyor	
Nerede	Sunshine Kafe'nin arkasındaki durakta
Ne düşünüyor	"Bunu nasıl temizlerim?"
Rahatsızlığı	"Şoförlüğünü yaptığımız yetmiyor, bir de temizliğini yapacağız otobüsün"
Tasarım Problemleri	

Figure 84 Rare event examples from the driver experience map.

6.2 Personas

Personas are based on the driver observations in the field and designed as graphical artifacts (Figure 85) to synthesize information derived from driving videos, field observations, and literature findings. Positive skills, such as fluent driving, and negative behaviors, such as violations, are considered to be measured by the Driver Behavior Questionnaire. These aspects, together with health conditions, were neither diagnosed nor measured in the drivers upon whom the personas in this study were based. Instead, they were assigned to the personas based on the author's observations. Furthermore, these attributes were deliberately exaggerated to stimulate participant discussions. However, the fictitious nature of these health conditions, skills, and behaviors was not disclosed to the participants, leading them to believe that this information was confirmed. Participant feedback and commentary about the personas are categorized into three main themes: persona-based problem observations, insights into the utilization of personas as bridges

between video data and participants' prior knowledge, and assessment of information content and design of personas.

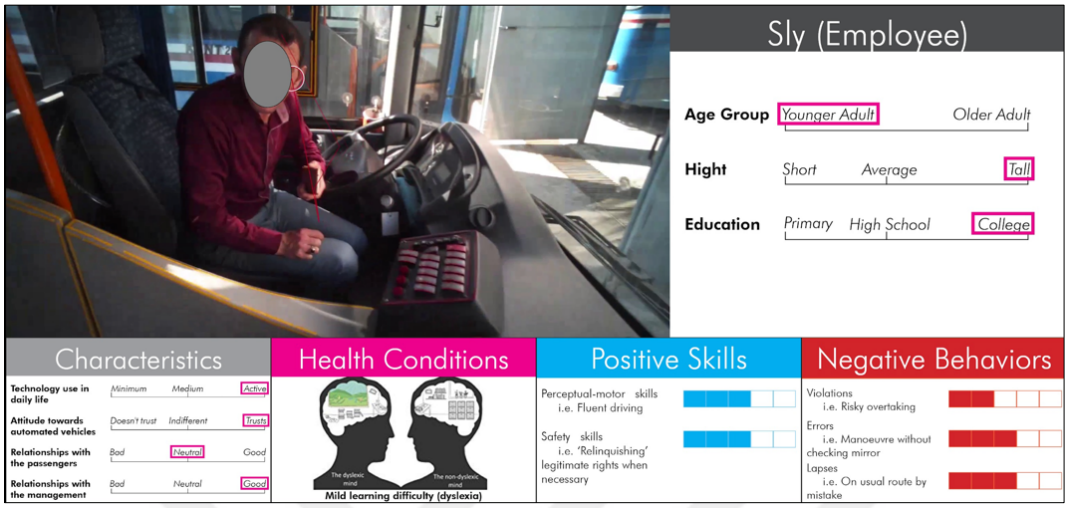


Figure 85 Uyanık (Sly) Persona

6.2.1 Persona-based problem observations

Persona-based problem observations include driver-related problems and the bus-type problem. Driver-related problems fall into enduring problems and malleable problems. The categorization of enduring and malleable driver problems centers on the potential for improvement, meaning that some driver-related problems are more open to improvements than others. Enduring problems are influenced by persona attributes such as age, certain health conditions, and skills. These qualities are considered resistant to interventions, making them unlikely to be addressed with design. Malleable problems, on the other hand, encompass driver behaviors, some health conditions, and skills, and while challenging to change, they still permit designers to explore potential interventions.

In addition to driver-related problems, two experienced primary participants, 3SG and 5FuA, noticed that two of the buses in persona photos were of the coach type and distinct from the others (3SG, Pos. 37 and 5FuA, Pos. 27). Coach type buses are designed for long-distance travels featuring more comfortable seats, a high

floor, and a luggage compartment below the passenger seating area. On the other hand, city buses are designed for efficient public transportation and short-distance travel, featuring a low floor design to facilitate convenient and frequent boarding and disembarking. Additionally, city buses incorporate wider aisles, ensuring smooth passenger movement within the bus. 3SG further raised concerns about using coach-type buses for shuttle services, noting that they are too high for this purpose. While younger passengers may not have difficulty boarding, older passengers could face challenges due to the height of these buses. Waiting for passengers to step up at each stop can lead to longer waiting times. Additionally, considering that drivers are not assigned to specific vehicles, they will alternate between coach-type and low-floor buses, which is not ideal. This is because these buses have different handling characteristics and technologies. Drivers accustomed to coach-type buses may initially find it challenging to adapt to low-floor buses (3SG Pos. 37-40).

Enduring Driver Problems

Enduring problems include difficulties in anger management, engagement in risky traffic behaviors, and some severe health problems. Participants argued that some enduring problems hinder drivers from performing correctly, raising questions about the employability of these individuals.

An example is the degradation of critical cognitive and motor skills with age. This issue is recognized as a risk in the literature (Shinar, 2007). Another example is aberrant behaviors or anger management issues, deeply rooted in the driver's upbringing, the education they received, their inherent properties, and other complex cultural factors. While two primary participants, 5FuA and 10KU, rendered these problems unsolvable, a secondary participant, 7IT, who is a design manager at a military vehicle manufacturer, and a deviant participant, 6EC, who is a UX designer at a marketing data technologies company, recommended

enforcement and surveillance as design interventions. 7IT even included cultural influences to justify enforcement by noting:

> We often believe that rules on paper will regulate life in Middle Eastern societies, but we fail to implement them. Unfortunately, we often need a prod to get people to follow the rules (7IT, Pos. 15)

The participants who didn't opt for enforcement and surveillance as solutions to enduring problems suggested utilizing driver characteristics to select the correct candidates as professional bus drivers since aberrant behaviors are considered significant traffic safety problems (2MeK and 10KU). One of the primary participants, 10KU, even expressed his safety concerns in a manner that reflects the extent of his apprehension:

> For instance, I strongly prefer not to have the first persona as a driver at my university campus because their behavior poses traffic risks. I believe there should be changes in driver selection, and drivers need to undergo a thorough evaluation to ascertain their suitability for the campus environment. (10KU, Pos. 54)

This apprehension is understandable, considering the effects of unsafe driver behaviors on severe traffic crashes. However, while risk-posing behaviors can often be identified more deterministically and can be acted upon, establishing what is considered unacceptable personal characteristics is a more complex and subjective judgment. Therefore, any actions taken based on such judgments must be carefully considered, as they can significantly impact individuals' rights and freedoms. Decisions related to behavior evaluation and its implications should be subject to thorough ethical analysis to ensure they are fair, unbiased, and aligned with broader societal values and norms. This multifaceted evaluation process acknowledges not only individual perspectives but also the deeper ethical and philosophical implications inherent in assessing and addressing enduring problems.

Malleable Driver Problems

Malleable problems include issues such as being overweight, having lower proficiency in certain driving skills, and experiencing health issues like perfume allergies and musculoskeletal problems. While some participants questioned the suitability of these personas for professional driving, they were able to come up with design opportunities. For example, dealing with a perfume allergy as a professional driver on a university campus where strong fragrances are typical among young people is considered challenging, if not impossible (3SG Pos. 65). However, creating an enclosed driver cabin with separate air circulation from the rest of the bus can address this problem. Other suggested solutions to malleable problems included improving cabin ergonomics, designing training, dietary, and exercise programs, and implementing a performance evaluation system that includes regular exercising as a metric to raise driver awareness of well-being.

While the matter of driver-related problems that are enduring and adaptable in nature may initially appear irrelevant to design, they hold significant implications for the specific project and the discipline of design. For an example of how participants problematized driver violation behavior and how it can be addressed with design, see below.

6.2.2 Utilization of Personas

The first type of participant utilization of personas was making problem observations directly from the persona artifacts. The categorization of these observations was explained in the previous section. The participants scrutinized persona text and photos for problem identification. Beyond these problem-focused observations, it is noteworthy that participants such as 3SG, 7IT, and 2MeK also articulated broader observations. Although not inherently categorized as problems, these general insights may have contributed to participants' holistic understanding of the challenges presented in the videos.

> İhtiyar persona’s communication with passengers is neither good nor bad. He's just going with the flow. While you were asking questions for the interview, I imagine that this driver constantly gave average answers, was unenthusiastic about the interview, and seemed to care so little that he wouldn't even bother to think. Persona text and the look on his face in the persona photo may have led me to think this way. He gives the impression, “Let me finish my job and go.” (3SG Pos. 41)

> It is possible to estimate the weight of the driver personas to some extent from the photos, but weight information can be added to the personas. While certain weights may not be a problem for some heights, it can be problematic for shorter drivers. (7IT Pos. 48)

> Even if I were to just look at the persona's photo, I could conclude that this profile is Şakacı; good communication with passengers aligns with my observations from the video, making this aspect consistent. (2MeK Pos. 66)

> When I read that Bezgin persona trusts in vehicle automation technologies, I wanted to see the persona photo to see what type of bus he is currently in. He drives a Mercedes of the coach type, which is a well-technologically advanced vehicle. This explains his trust. (3SG, Pos. 64)

The second type of persona utilization is the most prominent one, and it was the participant utilization of personas as approximations to potential events in the videos. Participants employed personas to determine whether the videos associated with a particular persona justified the participant’s limited time allocated for the study. While this may appear somewhat trivial in the context of real-world persona utilization, it is on the contrary. In a real-life project, which could span several years due to its complexity, users of this workshop framework would need to make selections during various time-bound goals, such as different design sprints focusing on enhancing the driver cabin, the driver-vehicle interface, and so on. Facilitating this selection, hence enabling prioritization, aligns with the findings of Töre Yargın (2013), who presented problem prioritization as a necessary system quality that designers need from user research communication.

The extended duration of real-life projects motivated the author to include memory retention as a quality of artifacts, in addition to prioritization. To address this, the design of workshop artifacts involved breaking down data into memorable chunks, like personas, and incorporating mnemonic cues through distinctive naming for both personas and videos. To inquire how the participants utilize personas as approximations to potential events in the videos and the effects of the mnemonic cues, participants were asked to select personas and videos to watch during the workshops and explain their reasons for selecting them. This, in return, revealed participants' selection criteria and their expectations of user research communication while spurring several types of discussions as expected.

Most of the participants utilized persona selection to identify the most eventful videos. Participants made this selection by facilitating various aspects of the workshop frameworks such as persona names, video names, video locations, video thumbnails, or asking the author. One participant, who utilized persona information for this approximation, inquired about the effects of some health issues, such as anger management and learning difficulty (1FA Pos. 12). In addition, some participants utilized the names of the personas as selection criteria as a secondary participant, 7IT noted:

> First, I would select Uyanık as he will be one of the most colorful personas. In addition, this is a character type that is quite common on Turkish roads. There is a high probability of displaying rule-breaking behaviors, and Uyanık may need the most design interventions as the risk factors are higher. (7IT Pos. 18)

Unlike most participants, two experienced primary participants (3SG and 5FuA), design managers at different bus companies, exhibited caution when seeking eventful videos. Their prior knowledge of public bus incidents likely heightened their awareness of the potentially distressing nature of such footage. Nevertheless, they utilized persona names, albeit for the purpose of avoiding excessively eventful videos, as presented as follows:

> I'd like to start with the Şakacı (Joker) persona because there might be aggression in the other videos, and I don't want that early in the morning. (3SG Pos. 13)

> I wanted to watch the videos of the Uyumlu persona because with a name like "Uyumlu" (Compliant), and considering his high level of education, advanced age, and fewer negative behaviors, except for occasional absentmindedness, I thought the driver in the video would be a more adaptable and orderly person who drives more cautiously. (5FuA Pos. 50)

In addition to utilizing personas as proxies for events, personas also served as anchors for driver comparisons, enabling the scrutinization of traffic behaviors and driver needs presented in the videos. This third type of utilization was particularly prominent for a secondary participant, 1FA, who is a motorcycle rider with a safety mindset who attends safe driving trainings and watches motorcycle riding videos to improve his riding skills. He searched for links between video behaviors and persona characteristics. He noted:

> I thought Bıçkın's anger control issues would negatively affect his driving in the videos, but it didn't turn out as I expected. From the perspective of driving the bus, Şakacı appeared to be more reckless (impulsive, careless, etc.) compared to Bıçkın. Perhaps it's because Şakacı has dyslexia. (1FA Pos. 12)

Finally, a deviant participant, 2MeK, with a background in user research, provided insights into how he would utilize the persona characteristics information (Figure 86) in the later stages of a real-life project as a fourth way of utilization.

> In the 'Characteristics' section, the most valuable information for me would be drivers' trust in automation technologies. Information about their daily use of technology, in general, would also be useful. I would use this information in the following way: When we have a mature design idea, I could refer to different personas that trust and those that don't trust to explore how these differences affect the development of the idea or to propose usability enhancements. For instance, we talked about a system that detects objects approaching the bus and provides recommendations to the driver. During the decision-making phase for that system, I might turn to Şakacı for advice. I would inquire about why he doesn't trust automation

technologies and whether he would trust the concepts we are developing. Of course, I wouldn't be able to extract usability information directly from the persona, but based on the information here, I would want to reach out to these individuals to gather their comments on certain technology proposals. (2MeK Pos. 66)

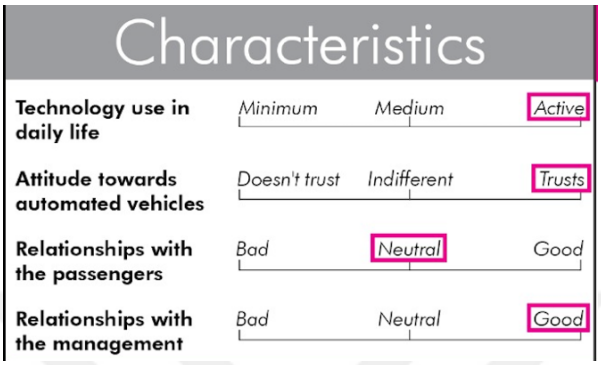


Figure 86 Persona characteristics information.

While most participants utilized personas in different ways explained here, two of the participants (8OB and 6EC) showed limited interest in personas. One of them was the same secondary participant, 8OB, who also refused to interact with the driver experience map. This participant is an experienced military vehicle designer and found it challenging to understand the personas, mainly due to the names lacking clear associations with drivers in the videos. He exemplified the mismatch with Şakacı persona, whom he considered as reckless rather than a joker personality, as the driver in the video was making a video call while driving (8OB Pos. 71). As a designer who is accustomed to working with military personnel and focusing on ergonomics and the driver's field of vision, his strict, rule-based perspective on problem identification may have influenced his limited interest in personas.

Moreover, participant 6EC, a deviant participant and a UX designer, expressed indifference to the personas, suggesting that they did not leave a lasting impression. He mentioned that, due to his time constraints, he preferred a smaller number of personas, possibly just one compliant and one aggressive, with simple details (6EC Pos. 73). Moreover, 6EC voiced his uncertainty about the potential benefits of

receiving these pre-designed personas compared to his usual practice of designing personas himself by interpreting raw user data. This uncertainty may stem from a lack of control over the design process of personas and potential differences in how the pre-designed personas align with his specific needs and expectations as a designer (6EC Pos. 77).

In terms of not utilizing the personas, one primary participant, a recent graduate (10KU), surprisingly decided not to use personas or their names for persona and video selection, as he was unsure how to utilize them. Instead, he decided to use map locations of the videos as a proxy for eventful videos (10KU Pos. 8). However, different from 8OB and 6EC above, this participant readily expected the effects of personas on the driving videos, but he was not sure how; therefore, he decided to select the videos that were recorded in the same location of the map to inquire about personas' effects. He noted this by saying:

> I'm curious if the persona information, such as being a younger adult, tall, or a high school graduate, is relevant, and I'm not sure about the benefits it will bring us. Therefore, to have variety, I will select one adult, one older adult, one short, etc... I want to select the videos that are recorded at the exact locations on the map because I want to establish a constant variable as the persona personalities change. (10KU Pos. 8-9)

6.2.3 Assessment of Persona Content and Design

Personas elicited various reactions. Some participants readily accepted the personas representing actual drivers in the videos, while others remained cautious. A primary participant, 5FuA, a design manager at a bus company, found the personas realistic and thought they accurately portrayed real-life drivers. However, upon empathizing with the drivers, he expressed reservations about being associated with names like Uyanık, İhtiyar, Bıçkın, and Bezgin, as these names carry negative traffic behavior connotations. He provided examples of behaviors associated with these connotations, such as secretly exploiting any advantage they encounter, making frequent mistakes, exhibiting rebellious behavior, and skipping bus stops,

respectively (5FuA Pos. 51). It's notable that these behaviors were exhibited by drivers who were associated with these persona names.

Another primary participant, 10KU, a recent graduate who works at a bus company, thought that persona names, which function as personality adjectives, created false traffic behavior expectations that were not reflected in the videos. He mentioned the persona 'Dingin' (Calm) as an example, noting that the persona's eyes were moving rapidly in the videos despite the name. He would have preferred to approach the personas without any preconceived bias (10KU Pos. 58). While the request for remaining unbiased before watching the videos is entirely justified, it's important to highlight that rapid eye movements cannot necessarily be conclusively linked to personality traits, such as having a calm demeanor, which was the case for the ‘Dingin’ persona.

A similar concern about the persona names was raised by a secondary participant, 8OB, who showed limited interest in personas and the driver experience map and said that he could not relate the names of the personas to drivers in the videos. He exemplifies this:

> For example, I didn't think of the Şakacı persona as a joker; I thought he was reckless because he was making a video call on the phone while driving. As for İhtiyar, I didn't observe any clear indication of old age apart from the prominent veins in his hands. (8OB Pos. 71)

Participant 9MuK, a UX designer at a social media platform, found the personas to be quite intriguing. However, he expressed the view that user personas, in general, tend to be a topic of controversy within the field of UX (9MuK Pos. 48). In addition, he found some persona names irrelevant to the task of designing the bus by noting:

> If you are selling fishing rods, does it really matter if the guy or the woman works in a bank, is married, or has children? We need to use only the relevant information, otherwise, demographic information may not be useful at all. So, with Şakacı, a person who likes joking, I’m not sure how

> much of an impact to the product that has, but Bıçkın, aggressive might be very relevant." (9MuK Pos. 49)

While Participant 9MuK's argument regarding the inclusion of only project-relevant information in the personas is valid, it's important to note that this project diverges from the common notion of industrial design as the activity of designing specific product categories as mentioned earlier. This necessitates to adopt a wider perspective when exploring users. Instead, it places the primary emphasis on the user experience, exploring dimensions that have the potential to improve the experience regardless of product categories.

On the other hand, a deviant participant with limited driving experience and extensive user research experience, 2MeK, said that he looked directly at the names of the personas since the names convey the overall characteristics of the personas. He also said that names served as shortcuts, which reassured him and made him feel at ease about moving forward with problem identifications (2MeK Pos. 5). Similarly, a secondary participant with limited driving experience and extensive user research experience, 4CB said:

> I liked the personas and having names like Bezgin, Bıçkın, and İhtiyar because it makes it easier for me to make quick decisions in the limited time I have dedicated to this study. So, if we want to get to the point as soon as possible […], this kind of guidance makes the job easier […] But if I were someone who wants to watch all the videos in a neutral way and identify the problems, the names can be overly directive. Reactions to the names can change depending on how much time one can allocate to the project […] Yet, they are more memorable than names like Ahmet and Mehmet, and they help me find my way within the information. (4CB Pos. 48 & 58)

Some participants also recommended some changes in the design of personas. 2MeK recommended including a female persona even though all the drivers in the study were male (2MeK Position: 2). This recommendation is entirely justified considering that the current demographics of drivers do not predict future demographics, and inclusivity should be a priority. He also recommended separating the "indifferent" label in the scale for attitude toward automated vehicles

(Figure 87) since it doesn't fit within the range from "doesn't trust" to "trusts." (2MeK Position: 4)

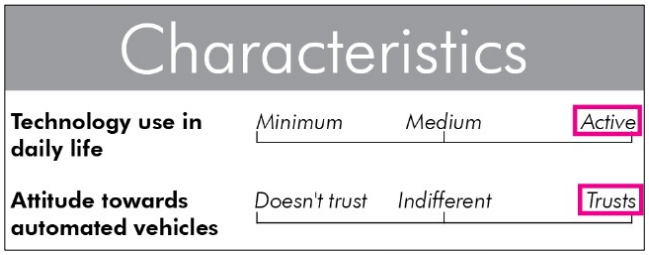


Figure 87 Labeling attitudes in personas.

A primary participant, 3SG, expressed a desire for more insights into the personas' family lives. In addition, he would like to see information related to the personas' daily routines, such as what time they arrive at work, how many hours they spend at work, the duration of active driving during work hours, the time it takes for their routes, and how many trips they make in a day. Essentially, he sought a broader understanding of the personas' daily lives and routines at work and beyond (3SG Position: 79). This participant also expressed that the personas are meaningful only if they are built on the actual driver data. He scrutinized personas' information, including the photos, to search for links between personas' emotional states, health conditions, personalities, and driving styles in the videos. When he suspected that the persona photo of İhtiyar did not belong to the driver in the video, the participant went back to the persona photo and zoomed in to check if the person in the photo was wearing the specific ring in the video. Since the videos were recorded from the driver's eyes, the participant could only see the driver's hands; therefore, this was the only evidence the participant could follow. Upon confirming the driver in the video and the persona photo are the same person, he noted:

> For example, if the person in the persona photo is not the actual driver, I wouldn't want to see this person. Because when the driver in the video contradicts the photo, it leads me to form an inaccurate perception. (3SG, Pos. 88)

As previously mentioned, a deviant participant, 6EC, expressed concerns about the excessive number of personas and the volume of information they contained. To address this, he suggested overlaying critical persona information on the videos, relieving viewers of the need to remember extensive details. Additionally, 6EC contemplated the advantages of involving participants in the persona design process (6EC Position: 77).

A secondary participant, 7IT, recommended additional information for personas. Firstly, he suggested including the weight of drivers, as mentioned earlier. Secondly, he expressed the need for more positive skill examples (7IT Position: 50). Personas already featured sections illustrating positive driving skills and negative behaviors, as shown in Figure 88. The Driver Behavior Questionnaire, as previously mentioned under the Personas section, assesses these skills. 7IT found it easier to comprehend negative behaviors but wanted more perceptual-motor and safety skills examples. This request for additional examples may be due to perceived ambiguities in skill names, as noted by a primary participant, 3SG, as:

> When we talk about safe driving skills in a persona, I understand it as the ability to control the vehicle in snowy weather, not just giving right of way. This also requires a high level of perception. It seemed contradictory that safe driving skills are high when perceptual motor skills are weak. (3SG Position: 17)

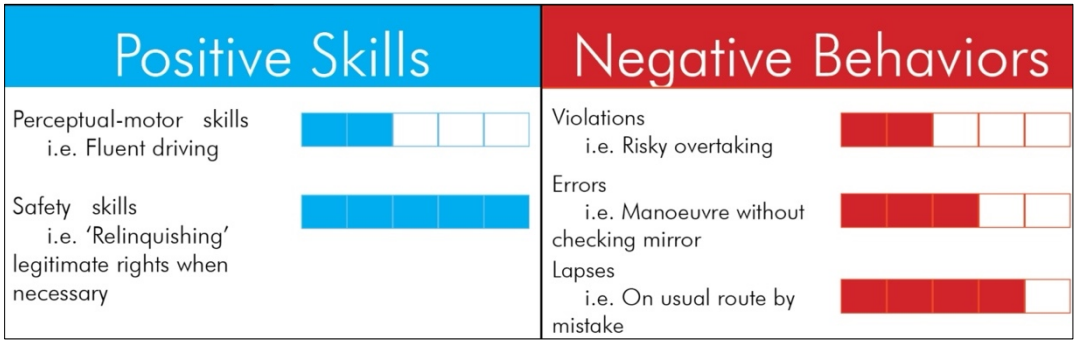


Figure 88 Persona skills and behaviors sections.

7IT also proposed an intriguing idea: incorporating a 'fatalism coefficient' into driver personas (7IT Position: 49). He raised concerns regarding individuals with a

fatalistic outlook, who believe that accidents are predetermined, and how this perspective may impact their receptiveness to efforts to improve their behavior. 7IT acknowledged the challenges in obtaining this information and did not view it as a deficiency in the personas. Instead, he underscored the significance of drivers recognizing their agency and responsibility in their actions. This notion aligns with the 'locus of control' concept in psychology, which has been identified as a potential risk factor in human-automated vehicle interactions (Heikoop et al., 2016).

6.3 Videos

This section delves into the utilization and assessment of eye-tracking videos. The unique perspective that eye-tracking videos provide piqued participants' interest and allowed them to utilize videos in various ways. This perspective combines visual, gaze, and audio data into a dynamic whole. Consequently, most participant observations were based on the video information. Even the observations made directly from the driver experience map and personas were evaluated or justified by considering the videos. Two examples from 8OB and 1FA were given in the Personas section. 8OB compared persona information and video information and deemed persona information inaccurate as he interpreted that the driver behaviors in the videos were different than the information in the persona artifact (8OB Position: 71). On the other hand, 1FA, upon facing a perceived inconsistency between persona information and the videos, tried to justify video information by referring to the health condition of the persona to (1FA Position: 12).

Videos ranging from 3 to 6 minutes were presented to the participants in an almost raw format. Almost-raw means that the eye-tracking videos have undergone some editing, as explained before. The editing includes selecting significant parts from the videos, speeding up some parts to reduce the overall duration while maintaining a coherent narrative of the original events, and slowing down other parts to emphasize specific details. Slowing down was necessary because certain elements

pass quickly in the natural-speed video, raising the author's concern that participants might overlook or not fully grasp these important details. Details of the editing process are provided in Chapter 5.

Given that the majority of the observations were affected by video information, this section will not feature a video-based observations section as opposed to the previous two sections (Driver Experience Map-Based Problem Observations and Persona-based problem observations). This decision was made to avoid redundancy.

As a final reminder, all participants were asked to select personas, watch their videos, and take notes on the videos facilitating the Vimeo notetaking interface before the workshops. However, only two participants (1FA and 8OB) had time to do that. This affected how the participants utilized the videos, as exemplified below.

6.3.1 Utilization of Videos

While the other artifacts provided overall information about the METU shuttle case, the leading utility of the videos is considered to provide detailed problems by a secondary participant, 4CB (Pos. 56), and a deviant participant, 2MeK (Pos. 74), each possessing extensive experience in user research. The design of the videos enabled timestamped note-taking and interpreting rich data that combines first-person view angle, gaze location, and sound. Therefore, two main types of video utilization were identified: note-taking on the videos and utilization of the gaze and the sound information of the videos.

Utilization of Notetaking

Two secondary participants (1FA and 8OB) could find time to watch and take notes on the videos through the Vimeo interface before the workshops. Therefore,

there is limited data about this type of utilization. That being said, the characteristics of the notes 1FA and 8OB took differed, providing some initial utilization insights. 1FA took short, observation-based notes with casual language, whereas 8OB added occasional suggestions in addition to his observation notes in formal language. Examples of 1FA's and 8OB's notes about the driver's gaze on the right-side exterior mirror when the driver is waiting for passengers to board the bus in different videos are:

> All drivers look at the right rearview mirror for extended periods of time during boarding and disembarking. Afterward, they check the left rearview mirror for departure control. (1FA, Pos. 98)

> For quite a while, the rearview mirror is checked to see if passengers have disembarked yet and if there are others waiting to disembark.
>
> Recommendation 1: Instead of mirrors, using screens with digital zoom capabilities could make it easier to observe passengers who appear small in the mirror, especially during boarding and disembarking. Side mirrors (screens) could automatically zoom in.
>
> Recommendation 2: With the current system, when passengers wish to disembark, they press a button. However, this system doesn't track the number of passengers wishing to disembark. Perhaps, a weight-sensitive area could be installed on the floor, and when passengers step into this area, they could notify the driver without needing to press a button. When all passengers in the area have disembarked, a weight sensor could send a message to the driver saying, "All passengers waiting to disembark have disembarked," eliminating uncertainty. (8OB, Pos. 75)

In addition, some notes of 1FA are shorter and more frequent, such as writing "route confirmation" several times on a video. For example, for the Uyumlu 5 video, he seemed to have utilized notetaking "route confirmation" to identify its frequencies. Later, he referenced this frequency and mentioned that communication is one of the most significant problems. He believed that if only one project emerged from this information, it should be about designing a communication system (1FA, Pos. 11).

> I remember I wrote “route confirmation” ten times in this video. The driver constantly says, “The bus goes to the A2 gate,” so no one boards incorrectly. After hearing the driver, some passengers get off again… Come on, it's a massive loss of efficiency. (1FA, Pos. 99)

In some videos, 8OB also took shorter notes and explained the reason as being more motivated while taking notes on the initial videos but got bored over time (8OB, Pos. 78). This reason is justified given the labor-intensive nature of notetaking. However, an additional factor might have contributed to 8OB's brevity. 1FA and 8OB shared some common video selections, including those of the Şakacı persona. However, 1FA viewed and noted the videos before 8OB, and as a result, 8OB could see 1FA’s notes, which may have influenced 8OB's note-taking approach. Subsequently, 8OB expressed a preference for not seeing others' notes, as those notes could inadvertently influence his observations (8OB, Pos. 76). To illustrate, consider their notes on the same video event:

> His gaze keeps shifting between the road and his phone. (1FA, Pos. 100)
> He's frequently engaged with his phone. (8OB, Pos. 77)

Utilization of Video Speed

A deviant participant, 2MeK, mentioned his need to pay attention to a pedestrian who suddenly appeared on the road in the Şakacı3 video (Figure 89). The participant attributed this heightened awareness to the slowed-down segment of the video and criticized the pedestrians for jaywalking. He stated that pedestrian training for compliant behaviors is necessary, but considering the slow pace of such processes at the campus, he suggested installing sensors on vehicles to alert drivers about pedestrians would be a more suitable solution (2MeK, Pos. 42,43).

For the same event, 4CB criticized Şakacı for not yielding to the pedestrian and passing by “as if the bus itself is another pedestrian” (4CB, Pos. 30). Identifying this behavior as dangerous, 4CB highlighted the possibility that the pedestrian could have had visual or cognitive impairments not immediately apparent such as

using a wheelchair. 4CB suggested providing constant reminders to drivers about the presence of pedestrians, possibly through augmented reality (AR) glasses similar to Google Glass. While the driver may initially ignore such warnings, repetitive redirection of attention to pedestrians could lead to learning and behavior change over time. 4CB also briefly mentions the alternative of automatic braking by the bus, acknowledging her limited knowledge in that area and expressing reservations about it as automatic braking may result in other types of dangers (4CB, Pos. 30). 4CB's heightened awareness about the invisible pedestrian impairments can speculatively be attributed to her design career in healthcare domain or the fact that the pedestrian is almost invisible in this scene, which was the reason for slowing down this video segment (Figure 89).



Figure 89 Şakacı, not yielding to a pedestrian in a visually challenging situation.

Focusing on the slowed-down segment of the Bezgin 1 video (Figure 90), where the bus is approaching a bus stop, a secondary participant and military vehicle designer, 8OB, noticed that passengers waiting at the bus stop are stepping away from the curb. 8OB wondered if passengers fear a potential collision, possibly explaining why drivers drive in the middle of the road, as observed in Figure 90. Bus driver interviews revealed that pedestrians often complain about buses

violating speed limits, though online tracking system shows buses aren't speeding. The manager of the drivers interprets this situation, suggesting that the buses' mass creates air pressure on the sidewalk, perceived as speeding by pedestrians even when buses adhere to limits. It's possible that pedestrians have developed a habit of moving away from the curb when a bus approaches as a response to its air pressure. However, in this case, Bezgin's hand gesture indicating that the bus wouldn't stop seemed to be the real reason for pedestrians moving away.



Figure 90 Bezgin makes a hand gesture, indicating he wouldn't stop (Bezgin 1).

Utilization of Sound

In some situations, the information in the video sound supported participant observations. This information encompassed driver narrations, conversations, audible expressions, disruptive sounds from road conditions, and using the horn for communication with other road users.

An example of utilizing gaze information in combination with video sound is found in the comments from 1FA and 5FuA regarding a significant event in the Bıçkın 3 video. This event was previously explained in Chapter 5, Trial Video Clips section,

Clip 2 above. In this video, Bıçkın complains about the illegally parked cars on the side of the road since they narrow the road and make passing difficult when two buses are simultaneously on the road. Following this speech, another bus emerges on the oncoming side of the road, leading to a challenging maneuver as both buses attempt to pass each other without collision (Figure 91). Meanwhile, Bıçkın continues to express his frustration.



Figure 91 Bıçkın tries to avoid collusion.

A primary participant 5FuA and a secondary participant 1FA watched this video and commented on the event. Without Bıçkın's narration, the video simply depicts a difficult maneuver. However, since the participants were able to listen to the driver's narration and expressions of frustration in his voice, both participants empathized with the driver while being able to comment on the frequency of the event, its chronic nature, and its impact on the driver's well-being.

> Bıçkın expressed his frustration, emphasizing that drivers face such situations daily, in a weary but non-accusatory tone. He sounded quite distressed at that moment. The problem, although solvable, remains unresolved, not due to the drivers' fault but rather due to cars parking without following the rules and road width constraints. Bıçkın has become accustomed to this situation, so his complaints seem resigned. I genuinely

> empathized with him; there's no denying that he had a tough time. (5FuA, Pos. 41)
>
> Bıçkın mentions encountering this problem way before, as he approaches from the opposite lane. […] When Bıçkın encounters the other bus, he says, "We experience this stress on a daily basis. It's not the other bus's fault." There's a sense of "We're all in the same boat" in his tone. This is a justified reaction and valuable input for me. I interpret this situation as follows: there is a chronic problem here; these cars shouldn't park on the side of the road. Drivers have told the management several times, but no one listens to them, so drivers are left with their own means. […] In that sense, the information from Bıçkın's speech is valuable. (1FA, Pos. 18, 22)

In this same video, the primary participant, 5FuA, also noticed the road surface problems by interpreting the video sounds. He mentioned that he began to hear the sounds of the bus parts hitting against each other, and he perceived that the bus was shaking. Building on this, he evaluated that this sound and shaking would create discomfort for drivers and passengers and increase the need for maintenance in the long run (5FuA, Pos. 40).

The other examples of utilization of the sound are found in the comments of 1FA, 4CB, and 6EC on different videos. 1FA combines the gaze information and the driver's voice in the Uyumlu 3 video (Figure 92) to identify a problem related to the door's opening. 1FA noted:



Figure 92 Uyumlu warns the passengers before closing the doors (Uyumlu 3).

> Uyumlu warns the passengers, saying, “I'm opening the doors” before opening them at the bus stop. This is probably because the bus is crowded, and there's a chance the doors might hit someone. Even though he looks at the left internal and external mirrors to see if anyone is still boarding before closing the door, he still feels the need to warn everyone. (1FA, Pos. 83)

In another instance, a secondary participant who works in the healthcare domain and who is not familiar with the METU campus, 4CB, is surprised by the fact that Şakacı takes a break in the third video by only calling out on the bus right before taking a break (Figure 93). 4CB noted:

> Oh, very interesting! The driver takes a break while the passengers are on board. Does everyone inside know that this is a break moment? [probably] But I might be a new passenger who doesn't know the shuttle routines. The driver says he is taking a break inside the bus, but it would have been better if passengers knew before boarding or at least one stop earlier. Passengers need an information system for this. Perhaps as a passenger, during the break, I could have chosen to walk instead of waiting inside the bus; maybe I would have reached my destination by that time. (4CB, Pos. 28)



Figure 93 Şakacı tells passengers that he will take a break.

4CB also displayed intense discomfort upon hearing Bıçkın shout in the seventh video (Figure 94). In this video, Bıçkın waits inside the bus at the fuel station. Another driver, Dingin, approaches the bus, warns Bıçkın about a broken part of the bus, and tells Bıçkın to take the bus to maintenance. Bıçkın gets angry and exclaims, ‘Let it go up in flames, I don't care.’



Figure 94 Bıçkın shouts at another driver (Dingin) waiting outside.

With a facial expression showing significant discomfort, 4CB exclaimed, “Oh, this was really bad!” (4CB, Pos. 31). Having witnessed the extent of pent-up anger of the drivers and combining it with her other observations from the Şakacı 3 video mentioned above (Figure 93), and driver experience map, 4CB suggested implementing an independent information system to address trust issues and conflicts with their teammates. This system could be in the form of an app or dashboard, providing the driver with essential information about their vehicle, responsibilities, and tasks. Similar to a pilot's checklist, it would guide the driver through their duties, reducing conflicts that arise from the interaction between drivers. The driver could also update information like refueling or breaks. Such a system can enhance efficiency and support the driver's psychological well-being (4CB, Pos. 33).

Another example of sound utilization occurred in Dingin 5 video. As Dingin waits at a bus stop, he stands up to hang his jacket. Subsequently, a conversation with a passenger outside the bus unfolds regarding the departure time. Following this interaction, another bus approaches from behind, necessitating Dingin to restart the engine to move forward, a maneuver that appears challenging. This sequence culminates with Dingin audibly sighing, conveying his evident fatigue. The sequence of events can be seen in Figure 95.

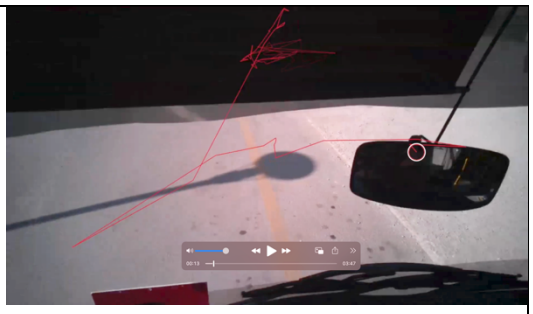
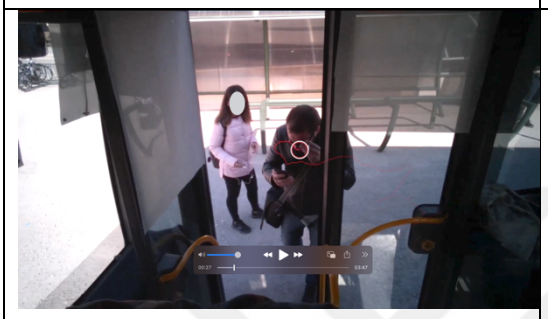
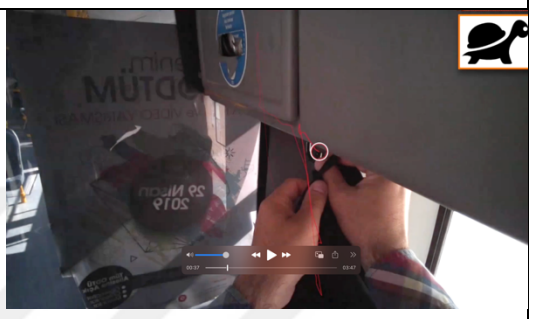
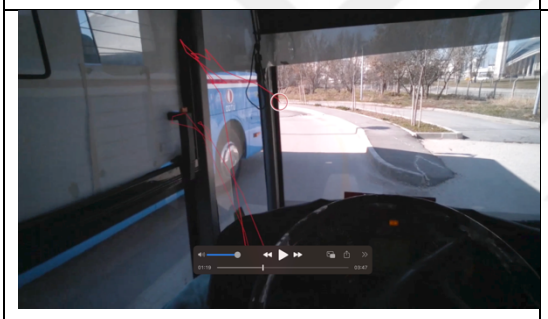
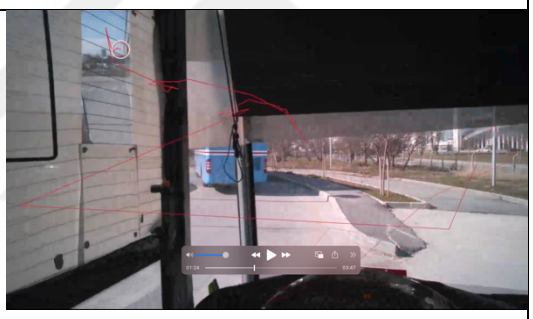
	
Dingin waits at the bus stop for the departure time	Stands up to hang his jacket
	
A passenger asks about the departure time	Turns back to reach the cloth's hanger
	
A bus comes from behind, forcing Dingin to maneuver forward	After the bus passes uneventfully, Dingin looks at the right mirror while he sighs

Figure 95 A sequence from Dingin 5 video.

Two deviant participants, 6EC and 9MuK, watched this video. 6EC noticed that Dingin was not wearing a seatbelt, inferring from the absence of any sound associated with unbuckling a seatbelt and Dingin's ability to stand up easily (6EC, Pos. 30). In addition, he commented on the conversation between the driver and the passenger. In this conversation, the passenger inquired about the time remaining until the bus departs, and Dingin inquired about the current time. 6EC found it odd that the driver did not check the current time by himself, indicating a sense of resignation on the driver's part (6EC, Pos. 31). Another deviant participant, 9MuK,

who is of Turkish origin but speaks English more fluently than Turkish and is not well-versed in the cultural intricacies in Turkish, asked whether the driver was being sarcastic by asking back the current time (9MuK, Pos. 16). This conversation between the passenger and driver seems like it hinted 6EC and 9MuK about the slight annoyance of Dingin at that moment and reinforced their ideas for the need for a departure information system for the passengers. Finally, participant 6EC expressed a sense of curiosity and fascination regarding the driver's sigh and gaze observed in the same video. 6EC considered the driver's sigh and gaze to the left, which he described as a "peek into driver's intimate space," as valuable data providing insight into the driver's experience. 6EC said that the driver sounded worn out with life at that moment, and 6EC would like to be present on the bus to ask the driver about the details of the driver's feelings (6EC, Pos. 34-36).

Another example of sound utilization happened in the İhtiyar 2 video. In this video, İhtiyar overtook a loaded tractor right before the bus stop and slowed down immediately after the takeover (Figure 96). At this moment, two separate horn tones are heard. While watching this video, a primary participant, 3SG, and a secondary participant, 4CB, asked the author the reason for the horn. 4CB suspected the horns were due to drivers' frustration, so she tried to figure out who honked and why. When told that both drivers are working at the same department and they are probably greeting each other, 3SG did not comment. But 4CB noted that using the vehicle's horn for greetings fosters a sense of camaraderie among drivers, enhancing their sense of well-being. This, in turn, contributes to the passengers' perception of safety, as they are carried by a psychologically well and happy driver. However, 4CB acknowledged that not all passengers may share this sentiment, especially those busy or preoccupied, and some might be disturbed by the noise. She also noted that misunderstandings can occur since the horn is not designed for this purpose (4CB, Pos. 14). Exploring the possibility of maintaining this sense of camaraderie and enhancing a playful sense of safety without the accompanying disturbance of the horn becomes a curious opportunity. One of the pilot participants, p2AK, who is a psychologist, humorously suggested a 'Selâmün-

aleyküm’ button upon watching this video and noticing the unnecessary use of the horn for greeting. Drivers might use this button to activate some animated lights as a courteous gesture to greet others on the road without the disruptive sound of the horn.

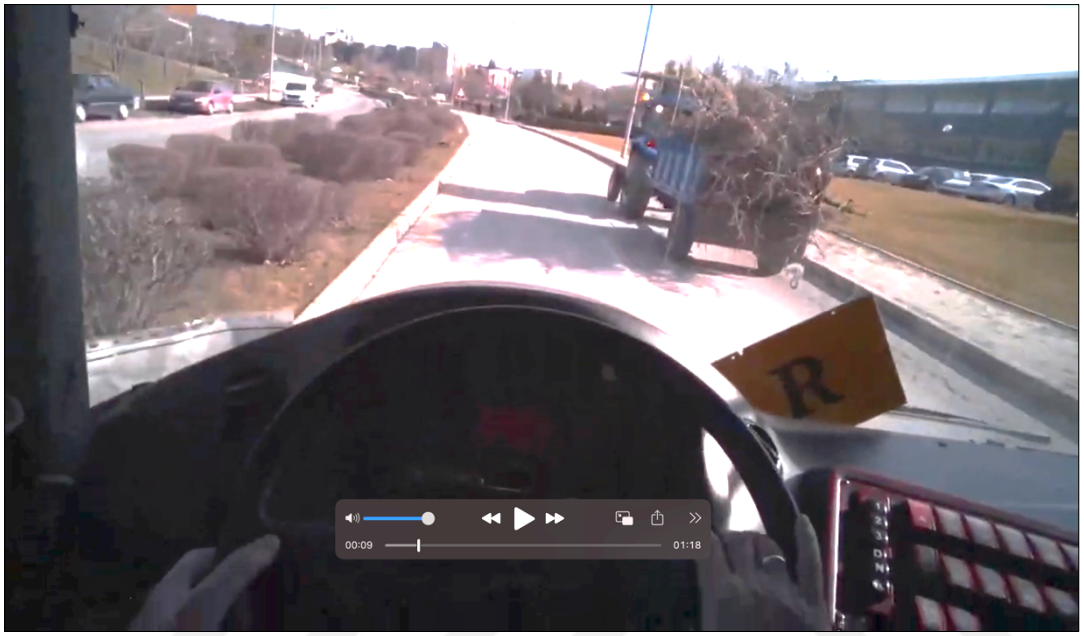


Figure 96 İhtiyar taking over a loaded tractor in video 2.

Passengers frequently asked questions to drivers about the route of the bus or asked them to describe how to go to a specific place. They asked the questions while they were on the bus, but one passenger asked a question from the window (Figure 97). Hearing how frequent these conversations are, participants identified these conversations as one of the significant aspects of drivers’ job experience.

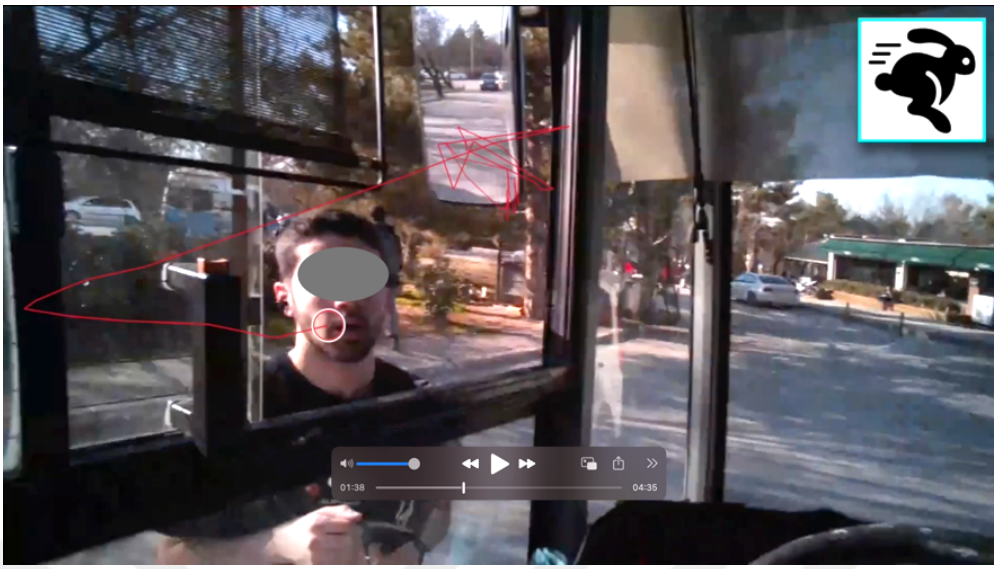


Figure 97 A passenger asks about the bus route before boarding (Uyanık 2).

In the Uyumlu 5 video, the driver notices a passenger in the back who hasn't disembarked after reaching the last stop. The driver initially calls out to the passenger and then resorts to making a hand gesture and turning back to reiterate the announcement, as the passenger is wearing headphones and cannot hear the driver's voice (Figure 98).



Figure 98 Uyumlu calls out to the passenger (Uyumlu 5).

1FA points out that the need for such warnings is the absence of a clear route plan. Therefore, the passengers do not know where the last stop is. 1FA suggests that this ambiguity might arise from the flexible scheduling of routes and buses. The participant expresses that while this flexibility may be necessary if the number of buses or drivers is insufficient, it is concerning not to have a clear plan, especially

for non-Turkish speakers or individuals using headphones. Additionally, this flexibility presents challenges for drivers who constantly have to make announcements due to the inherent unpredictability (1FA, Pos. 48, 49).

The ambiguity is not limited to not knowing the last stop; passengers also seem to be confused about the bus route and how they can reach certain destinations. Several participants observed this event in various videos (1FA, Pos. 8; 3SG, Pos. 55, 56; 4CB, Pos. 36, 39; 6EC, Pos. 38, 49, 52, 63; 8OB, Pos. 24). A primary participant, 3SG, two secondary participants, 1FA and 4CB, and a deviant participant, 6EC, proposed implementing a bus stop information system by syncing with passengers' phones or displaying real-time information on an onboard screen. Secondary participant 8OB suggested enclosed cabins that might provide drivers with personal space and potentially reduce fatigue from constant interactions.

Hearing the vehicle's horn also enabled a primary participant, 3SG, to identify a problem with driver behavior in the Şakacı 1 video (Figure 99). In this video, the driver sees a pedestrian walking on the road near the roundabout where the bus will make a right turn. The driver honks the horn to warn the pedestrian at the exact moment the bus makes the right turn. The pedestrian stops and turns back to see the bus. The bus passes next to the pedestrian as Şakacı focuses on the limit point of the curb ahead. Upon watching this event and hearing the horn, 3SG noted the dangerous nature of the driver’s behavior. 3SG noted with a tone of criticism:

> If the steering wheel slips from his hand, it's gone; he's not aware. He stops the pedestrian's movement by honking the horn. This narrows the area where the bus can pass. If he hadn't honked, the pedestrian would have continued walking, and a wider space would have opened in front of the bus. The driver requires an awakening to the consequences of their actions. He is unaware of his responsibility for himself and others outside (3SG, Pos. 23, 24).



Şakacı notices the pedestrian near the roundabout	Checks the limit point of the sidewalk
Checks the feet of the pedestrian	The moment Şakacı honks the horn
Pedestrian slows down and looks back at Şakacı	Şakacı checks the limit point of the curb

Figure 99 Şakacı honks the horn to a pedestrian during a right turn.

Utilization of Gaze Information

Participants recognized and analyzed drivers' gaze patterns and utilized them to evaluate drivers' attention, behaviors, skills, and interactions. In addition, they utilized gaze information to interpret the internal states and intentions of the drivers. In some cases, this evaluation and interpretation were utilized for comparing drivers.

Gaze on Passengers

The participants identified that drivers look at the passengers in three situations. Firstly, drivers look at the passengers during boarding through the front door, especially when passengers ask questions. Secondly, drivers look at the right-side mirror at bus stops to monitor passengers boarding and disembarking, determining the optimal time to close the doors and depart. Thirdly, while in motion, drivers occasionally check the central mirror inside the bus to monitor the passengers.

During boarding and disembarking at bus stops, drivers use interior and exterior mirrors on the right side to verify that passengers are safely on or off the bus (see Utilization of Notetaking section for exemplary participant observations). Drivers' extended gaze on the exterior mirror on the right side is considered as an unsatisfied information need, as a secondary participant, 1FA, noted (1FA, Pos.87). Primary participant, 10KU, also referred to the unsatisfied information need of the driver in Uyumlu 2 video (Figure 100) by noting:

> Many passengers boarded the bus, it became dark, and the bus filled up to the front door. […] The driver looked at the right external mirror for a long time. However, the driver couldn't see much from the mirror due to the darkness. The driver also looked at the passengers standing in front of the door inside the bus for a long time, but he couldn't gather information from there either due to the crowd. There is a problem with information flow to the driver. (10KU, Pos. 48)



Figure 100 Passenger crowd in Uyumlu 2 video.

In addition, deviant participant 6EC also expressed concerns about the limited visibility in a similar Uyumlu 3 video. He noted that relying solely on mirrors to monitor the passengers at night can be unsettling, especially exacerbated by the absence of proper illumination around the door area on the bus (6EC, Pos. 60).

Secondary participant 8OB also identified challenges in monitoring passengers during boarding and disembarking, emphasizing the difficulty of simultaneously overseeing front and rear doors through the right exterior mirror. An example of this difficulty is displayed in the Bezgin 1 video. The driver checks the two mirrors on the right side but cannot see the doors clearly. In addition, the passenger crowd started to obstruct the right exterior mirror. Bezgin makes a hand gesture and calls out to the passengers to move away from the mirror, allowing him a clearer view (Figure 101). Upon watching this video, the participant proposed replacing mirrors with screens and cameras for real-time monitoring of all doors, featuring the use of digital zoom through screens. Additionally, 8OB recommended implementing a weight sensor system near the doors, as mentioned before. This system would allow passengers to signal their intention to disembark without needing button presses, contributing to a streamlined disembarking process when combined with cameras and screens instead of mirrors.

While cameras and screens present promising solutions for simultaneous door monitoring, it's important to note that the bus featured in the Bezgin 1 video is a coach-type bus. The narrow corridor in such buses poses challenges for passenger movement. Furthermore, coach-type buses are not optimized for standing passengers, leading to mirror placements that struggle to accommodate crowds. A comparison with Figure 100, illustrating the passenger density in the Uyumlu 2 video, presents the difference. The bus in this video is a city bus designed for public transportation and tailored for standing passengers. As a result, the passenger crowd in the bus does not obstruct the mirror. Additionally, passengers benefit from enhanced comfort due to the presence of handrails on the dashboard.



Figure 101 Passenger crowd and mirror obstruction in Bezgin 1 video.

Another observation regarding the gaze on passengers includes driver comparison. Uyumlu is considered to be the driver who checks the passengers the most by the participants who watched his videos (1FA, Pos. 84; 3SG, Pos. 54; 6EC, Pos. 58; 10KU, Pos. 46). A secondary participant, 1FA, expressed confusion about why Uyumlu continually checks the interior of the bus through the central mirror. The participant pondered the nature of the information Uyumlu seeks by focusing on students in the back and interpreted that Uyumlu checks the interior mirror to identify passengers' intention to disembark (1FA, Pos. 84). Primary participant 10KU observed that after passing over a speed bump, Uyumlu looks into the bus through the interior mirrors (Figure 102). The participant interpreted that Uyumlu might be checking whether the bump affected the passengers' balance, viewing this as a positive and safety-conscious behavior (10KU, Pos. 46). While considering this behavior positively, 10KU also noted Uyumlu's head posture seemed uncomfortable (Figure 103) while looking at the interior mirror because of its the placement (10KU, Pos. 44).



Figure 102 Uyumlu checks passengers after passing over a speed bump.

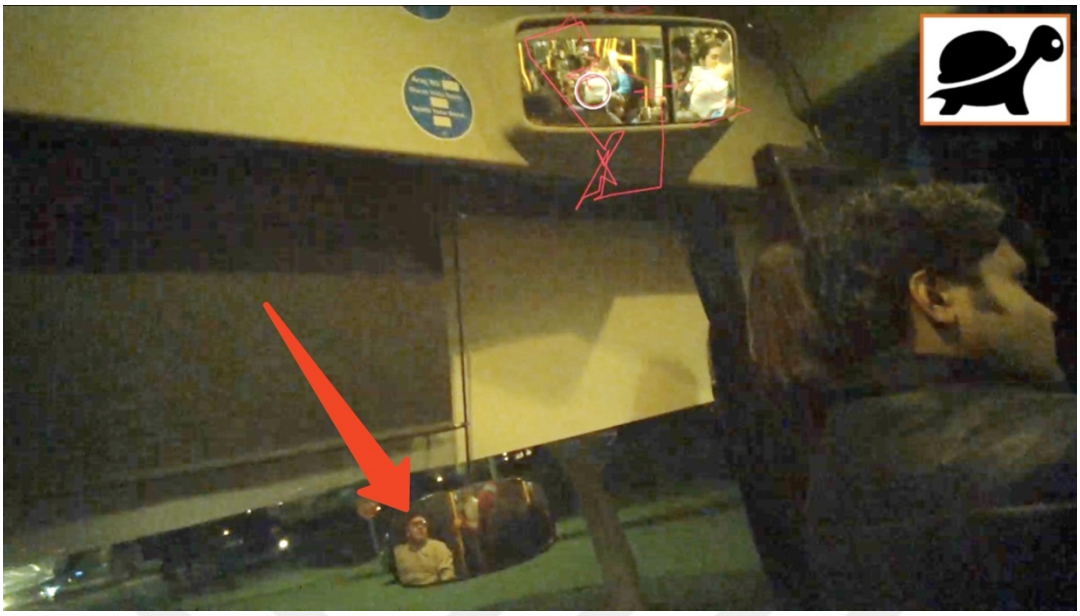


Figure 103 Uyumlu's head posture while looking at the top interior mirror.

Primary participant 3SG noted that Uyumlu's frequent gaze on the passengers suggests heightened attention and engagement. Moreover, he considered it as maintaining control of the bus which is a positive behavior (3SG, Pos. 54). Deviant participant, 6EC, compared Uyumlu's behavior to other drivers, highlighting that Uyumlu pays more attention to the cabin, possibly due to the bus's crowded interior (6EC, Pos. 58). 6EC speculated that Uyumlu might be checking the mirror reflexively or unconsciously because the movement of passengers in crowded bus causes changes in the image reflected in the interior mirrors. Regardless of the precise mechanism, 6EC inferred that crowded buses introduced an additional cognitive load, occupying the drivers' attention, and could be addressed by reducing the crowd in the buses (6EC, Pos. 65).

> Perhaps the driver reflexively looks at the interior mirror because the bus is crowded; there is a constantly moving crowd in the mirror, drawing his attention. Therefore, perhaps the bus shouldn't be as crowded. Additionally, the crowded group of people next to the driver sometimes obstructs the view of the right mirror. The driver might feel hindered or concerned by this. It's clear that this route attracts too many passengers at this hour. (6EC, Pos. 65).

A primary participant, 10KU, and a secondary participant, 4CB, recognized a gaze pattern to ensure safe door closure. Both participants noted that the drivers in the Dingin 3 and Uyanık 4 videos looked at the door area and the feet of the passengers to ensure that the door area was clear for closure. 10KU noticed this gaze movement in Dingin 3 (Figure 104) and interpreted that this action could be a habit formed to prevent accidental door collisions with passengers (10KU, Pos. 29). On a similar note, 4CB expressed empathy for the driver in the Uyanık 4 video and highlighted the common issue of people getting stuck in the door and, at times, buses moving before passengers can board—a situation deemed inhumane (4CB, Pos. 18). Upon watching this event, 4CB compared driver practices in Sweden and Turkey. She noted that in Sweden, buses wait for all passengers to board and settle in their seats before moving. The reason of this practice is not only to ensure passenger comfort but also passenger safety. 4CB suggested that anticipating such behavior from drivers might be unrealistic in Turkey, indicating a lack of patience among Turkish drivers. Therefore, she recommended that it might be necessary to emphasize the importance of passenger safety by informing the driver that all passengers have passed through the doors and settled in (4CB, Pos. 24).



Figure 104 Gaze pattern on the passenger's feet in Dingin 3 video.

Gaze on the Road Users

Another type of driver's gaze was on the road users, such as pedestrians and other vehicles. Drivers were looking at the faces, posture, and feet of pedestrians, as well as the lights and wheels of other vehicles. Participants interpreted this type of gaze behavior as drivers' attempts to understand the intentions of road users and act accordingly. One example of it occurred in Bıçkın 3 video and is explained in the Utilization of Sound section. Bıçkın looked at the lights of the bus to see if the hazard lights are on.

In addition, a primary participant 10KU, three secondary participants, 7IT, 8OB, and 1FA, and a deviant participant 6EC noted that drivers seemed they try to determine whether pedestrians at bus stops intend to board the bus (10KU, Pos. 11; 7IT, Pos. 36; 8OB, Pos. 36; 1FA, Pos. 37; 6EC, Pos. 13) (Figure 105). Knowing whether a pedestrian wants to board the bus is necessary because the driver must stop if a pedestrian wishes to board, and the driver can proceed if the pedestrian has no intention to board. Eliminating unnecessary stopping at the bus stops where there is no boarding and disembarking would save time and fuel. 8OB proposed implementing an integrated artificial intelligence system in buses. This system would identify pedestrians at bus stops who intend to board, streamlining the driver's decision-making process and enabling the driver to focus on the road and prioritize traffic safety.



Figure 105 Bezgin checks the pedestrian at the bus stop (Bezgin 2 video).

In another situation, Bezgin ignores a pedestrian at a bus stop. This pedestrian waves his hand to demonstrate that he wants to board the bus after he realizes that the bus will skip the stop (Figure 106). Deviant participants, 6EC and 9MuK, tried to explain Bezgin's behavior. 9MuK suggested the bus might be full and proposed a feature similar to taxis indicating occupancy status for buses (9MuK, Pos. 28). 6EC

thought Bezgin's gaze was a reflex, implying the pedestrian may have waved at the wrong bus, and Bezgin dismissed the mistake (6EC, Pos. 17). However, the bus wasn't full, and Bezgin should have stopped.



Figure 106 Bezgin ignores a pedestrian at the bus stop (Bezgin 3 video).

The screenshot from a few seconds before the event indicates another plausible reason. In the screenshot, another white bus is waiting at the bus stop, blocking Bezgin from approaching the stop. White buses were outsourced from a company since the number of institutional shuttle buses was insufficient. Their drivers were also outsourced, which created tension among the shuttle bus drivers as they considered these other bus drivers to behave recklessly on campus as they were not as strictly regulated as the shuttle drivers. This tension surfaced during the interviews and was not evident in the Bezgin 3 video, which led the participants to speculate on the reasons. However, Bezgin might well have been annoyed by the location of the white bus and continued driving instead of waiting behind it. A clue of this tension surfaced in the Şakacı 4 video, which is explained in the Gaze Utilization and Participant Perspectives section.

Another example of the utilization of the driver’s gaze on the road users is found in the comments of a secondary participant, 1FA (1FA, Pos. 36). While watching the Şakacı 2 video, 1FA inferred that the driver is trying to understand the intention of another driver and pedestrians by looking at them. In this event, a white car halts in front of the bus, and passengers disembark from the car (Figure 107). To avoid a collision, Şakacı must decide to either shift to the left lane or hit the brakes to wait for the white car to resume forward movement. To make this decision, Şakacı

checks the left mirror to ensure no vehicles are approaching from behind. Şakacı maneuvers slightly to the left after confirming the absence of oncoming traffic. Subsequently, he looks at the pedestrians to gauge if they might attempt to cross the road. He also looks at the brake lights and wheels of the car to assess whether the car has come to a complete stop. Upon deciding the car and the pedestrians will give way to the bus, Şakacı continues on the left lane. 1FA noted that looking at the brake lights and wheels is something he also does while riding a motorcycle to understand the intentions of other road users.

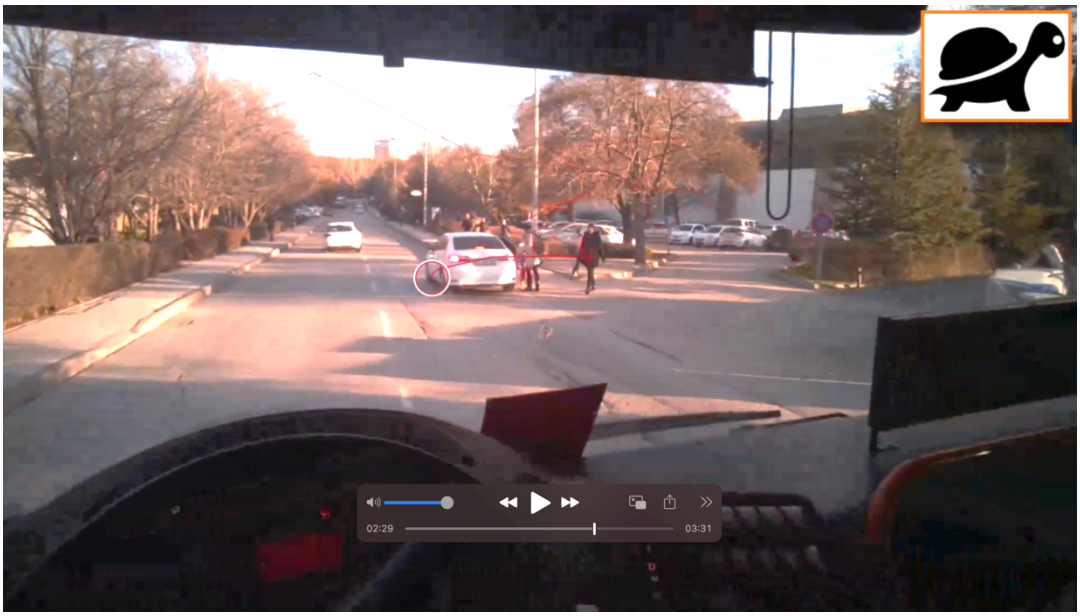


Figure 107 Şakacı looks at the wheels of the car.

The bus design influences the driver's direct field of vision through the windshield. There are various buses from different brands that are used for shuttle service at the METU campus, each with different fields of view. For example, the buses in Bıçkın's and Bezgin's recordings were the same coach-type bus equipped with a rear camera screen attached to the left A-pillar. The buses in Dingin's, Uyumlu's, and Uyanık's recordings were the same city bus with a middle mirror attached to the windshield. These elements can impede the driver's vision during specific maneuvers. Figure 108 displays how the screen obstructs the road view during a left turn, and Figure 109 displays how the mirror in the middle obstructs the road

view during a right turn. Several participants observed these obstructions and proposed relocating the screen and mirror to alternative positions. However, a secondary participant, 1FA, suggested that experienced drivers can adapt to challenges like the middle mirror or screen obstructing the view (1FA, Pos. 92).

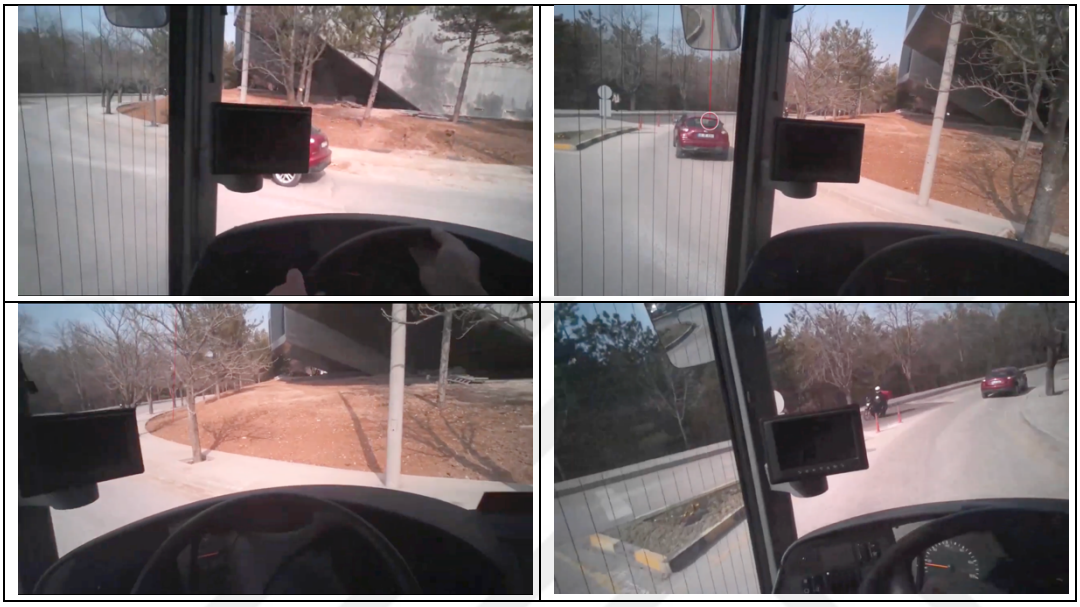


Figure 108 Screen on the left obstructs the road view while turning left (Bezgin 2)



Figure 109 Mirror on the middle-right obstructs the road view while turning right (Dingin 3)

Another instance of gaze on a road user occurred in the Uyanık 1 video. Although none of the participants selected and watched this video, the author considered it a noteworthy event, showcasing the variety of pedestrian encounters. In the video, the driver waits at the bus stop for passengers to board. A pedestrian runs in the middle of the road and passes from the left side of the bus. Simultaneously, another car approaches from the opposite side of the road. Uyanık monitors both the car and the running pedestrian and waits for the pedestrian to clear the road. However, the pedestrian continues running on the road, and the driver follows him until the driver finds a gap to move left and pass him (Figure 110). This event illustrates how close these buses sometimes maneuver in traffic among other vehicles and pedestrians and supports 8OB's observation. Secondary participant, 8OB, noted the risk of the driver overlooking pedestrians or getting too close to other vehicles due to the large size of buses and limited field of view. In addition, many distracting things happen on the bus: passengers talk to each other, embark and disembark, etc., which increases the risk of collision. As a result, 8OB recommended incorporating additional warnings and driving technologies into buses, emphasizing their greater importance for buses compared to cars.



Figure 110 Encounter with a runner in Uyanık 1 video.

Gaze During Maneuvers

Drivers' gaze travelled on the road geometry and other road users during the maneuvers. While this gaze type includes gaze on the road users, drivers sometimes have to handle difficult road geometries with or without other road users. A secondary participant 1FA was specifically interested in making this type of gaze observations. 1FA likes to watch first-person perspective motorcycle riding videos to improve his driving skills, and he expressed his enthusiasm about eye tracking recording several times during the workshop. Moreover, he said eye-tracking videos should be a default driving education material (1FA, Pos.46). In addition, a deviant participant, 6EC, expressed his interest in playing bus simulation games. This participant also noted a similar gaze observation.

Turning left around a turnabout

A secondary participant, 1FA, interpreted the gaze pattern of a bus driver during a left turn to assess the bus's maneuvering capacity (Uyumlu 5 video). This left turn is explained with eight screenshots of the video in Figure 112 at the numbered locations displayed in Figure 111. 1FA observed that, during the left turn, when the bus was in location 4, the driver looked at the limit point 1. When the bus arrives at location number 5, Uyumlu starts checking the limit point 2. When the bus arrives at location number 7, Uyumlu starts checking the limit point 3. The participant speculated on the reason behind this gaze pattern and noted that the driver calculates the trajectory of the bus considering its turning radius. He suggested that the design of the bus, with its front extending beyond the front wheels and the driver positioned farther ahead, necessitates different planning compared to a car to avoid collisions with the island (1FA, Pos. 56). In a similar vein, another participant noted that bus drivers commence their turns much later than the maneuver he would execute while driving his car to prevent collisions (3SG, Pos. 85). Explanations for the screenshot can be found in Figure 112.

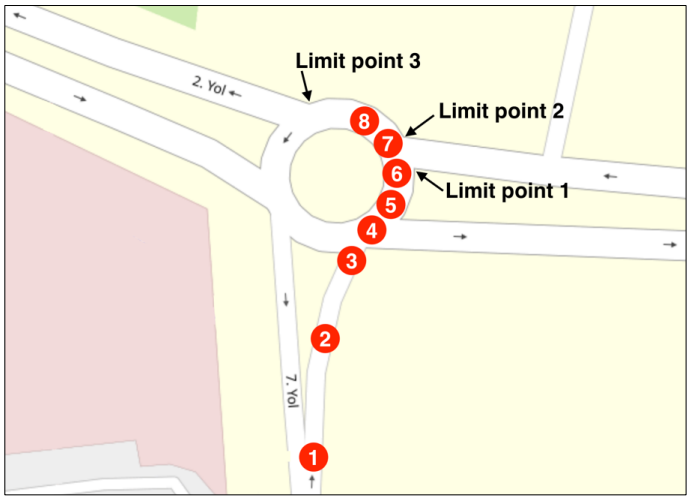


Figure 111 Screenshot locations of the left turn (Uyumlu 5)

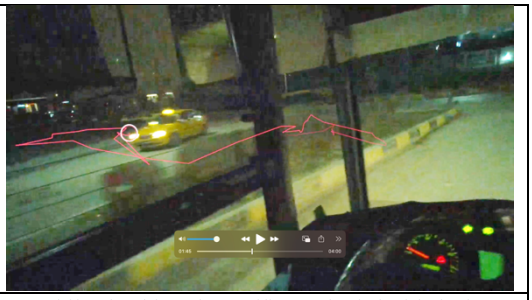
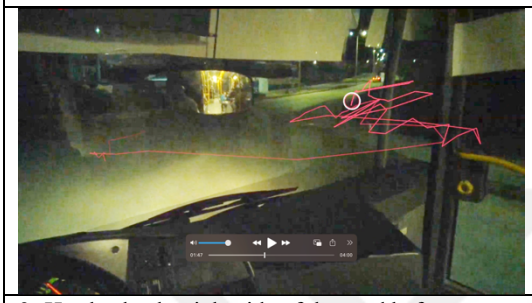
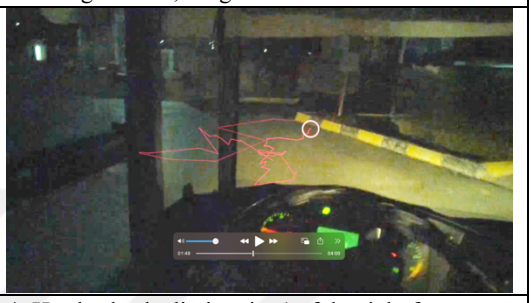
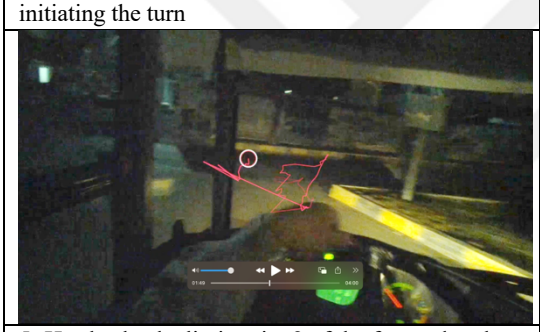
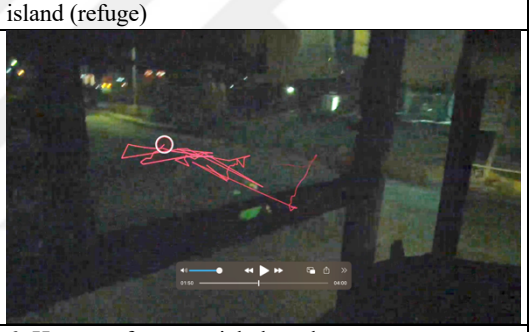
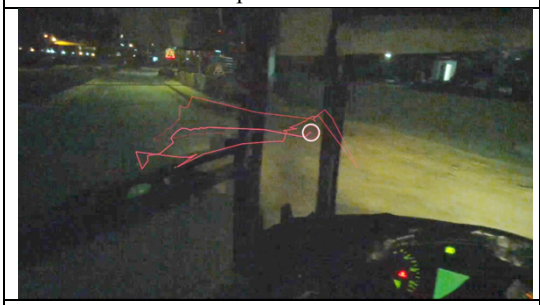
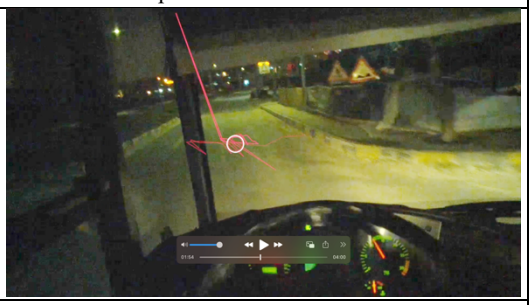
	
1- Uyumlu approaches a turnabout to make a left turn	2- While checking the traffic on the left side before initiating the turn, his gaze latches on the car beams
	
3- He checks the right side of the road before initiating the turn	4- He checks the limit point 1 of the right front island (refuge)
	
5- He checks the limit point 2 of the forward curb	6- He scans for potential obstacles
	
7- He checks the limit point 3 of the forward curb	8- He completes the turn

Figure 112 Gaze interpretations of Uyumlu during a left turn.

Departing from a bus bay

Bus bays are designated areas for shuttle buses, offering a traffic-free space for boarding and disembarking. Although there are several bus bays on campus, most bus stops are along the road. Bus drivers have highlighted the safety advantages of bus bays over regular stops, emphasizing that they provide a clear space for passengers to disembark. They have also noted instances of traffic incidents occurring at stops without bus bays, where disembarking passengers, unaware of vehicles approaching from behind the bus, crossed in front of it. For a visual demonstration of this scenario, please refer to Figure 113. Secondary participant, 8OB suggested a solution to improve pedestrian safety for the regular bus stops without bus bays. The suggestion involves installing sensors on the bus to detect approaching vehicles from behind. Once detected, passengers would be informed of the approaching vehicles, possibly through laser projection on the ground. The participant drew a parallel to school buses in the United States, where a retractable sign hinders other vehicles from passing the bus when students are crossing the road (8OB, Pos. 28).

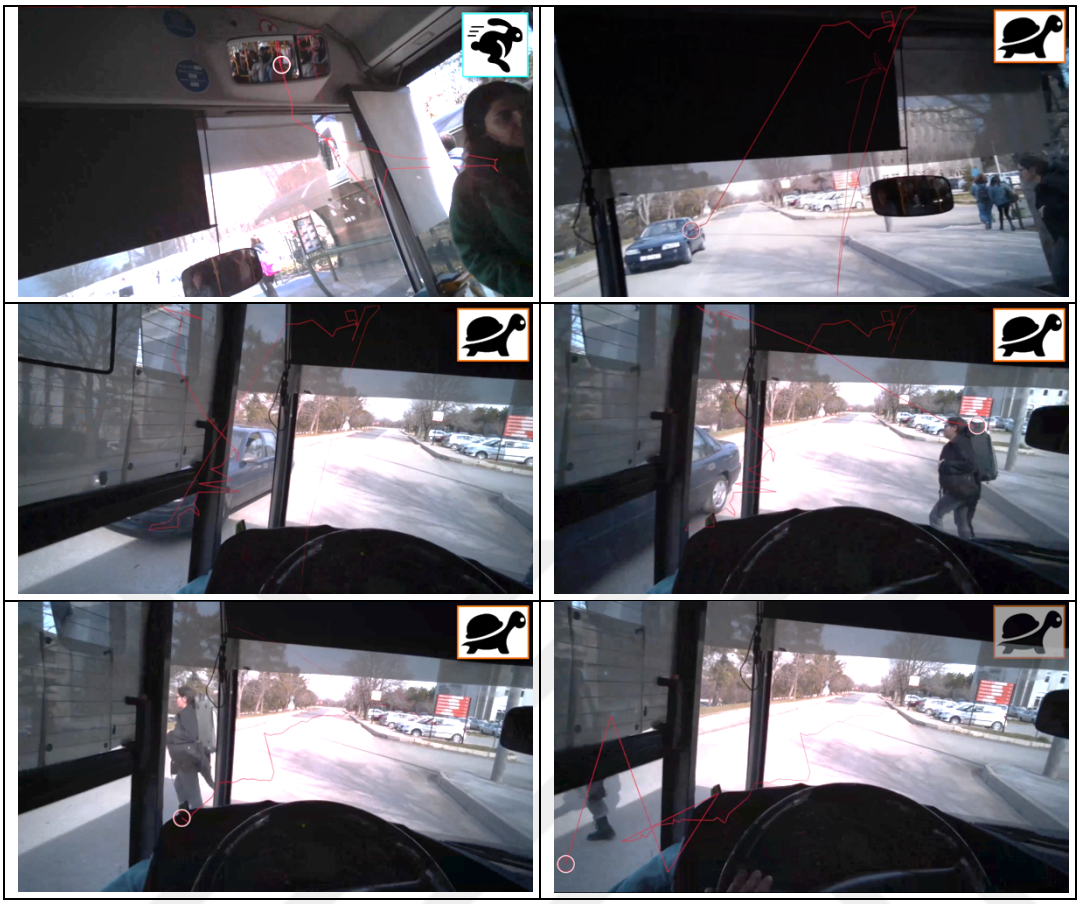


Figure 113 Passenger passing in front of the bus (Dingin 6)

While bus bays offer safe disembarking, maneuvering out of a bus bay presents challenges for the driver. 1FA commented on one of the slowed-down segments in the Şakacı 2 video that presents a departure from a bus bay. Şakacı checks the mirrors, turns his head to check the blind spot, and maneuvers out of the bay (Figure 114). The driver consistently monitors available spaces for passing through the traffic, assesses distances for pulling out, checks for sufficient space through the right mirror, and observes pedestrians on the road (Figure 115). 1FA called this “a rather chaotic decision-making process” (1FA, Pos. 33).

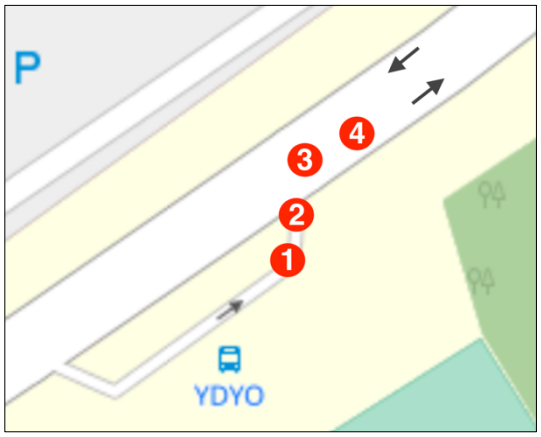


Figure 114 Şakacı leaves the bus bay.

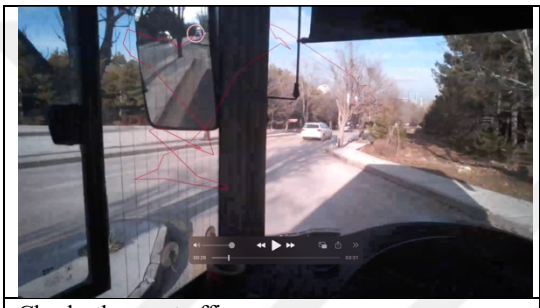
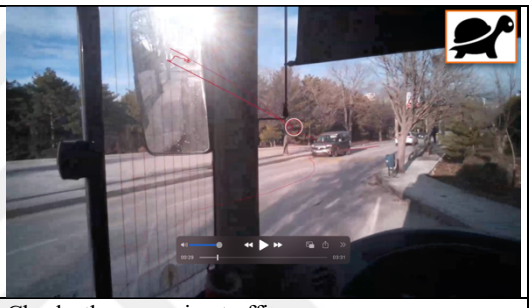
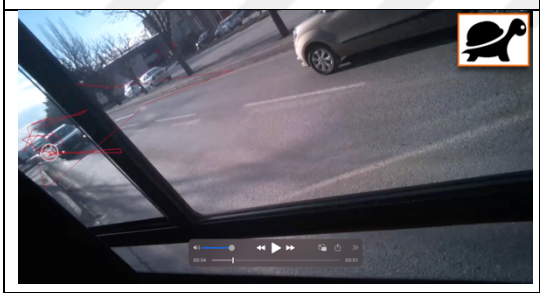
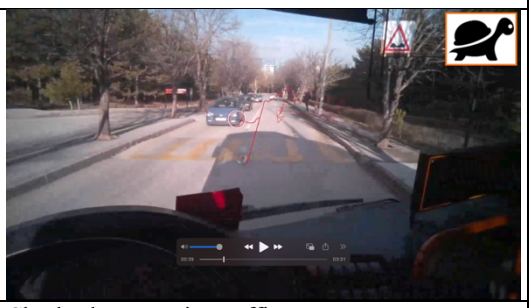
	
Checks the rear traffic	Checks the oncoming traffic
	
Checks the blind spot	Checks the speed bump
	
Notices the pedestrian	Checks the oncoming traffic



Figure 115 Screenshots from leaving the bus bay.

Deviant participant 6EC also commented on one event occurred at a bus bay in Uyumlu 3 video. Being familiar to the METU campus, 6EC noted that despite being designated as a bus bay, it is often rendered unusable due to vehicles parking in the area. Consequently, passengers end up waiting along the roadside (Figure

116). 6EC recognized one of those bus bays in the Uyumlu 3 video. He noted that not only the bus bay was occupied by the parking cars, but a passenger was waiting on the road instead of the sidewalk, prompting the driver to focus on the location of the pedestrian for an extended period. The driver aimed to approach the bus stop without getting too close to the waiting passenger, yet the crowded interior made it challenging to accurately gauge the proximity. As a result, the driver couldn't maneuver the bus as precisely as desired. The participant highlighted the usual practice of municipal buses aligning with the platform for accessibility, especially for passengers with disabilities, but in this instance, the driver's concern for the pedestrian on the road impacted the precision of approaching the stop (6EC, Pos. 66).



Figure 116 Pedestrian waiting on the road in Uyumlu 3 video.

Turning right and passing through a crosswalk

Demonstrating the cognitive load of turning and negotiating the traffic simultaneously, deviant participant 6EC commented on an event in the Uyanık 4 video. In this video, Uyanık departs from a bus stop after checking the left mirror and turns right at a major turnabout on campus (Figure 117). Two dark-colored cars are waiting in a location that forces the bus to make a difficult turn (Figure 118). Moreover, there is a crosswalk at the end of the junction between positions 5 and 6 in Figure 117. 6EC noted that the driver consistently checks the mirrors and environment to assess whether he can make the turn (6EC, Pos. 44). However, 6EC noted while the bus was around position numbers 4 and 5 in Figure 117, Uyanık almost exclusively looks at the right mirror to avoid a collision with the dark-

colored cars waiting on the right side of the bus. As a result, the driver does not look at the crosswalk extensively. While the driver appears to be solely looking at the right mirror, 6EC suggests that the driver could be able to see if a pedestrian started walking on the crosswalk via his peripheral vision. Despite the peripheral vision capacity, 6EC assumed that there could be some professional driving rules, such as “driver should look at the pedestrian crossing while passing,” and Uyanık could not comply with this rule in this event.



Figure 117 Uyanık turns right at one of the major turnabouts on campus (Uyanık 4)

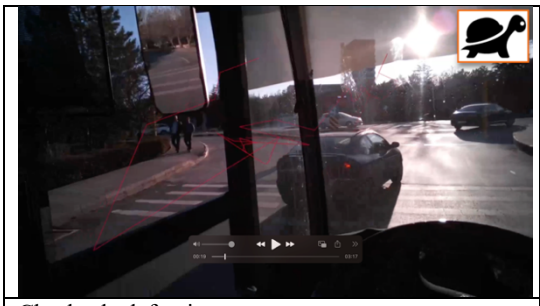
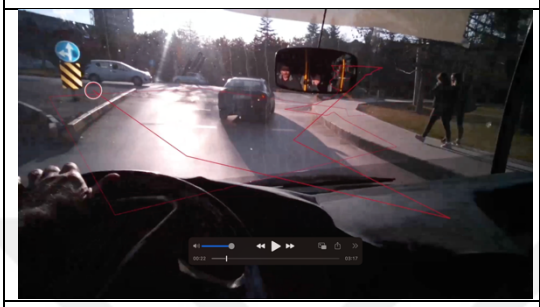
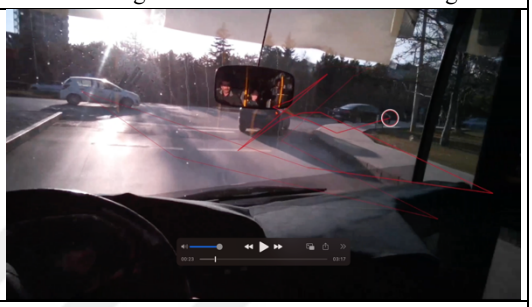
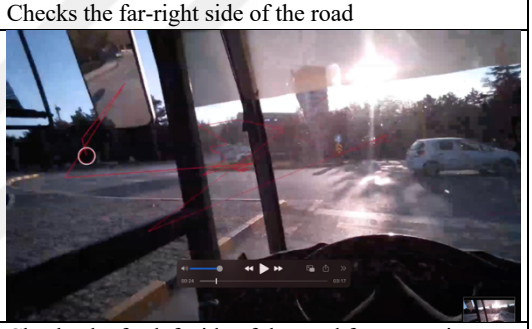
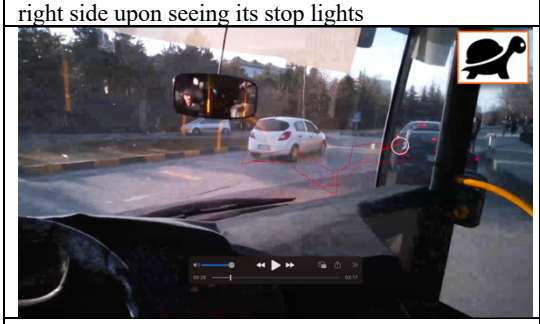
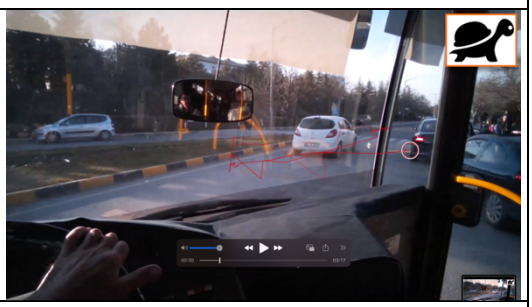
	
Checks the left mirror	Checks the right side of the road while moving
	
Checks the left side of the road	Checks the far-right side of the road
	
Checks the wheel of the white car to make sure it is moving	Checks the far-left side of the road for oncoming traffic
	
Checks the wheels of the dark colored car on the right side upon seeing its stop lights	Checks if the white car will move forward
	
Checks the stop lights of the dark colored car	Checks the wheels of another dark colored car



Figure 118 Interpretations of Uyanık's gaze movements during the right turn.

Even though 6EC's comment focused on the driver's violation of an assumed professional driving rule, the author wanted to analyze the details of this event further to point out some less visible dynamics that might have led to this potentially unsafe situation.

There are several hitchhiking points on campus that are recognized by the campus management, one of which is around point 6 in Figure 117. The dark-colored cars in Figure 118 were likely waiting to collect some hitchhikers from that spot and seemed to be disrupting the bus maneuver. Moreover, there is a bus stop around point 1 in Figure 117, where Uyanık departed immediately before making the right turn. This bus stop is the same bus stop at which Bezgin skipped stopping in the

Bezgin 3 video, which is explained above. Bezgin violated the rule and skipped the stop as another white bus was waiting in the middle of the stop, and Uyanık skipped looking at the crosswalk thoroughly as he was busy monitoring the cars waiting to collect hitchhikers. Even though these two events are shuttle driver violations from the outset, it is important to acknowledge the circumstances that make it difficult for drivers to comply with some rules. If these events were registered as shuttle driver violations, it could render these situations enduring problems, as explained above. However, this problem might be addressed by designing bus technologies and interfaces that support driver decision-making, as suggested by several participants. In addition, this problem might also be addressed by moving the hitchhiking spot, the bus stop, or the crosswalk to a safer place. This analysis exemplifies the intricate challenges associated with attributing responsibility to individuals in the context of road traffic, which is a multistakeholder sociotechnical system. Assigning blame to a human actor becomes particularly nuanced since the default inclination in the safety evaluations of human-system interactions is to identify events as human errors unless a system malfunction is evident.

Gaze on the Driver Cabin

Primary participant 5FuA and secondary participant 8OB criticized drivers for having limited interactions with the instrument panel (5FuA, Pos. 24, 35, 55; 8OB, Pos. 23). 5FuA expressed concern about Uyumlu and Bezgin having minimal interaction with the speedometer. The expectation was that drivers should frequently check the speedometer, especially considering the bus operates on campus with pedestrians, and adherence to strict speed limits is crucial (5FuA, Pos. 24, 35). The participant recommended introducing interventions to encourage drivers to monitor their speed actively. These interventions should extend beyond the incorporation of driving technologies like Advanced Driver Assistance Systems, which recognize posted speed limits and warn the driver if violated.

Instead, the focus should also be on creating a sense of being monitored in drivers (5FuA, Pos. 55). That being said, some drivers confessed that they look at the ceiling of the bus when they feel their speed is a bit over the limit to prevent the eye-tracking device from recording their violation. This information that emerged during the informal conversations with drivers both supports 5FuA's observation and renders his suggestion futile as some drivers tend to look for workarounds even if they have a sense of being monitored.

On the other hand, 8OB criticized Dingin for not paying sufficient attention to a red-illuminated engine warning. The participant noted two potential reasons for this negligence: either the warning is deemed unimportant, in which case it shouldn't be displayed in red, or the driver lacks a sense of ownership. Drawing a personal comparison, 8OB noted that he would not continue driving his car if confronted with a red warning for an extended period. Therefore, the absence of vehicle registration in the driver's name might contribute to a diminished sense of responsibility (8OB, Pos. 23).

Bıçkın tries to adjust the air conditioner while driving.

While not paying sufficient attention to the cluster is a source of concern for some situations, paying too much attention to the cluster is also concerning for others. For instance, deviant participant 9MuK expressed anxiety due to Bıçkın's intense interest in the cluster in Bıçkın 1 video while connecting this behavior to the traffic culture in Turkey, as explained below (9MuK, Pos. 5).

In the Bıçkın 1 video, the driver attempted to adjust the air conditioning but gave up when unsuccessful and proceeded to drive when the departure time arrived. This event was previously explained in the Trial Video Clips section as clip 3. After embarking on the journey, a passenger requested the air conditioning, and Bıçkın attempted to adjust it again. He persisted in trying throughout an extended part of the video while driving on narrow roads and making both left and right turns (Figure 119).

9MuK expressed confusion about Bıçkın continuously interacting with the dashboard since the participant expected a driver to exhibit the best representation of their skills while being recorded. Additionally, he suggested that the vehicle interface needs to be more punitive as a preventive measure against trivial interactions. On the other hand, the participant also proposed bringing the controls associated with the frequent actions that drivers need to complete closer to the forefront of the steering wheel (9MuK, Pos. 6, 10). The participant's anxiety was evident in his comments and nervous laugh, noting:

> Having been a passenger in a Turkish car is making me very anxious. The driver is not focused on the road, which is quite common in Turkey for drivers… He spends way too much time looking away. He is about to run someone over! (9MuK, Pos. 5).
>
> At the end of the Bıçkın 1 video, he didn't see the pedestrian and was about to run over him... so, that's fun… (9MuK, Pos. 9).

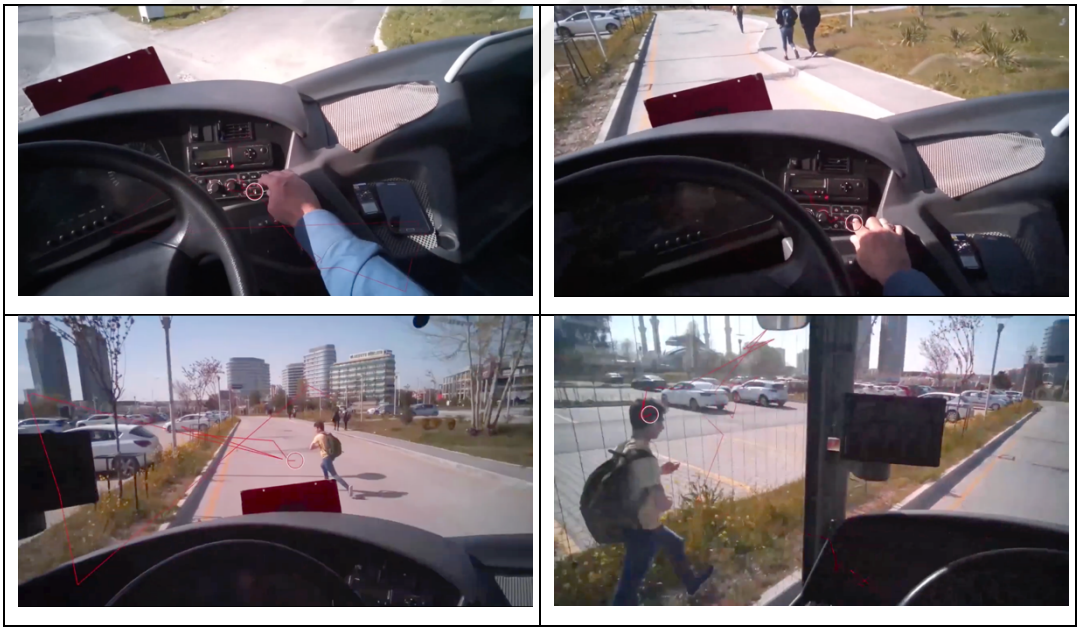


Figure 119 Bıçkın tries to adjust the air conditioner while maneuvering (Bıçkın 1)

Şakacı arranges his belongings before departure.

In the Şakacı 1 video, the driver arranges his belongings before departure. Upon entering the bus, he sits, looks for a spot to organize his belongings, stands up to hang his jacket, and then sits back down before departing (Figure 120). The driver leans back and stretches to reach a hanger positioned behind a protruded area and attempts to arrange the placement of the jacket several times.



Figure 120 Şakacı gets on the bus (Şakacı 1).

Secondary participant 8OB did not realize that the driver stood up to hang his jacket and appraised the bus for allowing the driver to hang while seated. In addition, he appreciated the presence of dedicated spaces in the driver cabin for the driver to place his belongings. Moreover, 8OB also appraised the bus in this video for having a slim cabin door, unlike the door in the Dingin 5 video, which is very thick and does not look elegant (8OB, Pos. 19). Thick doors can be more challenging to lock securely, increasing the likelihood of unintentional opening and they have a higher risk of breakage during opening and closing (8OB, Pos. 19). While appraising the bus in this video, 8OB also acknowledged that:

> The bus in the Şakacı 1 video is of X brand. The cabin door is thinner, which I consider better, unlike the door in the Dingin 5 video. I don't know; it looks better, perhaps unconsciously… because it is an X-brand bus from our company (8OB, Pos. 80).

Primary participant 3SG noticed that the first action the driver took was to look for a place to put his belongings and hang his jacket, emphasizing the priority of this action. His tone suggested he found something valuable for his future projects as a bus designer (3SG, Pos. 19). A deviant participant, 2MeK, noted the potentially uncomfortable placement of the hanger:

> Şakacı hangs his jacket, and I wondered if it bothers him while hanging. If the jacket is thick and the driver is meticulous, it might be uncomfortable for the driver if the coat hits him from behind (2MeK, Pos. 26).

Şakacı makes a video call while maneuvering.

In the Şakacı 1 video, driver engages in a video call with his child while navigating a narrow road with numerous twists and turns. The challenging road conditions, coupled with the direct glare of the sun in front of the bus, create a visually demanding environment. Notably, the reflection of the driver is visible on both the instrument cluster and the mobile phone, adding an additional layer of visual complexity to the situation (Figure 121).

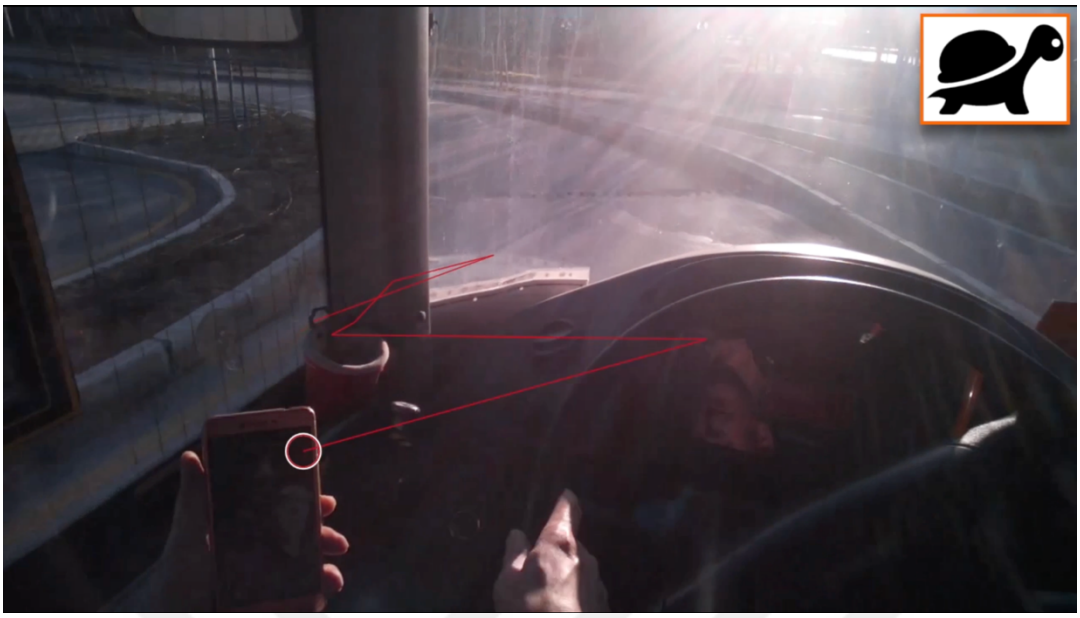


Figure 121 Şakacı makes a video call while maneuvering (Şakacı 1).

Some participants offered a range of perspectives, discussing safety concerns, potential emotional needs of the driver, and proposing design solutions to address the challenges posed by making video calls while driving. Deviant participant and user researcher, 2MeK, acknowledged that making a video call while driving is a safety and procedural concern. However, they didn't perceive it as a significant mistake (2MeK, Pos. 23). That being said, 2MeK discussed the potential emotional support that the video call might provide and suggested implementing a checklist of pre-departure 'tasks to be done.' This checklist aims to reduce the likelihood of making a video call while driving by reminding the driver to complete it before departure. He noted:

> If I were a designer who tends to extrapolate problems from minor issues, discuss the driver's personal space in the workplace, and make positive comments, I could say something like, 'In the briskness of the morning, he might need something to connect with his child emotionally, so could something be placed on one side of the vehicle to remind him of his child?' I could make comments like these just to generate ideas. But at the same time, I could say his child might have just coincidentally called him. Starting the day with his child could be uplifting; these days, I frequently video call my family to show them my puppy, and it's an uplifting

> experience. However, attempting to think that the driver will be more comfortable just because he saw his child and suggesting something as a designer in response to that idea makes me uncomfortable. […] What will the driver do, make a more beautiful maneuver [just because he is happier]? (2MeK, Pos. 24)

Primary participant 3SG expressed concern about the driver holding the phone while driving and maneuvering. He proposed two potential approaches: completely forbidding phone use and strictly monitoring it or providing suitable equipment if continuous connectivity is accepted. That said, the participant acknowledged the challenge of achieving complete disconnection from life while driving. Therefore, 3SG suggested designing equipment that minimizes distraction and eliminates the need to touch the phone (3SG, Pos. 21). The participant also highlighted the problem of the driver's reflection in the instrument panel, expressing concerns about the driver not receiving the necessary information from the screen (3SG, Pos. 22).

Secondary participant 8OB also pointed out the reflection problem and acknowledged that, as a designer, promoting video calls while driving is not advisable. However, he also suggested considering solutions such as hands-free options like Bluetooth to minimize distraction (8OB, Pos. 21). Additionally, this participant expressed surprise that, despite being observed and recorded, the driver controlled the vehicle with one hand while making a video call with the other, speculating that the driver might do more if not being recorded (8OB, Pos. 20).

Dingin searches for the route sign.

In the Dingin 5 video, the driver encounters an issue with the route sign of the bus. Route signs are thin plates measuring around 30cm by 20cm, displaying different colors and featuring a capital letter "R." Multiple signs, each assigned a different color corresponding to various routes available during different times of the day or on weekdays and weekends, are stored in the bus. When the driver realizes the route sign is missing, he stops the bus and initiates a thorough search. Dingin inspects the compartment on the cabin door, a typical storage location for the signs.

Unable to locate it, he stands up and checks the sides of the driver's seat, pulls the seat forward to inspect behind it, and examines the area around the dashboard. After revisiting the compartment on the door and inspecting numerous signs, he eventually finds the correct one buried under others (Figure 122).

While none of the participants of the main workshops selected Dingin 4 video, a participant from the pilot workshop, P2AK, commented on this event, deeming it noteworthy. P2AK's observation reflects the driver's exhaustive search and highlights the challenges related to the route signs:

> If Dingin goes as far as checking behind the seat to locate the sign, it suggests that, at this point, the sign could be anywhere. It means that he expects anything since there is no order whatsoever.



Checks the sides of the seat | Moves the seat forward and checks behind the seat

Checks the pile of route signs in the cabin door compartment | Finds the correct one and places it between the windshield and the dashboard

Figure 122 Dingin searches for the route sign (Dingin 5)

İhtiyar rotates the route sign.

In the İhtiyar 2 video, the driver stands up while making a right turn and adjusts the route sign. The sign has one side in yellow and the other in red, with the yellow side turned toward the inside of the bus, which is required to be visible as the bus moves in its current direction. Ihtiyar notices this as he is about to turn right, catching his eye on the sign. While turning the steering wheel with his left hand, he stands up, reaches the route sign with his right hand, and rotates it. He places it correctly on the first attempt but rises again and tries to place it at an angle (Figure 123). Upon witnessing this event, participant 4CB remarked:

> This is a very obvious problem; the driver constantly deals with other things while driving, leading to continuous distraction. Reaching for the sign is challenging due to its distance, with the steering wheel and dashboard in between, making this movement ergonomically demanding. Additionally, considering the driver's short stature, I wonder if he stood up while reaching for the sign. If he did stand up, can his feet reach the pedals, and did he change the position of his feet? The driver should not be doing this, but a situation prompting this behavior should not arise in the first place. Before starting the day, the driver has to search for the vehicle, consider the fuel situation, think about where the bus is located, etc., resembling an additional shift. Forgetting to change the direction of the sign is quite normal. If there were something as simple as an app, he wouldn't forget, or route information could be updated electronically without the driver having to do anything (4CB, Pos. 16).



Figure 123 İhtiyar rotates the route sign during a right turn (İhtiyar 2).

While echoing the need for a proper route sign design (3SG, Pos. 47), primary participant 3SG speculated about the driver's attempt to put the route sign at an angle:

> İhtiyar initially placed the route sign correctly, but then he stood up again and placed it at an angle. Perhaps to ensure visibility from the outside since the wipers might obstruct the readable text on the sign? Or he might be trying to cut off the light reflecting from the dashboard to the window… I can't figure it out (3SG, Pos. 46) …

Gaze During Night Driving

Several examples of the night driving gaze behavior of the driver have already been presented in previous sections. In addition, primary participant 10 KU and secondary participant 1FA discussed the gaze behavior while driving at night. 1FA noted that while driving during the day, the drivers started monitoring pedestrians along the roadside from a much greater distance. However, at night, weak headlights reduce the driver's visibility, and he cannot monitor distant areas.

Consequently, the drivers must continually scan the nearby surroundings (1FA, Pos. 61). Additionally, 10KU commented on the night driving gaze behavior in the Uyumlu 2 video. The driver faced challenges due to insufficient vehicle and road lighting while turning from an intersection. As a result, the driver significantly slowed down and scanned the surroundings by looking at the sides of the road and moving objects. The challenging conditions made the driving task quite demanding for the driver, as highlighted by participant 10KU (10KU, Pos. 45).

Gaze Utilization and Participant Perspectives

This study employed purposeful sampling to explore a variety of participant perspectives, as recommended by Koskinen (2003). The diversity of participant perspectives became apparent in problem identifications while utilizing gaze information. Within the boundaries of this study, problematization must occur for an event observation to transform into a design opportunity. This section elucidates two exemplary events in Şakacı 2 and Şakacı 4 videos, illustrating how a secondary participant, 1FA, and a deviant participant, 2MeK, problematized observations of the same events differently. 1FA possesses extensive driving and riding experience, watches motorcycle riding videos, and undergoes safe riding training to enhance skills. On the other hand, 2MeK, while holding a driving license, lacks driving experience. 1FA has previous involvement in form giving projects for bus design, while 2MeK, focused on user research, does not necessarily identify as a ‘designer who sketches a lot’ (2MeK, Pos. 75).

Effects of the awareness of power dynamics on driver behavior interpretation

In the Bezgin 3 video, the driver skipped a bus stop due to a white bus positioned in the middle of the bus stop area. Although Bezgin could have chosen to wait behind the white bus, he opted to skip the stop. The author attributed this decision to the underlying tension between white bus drivers, who are outsourced, and institutional drivers. The details of this event are explained above. An illustration

of this tension emerged in the Şakacı 4 video. This video also presents an example of the relationship between participant positionalities and the utilization of gaze information (Figure 124). In this video, Şakacı is waiting at a red light to turn left at an intersection, and a white bus swiftly passes from the right side of the queued vehicles and turns left instead of waiting for the light to turn green. Şakacı narrates, "If we did this, we would be complained about immediately."

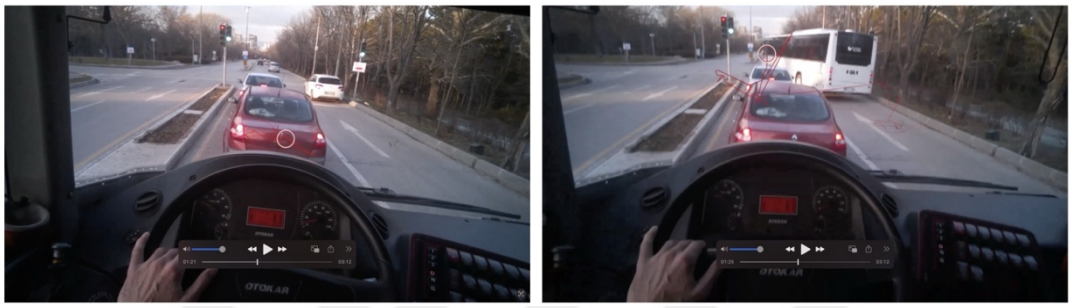


Figure 124 A white bus violating red light in Şakacı 4 video.

Upon observing this event, a deviant participant, 2MeK, expressed a personal connection to the event because he also experienced similar frustrations, which prompted him to share his thoughts (2MeK, Pos. 55). 2MeK started by addressing the sincerity of Şakacı, stating that Şakacı, too, would have proceeded without waiting at the light if he were driving a white bus. Yet, Şakacı operates a university-owned blue shuttle bus with an online tracking system. Therefore, pedestrians know that driver behaviors can be complained about by calling the METU Directorate of Transport. 2MeK contends that this event also reflects pedestrian insincerity, as pedestrians are less inclined to file complaints about white buses, likely because they are uncertain about the appropriate authority to address their complaints. In addition, pedestrians wouldn’t make the effort to find it out. 2MeK supported Şakacı's assertion that all road user violations should be treated similarly. Therefore, he contemplated whether the shuttle buses could be equipped with sensors and recorders to monitor and automatically report other road user violations. While the idea of utilizing blue buses as a mobile tracking system

for other road users may be perceived as over-surveillance, it could address the problem by applying the same monitoring rigor to all drivers (2MeK, Pos. 55).

While 2MeK demonstrated a nuanced understanding of current shuttle service conditions, a secondary participant, 1FA, characterized the same event merely as an interesting red-light violation, seemingly unaware of the prevailing power dynamics between the shuttle and white bus drivers.

The difference between the two participants was that 2MeK was thinking aloud while watching the video, whereas 1FA was recalling his memory of the event by looking at the GIF of the event without hearing the narration of the driver (1FA, Pos.40). While this alone can be the explanation for their differing comments, 1FA was able to recall video conversations by looking at the GIFs as explained below. Therefore, the difference can also be attributed to the positionalities of the participants. Their first positionality difference is 2MeK's declaration about his personal interest in these types of unfair treatments and the fact that 2MeK previously said he selected Şakacı because he could identify with him. The second difference is the participants' familiarity with the campus. 2MeK had a more up-to-date knowledge about shuttle service conditions than 1FA. This means 2MeK was aware that the university outsourced white buses recently. In addition, 1FA, being a driving enthusiast, has been more focused on analyzing the eye movements during the maneuvers, presented by his detailed interpretations of gaze during maneuvers as explained above. Moreover, 2MeK is focused on user research, and 1FA is focused on form giving, 2MeK could have been more attuned to the emotions in the tone of the speech. These explanations indicate the possibility of a relationship between participant positionalities and the utilization of gaze information.

Effects of driving experience on gaze interpretation

Another example of the relationship between participant positionalities and the utilization of gaze information can be seen in a segment of the Şakacı 2 video. Two participants watched and commented on the events in this video. One was a secondary participant, 1FA, a driving enthusiast who watches driving videos to

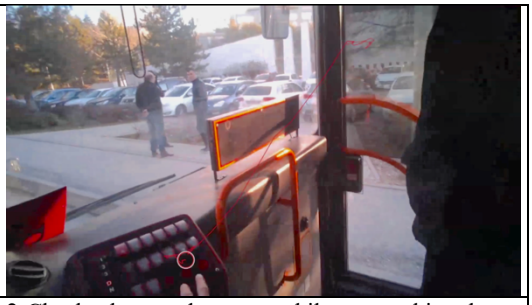
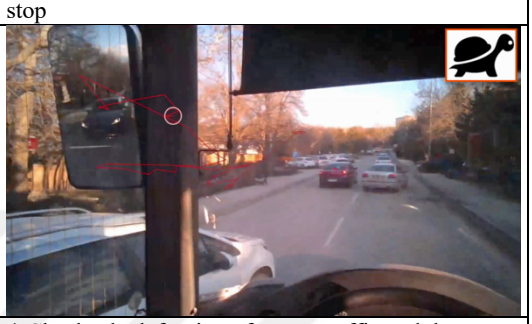
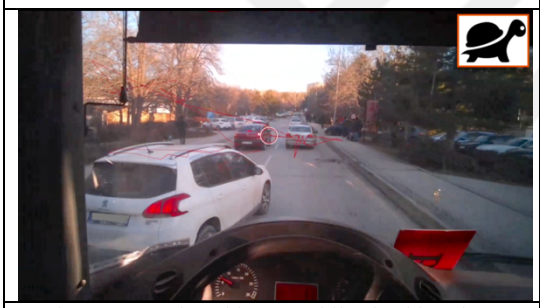
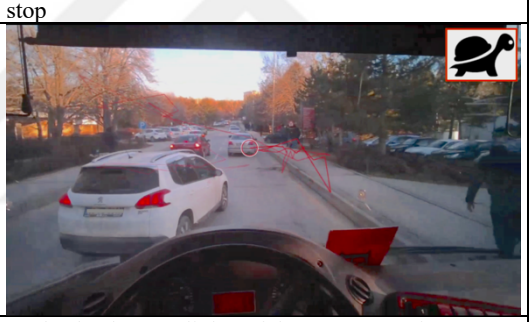
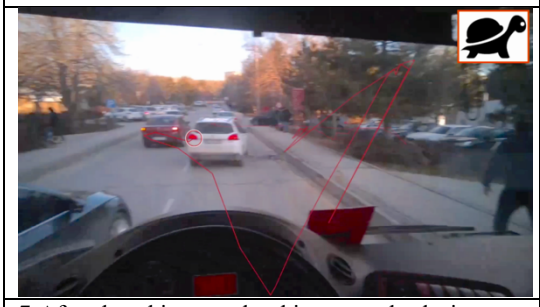
improve his driving skills. Another was a deviant participant, 2MeK, a user researcher who doesn't drive. Their following comments seem to be in line with their positionalities.

1FA observed and narrated this segment in a detailed way while interpreting the intentions of the other road users' intentions and Şakacı's decision-making processes (1FA, Pos. 38). In this video (Figure 125), Şakacı drives on a straight road, approaches a bus stop (1,2), and looks at the pedestrians on the sidewalk for an extended period of time. 1FA considered this look to demonstrate Şakacı's tendency to greet people and pay attention to pedestrians in the surroundings, suggesting that Şakacı's behavior might be influenced by his sociable nature. He noted:

> That's Şakacı for you; he probably behaves like that because of his nature implied by his persona name (1FA, Pos. 37).

After Şakacı waits for passengers to disembark (3) and departs from the bus stop to continue driving straight; however, while he is about to depart, he checks the left mirror to see another white car trying to cut him off (4). He gives way to it as there is another red car in the left lane that stops and blocks the traffic (5). While the white car moves to the right lane in front of the bus, Şakacı checks the stop lights of the gray car that is further ahead to understand if the white car he gives way to will have to stop after moving to in front of the bus (6). After the white car cuts him off, he checks its rear lights to see if it will stop as he gives way to another dark gray car (7). The reason for this relinquishing the right of his way can be because the red car on the left lane still stops and blocks the traffic. After the dark gray car also moves in front of the bus, Şakacı checks the rear lights and the wheels of the white car in front of the dark gray car and sees that it is braking (8). The red car on the left lane still waits; now the right lane in front of the bus is also filled with all the cars that Şakacı gave way (9). Another dark gray car emerges from the left of the bus and Şakacı checks its front wheels to see if it is rotated towards the bus (10). As the dark gray car proceeds, Şakacı sees its flashing signals meaning

that it will move in front of the bus; however, the red car on the left lane turns left into the parking area and clears the road (11). Therefore, Şakacı decides not to give way to the second dark gray car and checks the black car on the right side of the road waiting to join the road. He checks its front wheel to see if it will give way to the bus. Upon seeing its stationary wheels, Şakacı proceeds (12). While he approaches a speed bump that simultaneously serves as a raised pedestrian crosswalk, he notices a pedestrian with a stroller waiting to pass the road a couple of meters away from the pedestrian crossing (13). Even though there is a raised pedestrian crosswalk right in front of the bus, pedestrian prefers to use the sidewalk transition ramp placed next to the raised crosswalk. Şakacı gestures to communicate his intention to give way to the pedestrian (14). When the pedestrian proceeds to cross the road, Şakacı checks the rear traffic from the left mirror to ensure the pedestrian's safety (15). At this point, 1FA pointed out the irony of giving way to a pedestrian by stopping on a crosswalk since the rear part of the bus should still be on the raised crosswalk, considering the bus's length. After checking the rear traffic to ensure the safety of the pedestrian, Şakacı waits for him to cross the road (16).

	
1-Looks at the group of people while approaching the bus stop	2-Checks the rear door area while approaching the stop
	
3-Checks the rear door while passengers are disembarking	4-Checks the left mirror for rear traffic and the white car on the left before departing from the bus stop
	
5-Gives way to the white car while checking the stop lights of the red car, which blocks the left lane, to understand its intention	6-Checks the stop lights of the gray car to foresee possible interactions between the white and gray cars. The red car still stops
	
7-After the white car takes him over, checks its stop. He gives way to a dark gray car since the red car still stops and blocks the left lane	8-While the dark gray car proceeds, he checks the wheels of the white car ahead to check if it has stoped

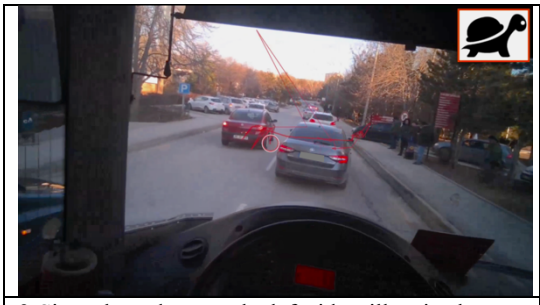
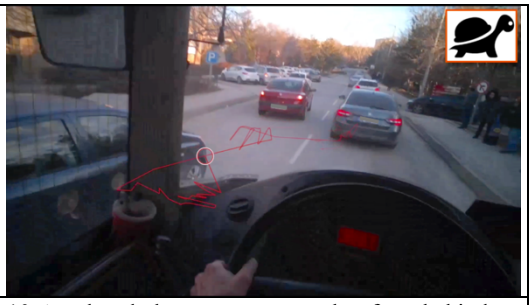
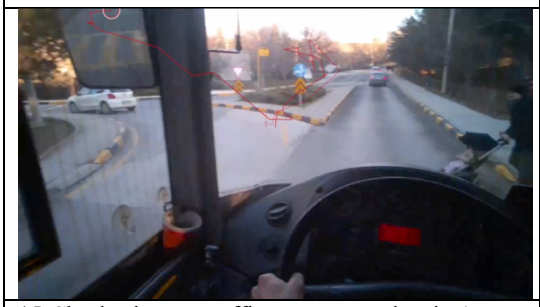
	
9-Since the red car on the left side still waits, he checks its wheels to understand if it will turn left to the parking area	10-Another dark gray car approaches from behind and he checks its wheel to see it is turning right to cut him off
	
11-As the dark gray car proceeds, he sees its signal showing it intents to cut him off. The red car turns left to parking area clearing the left lane.	12-He decides not to give way to the dark gray car as the left lane has cleared by the red car. He checks the wheels of the black car on right
	
13-Notices a pedestrian with a stroller waiting to pass the road next to a sidewalk transition ramp.	14-Gives way to the pedestrian and show his intention with a hand gesture. The rear part of the bus is still on the raised pedestrian crosswalk.
	
15-Checks the rear traffic to ensure pedestrian's safety	16-Waits for pedestrian to pass

Figure 125 Gaze interpretations of Şakacı while he gives way to other road users (Şakacı 2)

Like 1FA, 2MeK also noticed Şakacı's prolonged gaze on the pedestrians. Contrastingly, while 1FA swiftly contextualized the observation by attributing it to the persona's name, 2MeK took a more analytical approach, seeking to explore the rationale behind the observation. 2MeK considered two possible explanations for Şakacı's prolonged gaze. He speculated that Şakacı stops to pick up all pedestrians, even when there's no bus stop, which results in constantly monitoring pedestrians for potential passengers. Alternatively, 2MeK proposed that Şakacı may have developed a habit that seemed more likely. According to 2MeK, Şakacı's prolonged gaze behavior stems from his habit of consistently monitoring and yielding to various road users. This habitual practice, 2MeK suggests, is likely influenced by the campus management's expectation that drivers yield to pedestrians, a standard to which Şakacı appears to adhere (2MeK, Pos. 30). After observing Şakacı's consistent attention to road users and his practice of yielding to them in various parts of the videos, 2MeK concluded that aberrant behaviors from other road users pose avoidable risks and discomfort for Şakacı. Consequently, he recommended educating other road users to enhance the safety and comfort of bus drivers (2MeK, Pos. 42).

The difference between comments of 1FA and 2MeK encompassed the level of interpretation of gaze movements and the decision-making process during maneuvering. While 1FA provided a detailed account of gaze movements, approximating the level of detail illustrated in Figure 125, 2MeK utilized gaze data to conclude that Şakacı qualifies as a good driver due to his consistent practice of looking at and yielding to road users (2MeK, Pos. 30). Upon Şakacı's gaze on the mirror, 2MeK noted:

> I see that Şakacı checks the mirrors, of course, but I'm not conveying it to you. When he looks at the mirrors, he doesn't take any specific action, so I thought everything was in its place (2MeK, Pos. 27).

In addition, towards the end of the workshop, 2MeK noted that he was not able to identify driving errors in the videos due to his limited driving experience. He suggested a checklist for drivers to compensate for his lack of expertise,

acknowledging that his unfamiliarity prevented him from forming expectations about a good driver's specific gaze points. 2MeK's reliance on visible actions to form judgments, in the absence of a checklist, led him to conclude that Şakacı's mirror checks appeared normal and appropriate. By candidly acknowledging potential gaps in his understanding as a driver, 2MeK demonstrates thoughtful self-awareness. This reflection might be influenced by his extensive exposure to systematic research methodologies during his user research and Ph.D. studies, showcasing a rigorous thought process.

6.3.2 Assessment of Videos

The first-person perspective in the video, recorded with a camera positioned between the drivers' eyes and featuring a gaze indicator, was unanimously appreciated by all participants. For example, primary participant 3SG found several aspects of the videos insightful. Firstly, the gaze indicator provided valuable insights into what the driver was focusing on, how they read the road, and identified potential and imminent hazards. He then compared how he would maneuver if he were in the drivers' shoes, considering he usually drives a personal car. Analyzing maneuvers, he took into account factors like maintaining distance, acceleration, and braking distances, noting their differences from those in regular cars. This experience allowed him to directly immerse himself in the viewpoint of someone practicing this profession for years. Moreover, he highlighted the eye-tracking device's contribution to analyzing project contexts from the user's visual perspective, emphasizing its potential not only for bus projects but also for enhancing operational processes across various domains (3SG, Pos. 83-86). Similarly, some secondary participants also suggested additional application domains for this type of recording.

> Such a study could also be very beneficial in our domain (healthcare design). For instance, I would like to be able to watch surgeries from the perspective of an anesthesiologist. Typically, we observe surgeries from outside the operating room, like watching fish in an aquarium. Watching in

> this way is like stepping into their shoes and putting yourself in their place. This approach is much more appealing. (4CB, Pos. 63)

> Videos help us understand where the driver is currently focused. I also want the information on this eye-tracking device as I would like to see if it can be implemented in our context (military vehicles) or if our users would accept it. In addition, another nice feature of the videos was the smooth camera movements. We secure the camera inside the vehicle, and as a result, the vehicle's vibrations make the camera shake vigorously. The camera movements didn't bother me while watching these videos. (8OB, Pos. 73)

> These days, we're working on a high-capacity dump truck project, and I'm designing its interior. While watching these videos, I also examined where the driver was looking to figure out where to place everything in our project. So, watching these videos was beneficial for me as well, indeed. (1FA, Pos. 2)

Despite its proximity to a person's viewpoint, a camera remains distinct from actual human vision. Both 1FA and 8OB pointed out this distinction between the capacity of the eyes and the cameras.

> Since we are looking at the nighttime camera recording, we can't see pedestrians in the distance, but, anyway, it's pretty evident that the driver can't see the pedestrians either because the driver's gaze indicator doesn't move on the pedestrians until they get close to the bus. (1FA, Pos. 61)

> Since we are not in the driver's seat, we probably can't fully comprehend how the driver manages to navigate the road. To truly understand, it would likely be necessary to experience it firsthand inside the bus. From what we can see in the videos, it seems like the driver is threading the bus through a needle's eye during maneuvers, and it feels like they could mount the sidewalk at any moment. (8OB, Pos. 22)

While appreciating the first-person perspective, a primary participant, 10KU, expressed a desire to see videos that not only capture the driver's gaze movements but also show the driver from various angles. He specifically wanted to see parts of the bus where passengers are seated, observe passengers' actions and where they

hold onto, among other details (10KU, Pos. 61). While justifying his desire to see from different angles, he noted:

> The bus comprises not just the dashboard and the driver's seat; we also need to consider aspects such as handholds in the back, passenger seat comfort, materials used, and cleaning. That's why I want to see different video angles and what happens to a vehicle through 24 hours. (10KU, Pos. 62)

Similarly, primary participant 5FuA proposed enhancing the connection of video data with bus design by including recordings of drivers engaging in tasks beyond driving. These tasks could involve approaching the bus, opening doors, reaching the driver's cabin during boarding or alighting, and adjusting the steering wheel. According to 5FuA, such recordings could unveil ergonomic issues related to these activities. When informed that some of these recordings already exist, although they hadn't been encountered during the workshop, he expressed interest in continuing access to them post-workshop (5FuA, Pos. 53). Expanding on his desire for more video content, 5FuA referenced an incident where a child tragically lost his life after being forgotten on a school bus throughout the day. This incident underscored the importance of the driver's actions during boarding and disembarking. 5FuA noted that the bus, being a large vehicle with three doors, could pose challenges in locking and unlocking them. Considering this, he wondered if campus drivers lock the doors and suggested implementing remote controls similar to cars. Additionally, he expressed curiosity about observing situations such as how the driver enters the vehicle during cold weather, attempts to warm up the interior, handles rainy weather, and prepares for driving if the windows are fogged (5FuA, Pos. 54)."

These comments from primary participants with a direct interest in the study's data about bus drivers underscore the diverse perspectives required when designing buses. However, given that this Ph.D. thesis is a single-person data collection endeavor, it focused on collecting data from drivers that focus on their perspective from the outset, acknowledging that it cannot comprehensively address all the

aspects of bus design in a real-life corporate setting. Additional information on this can be found in section 6.4.4.

The primary participant, 10KU, also voiced additional concerns about the discomfort similar to motion sickness (10KU, Pos. 19) due to the driver's rapid eye movements in the Dingin 3 video. He also noted frustration with the rabbit logo that appears when the driver checks the right mirror (10KU, Pos. 20), obstructing part of the screen and making it difficult to determine the driver's gaze status (Figure 126).

Additionally, primary participants 10KU and 5FuA expressed dissatisfaction with some video segments being sped up without their control, as they hinder 5FuA's ability to determine whether the vehicle is moving at an appropriate speed (5FuA, Pos. 22), and 10KU's preference for the ability to adjust video speed, similar to platforms like YouTube (10KU, Pos. 64). The other primary participant 3SG, a secondary participant, 4CB, and a deviant participant 9MuK, also voiced their confusion about the video speed's interference with the comprehension of driver eye movement (3SG, Pos. 31; 4CB, Pos. 21; 9MuK, Pos. 18; 9MuK, Pos. 36).



Figure 126 Gaze indicator disappearing behind the logo in consecutive video frames.

Upon further evaluation of the specific video 10KU referred to (Dingin 3), the author realized that this video had an excessive number of jump cuts and sped-up segments that disrupted comfortable viewing and event comprehension. One of the uncomfortable segments in the Dingin 3 video happens between 00:18-00:35 of the video. In this part of the video, several problems occur such as sudden change of

the scene, frequent sped-up segments immediately followed by slowed-down segments, and unnecessary sped-up segments that disrupt the observation of a significant event. These problems make it hard to comprehend the event details as they confuse the viewer. The events and curation problems are explained more in detail in Table 14 and Figure 127.

Table 14 Curation problems for Dingin 3 video

#	Time	Video Event	Curation Problem
1	00:18	Dingin approaches to one major turnabout to make a right turn	The video suddenly jumps to a different scene while in sped-up mode, which is confusing.
2	00:18 - 00:26	Turns right on the roundabout	Sped-up portion disrupts viewing this significant maneuver and the driver's gaze.
3	00:26	Dingin drives on a straight road	The sped-up portion continues as the video jumps to a further point on the same straight road. There is a sudden change of scene, which is confusing.
4	00:27 - 00:29	Dingin drives on the same straight road and takes over another bus	The sped-up portion continues and disrupts observation during this significant event. Moreover, Dingin checks the right mirror to complete the takeover maneuver, but the rabbit logo obstructs the gaze indicator. The ego bus is on the left lane.
5	00:29	Dingin drives on the same straight road, passing over a speed bump	The sped-up portion continues as the video jumps to a further point on the same straight road. There is a sudden change of scene; speed bump suddenly disappears, and the bus is on the right lane, which is confusing.
6	00:29 - 00:31	Dingin waits at a bus stop and checks the left mirror before departing from the bus stop	Right after the disappearance of the speed bump, the video jumps to a point where there is another automobile on the left of the bus, trying to take over the ego bus. The video suddenly changes to being sped up to slowed down to emphasize the automobile behind the bus. This rapid speed change is confusing
7	00:31 - 00:35	Dingin departs from the bus stop	The video is slowed down at the beginning. The automobile behind the ego bus takes over while Dingin waits at the bus stop. Right after the automobile passes and Dingin commences departure from the bus stop, another sped-up segment starts disrupting the observation of this significant event. Departing from the bus stop was a significant event as a taxi driver cuts the ego bus off, and participants might like to observe the driver’s gaze movements.

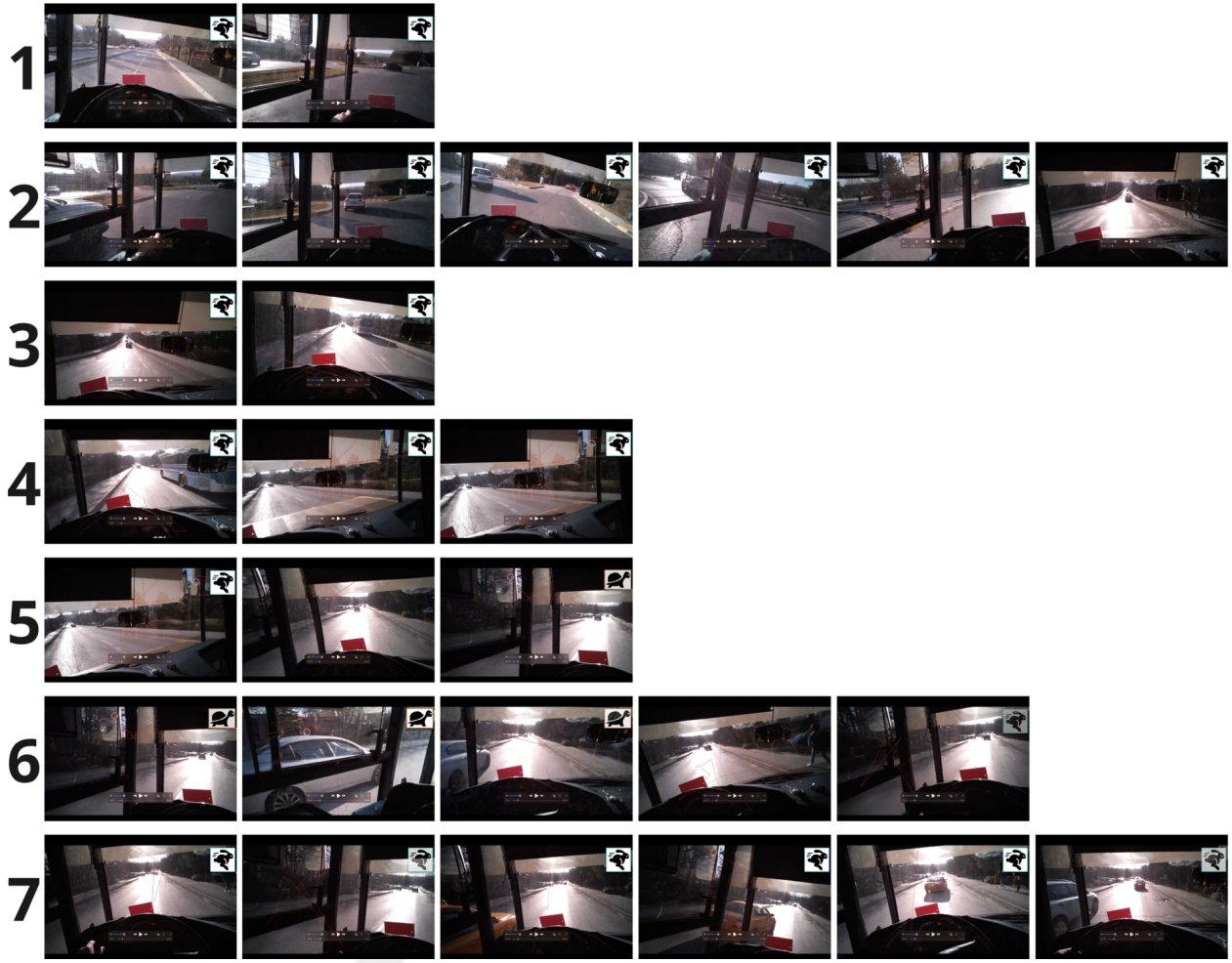


Figure 127 Dingin 3 video curation problems.

A secondary participant, 4CB, and a deviant participant, 6EC, also voiced their discomfort caused by the sped-up segments of the videos and the gaze indicator. 4CB also provided some improvement suggestions:

> The circles and lines constantly moving in sped-up segments made my head spin a bit, like a cat chasing a laser. Perhaps this is something that the driver experiences as well, or maybe a color other than red, like yellow, could be chosen for the gaze indicator for easier viewing. Alternatively, smoother lines could be used to reduce the dizziness instead of showing every detail of the gaze movements with jagged lines. (4CB, Pos. 60)

> Oh my God, wait... [nervously laughs and reacts as if startled by the excessive movement in the video]. I was about to comment on how abruptly he stopped when approaching the bus stop, but it turns out the video was sped up. (6EC, Pos. 42)

In addition to sped-up segments, slowed-down segments were also assessed by some participants. A deviant participant and a user researcher, 2MeK, assessed these segments as useful for signaling significant events (2MeK, Pos. 43). Another deviant participant and a UX designer, 6EC, expressed appreciation for the edited nature of the videos, particularly the sped-up and slowed-down segments. He stated that as a UX designer, he would have preferred to receive edited videos from the UX researcher he works with, as this optimizes the review process of the user research findings (6EC, Pos. 74). On the other hand, 8OB, a secondary participant and military vehicle designer, said that he carefully reviewed the slowed-down segments as he thought the researcher aimed to elicit responses by slowing them down; however, he could not see anything significant in many of the slowed-down segments. (8OB, Pos. 79). The only exception to the slowed-down segment he found slightly interesting was explained in the “Utilization of Video Speed” section before.

Primary participants 3SG and 5FuA and a deviant participant, 6EC, shared their thoughts on the privacy implications of eye-tracking recordings. 5FuA expressed surprise at drivers’ willingness to wear eye-tracking devices (5FuA, Pos. 4), while 3SG humorously remarked, "This eye tracking is a bit risky," emphasizing its

revealing nature and how it exposes a lot about a person (3SG, Pos. 30). 6EC pointed out that even though he is accustomed to watching user videos, he is intrigued by the depth of insights these videos afford. In a light-hearted tone, 6EC noted that watching eye-tracking videos felt tense, giving a sense of intruding on the person's privacy, especially when witnessing personal moments like a deep sigh (6EC, Pos. 34).

Participants extended their assessments to auditory information, uncovering challenges in comprehending specific audio qualities. Some participants expressed confusion in pinpointing the exact source of sound in the videos, encountered difficulties in understanding the speech articulation of the person speaking, and grappled with cultural nuances specific to the bus drivers. These audio-related hurdles contribute to limitations in participant comprehension for the video-centered user research communication tools. For instance, while watching the İhtiyar 2 video, 4CB and 3SG could not identify which vehicle used the horn and why, as explained before. Similarly, at the end of the Şakacı 4 video, the driver asked another person on the sidewalk, ‘Will you take this bus?’ to decide what to do with the bus after his shift (Figure 128). Upon watching this, 2MeK asked the researcher who posed the question, Şakacı or the other person waiting outside (2MeK, Pos. 58). As a general assessment of the sound, a deviant participant, 9MuK said that it was quite challenging to catch precisely what the conversation was about since the video speeds up and slows down (9MuK, Pos. 36). However, it is worth reminding that 9MuK was not very fluent in Turkish, which may contribute to this difficulty. A primary participant, 3SG, also pointed out another sound problem. In the Uyumlu 5 video, the driver talked about a previous crash he was involved in. 3SG expressed his frustration as he was interested in the crash details but unable to understand due to what he perceived as the incomprehensible accent of the driver. (3SG, Pos. 57). Moreover, 3SG mentioned that he felt immersed and could empathize with the drivers while watching the videos, but the drivers' speeches disrupted this immersion (3SG, Pos. 84).

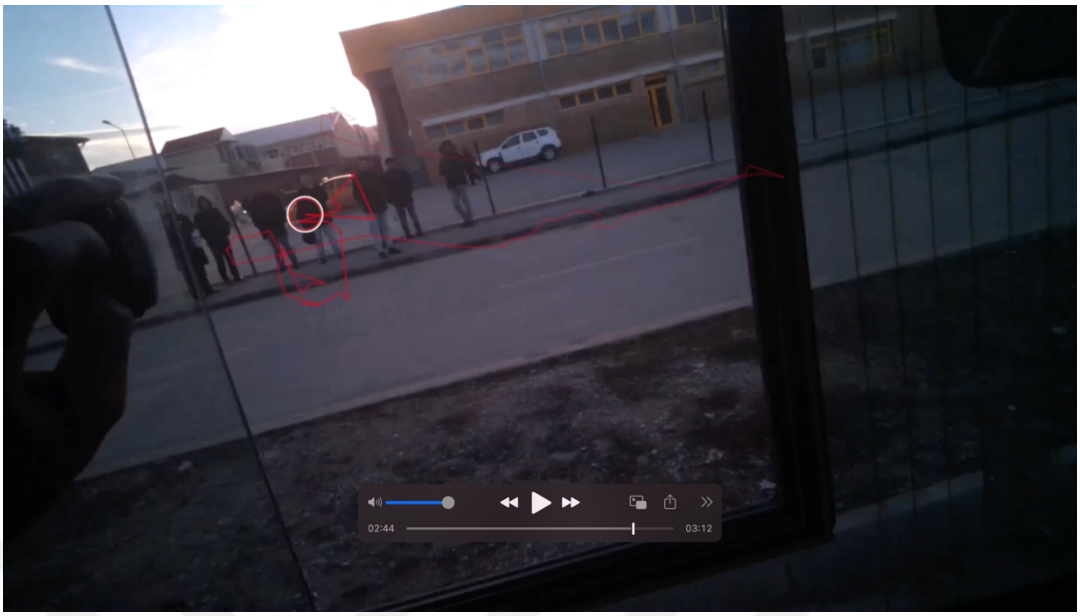


Figure 128 Şakacı talks to someone on the sidewalk in Şakacı 3 video.

Video and sound quality critiques:

Some participants complained about the visibility of and not knowing the functions of the displays and controls on the instrument panels. Since the videos were recorded in the natural environment and the illumination conditions changed a lot while driving in the daylight, the instrument panel of the buses remained in the dark most of the time. During night driving, the interior of the buses is even darker, so the instrument panel is not visible either. This prevented participants from comprehending the exact actions the drivers were trying to achieve in some situations. In addition, since there are various different buses, the design of the instrument panels varied a lot. Even though a map of a bus instrument panel was created for the participants (Appendix A), it was not utilized because of the variety of bus brands that are in use at the campus. This led some participants to ask questions or speculate, such as:

> There are many dials on the dashboard, and I don't understand what he is trying to achieve by looking at them. Maybe he must track the speed of the journey. If so, I would use any opportunity to make functions as automated as possible. Dealing with such tasks leads to distraction and an increased risk of making mistakes (9MuK, Pos. 13).

The driver did something here; let's take another look... pushed a lever forward, on the side of the steering wheel... Hm. What is that lever? Probably something like the brake system. Is it the handbrake? He pushes it forward; I'm not quite sure... If that lever is the handbrake, its placement on the dashboard seems convenient and practical… Since the driver just stopped the bus, I assume he pulled the handbrake afterward. That lever is the handbrake (8OB, Pos. 81).

I don't see Bezgin signaling when changing lanes; it might be because of the video, given that the instrument panel is in the dark, but he might not have signaled at all [laughing] (6EC, Pos. 19).

6.3.3 Utilization and Assessment of Video Representations and Campus Map

As explained in the Video Representations and Campus Maps section in Chapter 5, representations were designed to facilitate the prioritization of the videos and memory retention. These representations include animated GIFs, the nomenclature of each video, and route drawings on the campus map. These representations are placed on the campus map (Figure 129), which also displays roundabouts (red circles), landmarks (red text), and bus stops (orange text and rectangles).

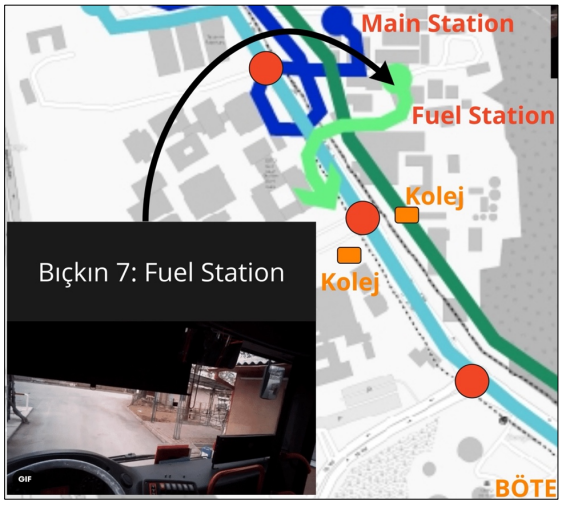


Figure 129 Video Representations on the campus map.

Video representations, specifically GIFs, were designed to signal significant events in the videos, facilitate video selection, and serve as mnemonic cues for later project phases. However, since this study does not include the whole design process in a real-life context, it was not possible to identify whether it could serve the purpose. That being said, preliminary insights into the mnemonic quality of representations could have been gained by allowing participants to watch the videos before the workshops, as initially planned. Unfortunately, as previously mentioned, only two secondary participants, 1FA and 8OB, had sufficient time to do so. Among these two, 1FA provided comments on the utility of GIFs.

1FA utilized GIFs to remember the key events, gaze patterns, video locations, and conversations that transpired within the videos. An illustrative example emerges from 1FA's experience with the GIF of Bıçkın 7 video (Figure 130). The GIF was taken from a specific video sequence featuring another driver persona, Dingin (Calm). Dingin warned Bıçkın about a broken part of the bus, asking Bıçkın to take care of it. Bıçkın expressed frustration, believing that the issue should have been already resolved by Dingin, and exclaimed, 'Let it go up in flames; I don't care.' The corresponding animated GIF aided 1FA's recollection of this scene and the conversation between drivers. When 1FA was asked about his assessment of GIFs, 1FA noted:

> Selecting videos by examining GIFs seemed less significant, but GIFs became meaningful for recalling video events. (1FA, Pos. 25.)

	
Bıçkın is about to depart from the fuel station	He hears someone talking at him, so turns his head
	
Dingin persona issues a warning regarding a broken part of the bus, asking Bıçkın to take care of it.	Bıçkın gets angry and exclaims, ‘Let it go up in flames, I don't care.’ Dingin says ‘as you wish’
	
Bıçkın complains about Dingin, saying it was Dingin who was supposed to fix the bus	Bıçkın closes the door and departs while talking about his delight about this event being recorded

Figure 130 Selected Frames from Bıçkın 7 GIF

Since the rest of the participants did not watch the videos beforehand, they were not able to provide insights about the mnemonic qualities of GIFs. However, unlike 1FA, some participants found GIFs of utility while selecting videos. Two primary participants, 3SG and 5FuA, and a secondary participant, 4CB, selected the videos by reviewing the GIFs. Their feedback on GIFs were:

> I want to observe during the drive. In Şakacı 3's GIF, the driver is outside the vehicle during a break. Therefore, I won't watch Şakacı 3. In Şakacı 1's GIF, the driver looks at the phone during the drive, therefore, I'd like to watch Şakacı 1" (3SG, Pos. 18).

> I was curious about the name Şakacı. Also, in the Şakacı 3 GIF, the driver is seen outside the bus. I'd like to watch this because I'm curious about what's outside the bus. CBp5 (4CB, Pos. 26).

> GIFs and Vimeo, I mean, being able to select videos based on GIFs was quite good, to be honest. (4CB, Pos. 57)

In addition, a deviant participant, 2MeK, with a background in user research, and who knows METU Campus, noted that the representations of the videos on the campus map enhance communication between workshop participants and the researcher, and they contribute to the development of a common language. Specifically, he appreciated that these representations allow participants who were unfamiliar with the campus and bus stops to precisely indicate locations on the map rather than attempting to point them out (2MeK, Pos. 36).

Besides positive feedback, a primary participant, 10KU, decided to select videos that are recorded in similar locations on the campus, disregarding the GIFs; a secondary participant, 8OB, ignored the questions about GIFs; two deviant participants and UX designers, 9MuK and 6EC, decided to randomly select videos after deciding on the personas. 6EC noted:

> I don't really have any thoughts about GIFs, to be honest. The videos are already about 2-3 minutes long, and it doesn't take much time to watch them. I think that's why I didn't feel the need to look at four GIFs and make a decision; I preferred to go directly to the video and watch it. (6EC, Pos. 75)

While some participants utilized GIFs for selecting the videos, and some did not, participants 1FA, 2MeK, and 7IT had difficulty playing the GIFs due to their internet connection speed. Participant 7IT gave up trying and asked the author to select some eventful videos to play. A deviant participant with a user research background, 2MeK, noted his frustration about the download duration:

> [When you told me to watch GIFs to select videos] I was disappointed, wondering if I was expected to watch all the GIFs, because it took a long time to download them. Actually, I think the GIFs were very well thought

> out. They serve as signals for the raw data before reaching it and make selecting easier. (2MeK, Pos. 18)

The other two types of video representations, route drawings on the campus map and video nomenclature, were not utilized and referred to as much as GIFs by the participants. Participants 1FA and 2MeK, both familiar with the METU Campus, considered the route drawings on the campus map as insignificant. 1FA noted:

> I didn't pay much attention to route drawings on the campus map. As someone familiar with the campus, I anticipate that it might be challenging for those unfamiliar with the campus to comprehend where the videos were shot by simply examining the lines on the map. However, I'm unsure how much you can improve the communication of that information. It's not easily conveyed, and I believe there's a limit to how much you can clarify it. (1FA, Pos. 44)

On the other hand, a primary participant, 10KU, a recent graduate who knows the campus traffic well, utilized route drawings for selecting the videos, as mentioned before. This participant did not utilize personas, video nomenclature, or GIFs for selection. Instead, he relied on the route drawings to select videos that were recorded in the same crowded area of the campus.

Finally, a deviant participant, 6EC, who is a UX designer and who was not interested in Personas, GIFs, and route drawings for video selection, noted the following while utilizing nomenclature to select a video:

> The title of Dingin's first video, 'Metro - buffer collision,' [hitting the buffer at the metro station] is very intriguing, and I got curious. I'm opening this. (6EC, Pos. 28)

6.4 Other Evaluations

In addition to utilizing and assessing the workshop artifacts, such as the driver experience map, personas, and videos, participants assessed different aspects of the workshop framework. Artifacts are built on Miro, and the workshop procedure was explained on the Miro boards. Participants found navigating Miro boards,

accessing information, and having an overall understanding of the procedure easy and reported that they did not encounter any major obstacles while participating in the study (1FA, Pos. 76, 79; 2MeK, Pos. 1, 74; 3SG, Pos. 80; 4CB, Pos. 51; 5FuA, Pos. 58; 6EC, Pos. 78; 8OB, Pos. 70, 10KU, Pos. 63).

A primary participant and a design manager at a bus company, 3SG, appraised the study as it aligned with the diversity and complexity of bus projects they undertook for different countries. They acknowledged the cultural, behavioral, and climatic variations, emphasizing how these factors impacted decisions on air conditioning systems, tires, safety equipment, and driver visibility based on the average height of the drivers in specific countries. The participant found value in the study's ability to provide rich data by observing the context through the eyes of the driver, emphasizing the importance of understanding the diverse perspectives and requirements influenced by regional differences (3SG, Pos. 87).

6.4.1 Design and Content Improvements:

Some participants suggested design and content improvements. One suggestion came from 7IT, recommending the addition of a fatalism coefficient to the personas, as explained above. Another suggestion was from 6EC, who requested information on the frequency of events to make informed decisions. He emphasized that to decide whether to work on a problem, he would need to understand how frequently these problems occur, as explained above.

In addition, secondary participant 4CB and deviant participant 6EC also suggested adding more contextual information to the artifacts. Being completely foreign to the campus, 4CB expressed curiosity about details such as the location characteristics (e.g., whether it's an urban or rural area, whether the campus traffic is open to city traffic, population density) and passenger demographics. According to 4CB, these details could contribute to a better analysis of the identified problems. She acknowledged that while this information might introduce additional

complexity, it would be valuable for understanding the context in which the observed behaviors occur (4CB, Pos. 52). As an example, she mentioned that knowing that bus drivers and tractor drivers in the campus recognized each other added depth to the understanding of certain behaviors (see above for details). Additionally, 4CB emphasized the importance of simple yet insightful information that could quickly orient the participant to the context, such as details about the typical passengers, their roles (students, teachers, hospital patients), and the social dynamics among them.

Similarly, 6EC thought the information content was clear; however, he pointed out that his perception might be influenced by his familiarity with the campus and shuttles. He suggested that it could be beneficial to incorporate additional contextual information directly into the artifacts for participants who are not familiar with the campus. For instance, overlaying contextual details, such as the locations of bus stops, on the videos could be a helpful way to provide a clearer understanding of the context (6EC, Pos. 78).

Moreover, deviant participant 2MeK mentioned that his lack of extensive driving experience might have hindered his ability to identify drivers' mistakes, as explained above. He uttered, “I don't have a checklist showing what the driver should do; therefore, I can't say they did or didn't do what they were supposed to (2MeK, Pos. 69).” This points out the need for additional information regarding driver tasks. It should be noted that the additional information that participants referred to was included in the earlier versions of the artifact designs as bus driver problems (see above) and ring facts (see above). However, these information segments were removed after the first pilot workshop to reduce the duration of the workshops.

6.4.2 Impact on the Design Process

Besides some participants explicitly expressing the need for more information, 8OB echoed a similar sentiment. He conveyed that although the videos offered initial insights, he derived a broader perspective and deeper insights through direct dialogue and interaction with the researcher (8OB, Pos. 72). While indicating the need for additional information, his perspective highlights the significance of workshop facilitation. Moreover, while the participant found sharing user research findings with designers in this way to be very successful, he underscored the greater importance he placed on generating ideas with the design team using the workshop information (8OB, Pos. 72). This indicates that the workshop framework is expected to address not only the problem identification, but also the ideation and design development phases of a project.

Similarly, deviant participant 9MuK voiced his concern about the next steps of the design process. This participant had extensively collaborated with user researchers, and he also designed some user tests for his design proposals while working at digital product companies such as social media platforms. While he found the content and delivery impactful, he uttered, “It can be a bit risky just to send these links to designers and leave them to their own devices” (9MuK, Pos. 54). He suggested that the researcher could plan some activities, such as design sprints, after giving some time to designers to note their own observations from the research findings. These activities could prevent designers from generating solutions without deeply considering the research findings and encourage thoughtful problem-solving. 9MuK stressed the significance of the interconnectedness between design and research, likening it to a clamp. He advocated for a continuous, agile process where designers actively contribute to research and iterate on prototypes based on user research findings. The participant mentioned his previous experience, stating, "At Google, we used to conduct design sprints, working on a project for one week. Yes, it takes time, but for product design, you inevitably have to do it this way. The first thing that comes to my mind

is, what happens after this problem identification workshop? How can we ensure designs will continue to be based on this research?" (9MuK, Pos. 53).

6.4.3 Comparisons with Other Sectors

Secondary participant 4CB assessed this workshop framework by drawing on her extensive experience as an industrial designer at a major healthcare company, where she regularly collaborates with user researchers. In comparing the workshop approach to her usual practice, she highlighted the practicality of the presented user research, contrasting it with traditional methods that often involve time-consuming processes such as reading through extensive reports, profiles, and maps. This streamlined approach allowed her to quickly grasp a comprehensive understanding of problems without the need for in-depth investigation. She also mentioned the possibility of direct dialogue and interaction with the researcher as a resource that she can rely on (4CB, Pos. 53). 4CB identified three significant contributions of the workshop framework to the design process, emphasizing its ability to strengthen empathy with users, immerse participants into real problems effectively, and provide an unfiltered perspective for more engaging interpretation of the observations (4CB, Pos. 62).

Moreover, 8OB, drawing from their experience in military vehicle design, highlighted that while they conduct user research similarly, their current practice involves observing, evaluating, and reporting at the moment, not revisiting the raw data afterward (8OB, Pos. 72). He acknowledged that recording information like the workshop framework in this study and engaging in further discussions could enhance the quality of the information obtained from the research (8OB, Pos. 74).

Besides the appraisals and suggestions about the content and the form of delivery, deviant participant 6EC, who is a UX designer for a marketing data technologies company, shared his concern about the resource-intensive nature of being a participant in a workshop as a routine practice. When asked if 6EC would like to

have similar data in his design practice, he described their routine process of integrating user research into the design of their screen-based web product (6EC, Pos. 36). They utilize software that records the mouse pointer movements on their website and highlights interesting points for subsequent review. 6EC drew parallels between this practice and the curated eye-tracking videos employed in this study. However, he noted that eye tracking provides more in-depth insights. To illustrate, he provided an example wherein the mouse pointer remains stationary for about 20 seconds in a video recording. He pointed out that this moment may not necessarily be related to the product, as the user could be engaged in unrelated activities. In contrast, he expressed that eye-tracking recordings offer a clearer understanding of the background context. He referenced Dingin's sighing in the Dingin 5 video, explained above, as an example of the additional layer of information provided by eye-tracking videos. Despite recognizing the potential value as explained above, 6EC noted:

> But on the other hand, I also thought about how it would be if we had such a resource in our hands, and I can't say I wasn't a bit scared. From that perspective, this study didn't seem scalable to me. I thought individually watching recordings for each user would be a very resource-intensive task (6EC, Pos. 36).

6.4.4 Bus Manufacturing Business

While assessing the impact of this workshop framework on his design practice, primary participant 10KU mentioned a barrier in front of improvements. He said that this workshop focuses on the driver; however, since the purchase decision of the buses is not consulted with the bus drivers, 10KU said that the driver-centered improvement opportunities identified with this framework may or may not be applied to the design of buses, depending on the project cost. He noted:

> In our business, drivers don't purchase the buses; they are purchased through a tender method, and being cost-effective is a significant concern. The findings of this study can be considered very valuable, but if there are

> no tender requirements for them or if it proves too expensive, the likelihood of implementation is low, and it may be offered as an option. (10KU, Pos. 62)

Similarly, 7IT emphasized the limited sensitivity to user needs in bus design within the Turkish context. He pointed out that decision-makers in institutions purchasing public transport vehicles, rather than drivers or passengers, make procurement decisions without considering the end-users. He pointed out that the institutions purchase the public transportation vehicles through tenders and bus drivers don't have any effect on the purchase decision which renders their needs invisible. This lack of user-centric focus results in designs that are limited to surface-level considerations, as passengers and drivers rarely question the decision-making mechanisms (7IT, Pos. 7). 7IT drew a comparison between the design processes of military vehicles and public transport buses. He emphasized that the procurement and product development decisions for military vehicles involve more rigorous considerations, underscoring the absence of room for errors in the military vehicle design process (7IT, Pos. 8). 7IT suggested that if passengers and drivers demand accountability from the beginning, decision-makers in purchasing can shift towards a more user-centric approach, leading companies to prioritize design in public transport vehicles.

Secondary participant 8OB identified several visibility-related problems and suggested driving technologies to attack them (8OB, Pos. 41). He considered some design aspects such as ergonomics, dashboard design, and the placement of the A-pillar as fundamental aspects of design, hence don't require any specific customer request for improvements (8OB, Pos. 67). However, for improvements that include sensors and driving technologies, direct customer request is needed. He noted:

> For this to happen, the customer must understand the significance of design and know what they want. Customers may not request them since adding technologies for vehicle safety will increase the vehicle's price. They might think that since these buses will be used as campus shuttles, the existing technologies are sufficient. (8OB, Pos. 66).

In addition, meetings with the bus manufacturer in Phase 1 of this study also showed that designers' workflow usually doesn't include designing the whole human-machine interface of the buses as the components such as steering wheel, route signs, and driver seat are outsourced.

When asked how they identified driver needs for the bus design projects, the secondary participant, 1FA, also mentioned the limited driver experience research practices in the previous company where he worked.

> While working at X company, most interior design aspects in the bus and truck division already came from the company's headquarters abroad. We were mainly making small material changes or adjusting things that needed to be customized for Turkey. And for that reason, we weren't conducting user experience research from scratch. For my own research, I interviewed intercity bus drivers about their usage, what is important to them in the bus, and similar topics. Honestly, my experience is limited to that, and I can't say that comprehensive, detailed user experience research was being conducted beyond that (1FA, Pos. 5).

6.4.5 Problematization of Observations

The limitations of the bus design business affect the impact of workshop findings on future bus designs, as explained in the previous section. Similarly, whether the participants problematized their observations or not also influences the impact of workshop findings on future bus designs. 1FA previously mentioned above that even though the mirror and the screen on the windshield of the bus obstruct the view, drivers are experienced, and it is not a big problem. Therefore, this participant did not problematize the observation as opposed to the others who watched the same situation. The section about Gaze Utilization and Participant Perspectives also presents the significance of the problematization of the observations.

With regard to problematization, some participants also reported that they had difficulty in what they were asked to frame as a problem. This difficulty can be

attributed to the clash between the nature of a research project such as this one and their day-to-day design practice as employees of product manufacturers. One explicit expression came from a secondary participant 7IT:

> What challenged me in the study was the question of whether the design problems referred to the product or the system. I got stuck there, couldn't quite understand it (7IT, Pos. 54).

Primary participant 5FuA, who worked as a design manager at a bus company, also needed to clarify if he correctly understood the question, “What do you think the bus driver needs?”. 5FuA demonstrated his confusion about how he could relate their observations to the design of the bus by noting:

> One of the problems the driver faces is not being given the right of way despite having it. I don't know if the solution would be a warning system, a traffic light, or something else. In that sense, I can't directly relate the problem to bus design. There is indeed a real need there, but unfortunately, I can't come up with a solution to this issue. This situation is entirely related to the incorrect behavior of other drivers (5FuA, Pos. 37).

A similar concern was also voiced by the other experienced primary participant, 3SG, in a different way. After being asked, “What do you think the bus driver needs?” he answered, “The driver needs a vacation” (3SG, Pos. 63) and commented about a driver’s unsuitability for the professional driving job because of his health conditions (3SG, Pos. 65). Following his responses, he asked the author if his discussions are in line with the scope of the study (3SG, Pos. 66). While this might be considered a mere universal need to comply on the participant’s side with the rules of the social contract, which is the protocol of the workshop in this case, it can also be interpreted as an indication of the clash of identified problems with the authority he as an industrial designer is warranted at a product corporation. The differing perspectives of the participants regarding the problematization of the observations predicate the impact of the workshop framework for generating solutions that cater to the driver needs.

Final remark:

Finally, it is noteworthy that before the workshops, design managers and experienced participants, 3SG and 5FuA, raised a critical inquiry about handling intellectual property if the workshops generated novel design opportunities. In response, they were informed that the study's primary focus was on identifying driver problems and communicating them. Therefore, the knowledge acquired from this study could be applied without raising intellectual property concerns. Although designed as an academic inquiry, the workshop assumed a commercial workshop's role to the extent that it delved into real intellectual property concerns. This juncture underscores a delicate nuance encountered in industry-academia collaborations.

CHAPTER 7

DISCUSSION AND CONCLUSIONS

This study focused on designing and utilizing a user research communication workshop framework in response to the challenges encountered in communicating user research findings within a corporate environment. To design the workshop framework for the specific case of campus shuttle bus drivers, meetings were conducted with designers at a bus manufacturer, and user research was undertaken with the bus drivers. The findings were utilized to design a user research communication workshop framework by going through a Research through Design (RtD) process and leveraging the author's prior design experience. The resulting workshop framework was employed with ten professional designer participants, who were grouped into three categories: primary, secondary, and end deviant. Primary participants were designers likely to be directly interested in the user research findings about bus drivers as they work at bus manufacturers. Secondary participants had prior experience in bus design and/or working in fields that the author considers similar, such as military vehicle design and professional healthcare products. Deviant participants had user research experience without apparent interest in knowing about bus drivers as users.

As a result, the learnings from this study inform design practice in two ways. The first is by providing domain knowledge, which is in the form of a generative driver experience model for the designers of the related projects. The second is by providing insights for designing and utilizing user research communication workshops. In this sense, this study generated “theory for design” (Zimmerman et al., 2010) that is described in Chapter 3 above. These two contributions also correspond to the answers to the research questions.

1. What are the safety and comfort problems that shuttle bus drivers experience during their daily routines and driving, and how might these problems be addressed? (see 7.1)
2. How might the user research findings be structured to help practicing designers discover design opportunities for safety and comfort problems? (see 7.2)

To be able to answer the second research question, the first research question needed to be answered. The answer to the first question was provisionally gathered from the literature and the field research during Phase 1: Exploring the Bus Design Practice and Phase 2: Driver Data Collection and Creation of Design Artifacts of the study. In addition, the provisional answer was further extrapolated to in light of participant responses to form domain knowledge about the bus driver experience.

According to Edelson (2002), domain knowledge regarding the context or outcomes of a design project can be derived by generalizing specific aspects of the problem analysis conducted for that project, as explained above in Chapter 3. In line with that definition, user data collected from the shuttle bus drivers and participants' interpretations of bus driver problems were integrated into a contextual domain theory in this study. Even though the user data was collected from a specific user group and the generalizability of the raw driver data is limited, the author argues that interpreting and abstracting the driver and participant data allows for the formulation of broader insights into the bus driver experience. Taking a step further, the author also argues that the model of the driver experience can be utilized for design projects within other sociotechnical systems such as other public transportation systems, medical systems used by healthcare professionals, military systems, mining systems, firefighting systems, etc. The model is generative in the sense that Höök & Löwgren (2012) and Lichtenstein 2000) describe (see 3.2.6). This means that it is aimed at being utilized while creating new designs, and it emerged through the active engagement of the author with the complex bus driver problems and ongoing processes of reflection during the design

process of the workshop framework. This engagement is achieved through reviewing literature about bus driver problems, analyzing the field data for preparing the artifacts, and observing and classifying the participant problem framings about the bus driver experience. The model is discussed in the next section below.

The second contribution of the study to design practice is the insights into the workshop framework's design, utilization, and assessment process. These insights were delivered throughout Chapter 5 and Chapter 6 and will be summarized in this chapter (see 7.2). The study's second contribution also involves providing conceptual constructs (refer to 3.2.5 Conceptual Constructs) such as mnemonic cues, intention reading, and system deadlocks, as explained in section 7.2 below.

In addition, the study produced an ultimate particular (Nelson & Stolterman, 2012) that is described in 3.2.2. The ultimate particular of this study is the combination of the online artifacts, the workshop procedure, and the design process explained in Chapter CHAPTER 5. Online artifacts of this study resemble an online database that can be utilized for future design projects or be subjected to further investigation of user research and critiquing the artifacts. The analysis for this dissertation is focused on how participants utilized and assessed the ultimate particular; however, implicit knowledge (see 3.2.4 for definition) that is embedded in the artifacts presents opportunities for further criticism (see 3.2.8 Critique of Design Artifacts for an example). The ultimate particulars of this dissertation are not made public due to the sensitive nature of the personal information content of some artifacts. The field data underwent anonymization, but certain details, such as people's faces or their voices, needed to be revealed to the participants to maintain persuasive, realistic, and immersive qualities. That being said, several parts of the artifacts underwent additional anonymization and are presented throughout the thesis, while the complete set of artifacts (except the full videos) is provided in Appendices 0 and 0. Moreover, access can be granted for the original artifacts if

there are specific inquiries or concerns related to the robustness and thoroughness of the user research content.

Finally, as a natural outcome of the fact that the first and foremost aim of this study is to contribute original knowledge to the design domain that is necessary to earn a Ph.D. degree, this study also includes clues about the challenges of conducting a design practice-focused study as an academic inquiry (i.e. see intellectual property concerns demonstrated by two of the workshop participants (Chapter 5), as well as the analysis of the meetings with a bus manufacturer (Chapter 4), the section 4.2.1. , and the failed attempt at collaborating with a bus manufacturer (Chapter 7) for other challenges).

7.1 Generative Model of Driver Experience Dimensions

While the analysis in Chapter 6 is focused on the utilization and assessment of the designed workshop framework, since the workshop artifacts were designed with real-life user research and the first research question in mind, it also guided the recategorization of the bus driver problems. Bus driver problems were identified through field research and literature review and iterated through the design process of the workshop framework (see the following sections in Chapter 5 for details: Identification of Problem Groups and Updating Problem Groups). However, this information segment was removed from the framework after the first pilot workshop to reduce the workshop duration, as explained before. The prior problem group categorizations were built on the bus driver tasks identified by Salmon et al. (2011) and guided the analysis of the user research data and curation of the workshop content. This is a task-centric categorization of the bus driver distraction sources and delineates driver challenges based on specific operational tasks such as handling passengers, interaction with road users, and pre-departure controls. In addition, they were rigorously identified by Salmon et al. (2011) and observed during the field research conducted by the author. However, during the subsequent analysis of participant responses, a shift from a task-centered to a socio-technical

system perspective emerged organically. This transition was not premeditated but surfaced due to challenges encountered while analyzing participant transcription data using task-based problems. For example, when asked about drivers' needs, participants occasionally identified broader stakeholders' needs, which in turn may affect the experience of the drivers, leading to a nuanced understanding of the challenges within the larger system and necessitating a socio-technical system perspective while categorizing the problems.

The new categorization was inspired by how the participants made sense of the user data and aligned with the participant problem framing when asked about the driver's needs regarding comfort and safety. This categorization acknowledges the interconnectedness of elements within the system, offering a more comprehensive view of the challenges faced by drivers. Interestingly, this shift in perspective led to the emergence of a distinct category—system integrations—that remained concealed within the confines of task-based categorization. Consequently, the refined approach not only facilitates a more nuanced interpretation of similar events but also captures the multifaceted nature of the challenges, ultimately contributing to a more holistic understanding of the design problem landscape.

According to the new problem categorization, the driver's experience unfolds across six dimensions (Figure 131). The first is the (1) driver needs, which emerges as a natural outcome of identifying the problems by asking the participants, “What does the driver need here?” The subsequent dimensions include (2) vehicle-related problems, (3) infrastructural challenges, (4) actions of traffic actors, (5) traffic culture and context, and (6) system integrations. Arrows in **Error! Reference source not found.** symbolize the system integrations.

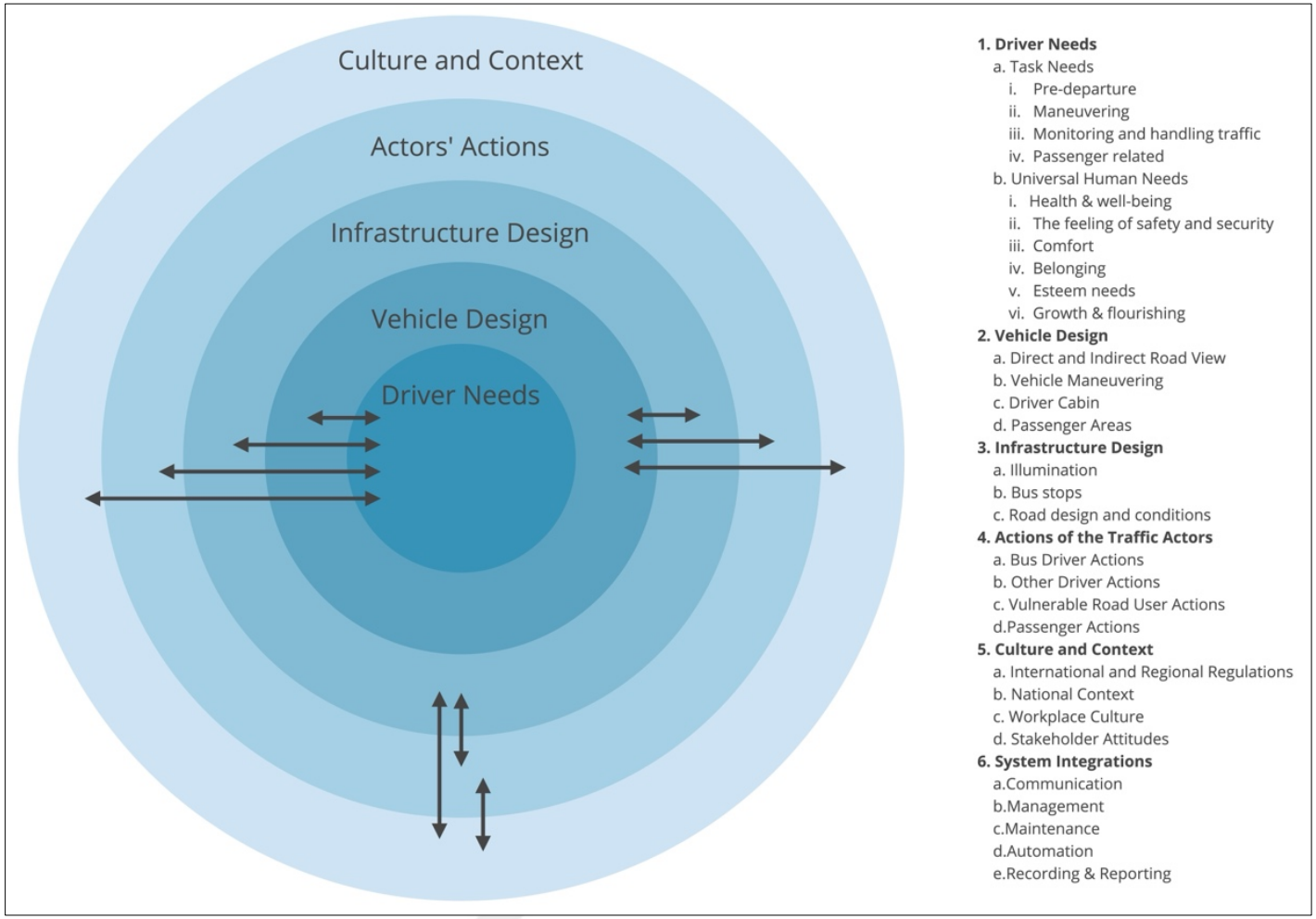


Figure 131 Dimensions of Bus Driver Experience

The needs of the drivers (1) encompass both task and performance-related necessities, such as adhering to schedules and approaching bus stops, alongside universal human needs like health, well-being, and comfort. While reducing "felt experiences" to a general list of needs is criticized (McCarthy & Wright, 2004), consideration of human needs can offer a nuanced understanding of the user experiences (Hassenzahl et al., 2010). The data of this study indicates some needs of the bus drivers, but it can be argued that the other definitions of human needs, such as the needs identified regarding the product experiences (Hassenzahl et al., 2010), can be of utility.

Vehicle problems (2) include obstructions to driver road vision, maneuverability of buses due to their structure and size, the layout and design of the driver cabin and human-machine interface, and the layout and design of areas that facilitate passenger and other road user interactions.

Infrastructural problems (3) include the illumination of the road and specific geometrical elements such as junctions and curbs, the design of bus stops, and road design and conditions. Road design refers to the locations of bus stops, traffic lights, signs, pedestrian crossings, speed bumps, etc. Road conditions refer to the potholes and road surface maintenance.

Actions of the Traffic Actors (4) include the risky actions of bus drivers, passengers, other drivers, and vulnerable road users such as pedestrians and bike and motorbike riders. Risky actions can be in the form of intentional violations, such as aggressive driving. Additionally, they may manifest as unintentional mistakes or errors, such as a driver inadvertently turning into a one-way street due to a momentary lapse in attention.

Culture and context (5) include international and regional regulations, national context, and workplace policies and culture. Transportation is strictly regulated by international and national standards and policies that lead the design of the infrastructure and the vehicles. National context encompasses weather conditions and environmental factors that can impact transportation and road usage,

prevalence of public transportation, and general attitudes towards traffic rules and safety practices within the specific country. Workplace policies refer to the written rules, culture refers to the shared values, beliefs, attitudes, and behaviors that characterize an organization's work environment. In combination, workplace policies and culture encompass the norms and practices that influence how individuals within the organization interact with each other, make decisions, and approach their work.

System integrations (6) include communication, management, maintenance, recording & reporting, and automation within the system. Integrations are any products, systems, and services that facilitate (a) communication between traffic actors and system stakeholders such as communicating actor intentions in the traffic, emergency communication, and route communications for passenger (b) management of drivers, shift, workplace facilities, bus fleet, and conflicts between traffic actors and system stakeholders (c) maintenance of the buses, workplace facilities, and system integrations, (d) recording and reporting of needs and actions of actors and stakeholders related to communication, management, and maintenance, (e) automation of appropriate tasks and processes related to bus driving or management, maintenance, and recording and reporting.

System integrations facilitate seamless operations, sustain system stability, and ensure vital progress. they are essential for maintaining order, efficiency, and stability, preventing the natural decay or breakdown that the system may undergo if not actively managed. They operate by enabling information permeability between different experience dimensions and by facilitating preventative or corrective actions.

According to this model, driver experience can be enhanced by addressing the problems of each dimension or addressing them as system integrations. While this model provides only an initial framework for understanding problem relationships, it aligns with participant perspectives on problem framings and improvement suggestions. Examples of participant-framed problems and suggested

improvements are discussed below, illustrating different types of system integrations.

- Blind spots of the vehicle, which are about the direct and indirect view of the vehicle, can be addressed on the vehicular dimension by improving the design of the vehicle or by *communication* integrations between the infrastructure and vehicular dimensions in the form of advanced driving assistance systems.
- Driver rule violations can be addressed by designing outreach or training programs to improve driver awareness and sensitivity within the driver actions dimension or by *management* integrations between driver and the workplace management in the form of an interconnected performance management product.
- Outdated vehicle automation regulations, which are in the culture and context dimension, can be informed by *recording and reporting* integrations between traffic actor actions, vehicles, and policymakers.
- Navigating conflicts among drivers poses a challenge, but the author is willing to risk being perceived as naive for the sake of illustrating an example. A previously explained conflict surfaced in the Bıçkın 7 video (Figure 130), depicting a dispute between two drivers, each blaming the other for neglecting bus maintenance. Such a conflict could be addressed by implementing occupational therapy programs in the driver action dimension or by developing *maintenance* integrations between vehicles, drivers, and other relevant stakeholders.
- Adjusting difficulties of the bus's temperature, seat, and mirror position can be addressed by improving the usability of individual features or by integrating adjustment *automation* for the specific preferences of the drivers.

Although some solution suggestions may appear beyond typical design opportunities, the author proposes expanding the scope of design and user research

is essential, especially for addressing wicked sociotechnical system problems. This conceptual expansion entails integrating hardware, software, and service aspects and utilizing design as a strategic planning tool for designing complex systems (refer to 2.4 Discussions About User Research and Design).

This approach may challenge conventional notions of the development of the shuttle system. For instance, as explained in the Bus Manufacturing Business section, participants demonstrated that the purchase mechanisms of the buses render bus driver needs effectively invisible. The shuttle service is not considered a socio-technical system that needs to be designed holistically, but rather a combination of separate system elements such as the buses, infrastructure, online tracking system, and stakeholders such as drivers, passengers, road users, bus manufacturers, transportation departments, funding departments, policymakers, and so on. This situation leads to disconnection points in the system development that leak essential information, resulting in overlooking some issues or neglecting the crucial nature of some needs, thereby accentuating the challenges outlined in the Problematization of Observations section since stakeholders cannot foresee the effects of the problem relationships. This model suggests the importance of problem relationships, opening discussions about power dynamics in decision-making processes. The model also indicates that with the right stakeholders interested in systemic improvements and possessing the necessary resources, the improvement suggestions from the participants could become viable design considerations.

7.2 Concluding Remarks About the Workshop Framework

While workshops with the participants indicate that the framework developed in this study demonstrates positive outcomes in terms of being engaging and immersive and informing participants about both the contextual and particular problems that the bus drivers experience, it is important to remember the author's assumptions while assessing the utility of the workshop framework for specific

projects. The author assumes that, due to the division of labor, the people who conduct the user research and the people who design the products are not the same, sometimes not even working for the same corporation. Consequently, communication of user research findings is a necessity even though it can be argued that the condition in which the designer contacts the user and gets immersed in the user context is necessary for forming a comprehensive understanding. The author also assumed that using eye-tracking videos as a user observation technique would yield valuable knowledge for designers for the projects developed for professional users, such as professional drivers and those who operate devices within a sociotechnical system, such as buses. At the outset of this study, the author initially intended to develop the workshop framework for a corporate setting, such as a bus manufacturing company. Yet, as the interactive nature of system problems affecting the driver experience unfolded, it became apparent that this framework may be better suited for projects allowing multilevel design interventions beyond the exclusive focus on bus design.

7.2.1 Appraised qualities of the workshop framework

1. **Enhanced Immersiveness:** The following features of the framework were able to immerse participants in the user context:
    - Utilizing a first-person perspective and gaze indicators in videos contributes to a more immersive experience for participants. This allows participants to perceive the driving context from the driver's viewpoint, enhancing the authenticity of their understanding.
    - Including naturalistic videos depicting a regular day for users and traffic actors adds a layer of realism to the workshop framework.
    - Real-life photos and comprehensive driver information in personas further immerse participants in the world of bus drivers.
    - Contextual information, presented through the driver experience map, contextual images, and the use of first-person language in the map, also

enriches the immersive quality of the framework, providing participants with a holistic understanding of the user experience.

2. **Engaging and Empathy-Facilitating Features:** The framework engaged participants and fostered empathy through several aspects:

The unique information offered by eye-tracking recordings and the novelty effect served as a motivating factor for participants, even for the secondary and deviant participants who were not directly interested in the project topic or user group. The implication is that the engaging quality could potentially be heightened for participants employed in the project in real life or if the framework was applied to communicate user research in the domains of secondary and deviant participants.

The narrative style of the data presentation promoted participant engagement and empathy. The incorporation of driver frames was instrumental in presenting videos in a narrative format, marking a departure from traditional presentations. Rather than presenting individual video clips in isolation, the driver frame integrates them into a journey depicted on the campus map. This journey is conducted by a real driver symbolized by a persona with specific characteristics, unfolding at a designated day and time. Besides watching the context from the drivers' eyes, participants could hear the contextual sounds, such as emotional expressions, voices of the passengers' when asking questions, and sounds of the bus parts hitting against each other. This provided a more personal connection to the experience of the drivers.

The naturalistic videos enriched the participant experience by providing rich information. Elements such as ambient sounds, variations in lighting, and prolonged driver gaze on specific aspects of the scene offered nuanced details, encouraging participant interpretations. The inherent room for participant interpretation is a significant advantage of the videos, promoting a deeper engagement with the material.

Presenting driver videos connected to specific personas encouraged comparing driver behaviors, skills, and needs. Some participants perceived discrepancies

between the characteristics listed on the persona artifacts and the actual behavior of the driver in the video. If viewed as an undesirable situation, adjustments to the workshop could address this issue. For example, participants could be prompted to design new personas considering the existing ones and the videos. Alternatively, the author's fictional attribution of specific driving skills to personas, based on observations of drivers without actual measurements, could be enhanced for accuracy through the use of established psychological assessment scales. However, disagreements about personas do not necessarily have to be perceived as undesirable. Personas are the reductionist and static representations of real people with a high degree of fictional consistency, a quality not mirrored in real individuals. An example can be a driver who has experienced a cognitive decline due to age and may compensate for this shortcoming in real life by driving more slowly or paying more attention to traffic, and in return, s/he may be a better driver than some others without cognitive decline. In this case, watching the driving videos of this person would not reveal her/his cognitive decline which will create a dissonance akin to what some participants mentioned. Yet, the possibility of dissonance in this example does not negate the utility of personas. Conversely, the capacity of personas to foster such discussions can be regarded as a beneficial attribute, aiding product developers in achieving a more profound comprehension of users as individuals.

3. Enabling System-Level Insights:

Even though the problem framing was focused on the driver's needs, the framework goes beyond the individual user perspective, allowing participants to glean system-level insights and question the effects of power dynamics on user experience. By presenting both a context overview through the driver experience map and granular data through driving videos and asking about the driver's needs to identify design opportunities, the framework enables a multidimensional understanding of the needs of different traffic actors. This dual presentation and driver-focused problem-framing approach encourage participants to question the extent of user needs and who is responsible for addressing it, enabling them to

consider the broader context and systemic factors influencing the driver experience. Enabling this is considered a positive attribute of the framework as some system deadlocks can emerge when the design focus moves away from a product perspective, which, in this case, is bus design. System deadlock refers to the problematic situations that affect the experience of the user but may require system integrations (see System integrations above) rather than design improvements in the individual products. The examples in the Problematization of Observations and Bus Manufacturing Business sections demonstrate some system deadlocks.

4. Information Navigation:

This study expected participants to navigate through a large amount of user information to identify driver needs. Handling this information for designing the user communication artifacts in this study could benefit from knowledge management and usability domains, fields with substantial bodies of literature. However, the author designed these artifacts following the guidelines explained in Chapter 5. While the author is aware of the literature on usability and navigation issues related to information-heavy, knowledge-management digital products similar to the artifacts in this study, she did not review the literature for designing the artifacts as it was considered beyond the scope of this study. Moreover, the workshops in this study were not focused on the usability evaluation of the framework. Therefore, definitive conclusions about the navigation quality cannot be drawn. However, dividing the user information into narratively coherent, manageable chunks such as driver frames, personas, and short video clips with distinct names aided participants in utilizing the user information. The author defined two conceptual constructs: mnemonic cues (see Video Representations and Campus Maps and Utilization and Assessment of Video Representations and Campus Map sections) and spatial cues as aids for creating these chunks. These constructs align with this study's narrative data presentation style and serve as measures to counterbalance the overwhelming amount of user data that participants

were expected to navigate on a board platform like Miro for sociotechnical system projects.

7.2.2 Improvement Areas

1. Additional Information for Participant Agency:

Additional information can reduce the need for the workshop facilitator's input, therefore enhancing participant agency.

- Contextual information, such as the information about whether the campus traffic is open to city traffic, can be useful for participants unfamiliar with the campus and shuttles. This is similar to the Miro frame about the campus shuttle facts mentioned in the section Organizing the Miro Board with Complementary Information. This segment was excluded following the pilot workshop to streamline its duration, yet its potential utility for real-life projects became evident.
- Information about driving tasks can prove beneficial for participants lacking proficiency in driving. This type of information holds particular significance for professional users engaged in specialized tasks, such as surgeons, mineworkers, firefighters, etc. Moreover, professional bus driving can also be deemed beyond the expertise of designers, given the distinct vehicle structure and dynamics and unique responsibilities of professional drivers compared to non-professional drivers. This type of information can be delivered through a checklist or as video annotations.
- Additional information indicating the frequency of events or the severity of the problems can enhance decision-making about problem prioritization and selection.

2. **Enhancements about Video Content:**

Video content in this study only includes drivers' viewpoint and the events that spontaneously occurred during the recorded shifts. Broadening the scope of recordings by capturing different video angles and including some tasks, such as adjusting mirrors or locking bus doors, that were not present in the current recordings can contribute to a more comprehensive understanding of user needs. While adding more cameras may increase the richness of the data, it would require extensive video editing. Furthermore, while asking drivers to perform the tasks that they didn't spontaneously do may mitigate the unpredictability associated with being limited to whether an event occurred during the recordings, it may compromise the authenticity of the data and introduce potential biases in the findings regarding driver needs.

3. **Enhancements of Video Design:**

Design of the videos can be enhanced in the following ways.

- It is advisable to be cautious and selective when choosing sped-up segments in the videos as some participants found these sections to be dizzying, particularly when they were repeatedly alternated with slowed-down portions.
- Additional annotations on the videos can provide guidance to participants regarding problematic situations specific to bus driving. However extra caution is necessary to avoid obstructing information in the video when overlaying annotations. The Trial Video Clips section in Chapter 5 featured some examples of these annotations; however, they were later decided to be removed. This decision stemmed from the time-consuming nature of preparing videos with detailed annotations. Additionally, concerns were raised about diminishing the immersive quality of the videos. One potential solution to maintain immersiveness is an interface that allows users to turn off annotations when watching the videos in an immersive mode. However, implementing such a feature would require extensive software development

for a specialized interface. Furthermore, annotating the videos with several problematic situations would likely result in a substantial amount of video editing.

4. **Targeted Design Activities for Different Design Phases**

Framework already provides a degree of flexibility in the sense that it can be utilized during different phases of the projects that can fit iterative design processes described in design thinking or design sprints. Additionally, it can be kept as a database that can possibly be utilized for different projects for similar user groups. However, additional targeted design activities can be developed to ensure that the findings will be expressed through the final products. An example can be creating worst-case scenarios at the end of the workshops, as tried during the Pilot 3 workshop and documenting actionable outcomes as a guide for the ideation and design development phases. Another example can be the design activities that include several stakeholders for more comprehensive system improvements. Considering the campus case, an initial problem identification workshop can be conducted, in which the stakeholders such as campus management, directorate of transport, bus manufacturer, other technology and infrastructure providers, as well as the representatives for bus drivers, passengers, and other drivers, gather to identify the possibilities, negotiate the extent of the projects, and distribute responsibilities, that is akin to define phase of the design thinking process. This workshop can produce different project groups and documents for guiding the distributed projects. Each project group can refer to the artifacts of this study when necessary or add additional user research about passengers, other drivers, and so on.

7.2.3 Limitations of the Workshops

- Situatedness: The content of the workshop is highly situated to the case it focuses. This means that the language of and the cultural cues in the videos are limited to Turkish speaking stakeholders. English translations of the

conversations in the videos were tried out for Trial Video Clips . However, it was time consuming and translating some expressions was challenging.

- It is labor intensive to analyze and edit the videos, adjust the video privacy, rename and upload the videos separately, and link the uploaded videos on Miro. However, AI supported video editing tools can help in the future selecting and annotating the videos. In addition, doing this work with a team, which would more likely happen in the case of a funded project, would mitigate the burden on a single researcher.
- Integrating a user research workshop framework into the design process can be labor-intensive for participants. Nevertheless, some designers, particularly those at companies with established user research departments, already dedicate significant time to incorporating user knowledge into the design process. For example, designers at leading companies engage in activities such as design sprints, lasting a week, or kickoff workshops which involve integrating user research findings with all project stakeholders and may extend over one or two weeks. Therefore, it is possible to overcome this limitation if the integration of user research into design is acknowledged as a part of the routine designer workflow by employers and customers.

7.3 Limitations & Challenges

7.3.1 Generalization

While this study has yielded insights into the experiences and challenges encountered by bus drivers through the implementation of research through design, it is essential to acknowledge the inherent limitations in terms of generalizability. In design research, concentrating on studying one culture or context at a time is often more fruitful, fostering creativity and facilitating an in-depth comprehension of specific cases. Notably, unique methodological approaches such as cultural

probes, experience prototypes, bodystorming, Magic Things, and role-plays have originated from individual projects, significantly contributing to the design field (Koskinen et al., 2011). These methodologies exemplify the potential of investigating distinct cases and embracing diverse research methods to engender fresh perspectives and identify novel opportunities.

Nonetheless, it is imperative to exercise caution when generalizing the findings of this study to other bus drivers or transportation systems, as well as to the broader domain of communicating user research results. The idiosyncratic characteristics of distinct cultures, contexts, and organizational settings may significantly influence the applicability and transferability of the obtained results. Therefore, future research endeavors should consider conducting analogous investigations in diverse contexts to enrich our understanding of the broad spectrum of bus driver experiences and challenges and validate and refine the effectiveness of the developed tool for communicating user research findings.

In conclusion, this study has illuminated the experiences of bus drivers within the selected organizations through the utilization of research through design. Moreover, it contributed to the design field by developing an interactive tool for effectively communicating user research findings with designers. However, the limitations pertaining to generalizability emphasize the value of context-specific inquiries and necessitate further exploration of varied settings and cultures to enhance the wider applicability of the findings and the robustness of the communication tool.

7.3.2 Researcher as a detached observer

In this study, the researcher actively engaged as a designer and facilitator in the action research and research through design process. According to Koskinen et al. (2011), this approach blurs the boundaries between researchers and designers, as design research emphasizes collaboration and exploration.

As a result, one limitation of this study is the departure from the traditional researcher role of a detached and impartial observer. Instead, the researcher actively participated and facilitated the action research and research through the design process. This involvement introduces the risk of researcher bias, potentially influencing data collection, analysis, and interpretation.

The evaluation of the interactive tool for communicating user research findings involved a small sample size of 10 design professionals, which only partially represents all potential stakeholders. Moreover, the tool was designed by the researcher, who also served as the workshop facilitator, possibly introducing bias in the evaluation process.

Despite these limitations, measures were taken to address potential bias. The researcher maintained detailed records, engaged in reflexivity, and sought external perspectives. In addition, the researcher triangulated bus driver experience data by integrating insights from various sources, including literature, user research with drivers, the bus manufacturer, and designers who utilized the user research findings. These efforts aimed to mitigate bias and ensure a more comprehensive and balanced interpretation of the findings and the developed tool.

In conclusion, the active role of the researcher and the involvement in the design process present limitations regarding researcher bias. The small sample size and the researcher's dual role in the tool evaluation further underscore the need for cautious interpretation. Nonetheless, transparency, reflexivity, and external validation were employed to mitigate potential biases.

7.3.3 Failed Attempts

In the course of the study, the following challenges and unexpected complexities arose, prompting adjustments to the process.

- **Company Collaboration:** The author tried collaborating with a bus manufacturer company and visited their premises to discuss further steps

(4.2.1). However, after the meetings, it was decided that the company's expectations from an academic research collaboration did not align with the author's explorative vision for this study. While failure to collaborate removed the possibility of funding, it enabled the author to carry out the project from a wider system perspective instead of a product perspective. In addition, they provided insights about their design process, and some of their designers participated in the workshops, sharing valuable input.

- **Semi-structured interviews with bus drivers:** A semi-structured interview guide was prepared to use with the drivers (Appendix B). This guide was designed to explore issues related to driver tasks and challenges. For instance, one question was, 'Do you encounter any problems with the route signs on the buses?' The two drivers that were interviewed unanimously claimed that they had no problems with the route signs and that the more significant issue was passengers continuously asking questions. Moreover, when the author attempted to ask similar questions using different phrasing to explore their authentic answers, the drivers became impatient and displayed signs of frustration. However, observations and video recordings during their driving revealed that they did indeed experience several problems with the route signs. Additionally, the problem they identified as significant, namely repetitive passenger questions, actually stemmed from issues with the route signs. Consequently, driver interviews were discontinued due to their futility and to maintain the rapport established with the drivers.
- **Eye Tracking Analysis:** From the outset, eye tracking was employed for observational purposes in this study. On the other hand, the availability of such data motivated experimentations for creating images like heat maps and gaze plots to visualize the frequency of gazes during challenging maneuvers (Appendix C). However, an unexpected challenge arose when utilizing the Tobii Pro Lab software to generate these visualizations. The software struggled to accurately map the gaze indicator from the video to

the imported image of the bus, resulting in discrepancies in the analysis process. This discrepancy repeated when the driver looked at the mirrors, leading to inaccuracies in representing the driver's gaze within the mapped images. Despite the efforts to rectify this issue, the mapping results proved to be unreliable (Appendix C). A potential solution to this problem could involve taking precautions during recording, such as affixing marker stickers around the mirrors to assist the software in distinguishing the placement of the mirrors and the driver's gaze.

7.4 Further Studies

The sections about the improvement areas for the proposed workshop framework (7.2.2) and failed attempts (7.3.3) presents opportunities for further studies. In addition to planning further studies regarding this specific workshop framework, this study raised awareness about the possibility of focusing solely on developing and utilizing driver experience maps or driver personas. In this study, the driver experience map and the personas were designed to communicate the user information that was not possible to communicate through videos. Therefore, the main focus was to communicate the data that was already collected and not to evaluate these artifacts' nature and precise effects on different design phases. The focus of further studies can be on developing artifact alternatives with more refined visual design and planning more controlled experiments about the usability of the artifacts or their effects on problem identification, ideation, and design development phases of the design process.

REFERENCES

Abbott, H. P. (2008). *The Cambridge Introduction to Narrative* (2nd ed.). Cambridge University Press.

Alexander, C. (1977). *A pattern language: towns, buildings, construction*. Oxford university press.

Archer, B. (1965). Systematic Method for Designers. In *Technology*. Council of Industrial Design.

Aylward, K., Dahlman, J., Nordby, K., & Lundh, M. (2021). Using operational scenarios in a virtual reality enhanced design process. *Education Sciences*, *11*(8). https://doi.org/10.3390/educsci11080448

Ball, J. (2019). *The Double Diamond: A universally accepted depiction of the design process - Design Council*. Design Council. https://www.designcouncil.org.uk/our-work/news-opinion/double-diamond-universally-accepted-depiction-design-process/

Bardzell, J., Bardzell, S., & Hansen, L. K. (2015). Immodest proposals: Research through design and knowledge. *Conference on Human Factors in Computing Systems - Proceedings*, *2015-April*, 2093–2102. https://doi.org/10.1145/2702123.2702400

Bergomi, M., Modenese, A., Ferretti, E., Ferrari, A., Licitra, G., Vivoli, R., Gobba, F., & Aggazzotti, G. (2017). Work-related stress and role of personality in a sample of Italian bus drivers. *Work*, *57*(3), 433–440. https://doi.org/10.3233/WOR-172581

Bergstrom, J. R., & Schall, A. J. (2014). *Eye Tracking in User Experience Design*. Morgan Kaufmann.

Boon, B., Baha, E., Singh, A., Wegener, F. E., Rozendaal, M. C., & Stappers, P. J. (2020, September 10). *Grappling with Diversity in Research Through Design*. https://doi.org/10.21606/drs.2020.362

Brandt, E., & Binder, T. (2007, October). Experimental design research: genealogy, intervention, argument. *International Association of Societies of Design Research*.

Broadbent, G. (1984). Design and Theory Building. In *Developments in Design Methodology* (pp. 277–290). John Wiley & Son.

Broadbent, G. (2002). *Generations in design methodology*. *12*, 5–7. https://dl.designresearchsociety.org/drs-conference-papers/drs2002/researchpapers/11

Carroll, J. M. (2010). Conceptualizing a possible discipline of human-computer interaction. *Interacting with Computers*, *22*(1), 3–12. https://doi.org/10.1016/j.intcom.2009.11.008

Chung, E. S., Hong, J. I., Lin, J., Prabaker, M. K., Landay, J. A., & Liu, A. L. (2004). *Development and Evaluation of Emerging Design Patterns for Ubiquitous Computing*. http://guir.berkeley.edu/projects/patterns

Cross, N. (1984). *Developments in Design Methodology* (N. Cross, Ed.). John Wiley & Sons Ltd.

Cross, N. (2007). From a Design Science to a Design Discipline: Understanding Designerly Ways of Knowing and Thinking. In *Design Research Now: Essays and Selected Projects* (pp. 41–54). Birkhäuser Verlag AG.

Dalsgaard, P., & Dindler, C. (2014). Between theory and practice: Bridging concepts in HCI research. *Conference on Human Factors in Computing Systems - Proceedings*, 1635–1644. https://doi.org/10.1145/2556288.2557342

Davis, F. D. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*, *13*(3), 319–340.

Davis, M. C., Challenger, R., Jayewardene, D. N. W., & Clegg, C. W. (2014). Advancing socio-technical systems thinking: A call for bravery. *Applied Ergonomics*, *45*(2), 171–180. https://doi.org/10.1016/j.apergo.2013.02.009

Dourish, P. (2006). *Implications for Design*. 541–550.

Edelson, D. C. (2002). Design Research: What We Learn When We Engage in Design. *Journal of the Learning Sciences*, *11*(1), 105–121. https://doi.org/10.1207/S15327809JLS1101_4

Ehn, P. (1993). Scandinavian Design: On Participation and Skill. In D. Schuler & A. Namioka (Eds.), *Participatory Design: Principles and Practices* (1st ed., pp. 41–77). CRC Press.

Fallman, D. (2003). Design-oriented human-computer interaction. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 225–232. https://doi.org/10.1145/642611.642652

Fallman, D. (2008). The Interaction Design Research Triangle of Design Practice, Design Studies, and Design. *Design Issues*, *24*(3), 4–18. https://about.jstor.org/terms

Farrell, S. (2017). *UX Research Cheat Sheet*. Nielsen Norman Group. https://www.nngroup.com/articles/ux-research-cheat-sheet/

Forlizzi, J., DiSalvo, C., Bardzell, J., Koskinen, I., & Wensveen, S. (2011). Quality Control: A Panel on the Critique and Criticism of Design Research. *CHI*, 823–826.

Forlizzi, J., Zimmerman, J., & Stolterman, E. (2009). From Design Research to Theory: Evidence of a Maturing Field. *International Association of Societies of Design Research Conference*. https://www.researchgate.net/publication/230683193

Frayling, C. (1993). Research in Art and Design. In *Royal College of Art Research Papers* (Vol. 1, pp. 1–5). https://doi.org/2016.01.18

Fulton Suri, J. (2003). Empathic Design: Informed and Inspired by Other People's Experience. In *Empathic Design*.

Gama, K., Valença, G., Alessio, P., Formiga, R., Neves, A., & Lacerda, N. (2022). The Developers' Design Thinking Toolbox in Hackathons: A Study on the Recurring Design Methods in Software Development Marathons. *International Journal of Human-Computer Interaction*. https://doi.org/10.1080/10447318.2022.2075601

Gaver, W. (2012). What Should We Expect From Research Through Design? *CHI '12: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 937–946. https://doi.org/10.1145/2207676.2208538

Giacomin, J. (2014). What is human centred design? *Design Journal*, *17*(4), 606–623. https://doi.org/10.2752/175630614X14056185480186

Gibbons, S. (2017). *UX Mapping Methods Compared: A Cheat Sheet*. Nielsen Norman Group. https://www.nngroup.com/articles/ux-mapping-cheat-sheet/

Godin, D., & Zahedi, M. (2014). Aspects of Research through Design: A Literature Review. *Design's Big Debates - DRS International Conference*. https://dl.designresearchsociety.org/drs-conference-papers/drs2014/researchpapers/85

Grudin, J. (1988). Why CSCW applications fail: problems in the design and evaluationof organizational interfaces. *Proceedings of the 1988 ACM Conference on Computer-Supported Cooperative Work - CSCW '88*, 85–93. https://doi.org/10.1145/62266.62273

Grudin, J. (1994). Computer-Supported Cooperative Work: History and Focus. *Computer*, *27*(5), 19–26. https://doi.org/10.1109/2.291294

Hanington, B. M. (2003). Methods in the making: a perspective on the State of human research in design. *Design Issues*, *19*(4), 9–18. https://doi.org/10.1162/074793603322545019

Hanington, B. M. (2007). *Generative research in design education*. 1–15. http://www.sd.polyu.edu.hk/iasdr/proceeding/papers/Generative Research in Design Education.pdf%5Cnhttp://web.mac.com/bhanington/iWeb/BruceHanington/News/01FB8345-179F-4912-9A47-B52F8DBF998B_files/Generative Research in Design Education.pdf

Hasdoğan, G. (1996). The role of user models in product design for assessment of user needs. *Design Studies*, *17*(1), 19–33. https://doi.org/10.1016/0142-694X(95)00007-E

Hassenzahl, M., Diefenbach, S., & Göritz, A. (2010). Needs, affect, and interactive products - Facets of user experience. *Interacting with Computers*, *22*(5), 353–362. https://doi.org/10.1016/j.intcom.2010.04.002

Heikoop, D. D., De Winter, J. C. F., van Arem, B., & Stanton, N. A. (2016). Psychological constructs in driving automation: a consensus model and critical comment on construct proliferation. *Theoretical Issues in Ergonomics Science*, *17*(3), 284–303. https://doi.org/10.1080/1463922X.2015.1101507

Heskett, J. (2005). *Design: A Very Short Introduction*. Oxford University Press.

Holtzblatt, K., & Holtzblatt, S. (2014). Effectively communicating user research in order to drive design and product decisions. *Conference on Human Factors in Computing Systems - Proceedings*, 1155–1158. https://doi.org/10.1145/2559206.2559207

Höök, K., & Löwgren, J. (2012). Strong concepts: Intermediate-Level Knowledge in InteractionDesign Research. *ACM Transactions on Computer-Human Interaction*, *19*(3), 1–18. https://doi.org/10.1145/2362364.2362371

Hughes, J., King, V., Rodden, T., & Andersen, H. (1995). The role of ethnography in interactive systems design. *Interactions*, *2*(2), 56–65. https://doi.org/10.1145/205350.205358

Interaction Design Foundation. (2020). *Creating Personas from User Research Results*. https://www.interaction-design.org/literature/article/creating-personas-from-user-research-results

Jefsioutine, M., & Knight, J. (2006). Design Methods for Experience Design. In P. Zaphiris & S. Kurniawan (Eds.), *Human Computer Interaction Research in Web Design and Evaluation* (pp. 130–147). IGI Global. https://doi.org/10.4018/978-1-59904-246-6.ch006

Johansson, G., Evans, G. W., Rydstedt, L. W., & Carrere, S. (1998). Job hassles and cardiovascular reaction patterns among urban bus drivers. *International Journal of Behavioral Medicine*, *5*(4), 267–280. https://doi.org/10.1207/s15327558ijbm0504_2

Jones, W., Haslam, R., & Haslam, C. (2014). Measuring job quality: A study with bus drivers. *Applied Ergonomics*, *45*(6), 1641–1648. https://doi.org/10.1016/j.apergo.2014.05.015

Jorritsma, W., Haga, P. J., Cnossen, F., Dierckx, R. A., Oudkerk, M., & van Ooijen, P. M. A. (2015). Predicting Human Performance Differences on Multiple Interface Alternatives: KLM, GOMS and CogTool are Unreliable. *Procedia Manufacturing*, *3*, 3725–3731. https://doi.org/10.1016/j.promfg.2015.07.806

Karat, J. (1996). User centered design: quality or quackery? *Interactions*, *3*(4), 18–20.

Kensing, F., & Blomberg, J. (1998). Participatory Design : Issues and Concerns. *Computer Supported Cooperative Work*, *7*(1993), 167–185. https://doi.org/10.1023/A:1008689307411

Kompier, M. A. J. (1996). *Bus drivers: Occupational stress and stress prevention*.

Koskinen, I. (2003). Empathic Design in Methodic Terms . In *Empathic Design*.

Koskinen, I. (2015). Four Cultures of Analysis in Design Research. In P. A. Y. J. Rodgers (Ed.), *The Routledge Companion to Design Research*. Routledge.

Koskinen, I., Zimmerman, J., Binder, T., Redström, J., & Wensveen, S. (2011). Design Research Through Practice: From the Lab, Field and Showroom. In *Design Studies*. Morgan Kaufmann. https://doi.org/10.4324/9780203855836

Kouprie, M., & Sleeswijk Visser, F. (2009). A framework for empathy in design: Stepping into and out of the user's life. *Journal of Engineering Design*, *20*(5), 437–448. https://doi.org/10.1080/09544820902875033

Kuiper, K., Chauhan, Y., Augustyn, A., Rodriguez, E., Lotha, G., & Gaur, A. (2023). A Modest Proposal. In *Encyclopaedia Britannica*. https://www.britannica.com/topic/A-Modest-Proposal

Kujala, S. (2003). User involvement: A review of the benefits and challenges. *Behaviour and Information Technology*, *22*(1), 1–16. https://doi.org/10.1080/01449290301782

Lewis, C. A., & Johnson, P. W. (2012). Whole-body vibration exposure in metropolitan bus drivers. *Occupational Medicine*, *62*(7), 519–524. https://doi.org/10.1093/occmed/kqs096

Lichtenstein, B. M. B. (2000). Generative knowledge and self-organized learning: reflecting on Don Schön's research. *Journal of Management Inquiry*, *9*(1), 47–54.

Margolin, V. (1997). Getting to know the user*. *Design Studies*, *18*(3), 227–236.

Martin, B., & Hanington, B. M. (2012). *Universal Methods of Design*. 2–480. https://doi.org/1592537561

Mattelmäki, T., & Battarbee, K. (2002). Empathy Probes. *PDC '02 Proceedings of the Participatory Design Conference*.

Mccarthy, J., & Wright, P. (2004). Technology as Experience. *Interactions*, 42–43.

Melican, J. P. (2000). *Describing User-Centered Designing: How Design Teams Apply User Research Data In Creative Problem Solving*.

Naur, P., & Randell, B. (1969). *Software Engineering: Report on a Conference Sponsored by the NATO Science Committee*.

Nelson, H. G., & Stolterman, E. (2012). *The Design Way: Intentional Change in an Unpredictable World* (2nd ed.). The MIT Press.

NHTSA. (2020). *Driver Assistance Technologies*. National Highway Traffic Safety Administration. https://www.nhtsa.gov/equipment/driver-assistance-technologies

Nielsen, J. (2012). Usability 101: Introduction to Usability. *Nielsen Norman Group*. https://doi.org/10.1145/1268577.1268585

Norman, D. A. (2013). *The Design of Everyday Things* (Revised Ed). Basic Books.

Otto, T., & Smith, R. C. (2013). Design Anthropology: A Distinct Style of Knowing. In W. Gunn, T. Otto, & R. C. Smith (Eds.), *Design Anthropology: Theory and Practice* (pp. 1–29).

Redström, J. (2005). Towards user design? on the shift from object to user as the subject of design. *Design Studies*, *27*(2), 123–139. https://doi.org/10.1016/j.destud.2005.06.001

Regan, M. A., & Hallett, C. (2011). Driver distraction: Definition, mechanisms, effects, and mitigation. In *Handbook of Traffic Psychology*. Elsevier. https://doi.org/10.1016/B978-0-12-381984-0.10020-7

Rittel, H. W. J., & Webber, M. M. (1984). Planning Problems are Wicked Problems. In *Developments in Design Methodology* (pp. 135–144).

Ritter, F. E., Baxter, G. D., & Churchill, E. F. (2014). User-Centered Systems Design: A Brief History. In *Foundations for Designing User-Centered Systems* (pp. 33–54). https://doi.org/10.1007/978-1-4471-5134-0

Rohrer, C. (2022). *When to Use Which User-Experience Research Methods*. Nielsen Norman Group. https://www.nngroup.com/articles/which-ux-research-methods/

SAE. (2016). *Surface Vehicle Recommended Practice* (Vol. J3016). https://doi.org/10.4271/2012-01-0107.

Salmon, P. M., Young, K. L., & Regan, M. A. (2011). Distraction "on the buses": A novel framework of ergonomics methods for identifying sources and effects of bus driver distraction. *Applied Ergonomics*, *42*(4), 602–610. https://doi.org/10.1016/j.apergo.2010.07.007

Sanders, E. B.-N. (1992). Converging Perspectives: Product Development Research for the 1990s. *Design Management Journal (Former Series)*, *3*(4), 49–54. https://doi.org/10.1111/j.1948-7169.1992.tb00604.x

Sanders, E. B.-N. (2001). Virtuosos of the Experience Domain. *Proceedings of the 2001 IDSA Education Conference*.

Sanders, E. B.-N., & Stappers, P. J. (2008). Co-creation and the new landscapes of design. *CoDesign*, *4*(1), 5–18. https://doi.org/10.1080/15710880701875068

Schmarzo, B. (2017). *Can Design Thinking Unleash Organizational Innovation?* https://www.datasciencecentral.com/can-design-thinking-unleash-organizational-innovation/

Shackel, B. (1997). Human-Computer Interaction - Whence and whither? *Journal of the American Society for Information Science*, *48*(11), 970–986. https://doi.org/10.1002/(SICI)1097-4571(199711)48:11<970::AID-ASI2>3.0.CO;2-Z

Shinar, D. (2007). *Traffic Safety and Human Behavior* (1st ed.). Elsevier Ltd.

Simon, H. A. (1984). The Structure of Ill-Structured Problems. In N. Cross (Ed.), *Developments in Design Methodology* (pp. 145–166). John Wiley & Sons.

Sleeswijk Visser, F. (2009). *Bringing the Everyday Life of People into Design* [Doctoral Dissertation, Delft University of Technology]. https://www.researchgate.net/publication/27352966

Sleeswijk Visser, F., Stappers, P. J., van der Lugt, R., & Sanders, E. B.-N. (2005). Contextmapping: experiences from practice. *CoDesign*, *1*(2), 119–149. https://doi.org/10.1080/15710880500135987

Squires, S., & Byrne, B. (2002). Doing the work: Customer research in the product development and design industry. In *Creating breakthrough ideas: The collaboration of anthropologists and designers in the product development industry* (pp. 103–124).

Stappers, P. J. (2007). Doing Design as a Part of Doing Research. In *Design Research Now* (pp. 81–91). DE GRUYTER. https://doi.org/10.1007/978-3-7643-8472-2_6

Stappers, P. J. (2013). Prototypes as central vein for knowledge development. In L. Valentine (Ed.), *Prototype: Design and Craft in the 21st Century* (pp. 85–97). Bloomsbury Academic.

Stappers, P. J., & Giaccardi, E. (2017). Research Through Design. In *The Encyclopedia of Human-Computer Interaction* (2nd ed.). Interaction Design Foundation. https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed/research-through-design

Stolterman, E. (2008). The Nature of Design Practice and Implications for Interaction Design Research. *International Journal of Design*, *2*(1), 55–65. https://doi.org/10.1016/j.phymed.2007.09.005

Stolterman, E., & Wiberg, M. (2010). Concept-Driven Interaction Design Research. *Human–Computer Interaction*, *25*(2), 95–118. https://doi.org/10.1080/07370020903586696

Strickler, Z. (1999). Elicitation Methods in Experimental Design Research. *Source: Design Issues*, *15*(2), 27–39. https://about.jstor.org/terms

Sümer, N., & Özkan, T. (2002). Sürücü Davranışları, Becerileri, Bazı Kişililik Özellikleri ve Psikolojik Belirtilerin Trafik Kazalarındaki Rolleri. *Türk Psikoloji Dergisi*, *17*(50), 1–22.

Thomas, J. C., & Carroll, J. M. (1984). The Psychological Study of Design. In N. Cross (Ed.), *Developments in Design Methodolgy* (pp. 221–235). John Wiley & Sons.

Töre Yargin, G. (2013). Developing A Model For Effective Communication Of User Research Findings To The Design Process [Middle East Technical University]. In *Middle East Technical University* (Issue January). http://etd.lib.metu.edu.tr/upload/12615607/index.pdf

Tracy, S. J. (2020). *Qualitative Research Methods: Collecting Evidence, Crafting Analysis, Communicating Impact*. John Wiley and Sons.

Useche, S. A., Ortiz, V. G., & Cendales, B. E. (2017). Stress-related psychosocial factors at work, fatigue, and risky driving behavior in bus rapid transport (BRT) drivers. *Accident Analysis and Prevention*, *104*(April), 106–114. https://doi.org/10.1016/j.aap.2017.04.023

User Experience Professionals Association. (n.d.). *Cognitive Models*. Usability Body of Knowledge. Retrieved May 17, 2023, from https://www.usabilitybok.org/cognitive-models

Vaughan, L. (Ed.). (2017). *Practice-based Design Research*.

Weber, S. (2020, September 7). *An Immodest Proposal*. Los Angeles Review of Books. https://lareviewofbooks.org/short-takes/an-immodest-proposal/

Wensveen, S. (2018). Constructive Design Research. In *Technische Universiteit Eindhoven*.

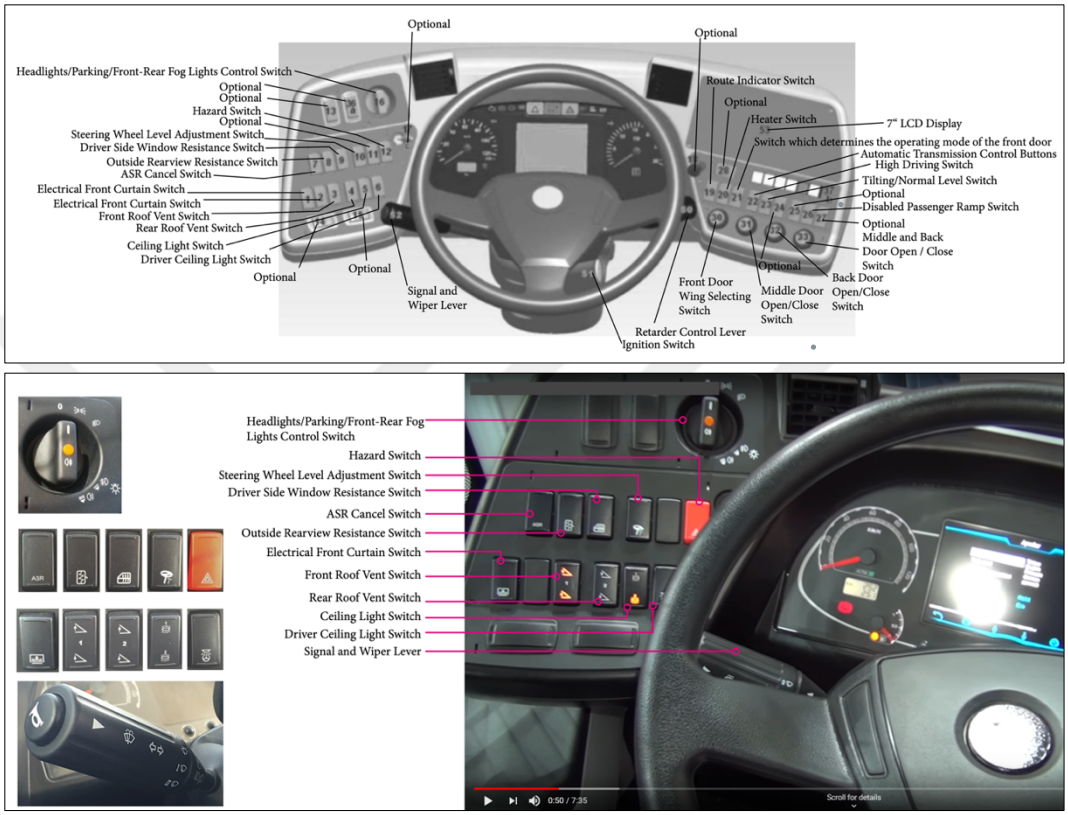
Zimmerman, J., & Forlizzi, J. (2008). The Role of Design Artifacts in Design Theory Construction. *Artifact*, *2*(1), 41–45. https://doi.org/10.1080/17493460802276893

Zimmerman, J., Forlizzi, J., & Evenson, S. (2007). Research through design as a method for interaction design research in HCI. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems - CHI '07*, 493. https://doi.org/10.1145/1240624.1240704

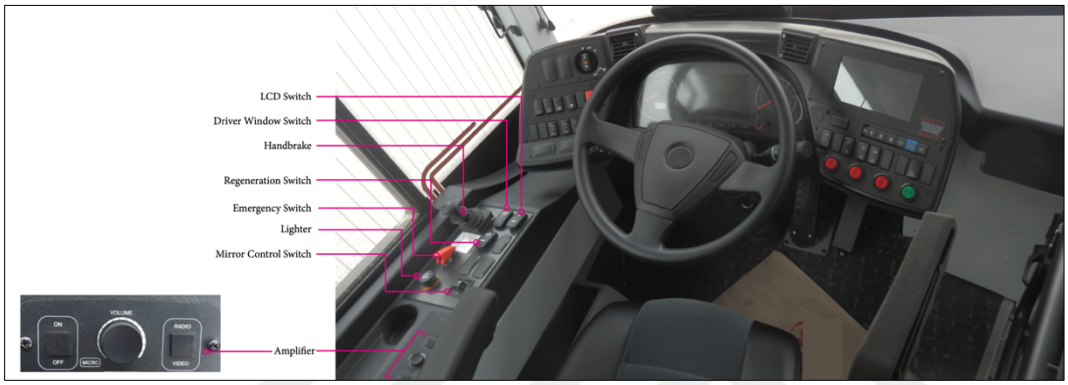
Zimmerman, J., Stolterman, E., & Forlizzi, J. (2010). An analysis and critique of Research through Design: towards a formalization of a research approach. *Proceedings of the 8th ACM Conference on Designing Interactive Systems (DIS '10)*, 310–319. https://doi.org/10.1145/1858171.1858228

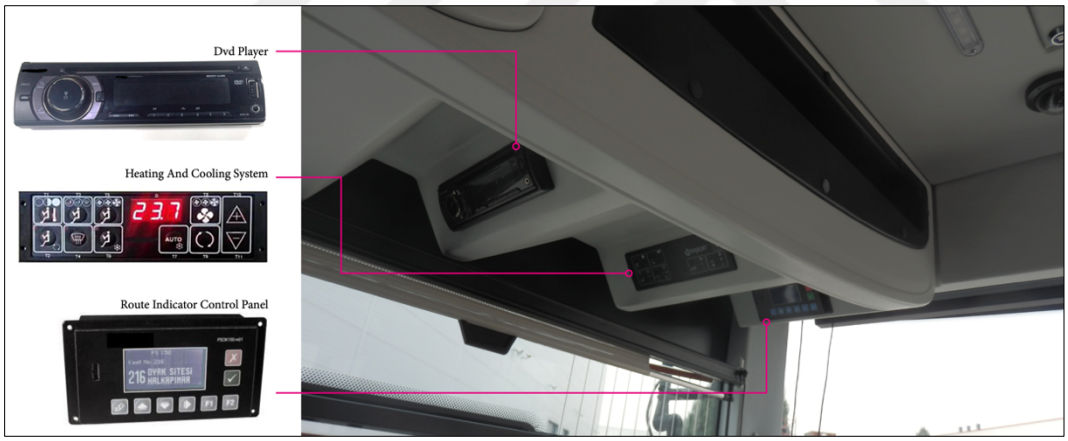
APPENDICES

A. Mapping the Driver Cabin

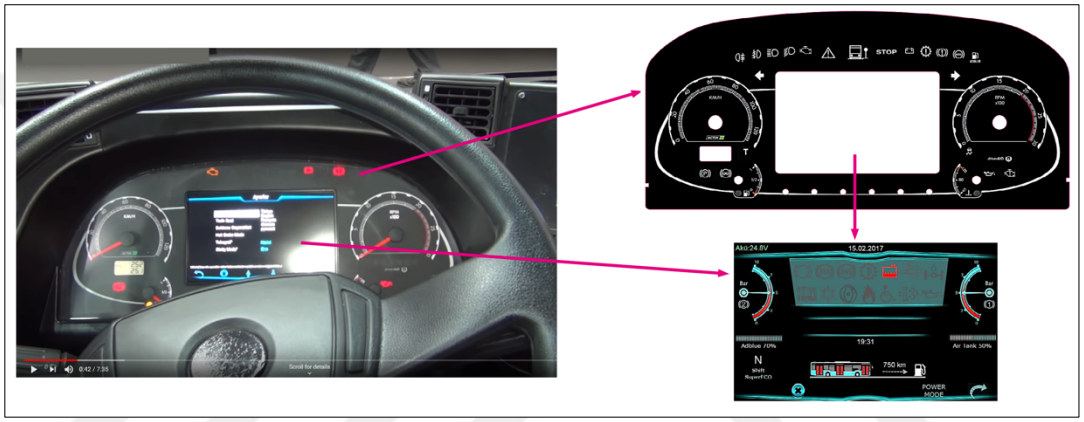


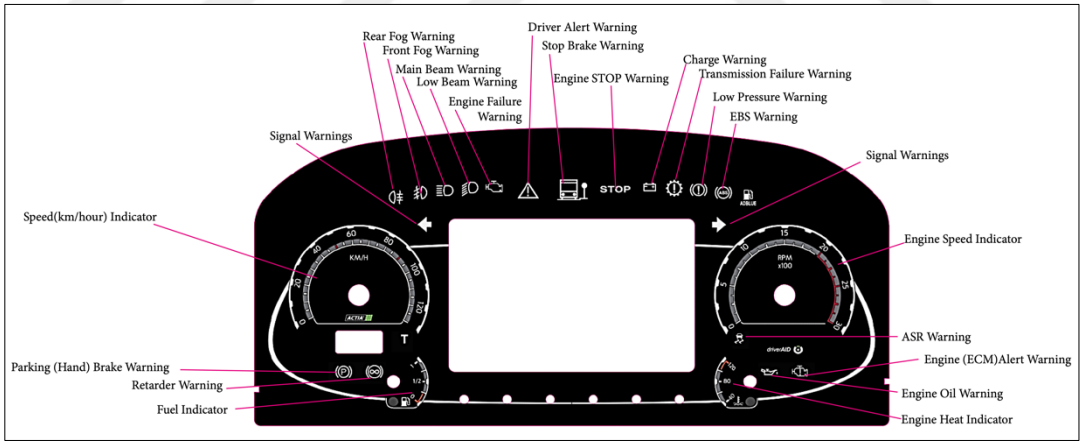

7" LCD Display
Route Indicator Switch
Heater Switch
Switch which determines the operating mode of the front door
Automatic Transmission Control Buttons
High Driving Switch
Tilting/Normal Level Switch
Disabled Passenger Ramp Switch
Front Door Wing Selecting Switch
Middle and Back Door Open/Close Switch
Back Door Open/Close Switch
Middle Door Open/Close Switch
Retarder Control Lever

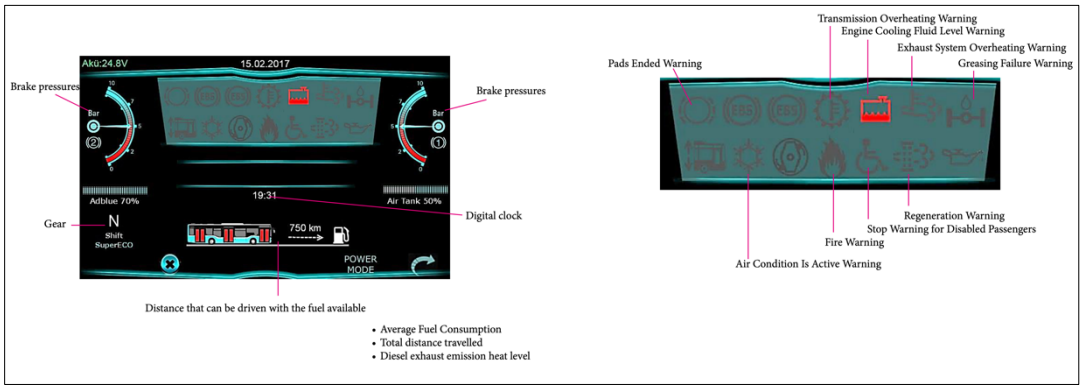

LCD Switch
Driver Window Switch
Handbrake
Regeneration Switch
Emergency Switch
Lighter
Mirror Control Switch
Amplifier


Dvd Player
Heating And Cooling System
Route Indicator Control Panel


Digital Tachograph




Rear Fog Warning
Front Fog Warning
Main Beam Warning
Low Beam Warning
Engine Failure Warning
Driver Alert Warning
Stop Brake Warning
Engine STOP Warning
Charge Warning
Transmission Failure Warning
Low Pressure Warning
EBS Warning
Signal Warnings
Signal Warnings
Speed(km/hour) Indicator
Engine Speed Indicator
ASR Warning
Engine (ECM)Alert Warning
Engine Oil Warning
Engine Heat Indicator
Parking (Hand) Brake Warning
Retarder Warning
Fuel Indicator
STOP
KM/H
RPM x100


Akü:24.8V
15.02.2017
Brake pressures
Brake pressures
Bar
Bar
Adblue 70%
19:31
Air Tank 50%
Digital clock
Gear
N
Shift
SuperECO
750 km
POWER
MODE
Distance that can be driven with the fuel available
• Average Fuel Consumption
• Total distance travelled
• Diesel exhaust emission heat level
Transmission Overheating Warning
Engine Cooling Fluid Level Warning
Exhaust System Overheating Warning
Pads Ended Warning
Greasing Failure Warning
Regeneration Warning
Stop Warning for Disabled Passengers
Fire Warning
Air Condition Is Active Warning

B. Semi structured interview guide

1	Hazırlık & Mola	Vardiya öncesinde araçla ilgili ya da aracın içinde ne gibi hazırlıklar yapıyorsunuz?
		Hat tabelası vs.
		Sefer aralarında mola sırasında neler yapıyorsunuz?
2	Raporlama & Planlama	Vardiya planlaması nasıl yapılıyor, sürücüler bu konuda neler yapıyorlar?
		Vardiya / Sefer sonrasında yapılanlar, prosedürler, raporlar
3	Bakım & Temizlik	Araç arızaları oluyor mu, neler yapılıyor
		Düzenli yapılan bakım ve temizlikler oluyor mu?
		Ampullerin değiştirilmesi
4	Durağa Yaklaşma	Durağa yaklaşma sırasında ne tür problemlerle karşılaşıyorsunuz?
		Durakta dur (stop) butonu kullanımı problemleri
5	Yolcu indirme bindirme	Durakta yolcu indirme bindirme sırasında ne tür problemlerle karşılaşıyorsunuz?
		Yolcu giriş çıkış ve kapılar
		Kimlik kontrolü yapılıyor mu?
		Engelli yolcularla ilgili özel bir şeyler yapmanız gerekiyor mu?
6	Harekât merkezi	Park etmekle ilgili sorunlar
		Otobüsle merkezden çıkış/merkeze giriş sırasındaki problemler?
		Sefer sırasında Merkezle iletişim kurulması gerekiyor mu? Problem yaşanıyor mu?
7	Yolcularla iletişim	Yolcularla iletişim kurmanız gerekiyor mu? Sorunlar oluyor mu?
		Yolcuları uyarmak durumunda kalıyor musunuz?
		Yolcularla anlaşmazlık yaşandığı oluyor mu?
		Anons sistemi
		Yolcuların koridoru tıkaması
		İniş/binişte yavaş hareket etme
8	Beklenmedik durumlar	Sefer sırasında oluşacak acil durumlara yönelik prosedür var mı?
		Yangın söndürme ekipmanı?
		Güvenlik çıkışları
		Arıza / Yolda kalma
		Kaza durumları
9	Diğer araç, yaya ve bisikletlilerin ihlalleri	Kural dışı park eden araçlarla karşılaşıyor musunuz? Neler yaşıyorsunuz?
		Kural dışı sollama yapan araçlarla karşılaşıyor musunuz? Neler yaşıyorsunuz?

		Kural dışı hız yapan araçlarla karşılaşıyor musunuz? Neler yaşıyorsunuz?
		Kampüs içi diğer toplu taşıma araçlarıyla (dolmuş, otobüs) ilgili yaşadıkları problemler?
		Yola aniden atlayan yayalar/ hayvanlar ile ilgili yaşanan problemler?
10	Yol görüşü	Aracın kör noktalarıyla ilgili problemler var mı?
		Araç aynaları hakkında neler düşünüyorsunuz?
		Cam silecekleri
		Farlar, fren lambaları
		Işık koşulları (yansımalar)
11	Yolların yapısı	Yolun daraldığı yerler/başka manevra zorlukları
		Yol üzerinde engeller, yolu tıkayan cisimler vs.
		Yol işaretleri ve tümseklerle ilgi yaşanan sorunlar?
		Hava koşulları ve yol yüzeyi ile ilgili ne tür problemlerle karşılaşıyorsunuz?
12	Kendi yaptıkları hatalar	Araç içinde telefonla görüşme, mesajlaşma
		Başka ihlal/hata (sollama, göbeklerden dönerken vs.)
13	Trafik yoğunluğu	Yoğun trafik saatlerinde sürüş
		Işıklarda bekleme
14	Son görüşler?	Sürüş sırasında riskli bulduğunuz başka durumlarla karşılaşıyor musunuz?
15	Kabin aydınlatma	Kabin aydınlatma
16	Kabin içi hava / Sıcaklık	Havalandırma/ klima kullanımı
17	Kişisel ihtiyaçlarınıza yönelik problem yaşıyor musunuz?	Depolama yerleri
		Müzik dinleme/ radyo?
		Araç içinde kişisel eşya oluyor mu?
		Araç içinde yeme-içme?
		Mobil cihaz şarj ünitesi
18	Input cihazları	Araç tuş ve kontrolleri konusunda neler düşünüyorsunuz?
19		Aracın sesli ve ışıklı uyarılarıyla ilgili problemler?

	Output cihazları / Ses ışık	Güvenliği olumsuz etkileyen uyarılar var mı? Acil, acil olmayan, gereksiz?
20	Output cihazları / Ekranlar	Araç göstergeleri hakkında ne düşünüyorsunuz?
		Araç içi ekranlar
21	Security	Yolcu ve diğer sürücülerin saldırgan davranışları?
		Kişisel eşyaların güvenliği
		Kamera sistemleri
		Araç takip sistemi
22	Son görüşler?	Sürücü kabini
		Kullandığınız otobüslerle ilgili başka problemler?

C. Remarks From Driver Encounters

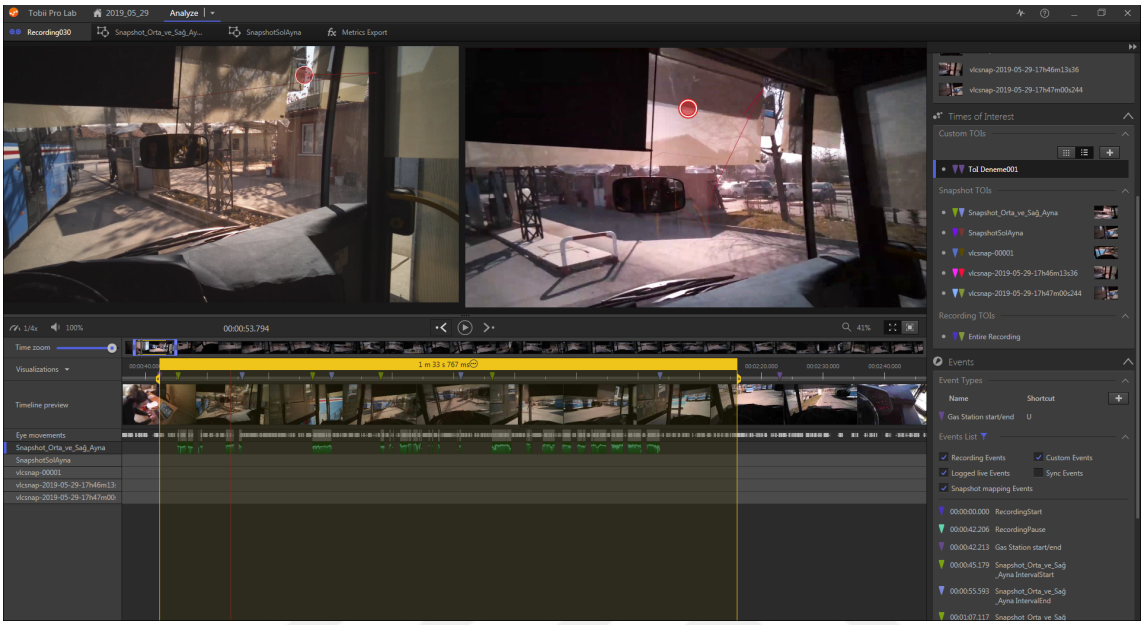
1	Öğrenciler “sen bana hizmet etmek için buradasın” havasında bizi aşağı görüyorlar
2	Yönetim bizi dikkate almıyor. X firması araç hibe etmeye karar verdi, geldiler, biz de nasıl bir araca ihtiyaç olduğunu anlattık, 3 kapılı, alçak ve geniş koridorlu araçlar ringe uygun oluyor dedik. Gittiler, artık yönetim ne dediyse yine gidip 2 kapılı, yüksek ve şehirlerarası yolculuklara uygun olan otobüslerden gönderildi.
3	Şoförlerin kimi memur kimi işçi kadrosunda olduğu için kazançları eşit olmuyor. Memurun maaşı daha yüksek ama fazla mesai ücreti daha az, işçinin maaşı daha düşük ama fazla mesai ücreti daha fazla.
4	Yeterli sayıda araç yok. Eski araçlar kazadan sonra kenara ayrıldığı için artık sadece ayakta yolcu alma ruhsatı olan yeni otobüsleri kullanıyoruz. Toplamda 7 tane böyle yeni araç var, onlar da hiç durmadan ringde kalmak zorunda, biri arızalanırsa ringler aksar.
5	Yeterli sayıda sürücü yok. Birçok kişi iş göremez raporlu, yeni kadro açılmıyor ve olan şoförler de masa başı işlerde görevlendiriliyor. Dolayısıyla da ringin yükünü az sayıda şoför çekiyor, üstüne üstlük bazıları ringe hiç çıkmaz.
6	X bey şoför kadrosunda ama bilgi işlem bölümlerinde çalışacak kadar bilgisayar bilgisi var. O yüzden daha çok bilgisayarla ilgili işlerde çalıştırılıyor. Örneğin aylık vardiya çizelgelerinin içeriğini ona veriyoruz, Excel'de hazırlıyor sağ olsun, elimiz ayağımız (Yapılan görevlendirmenin meşrulaştırılması gibi geldi bana).
7	Araçlar ringe uygun değil, 2 kapılı, dar koridor aynı araçlar personel servisi olarak da kullanılıyor, daha rahat olduğu için personelin rahatını düşünüp ringe uygun olmayan araç alıyorlar. Sonra zorluğu biz çekiyoruz.
8	Vardiyalar eşit şekilde dağıtılmıyor, bazılarımız daha fazla ring seferi yapmak durumunda kalıyor.
9	Ring sefer saatleri öğle yemeği ya da kahvaltı saatlerine denk gelir şekilde ayarlandığında yemek yemek sorun oluyor.
10	Gece mesaisindekilerin dinlenecek ve yatacak yeri yok
11	Şikâyet edildiğimizde haklı olduğumuzu ispatlayamıyoruz, araçlara kamera konulsun diyoruz ama istenmiyor
12	Duraklar birbirine çok yakın, çok kısa mesafelerle sürekli dur-kalk yapmaktan bunalıyoruz

13	Sadece 1 duraklık yol için bile binen oluyor, nasılsa bedava (kinayeli ve irite olmuş bir şekilde söylüyor)
14	Bazıları kız arkadaşlarını alıp kampüs turu atıyor, koca otobüs onun kişisel hizmetine özel araç ya (kinayeli ve irite olmuş bir şekilde söylüyor)
15	Diyelim ki araç duraktan kalkacak, bir bakıyorsun ileriden yavaş yavaş yürüyerek geliyor yolcu. Hiç acelesi yok gibi, beklemek zorundayız ya! (kinayeli ve irite olmuş bir şekilde söylüyor)
16	Durak harici durmadığımızda telefon ya da e-mail atarak şikâyet ediyorlar. Trafik ve yol uygun olduğu sürece durak harici de olsa almaya çalışıyoruz ama bazen uygunsuz yerlerde durdurmak istiyorlar. Öyle olunca da durmuyoruz ama bazen gerginlik yaşanıyor.
17	Otobüs dolu olduğu için bazı duraklarda durmadığımızda keyfimizden durmadık sanıyorlar, şikâyet ediyorlar
18	Duraktayken araç dolunca daha fazla yolcu alamayacağımızı söylediğimizde bazı yolcular tepki gösteriyorlar, yolcuları alırsak da yönetim aracın ruhsatında işlenmiş yolcu sayısından fazla yolcu almanız yasak, alırsanız sizin sorumluluğunuzda diye kenara çekiliyor.
19	Bazen sarhoş biniyorlar veya sınav zamanı stresli oluyorlar, belli oluyor zaten. O zamanlarda elimizden geldiği kadar yardım etmeye veya alttan almaya çalışıyoruz ama biz de melek değiliz neticede, sabrımız taşıyor bizim de stresli olduğumuz zamanlara denk gelince patlayabiliyoruz.
20	Yüksek araçları kullanırken yayalar ya da inen/ binen yolcular aracın hemen önünden geçerken kör noktaya denk geliyorlar, göremediğimiz için çarpma riskimiz oluyor.
21	Kampüs yaya öncelikli olduğu için yayalar karşıdan karşıya geçerken hiç sağa sola bakmıyorlar (yayalar kuralı kötüye kullanıyorlar), bir de kulaklık takıyorlar ya da telefonun ekranına bakarak yürüyorlar. Bu araç binek otomobil değil ki frene basınca hemen dursun, yeri geliyor araç 15-20 ton oluyor ama adamın hiç umurlarında değil. Rektörlük de bunlara sen haklısın deyip duruyor, oradan güç alıyorlar, “durmak zorundasın” havasında yola bakmadan atlıyorlar.
22	Bazen otobüs çok hızlı gidiyordu diye şikâyet geliyor, takip sisteminden bakıyoruz gitmemiş. Şikâyet ediyorlar çünkü onlara öyle geliyor, bilmiyorlar ki bu koca otobüs, hız sınırının altında bile gitse yakınından geçerken yarattığı rüzgâr bile aracın hızlı gittiğini düşündürmeye yetiyor.

23	Araç durakta beklerken inen bir yolcu karşıya geçmek için yola fırladı, arkadan gelen araç yolcuya çarptı. Yolcu otobüsün ön tarafından yola çıktığı için araç yolcuyu, yolcu da aracı görmemiş.
24	Çok fazla şuraya gider mi diye soruyor yolcular. Bazen sinirleniyoruz, özellikle de yorulduğumuzda ve bizim de problemlerimiz olduğunda
25	Merkezden ayrılmak zorunda kalmadan psikolojik destek almak istiyoruz.
26	Aracı sürerken tepemizde yüksek sesle telefonda konuşuyorlar, dikkatimiz dağılıyor.
27	Çok kalabalık saatlerde bazen çantalarını omzumuz üzerine yerleştiriyorlar, uyarıyoruz ama kalabalık fazla olduğunda çekemiyorlar.
28	Kalabalık saatlerde araç içindeki yolcular sağ ayna görüşünü kapatıyor
29	Sunshine ve Demiraylar taraflarında yola park eden araçlar yolu daralttığı için manevra yapamıyoruz/ ilerleyemiyoruz
30	İşçilerin fazla mesai saat ücreti yüksek olduğu için sabah-akşam semt servislerinde işçi kadrosundakilere görev vermeyi tercih etmiyorlar. Sabah erken saatte başlayan mesaiye toplu taşımayla gidip gelmek durumunda kalıyoruz.
31	Yürüyerek 3 km olan yolu ring atarken 12 km'de gidiyoruz. Hâlbuki yolcular kısa mesafeleri yürüseler, sağlıkları için de faydalı olur. Biz de sadece uzak noktalar arasında ring atarız.
32	Şoförler arasında psikolojisi normal kişi yok denecek kadar az. Çok stresli bir iş bizimki/stres işin kendisinde değil yönetilme şeklinde.
33	Burada yaşadığımız stres yüzünden evde ailemizle ilişkilerimiz de olumsuz etkileniyor, evde kavga ediyoruz.
34	Yönetimle iyi geçinirsen ringe çıkmak zorunda da kalmazsın, semt servislerine görevli de yazılırsın (ringe çıkmak tercih edilen bir görev değil ve semt servislerine çıkınca hem eve araçla gidiyor hem de fazla mesai ücreti alıyorlar)
35	Burada aracın yakıtını da biz doldurmak zorunda kalıyoruz. Hâlbuki benzinlikte görevli kişiler var, eskiden bir de takım elbise kravat zorunluydu, o kılıkta mazotla iş yapıyorduk.
36	Bazı sürücüler ring atmayı beğenmiyor ama bu bizim görevimiz, biz bu öğrenciler sayesinde ekmeğimizi kazanıyoruz. Problem ring atmak değil adaletli olunmaması (eşit mesai dağılımı yapılmadığını söylüyor).

37	Eski otobüslerde duracak düğmesi olmadığı için inmek isteyen kapıya doğru ilerliyordu. Şimdi düğme var, hem düğmeye basmıyorlar hem de yerinden zahmet edip kalkmıyorlar. Öyle olduğu zaman durmuyorum, "düğmeye bassaydınız" diyorum.
38	Aynalar bizim elimiz ayağımız, çok önemliler
39	(Havalandırmak için aracın camını açmak istiyor ama tuşu bulamıyor) Biz aracı kullanmayı biliyoruz da bu yeni araçların böyle şeylerini bilmiyoruz. Eğitimi de herkese vermediler (birçok sürücü yeni araçlarla ilgili eğitim almadığı için bazı fonksiyonlarını kullanmayı bilmiyor).
40	Bu yeni araçlarda kapı açıkken araç hareket etmiyor, her durakta birkaç saniye kaybetsek bir sonraki ringe yetişemeyiz, (yanında seyahat eden şoför arkadaşına soruyor) bunu nasıl kapatıyoruz?

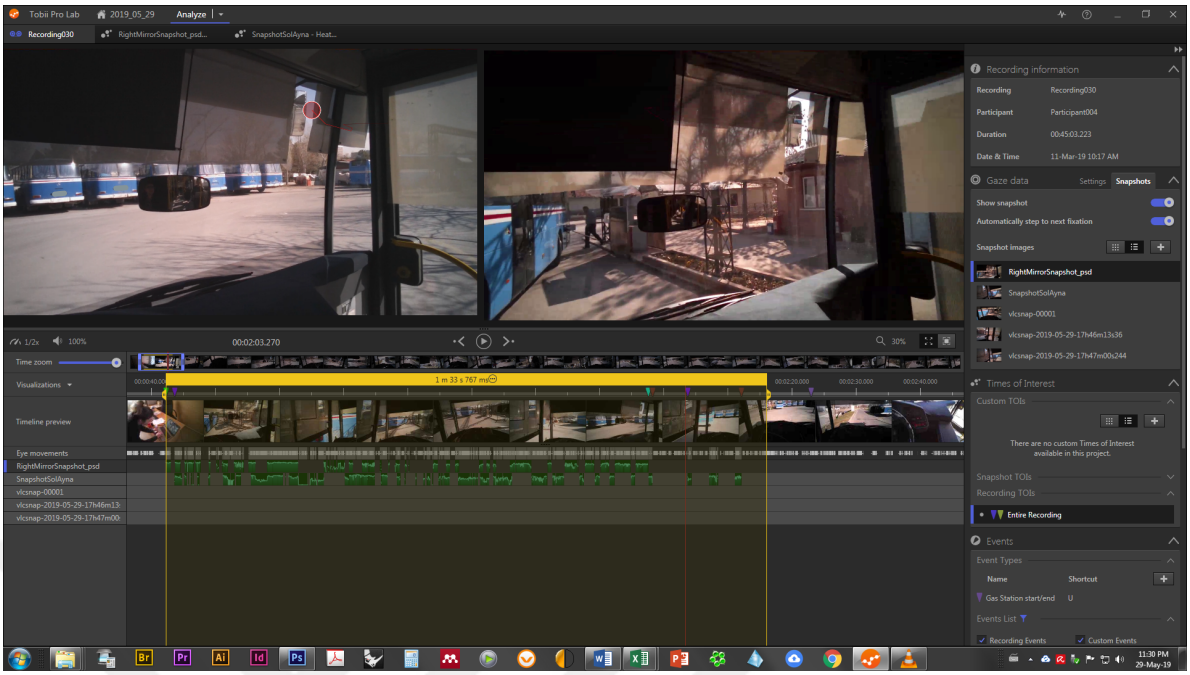
D. Eye Tracking Analysis Problem for Dingin 4 Video



The gaze indicator on the video shows that the driver is looking at the right mirror. However, the gaze indicator is on the left side of the right mirror on the mapped image. The mapped image is taken as a snapshot of the actual video that was exported from Tobii Pro Lab software. Therefore, according to the company's claims, the software was supposed to find the mirror. On the other hand, curtains were attached to the bus windows to prevent excessive daylight. In addition, the image in the mirror constantly changes. These two can be why the software could not detect the borders of the right mirror.

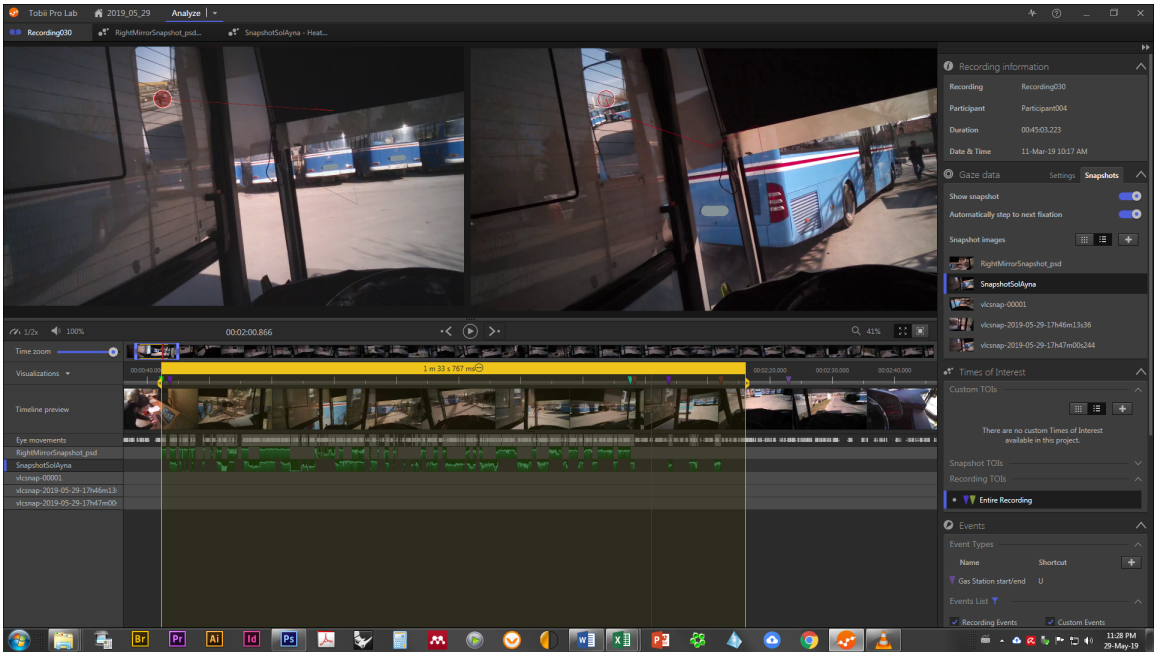
Second Instance of the problem for the right mirror:

Also, around this time frame, the driver looks at the right mirror again; this time, 7 fixations occur in the recording, but these fixations are still not visible on the mapped image on the right side.



The same problem occurred for the left mirror:

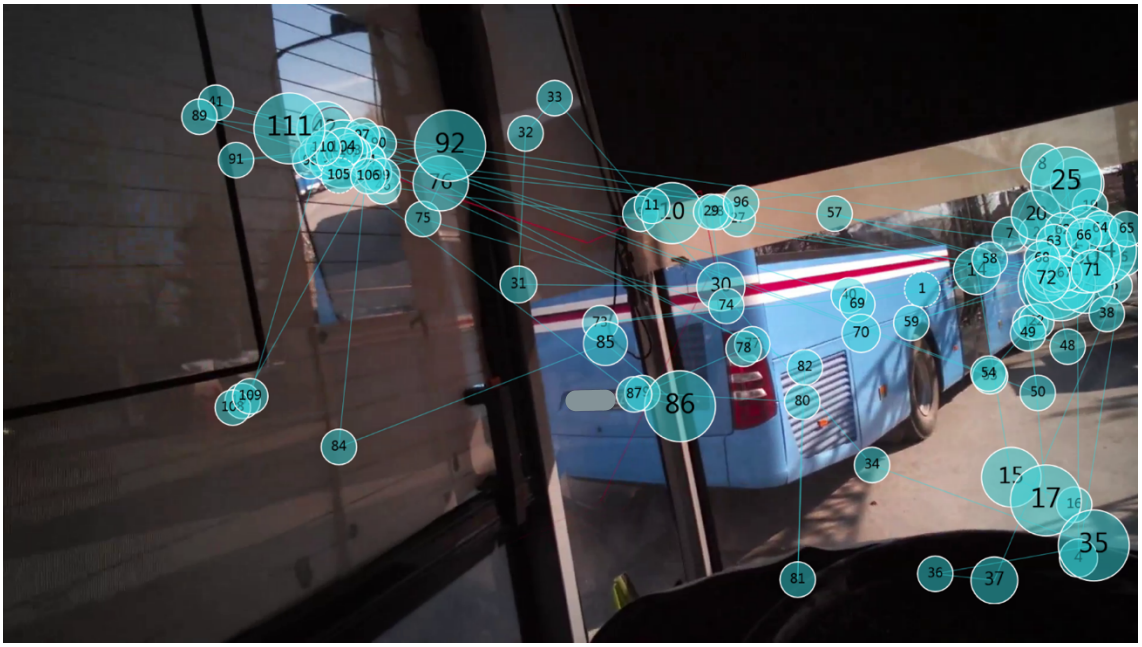
The software also did not recognize the left mirror fixation later on the recording, immediately before leaving the gas station. Here:



The snapshot image has the gaze indicator on it, but the software is not the mapping. There are 2 fixations on the left mirror, but the mapped image does not show those fixations. It will not be possible to rely on mapping results.

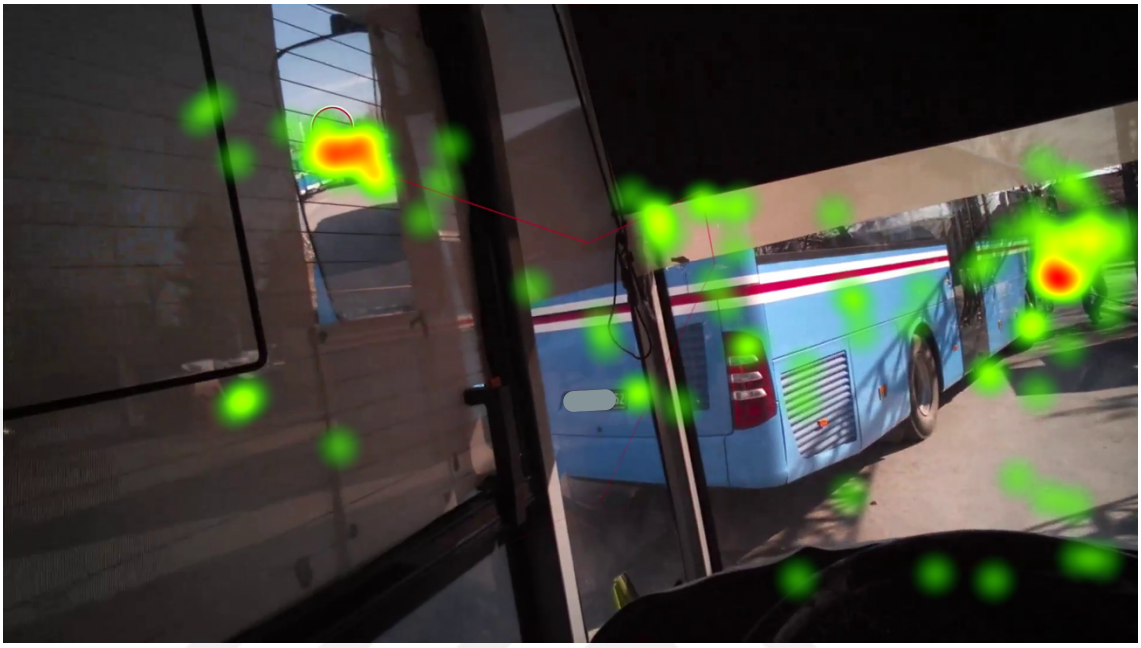
Analysis outcomes 1: Gaze Plots

Gaze plots for 1 participant, 26 seconds of reversing the vehicle:



Analysis Outcomes 2: Heat Map

Heat map for 1 participant, around 1 minute of reversing the vehicle.



E. Eye Tracking Recordings

Driver #	Reminder	# of Tours	# of Recs	Route	Recording name	Rec date	Rec Day	Vehicle	Recording start time	Duration	Duration Total	%	% Median
1	İhtiyar	2	2	SarıKırmızı	Recording002	29.01.2019	Tues (holiday)	Otokar	14:14	00:34:43055	01:12:44140	47%	46%
1	İhtiyar	2	2	SarıKırmızı	Recording003	29.01.2019			14:57	00:38:01085		45%	
2	Şakacı	2	1	SarıKırmızı	Recording004	29.01.2019	Tues (holiday)	Otokar	15:47	01:25:53491	01:25:53491	78%	78%
3	Bezgin	1	1	SarıKırmızı	Recording007	22.02.2019	Fri	Coach Mercedes	13:04	00:38:24667	00:38:24667	53%	53%
4	Uyanık	2	2	Gri	Recording021	9.03.2019	Sat	Mercedes Connect	16:05	01:09:26355	1:38:45630	81%	82,50%
4	Uyanık	2	2	Gri	Recording022	9.03.2019			17:23	00:29:19275		84%	
5	Uyanık2	2	2	Gri	Recording024	10.03.2019	Sun	Mercedes Connect	15:46	00:46:01465	01:27:59147	80%	82,50%
5	Uyanık2	2	2	Gri	Recording025	10.03.2019			16:51	00:41:57682		85%	
6	Uyumlu	2	2	Gri	Recording026	10.03.2019	Sun	Mercedes Connect	17:45	01:26:03808	01:48:31724	85%	83,50%
6	Uyumlu	2	2	Gri	Recording027	10.03.2019			19:27	00:22:27916		82%	
7	Dingin1	0,25	1	Turuncu	Recording028	11.03.2019	Mon	Mercedes Connect	08:26	00:07:19251	00:07:19251	75%	75%
8	Dingin2	0,75	1	Turuncu	Recording029	11.03.2019	Mon	Mercedes Connect	08:35	00:35:15438	00:35:15438	73%	73%
9	Dingin3	2	2	SarıKırmızı	Recording030	11.03.2019	Mon	Mercedes Connect	10:17	00:45:03223	01:23:56853	85%	87,50%
9	Dingin3	2	2	SarıKırmızı	Recording031	11.03.2019			11:08	00:38:53630		90%	
10	Bıçkın	1	1	Turuncu	Recording033	12.03.2019	Tues	Otokar	08:59	00:24:03195	00:24:03195	35%	35%
11	Bıçkın	2	1	SarıKırmızı	Recording034	43579	Wed	Coach Mercedes	0,5340278	01:23:00000	01:23:00000		75%

F. Videos and Participants

#	Name	Length	1FA	2MeK	3SG	4CB	5FuA	6EC	7IT	8OB	9MuK	10KU	View Count
1	Bezgin 1: ODTÜ Kent - Demiraylar	04:43								3			1
2	Bezgin 2: UçanKaçan-Devrim	05:20								Pre-w			0
3	Bezgin 3: Sunshine - Kimya	04:02			5		2	1		Pre-w	3		4
4	Bezgin 4: Eğitim-Mendil	04:13				5			3	Pre-w			2
5	Bıçkın 1: Garajdan Çıkma	04:24	Pre-w								1		1
6	Bıçkın 2: Metro - Egitim	04:05	Pre-w										(1)
7	Bıçkın 3: Demiraylar "U" Dönüş	03:00	1				3						2
8	Bıçkın 4: Yuva-Çarşı	03:09	Pre-w										(1)
9	Bıçkın 5: İşbank-Bölümler	03:35	Pre-w									1	1
10	Bıçkın 6: Yuva - Son durak	05:09	Pre-w										(1)
11	Bıçkın 7: Yakıt İstasyonundan Çıkma	01:12	Pre-w			4							1
12	Dingin 1: Garajdan Çıkarken Arkadaşlara Sitem	04:15								Pre-w			(1)
13	Dingin 2: Otobüsü Devraldıktan Sonra - 1. Yol Kavşağı	03:49								Pre-w			(1)
14	Dingin 3: Birinci Yol Kavşağı - Ring Sonu	04:46								Pre-w		2	1
15	Dingin 4: Yakıt İstasyonu - Levha Arama	03:49								Pre-w			(1)
16	Dingin 5: Metro- Tampon Çarpma	03:47						2		1	2		3
17	Dingin 6: Teknokent - Bölümler	03:55								Pre-w			0
18	Dingin 7: Rektörlük - Ring Sonu	03:58								Pre-w			0
19	İhtiyar 1: Garajdan Çıkma	02:45											0
20	İhtiyar 2: Traktör Sollama	01:18			3	1							2
21	İhtiyar 3: Devrim - Sunshine	02:38								4		3	2
22	Şakacı 1: Garajdan çıkma	02:41	Pre-w	1	1					2			3
23	Şakacı 2: Hazırlık-Devrim	03:31	2	2						Pre-w			2
24	Şakacı 3: Sunshine Mola - Devrim	03:11	Pre-w	3		3				Pre-w			2
25	Şakacı 4: Son duraktan garaja dönüş	03:12	Pre-w	4						Pre-w	4		2
26	Uyanık 1: Başlangıç - İnşaat	04:28											0
27	Uyanık 2: Ziraat Durağı - Sunshine - KKM	04:35			2				1				2
28	Uyanık 3: KKM Durak - A1 Nizamiye	03:17						3					1
29	Uyanık 4: Birinci Yol Kavşağı - Kimya Kavşağı	02:58				2							1
30	Uyanık 5: ODTÜ Kent- Demiray	03:27											0
31	Uyanık 6: RingSonu- Garaj	04:19											0
32	Uyumlu 1: Metro-Demiray	04:08	Pre-w						2				1
33	Uyumlu 2: ODTÜ Kent - KKM	03:57	4									4	2
34	Uyumlu 3: A1-ODTÜ Kent	04:01	5					4					2
35	Uyumlu 4: ODTÜ Kent - Demiray - Metro	04:34	Pre-w				1						1
36	Uyumlu 5: Garaja Dönüş	04:00	3		4								2
	Total video length	02:14:11											41

Session date		14.Mar	15.Mar	17.Mar	21.Mar	21.Mar	22.Mar	22.Mar	23.Mar	15/23Mar	24.Mar
# of watched videos		5 (16)	4	5	5	3	4	3	4 (15)	4	4
Session length (Sum 17:51)		01:54	02:06	02:12	01:34	02:10	01:39	01:24	01:37	01:19	01:57
Transcription word count (Sum		9058	13009	8633	7620	11848	10021	7875	10101	10608	6911
Participant group		Sec.	Dev.	Pri.	Sec.	Pri.	Dev.	Sec.	Sec.	Dev.	Pri.

Merhaba, çalışmaya katıldığınız için çok teşekkürler. Çalışmada kullanıcı araştırması bulguları, akademik bir araştırma için sizlerle paylaşılmaktadır. Sürücülerin ve çalışmanın gizliliğini korumak için **lütfen çalışmadaki bilgileri ve videoları kaydetmeyin** veya **paylaşmayın**.

Dilediğiniz herhangi bir anda çalışmadan çekilebilirsiniz. Sorunuz olduğunda Ayça Kınık ya da Prof. Dr. Gülay Hasdoğan ile iletişim kurabilirsiniz.

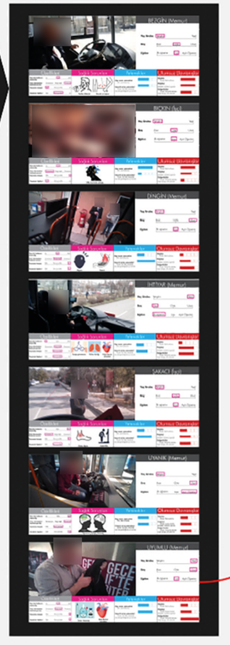
- **Bazı araç fonksiyonlarının otomatik olduğu** gelecekteki bir ortam için bir projede sizinle **aynı ekipte çalıştığımızı varsayıyoruz**. Ben **kullanıcı araştırmacısı** olarak çalışıyorum, siz de **tasarımcı** olarak çalışıyorsunuz.
- Bu amaçla ODTÜ'deki ring otobüsleriyle ilgili **gözlem ve röportajlar** yaptım. 11 sürücüye giyilebilir **göz izleme cihazı** takarak **sürüş videoları** kaydettim.
- **Kullanıcı araştırması bulgularını etkili bir şekilde tasarımcılara aktarmaya çalışıyorum** ve bu nedenle bulguları size sunuyorum.
- Sizden, **güvenlik ve konfor ile ilgili tasarım problemleri** saptamanızı istiyorum.
- Miro panosu üzerinde **3 basamak** var. **Birinci** basamak **sürücü personalarını** tanıtıyor. **İkinci** basamak **hafta sonu vardiyasında olanları** anlatıyor.
- **Üçüncü** basamakta **sürücü videolarının** linkleri var. Bu linkleri tıkladığınızda **başka bir sayfaya** yönlendirileceksiniz. Sürücü videoları üzerinde **hareket eden kırmızı bir daire** göreceksiniz. Bu daire göz izleme cihazının kaydettiği ve **sürücünün tam olarak baktığı yeri** gösteriyor.
- **Zoom toplantısından önce** 2. basamaktaki sürücü deneyim haritasında parlak sarı renkli kısmı **doldurunuz.**
- Uygun olduğunuz zamanda bir **Zoom toplantısı** yapacağız ve yaklaşık 2 saat boyunca seçtiğiniz 1 sürücü personasının **videolarını izleyeceğiz** ve için tasarım problemleri hakkında bir çalıştay yapacağız.

Çalışmaya Gönüllü Olarak Katılmayı Kabul Ediyor musunuz?

1. Basamak: Sürücü Personaları İnceleyin

Başlamadan Önce >>

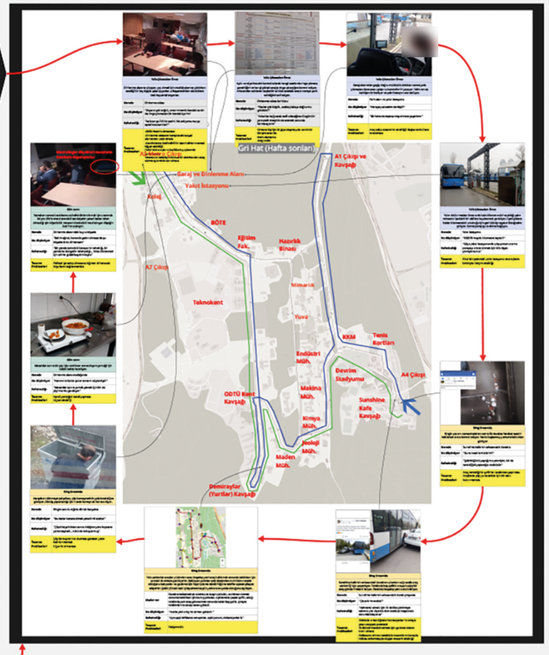
- Burada sürücü personalarını görüyorsunuz; **İhtiyar, Bıçkın, Bengin, Uysal** ve **Uyanık**.
- Her bir persona, panoda belirtilen özellikleri açısından **birbirlerinden ayrılıyorlar**. Sürücülerin hepsi erkek.
- Videoları **personaların özelliklerini göz önünde bulundurarak** izleyiniz.



2. Basamak: Sürücü deneyim haritasını inceleyip gözlemlediğiniz tasarım problemlerini kısaca not alın

Başlamadan Önce >>

- Sağlıklı kampüs haritası üzerinde işaretlenmiş **sürücü deneyim haritasını inceleyiniz.**
- Gözlemlediğiniz **güvenlik ve konfor ile ilgili tasarım problemlerini** parlak sarı **renkli satırlara çift tıklayarak** yazınız.
- Harita sol üst köşeden başlıyor ve saat yönünde ilerliyor.



3. Basamak: Seçeceğiniz 1 tane sürücünün videolarını Zoom toplantısında **beraber** izleyeceğiz.

Başlamadan Önce >>

- Sağlıklı linki tıkladığınızda **ayrı bir sayfada** sürücülerin video panosu açılacak.
- Tercih ettiğiniz **1 sürücünün videolarını** Zoom toplantısında **beraberken izleyeceğiz.**
- İzlerken size **güvenlik ve konfor ile ilgili tasarım problemlerini** soracağım.
- Zoom toplantısından önce videolara bakmanız **gerekmiyor** ancak önceden **fikir edinmek** isterseniz bakabilirsiniz.



This driver persona includes driving videos from 2 different drivers. One of them expressed intense frustration by stating he was going to "burn the building down" due to perceived unfair treatment by the management.

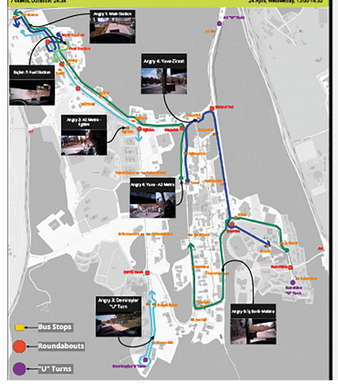
Bigkan (Contractor)

Age Group: Younger Adult / Older Adult
Hight: Short / Average / Tall
Education: Primary / High School / College

Characteristics | Health Conditions | Positive Skills | Negative Behaviors

7 videos, Duration: 24:34

24 April, Wednesday, 13:00-14:30



This driver persona has the driving videos of 1 driver. Videos were recorded right after the winter break when the classes started recently.

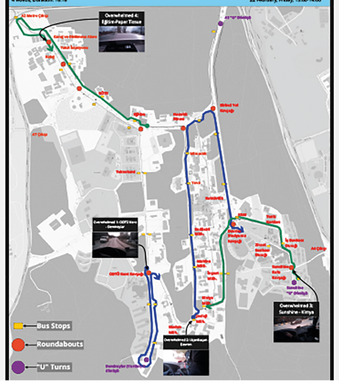
Overwhelmed (Employee)

Age Group: Younger Adult / Older Adult
Hight: Short / Average / Tall
Education: Primary / High School / College

Characteristics | Health Conditions | Positive Skills | Negative Behaviors

4 videos, Duration: 18:18

22 February, Friday, 13:00-14:00



This driver persona has the driving videos of 3 different drivers. The first Tranquil driver received a phone call and left the bus to another driver at the end of the "Tranquil 1: Main Station" video.

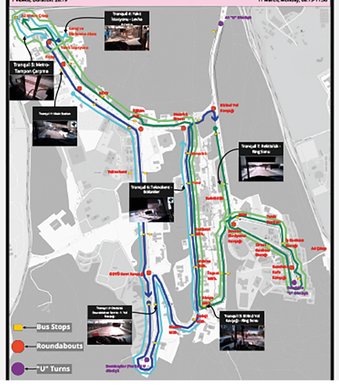
Tranquil (Employee)

Age Group: Younger Adult / Older Adult
Hight: Short / Average / Tall
Education: Primary / High School / College

Characteristics | Health Conditions | Positive Skills | Negative Behaviors

7 videos, Duration: 28:19

11 March, Monday, 08:15-11:00



This driver persona has the driving videos of 1 driver. Videos were recorded during the winter break.

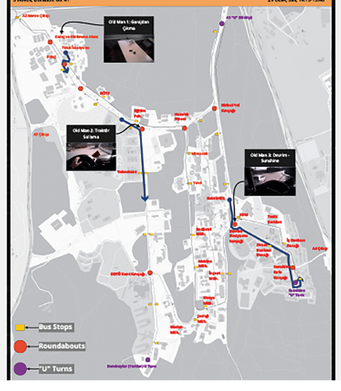
Old Man (Employee)

Age Group: Younger Adult / Older Adult
Hight: Short / Average / Tall
Education: Primary / High School / College

Characteristics | Health Conditions | Positive Skills | Negative Behaviors

3 videos, Duration: 06:41

29 Octat, Sat, 1415-1540



This driver persona has the driving videos of 1 driver. Videos were recorded during the winter break.

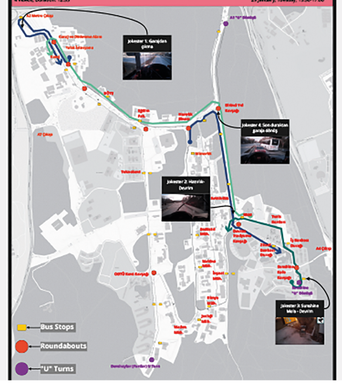
Jokester (Contractor)

Age Group: Younger Adult / Older Adult
Hight: Short / Average / Tall
Education: Primary / High School / College

Characteristics | Health Conditions | Positive Skills | Negative Behaviors

4 videos, Duration: 12:05

29 January, Tuesday, 15:30-17:00



This driver persona has the driving videos from 2 drivers. One of them confessed he looked up the ceiling of the bus when he violates the speed limit so his violation would not be recorded on the video.

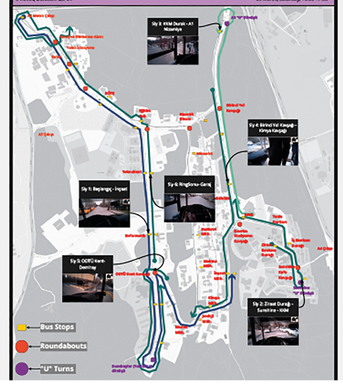
Sly (Employee)

Age Group: Younger Adult / Older Adult
Hight: Short / Average / Tall
Education: Primary / High School / College

Characteristics | Health Conditions | Positive Skills | Negative Behaviors

4 videos, Duration: 23: 04

03 March, Saturday, 16:00-17:00



This driver persona has the driving videos of 1 driver. Videos were recorded during weekend evening when the bus was crowded.

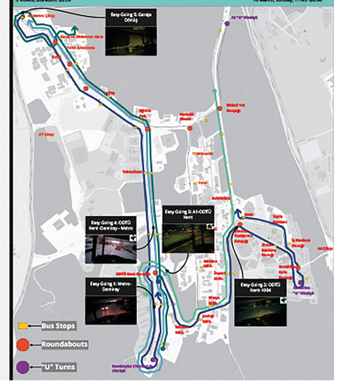
Easy Going (Employee)

Age Group: Younger Adult / Older Adult
Hight: Short / Average / Tall
Education: Primary / High School / College

Characteristics | Health Conditions | Positive Skills | Negative Behaviors

5 videos, Duration: 20:39

10 March, Sunday, 17:45 -20:00



I. Workshop Questions (Turkish)

Çalıştay öncesi sorular

1. Araç kullanıyor musunuz?
    - Ne zamandır kullanıyorsunuz?
    - Ne sıklıkla kullanıyorsunuz?
    - Araç kullanmayı seviyor musunuz?
2. Toplu taşıma veya ücretsiz ring servis otobüslerinde yolcu olarak seyahat ettiniz mi?
    - Olumlu veya olumsuz tecrübeleriniz var mı?
3. Taşımacılık veya taşıt tasarımı ile ilgili projelerde çalıştınız mı?
4. Tasarladığınız ürünler için kullanıcı ihtiyaçlarını nasıl tanımlarsınız?

Çalıştay soruları

1. Başlamadan önce, sürücü deneyim haritası üzerinde çalışabildiniz mi?
2. Sürücü deneyim haritasında gözlemlediğiniz en önemli 3 tasarım problem nedir?
3. Bir persona ve video seçer misiniz? Neden bu personaları seçtiniz? (x3)
4. Videoları izlerken düşündüklerinizi paylaşır mısınız?
5. Sizce bu videoda sürücünün neye ihtiyacı var?

Çalıştay sonrası sorular

1. Çalıştayda sunulan bilgiler hakkında ne düşünüyorsunuz?
    - Personalar
    - Deneyim haritası
    - Videolar
    - Haritayla ilişkilendirilmiş bilgiler
2. Videolar hakkında ne düşünüyorsunuz?
    - Videolar üzerindeki kırmızı daire sürücünün nereye baktığını gösteriyordu. Bu dairenin gözlemlerinize etkisi oldu mu?
3. Çalışma sürücülerle empati kurmanıza etki etti mi?
4. Böyle bir çalışmanın tasarım sürecinize etkisi olur mu?
5. Çalışmanın aldığı süre hakkında ne düşünüyorsunuz?
    - Çalışmaya katılımınız sırasında yorulduğunuz ya da sıkıldığınız yerler oldu mu?
6. Çalışmayla katılımınızla ilgili olumlu ya da olumsuz görüşleriniz?

J. Workshop Questions (English)

Pre-workshop Questions

1. Do you drive?
   - How long have you been driving?
   - How often do you drive?
   - Do you like to drive?
2. Have you been a passenger on public transportation or free shuttle buses?
   - What are your experiences - positive or negative?
3. Have you worked on projects related to transportation or vehicle design?
4. How would you define user needs for the products you design?

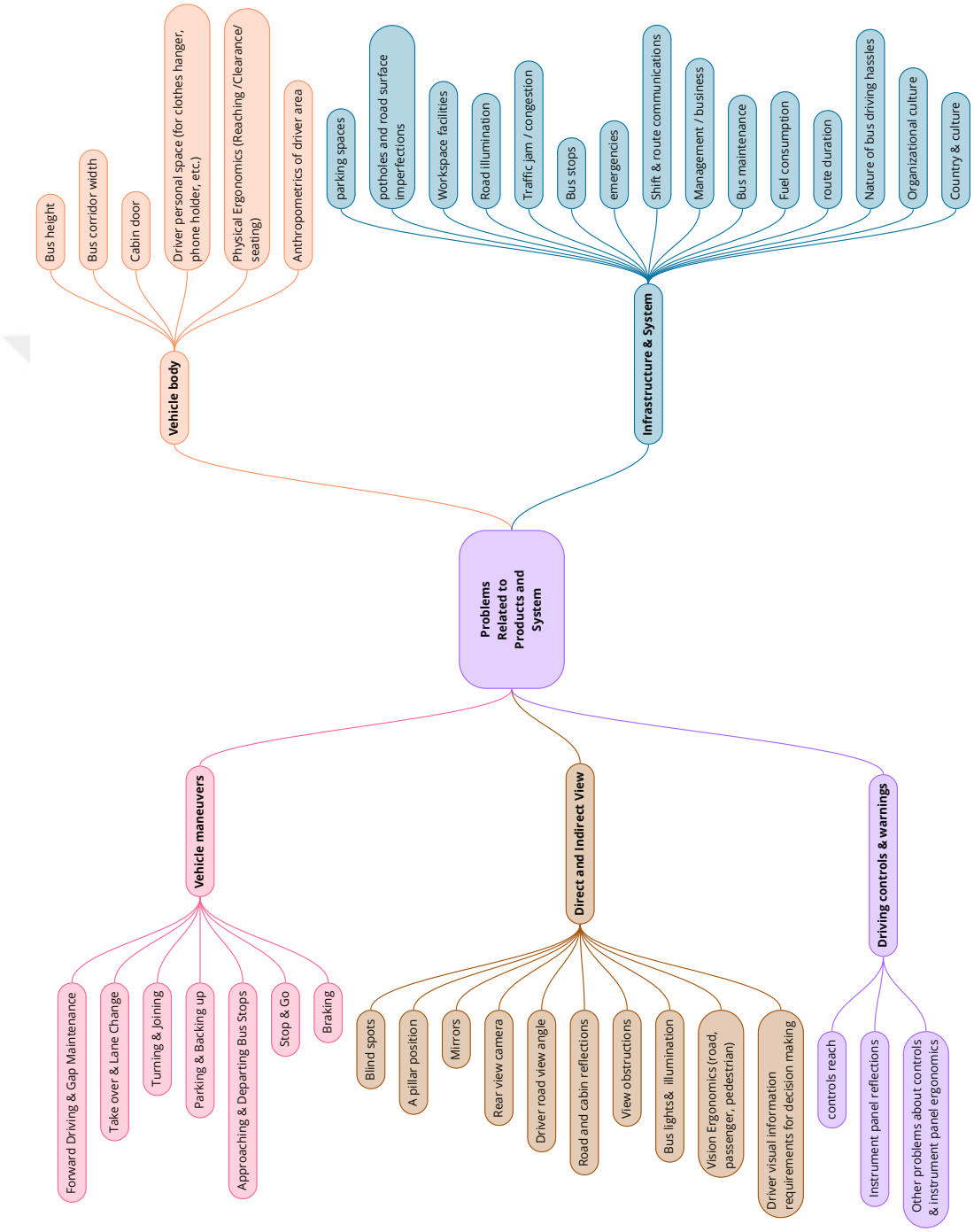
Workshop questions

1. Did you have a chance to work on the driver experience map?
2. What are the top 3 design problems you observed in the driver experience map?
3. Can you choose a persona and a video? Why did you choose those personas (x3)?
4. Can you share your thoughts as you watch the videos?
5. What do you think the driver needs in this video?

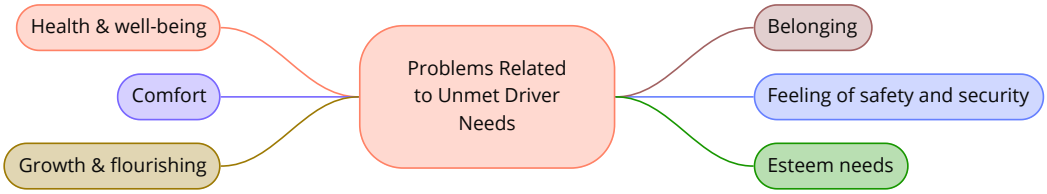
Post-workshop Questions

1. What do you think about the information presented at the workshop?
   - Personas
   - Experience Map
   - Videos
   - Information associated with the map
2. What do you think about the videos?
   - The red circle on the videos indicated where the driver was looking. Did this circle affect your observations?
3. Did the study have an impact on your empathy for the drivers?
4. Would such a study have an impact on your design process?
5. What do you think about the time the study took?
   - Did you get tired or bored while participating in the study?
6. What positive or negative opinions do you have about your participation in the study?

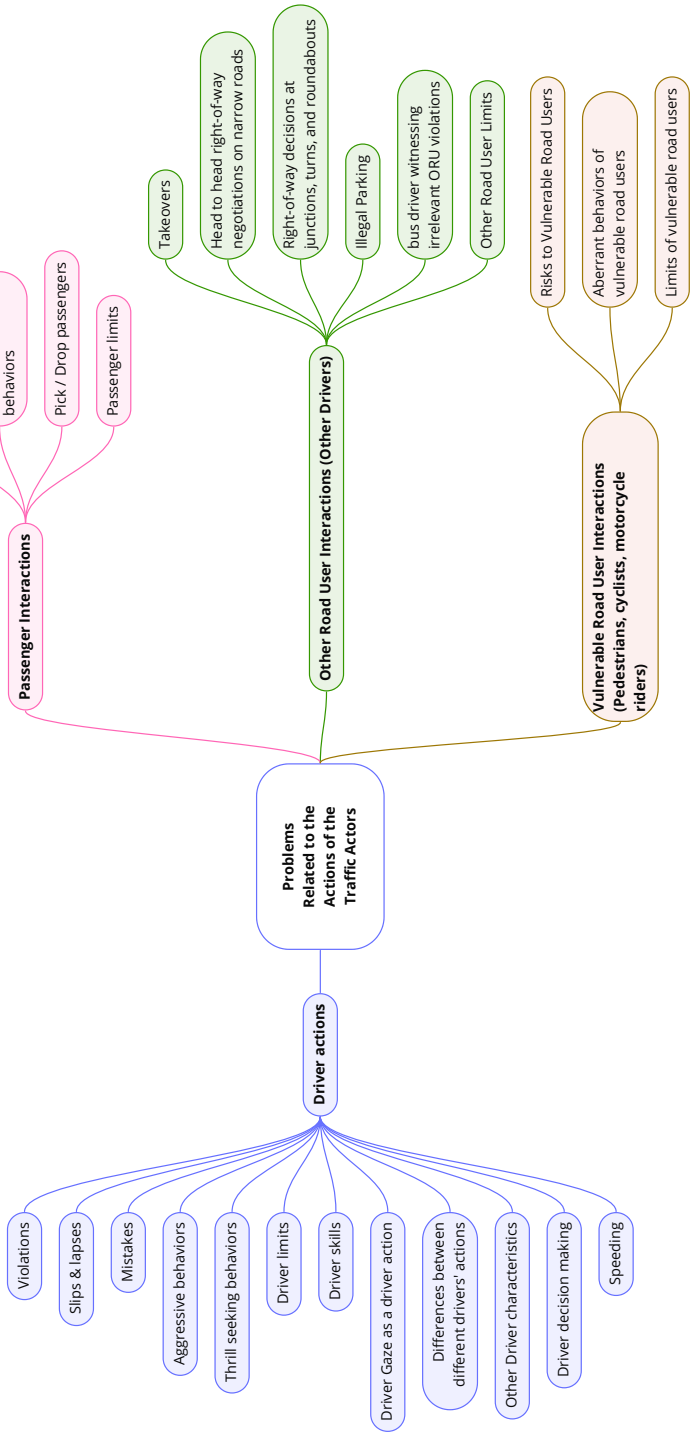
K. Problems Related to Products and Systems



L. Problems Related to Unmet Driver Needs



M. Problems Related to the Actions of the Traffic Actors



N. 1FA Synopses

[Çalıştığın projelerde kullanıcı ihtiyaçlarını tanımlamak için neler yaparsın? AK] X firmasında çalışırken otobüs ve kamyon kısmında interior design'da zaten çoğu şey firmanın yurt dışındaki merkezinden geliyordu. Biz sadece ufak malzeme değişiklikleri yapıyorduk ya da Türkiye'ye özelleştirilmesi gereken bazı şeyler varsa onları değiştiriyorduk. Bu yüzden de kendimiz sıfırdan bir kullanıcı deneyimi araştırması yapmıyorduk. Ben kendi araştırmam için şehirler arası otobüslerde sürücülük yapan sürücülerle kullanıma, otobüse, nelerin önemli olduğunu düşündüklerine dair röportajlar yapmıştım. Doğruyu söylemek gerekirse o kadar bir tecrübem var, onun dışında kapsamlı, detaylı bir kullanıcı deneyimi araştırması yapılıyordu diyemem. FA1

1FA Position: 5 - 5

Sürücülerin yaptıkları işin gereklerine dair bazı açıklar olduğu aşikâr. Vardiya tablosunu ufak bir Excel tablosundan çıktı alıp asıyorlar, bunun iletişimini sürücülerle düzgün ve makul bir şekilde kuramıyorlar. Sürücüleri gün boyu sürekli ortaya çıkabilecek potansiyel problemlerde yolcular ya da amirlerin arasında bırakıyorlar. Mesela videolarda çok gördüm, herkes oraya mı gidiyor buraya mı gidiyor, oraya mı gidiyor buraya mı gidiyor diye soruyor. Demek ki ya öğrenciler ringleri çok az/nadiren kullanıyorlar ve güzergahları öğrenemiyorlar ya da bunun net bir güzergahı yok/belirtilmemiş. Güzergâh bilgisini ne öğrencilerin bilmesini ne de sürücülerin anlatmasını bekleyemezsin. Yine de sürücüler çoğunlukla baya bir üstlerine almışlar bu anlatma görevini. FA2

1FA Position: 8 - 8

Bu gözlediğim datada bir tane tasarım problemini ele alacak olsam bu en net şekilde iletişim tasarımını çözmeye çalışırdım. Mesela yumurta kabuğu örneği enteresan bir örnek ama sürekli tekrarlanan bir şey olduğunu düşünmüyorum. Sürücülerin en çok maruz kaldıkları problemlerin araç nerede, hangi saatte

çıkacağım, ben bu durağa gidiyorum ama yolcular nereye gittiğimi biliyorlar mı, bunu bana sormadan nasıl öğrenebilirler gibi problemler olduğunu gördüm. Yani işin iletişim tarafının acilen çözülmesi birçok sorunu ortadan kaldırabilir. FA2

1FA Position: 11 - 11

Videolarını önceden izlemek için Uyumlu, Bıçkın ve Şakacı'yı seçtim. Uyumlu'yu gece sürüşü ve kalabalık otobüs olduğu için seçtim. Bıçkın'ın öfke kontrolü olması dikkatimi çekti. Kullanıma dair bir şeyler göreceğimi düşündüm ama çok düşündüğüm gibi çıkmadı. Şakacı kullanım açısından Bıçkın'dan daha çok kafasına göre gidiyordu. Belki Şakacı'nın dislektik olmasındandır. O dikkatimi çekti, dikkat dağınıklığı sürüşü nasıl etkiler acaba diye merak ettim. FA2

1FA Position: 12 - 12

Bıçkın3 Demiraylar yolunda karşıdan otobüs geldiği zaman kendi otobüsünün geçeceği alanı anlamaya çalışıyor. Karşıdaki otobüsü bekliyor, ne yapacağını anlamaya çalışıyor, dörtlüleri mi yaktı, geri mi gidecek diye sinyallerine bakıyor. Sürücüler muhtemelen birbirlerini görüyorlardır ama diğer otobüsün nasıl davranacağını aracın çeşitli kısımlarına bakarak anlamaya çalışıyor. FA3

1FA Position: 17 - 17

Bıçkın3'ün FA18 bitindeki otobüs karşılaşmasıyla ilgili yorumunun iyi bir input olması şu anlama geliyor. Bıçkın3 daha karşı şeritten gelirken bile böyle bir problemde çok karşılaştıklarını söylüyor. Kural ihlali yapan bir sürücü bile karşıdan araba gelecek mi acaba diye bir endişe duyar ya, bunlar da "karşıdan araç gelirse uff uğraşacağız" diye düşünüyorlardır ve bunu da her gün yaşıyorlardır. Sonra da zaten korktuğu başına geliyor ve karşıdan gelen bir otobüsle karşılaşıyor. Bu durumda "haah, bak gördün mü, demiştim, denk geldi" gibi bir tepki veriyor sana. Bu durumu şöyle okuyorum: burada kronik bir problem var, bu insanların buraya park etmemeleri gerekiyor, biz bunu söyledik ama bizi kimse dinlemiyor ve sonuçta da yine biz bu stresi her gün yaşamak durumunda kalıyoruz. Sürücünün bu

tepkiyi vermesi mantıklı ve bu sorunun düzgün bir şekilde çözülmesi ve bu sorunu yaşamaması gerekiyor. O anlamda videodaki bu bilgi anlamlı geldi. FA4

1FA Position: 22 - 22

Bıçkın5 GIF'inde kimya kavşakta otobüsü kuralsız sollayan otomobilden dolayı söyleniyor ama bir şey yapmıyor, korna çalmıyor, sadece serzeniyor. Bıçkın bir karakterden daha fazla tepki vermesini beklerdim ama tepki vermiyor. FA6

1FA Position: 26 - 26

Uyumlu5 GIF'ine bakınca hatırlıyorum, sürücü metro durağında ulaştığında ringi bitiyor ama orta ayna baktığında arkada bir yolcunun inmediğini görüyor. Arkaya dönerek yolcuya sesleniyor ama yolcu duymuyor. Sanırım bu da Bıçkın1'de "kulaklığı takıyorlar bizi duymuyorlar" diye şikâyet ettiği gibi bir durum. Sürücü "sonn durak hocam" diye özellikle onu uyarmak durumunda hissetti. Demek ki gerçekten net bir şey yok. Kim neyin nerede son durak olduğunu bilmiyor, onu açıklamak gerekiyor. Bu şununla da alakalı, güzergahların, hangi saatte kaç otobüs çıkacağının esnek olmasını istersen kafana göre ayarlayabilmek için ring planını belirsiz tutman ve gerekiyor. Ancak esneklikten feragat ederek insanların anlayacağı, kabul edeceği ve her tarafta düzgün bir şekilde açıklanabilecek bir plan yapılabilir. Esnek olunca buradaki gibi durumlar ortaya çıkıyor. Bir yandan da bu yeterli sayıda araç olmaması gibi kaynaklarla ilgili bir durum ve bir tercih aslında, ona da bir şey diyemiyorsun. FA9,10

1FA Position: 48 - 48

Uyumlu5'teki orta yukarıdaki aynayı - bütün otobüslerde var mı bilmiyorum ama- bi tek bu sürücüde gördüm [FA'nın izlediği sürücüler arasında aynı otobüsü kullanıp kısa boylu olan olmadığı için olabilir. Uyumlu boyu uzun olduğu için olabilir mi? ihtiyarda da mesela yolun yarınsan aşağısı görünüyordu sadece] kullanan tek o. FA10

1FA Position: 51 - 51

Uyumlu5 Demiraylardan A2'ye dönerken havacılık durağında araca binmek isteyenlere "A2'ye gider, çarşıya gitmiyor [çünkü ringi bitti ve A2'den sonra garaja dönecek, başka bir otobüs gelecek ve sonraki ringe çıkacak]" diye uyarıyor. Bu videoda 10 kere falan "güzergâh konfirmasyon" notu aldım. Çarşıya gitmek isteyenler yanlışlıkla binmesin diye. Binen yolcular haydiii iniyor tekrar. Çok büyük bir verim kaybı ya. FA10

1FA Position: 52 - 52

Uyumlu5 Demiraylar cepten çıktıktan sonra aklıma geldi. Uyumlu videoları gece çekimi olduğu için hatırlıyorum ama hangi videodaydı emin değilim. Ayrıca kayda değer mi ondan da emin değilim ama bir yerde gene Demiraylardaki bu cepli durağa benzer bir cepten çıkarken [Uyumlu2 3:30 civarı KKM durağından kalkıp sola 1. Yola döndüğü noktada AK] önden giden 2 tane araç var. Sürücünün gözü öndeki aracın stoplarına takılıyor, otobüs sağa dönmekte olduğu için araç otobüsün orta aynasının arkasında kalıyor, dönüş tamamlanınca araç orta ayna hizasından çıkmış oluyor ve Uyumlu'nun gözü aracı aynadan çıktığı noktada tam isabetli bir şekilde yakalıyor. Çok enteresandı. [o videoyu da izleyelim AK] FA10,11

1FA Position: 54 - 54

Uyumlu5 enformatikten tarafından BÖTE tarafına doğru geliyor, Teknokent kavşağından sola dönüyor. Bu kavşaktan dönerken sağ ön taraftaki refüjün ileri limit noktasını görüyor, otobüsün burnu arabadan farklı ve sürücü ön tekerden çok önde oturuyor ya, o yüzden dönüş için planlama yapmak zorunda kalıyorsun. Çünkü otobüste aracın en dıştaki noktası/refüjün sağ dış ucuna çarpma ihtimali olan kısmı arabadan çok daha farklı bir yerde oluyor. Bu bakış patterni enteresan bir şey bence. FA11

1FA Position: 56 - 56

Uyumlu2 ODTÜ Kent'ten sağa gıda mühendisliği yoluna dönmek üzereyken başlıyor. Yukarı çıktıktan sonra MM binası önünden Devrim kavşağa girerken yolun sol kısmında yayalar kaldırıma çıkıyor. Gece sürüşünde bakış patterni çok

farklı oluyor. Şakacı'da gündüz sürüşünde sürücü uzaktan bile yol kenarındaki yayaları sürekli kontrol ediyordu. Gece sürüşünde farların da [yeteri kadar kuvvetli olmamasının] etkisiyle görüş mesafesi kısalıyor ve sürücü uzaktan kontrol edemediği için sürekli olarak yakınındaki alanı taramak zorunda kalıyor. Biz kamera kaydı olduğu için uzaktakileri göremiyoruz ama zaten sürücünün de göremediği çok belli oluyor [göz işaretçisi yayalar yakınına gelene kadar onların üzerine gitmediği ve yayalar yakınlaşınca baktığı için AK]. Yanılmış da olabilirim ama. FA11

1FA Position: 61 - 61

Uyumlu2 KKM'den sağa, A1 tarafına dönerken görüntü kapanıyor biraz, hooop tekrar aracın olduğu yerden aynanın arkasından çıkıyor. Çok enteresan gerçekten [FA53'te bahsettiğimiz orta aynanın sürücünün yol görüşünü kestiği yer burası]. Hani tavukları elde havaya kaldırıp sağa sola oynatsan bile kafaları aynı yerde sabit kalır ya, onun gibi bi durum. FA12

1FA Position: 71 - 71

Videoları izlerken değil ama UJM'yi doldururken kendimi sürücülerin yerine koyduğum oldu. Özellikle masa üzerinde yatma işi baya dokundu bana, çok haksız olduğunu düşündüm. Düzgün bir dinlenme alanlarının olmaması üzücü, görevleri olmayan işleri yapmak zorunda kalıyorlar, yine de [videolar sırasında] sürekli herkesin sorularını cevaplıyorlar, sıkılmıyorlar, bunu benimsemişler. Ben olsam isyan ederdim. Onun dışında Bıçkın3'te karşıdan otobüs geliyor, dar ve sıkışıyorlar ya, o gerginliği hissettim, ben olsam ben de hissederdim diye düşünüyorum. FA13

1FA Position: 77 - 77

İlk linkedinden iletişime geçtiğinde tam olarak nasıl bi şeyle karşılaşacağımı bilemedim ve o zaman 3 saat süreceğini söylediğinde gözüme büyük göründü. Tahminimden daha eğlenceli çıktı, özellikle videolar ve yorum yazma kısmı. Tabii dediğim gibi ben biraz böyle aklıma geleni yazdım da. Miro kısmı gayet makuldü, sürekli kullandığım bir şey, vimeo kullandığım bir şey, önüme iş hayatında, ortaya

çıkan bir şeyle ilgili fikirlerimi yazma ve onunla ilgili yorumlarda bulunma işine çok alışık da olduğum için, sürekli yaptığım da bir şey olduğu için, çok da şey yapmadım, gayet akıcıydı süreç tasarımı. FA13

1FA Position: 79 - 79

Neden sürekli orta aynadan otobüsün içini kontrol ettiğini anlamadım, inecek olan var mı diye mi kontrol ediyor? Aklı sürekli arkadaki öğrencilerde gibi, niye anlamıyorum. Nasıl bir input peşinde? FA14,15

1FA Position: 84 - 84

Uyumlu3 durakta yolcular indikten sonra kapıları kapattı ama sonrasında da uzun süre sağ aynadan arkaya bakmaya devam etti. Herhalde inecek olanların indiklerinden emin olmaya çalışıyor. FA15

1FA Position: 87 - 87

Uyumlu2 KKM'den sağa dönüşte orta aynanın yoldaki aracı kapatması ama yine de sürücünün bakışının yoldaki aracı yakalaması meselesinde [sence konfor ve güvenliği artırmak için bir şeyler düşünülebilir mi? AK]. Aslına bakarsan sürücüler tecrübeyle birlikte birçok problemi kendileri çözebilir hale geliyorlar. Orta aynanın Uyumlunun görüşünü kapatması ya da Bıçkın'da sağ A posttaki ekranın yol görüşünü kapatması aslında sürücünün çok da rahatsız olduğu bir şey değil. FA17

1FA Position: 92 - 92

Uyumlu 2 - 00:00:55 - FA - İniş biniş sırasında her kullanıcıda yoğun bir sağ arka ayna kontrolü var. Ardından da kalkış kontrolü için sol arka ayna kontrolü geliyor.

1FA Position: 98 – 98

O. 2MeK Synopses

Çalışma öncesi açıklamalardan sonra bu çalışmaya yaklaşımım şu şekilde oldu: ben bir tasarımcı olarak çalışıyorum ve kullanıcı araştırması sonuçlarıyla bir şeyler yapacağım. O zaman ikinci bir ekranda seninle paylaşmak isteyeceğim notları almak için bir belge hazırlamaya başladım. Bu notlarda çalışmaya dair hissettiklerim de oldu. Bir ekranda Miro'ya bakarken diğer ekranda notlarım açıktı ve çalışma konforum yerindeydi. MeKp1

2MeK Position: 1 - 1

Birebir sürücüleri personalara mı yansıttık? Sürücülerin hepsi erkek olabilir ama personaların hepsinin erkek olması gerekiyor muydu? Belki erkeklerle yapılan çalışmalarla beraber bir kadın personası ortaya çıkarılabilir miydi? MeKp1

2MeK Position: 2 - 2

Sürücülerin özellikleri kısmında güvenmiyor, bilgili değil, güveniyor arası olan skalada "bilgili değil" seçeneğini ayrı bir yere koyardım, ortaya orta karar güveniyor gibi bir şey eklerdim. MeKp1

2MeK Position: 4 - 4

Personaları izlerken doğrudan sıfatlara baktım, persona detayları hakkında overall bilgiyi iyi anlatıyor zaten, detaya ihtiyaç duyarsam geri dönerim dedim. Bu beni reassure etti, mutlu etti. Persona seçme kriterim bu sıfatlar oldu çünkü bana göre o sıfatlar bana göre çok güzel ve böylece personaları hızlı tarayabilirim. 3 tane persona seçeceğim ve zaten seçmeyeceğim personaların detaylarıyla ne yapacağımı bilemedim. MeKp1,2

2MeK Position: 5 - 5

UJM’nin olduğu Miro ekranı çok manage edilebilir idi. Ama UJM’yi doldurup videolara yönlendiren linke tıkladığımda bölüm sonu canavarıyla karşılaşmış gibi oldum. Çünkü tek bir video açılacakmış hissi verdi ama o Miro’da yoğundu. Dolayısıyla biraz gözümü korkuttu. MeKp2

2MeK Position: 7 - 7

Sürüş videoları board’una geçtikten sonra buradaki güzel bilgileri değerlendirdim, birkaç kez “başlamadan önce” kısımlarını okudum. Sonra bütün GIF’leri izleyecek miyim diye hüsrana uğradım çünkü GIF’lerin ilk kez inmesi çok zaman aldı. Aslında bence GIF’ler çok güzel düşünülmüş. Ham dataya ulaşmadan önce o datayı sinyalleyen şeyler ki o datada ben bir seçim yapacağım ve bu seçimi kolaylaştıran bir şey. MeKp6

2MeK Position: 18 - 18

Şakacı1 aracı sürerken cep telefonuna kendi ihtiyacı için bakıyor. Ben araç kullanmıyorum ama bu aşamada benim de yapabileceğim bir şey bu. Gerçekten de güvenlik ve prosedür açısından olmaması gereken bir şey ama çok da ahım şahım bir hata değilmiş gibi geliyor. MeKp8

2MeK Position: 23 - 23

Şakacı1 metro istasyonundaki ilk duraktan hareket ediyor ve aracı kullanırken çocuğuyla görüntülü görüşüyor. Buradaki ihtiyacı 2’ye ayırabilirim. İlki başta söylediğim gibi sürücüye yolculuğa çıkmadan tamamlaması istenen bir check list verilmesi. Yapması gereken işler “itimize” edilerek bir prosedüre dönüştürülebilir ve sürücü hareket etmeden önce bunları yerine getirebilir. Aracı kullanırken çocuğuyla konuşması için problem çıkartmaya çalışan, iş ortamında problem alanı hakkında konuşan ve de güzel yorumlar yapmak isteyen bir tasarımcı gibi konuşursam şöyle diyebilirim: sabahın ayazında çocuğuyla beraber duygusal şeyini destekleyecek bazı şeylere ihtiyacı var, o yüzden aracın bir tarafına onu hatırlatacak bir şeyler konulabilir mi falan gibisinden yorumlar yapabilirim sırf çıktı sağlasın diye. Ama aynı zamanda denk düşmüştür çocuğu aramıştır da

diyebilirim. Çocuğuyla güne başlamak mutluluk vericidir, bu aralar ben de yavru köpeğimi aileme göstermek için sık görüşmeler yapıyorum ve bu uplifting bir şey. Ama sürücü çocuğunu gördü de uplift oldu diye daha konforlu bir şekilde sürüş yapacaktır düşüncesi ve bir tasarımcı olarak buna yönelik bir şeyler söylemek beni rahatsız hissettiriyor. Yani aracı sürüyorsun ve konforsuz da değilsin, daha mutlu olunca performansın artmayacak. Sürüş sırasında ekstra bir performans göstermenin artı bir şey sağlayacağını düşünmüyorum, performanssızlığın kötü olduğu bir durum. Ne yapacaksın yani, daha güzel bir manevrayla mı döneceksin? Dolayısıyla durumlar böyle. MeKp8,9

2MeK Position: 24 - 24

Şakacı1 başlangıcında montunu asıyor ve acaba asarken onu rahatsız ediyor mudur diye düşündüm. Montu kalınsa ve sürücü huylu biriyse montun arkadan çarpması rahatsız eder mi diye düşündüm. MeKp9

2MeK Position: 26 - 26

Şakacı3'te KKM durağından kalkarken soldaki refüjden yola aniden atlayan ve hemen arkasından Devrim kavşakta da roundabout kenarından/yürümemesi gereken bir yerden yürüyen yayalar vardı, sürücünün ona karşı hassasiyeti oldu. O yürüdükleri yerler tercih edilen yürüme yerleri değil, belirlenmiş yaya geçitlerinden geçmeleri gerekir ve yayaların buralardan geçmeleri sürücünün problemi değil. Dolaylı olarak sürücünün konfor ve güvenliğini artırmak için diğer yol paydaşlarına eğitimler verilerek farkındalıkları artırılabilir, yolun başka taraflarını kullanmaya yönlendirilebilirler. MeKp15

2MeK Position: 42 - 42

Şakacı3'te KKM durağından kalkarken soldaki refüjden yola aniden atlayan yayaya, araştırmacı arkadaşımın videoyu yavaşlatmasından da dolayı dikkat etmem gerekiyormuş hissi geldi. Buna çözümler üretmek istediğim noktada kendime ket vuruyorum, ODTÜ'yü ve bazı işlerin ne kadar yavaş gerçekleştiğini bildiğim için bir sistem önersem o sistemin çok zar zor yerleşebileceğini düşündüğüm için. Ama

aklıma yola atlama potansiyeli olan yayaları sürücüye haber verecek sensörler kullanılması geliyor. MeKp16

2MeK Position: 43 - 43

Şakacı4 videosunu izledim, tam iyi yazılı notlar alamadım, akılda notlar aldım çünkü gözlediğim olaylar üzerinde düşündüklerimi hızlı bir şekilde ifade edemedim yazılı olarak. Daha bir elaborate etmek istediğim şeyler olduğu için bir kez daha hızlandırmadan izleyeceğim aralarda videoyu durdurup üzerine konuşacağım. Çünkü sesi duymak da önemli. MeKp17

2MeK Position: 47 - 47

Şakacı4 sonunda "bununla mı gideceksin? Servise gidecek bu araç" diye bir ses geliyor. İçerideki kişi mi sordu yoksa ses dışarıdan mı geldi? (İçerideki sürücü dışarıda bekleyen sürücülere sordu). MeKp21

2MeK Position: 58 - 58

Başka bir Personada özelliklerin üzerinden tek tek geçeyim. Şakacı persona: yetişkin, boyu belli, eğitimi belli, yani bu bilgileri toplamak Allah'ın emri gibi geliyor artık, bu bilgilerle tam ne yapabilirim bilmesem de. Sadece persona fotoğrafına baksam bile bu profilin Şakacı olduğu sonucuna varabilirdim, yolcularla iletişimi iyi, bu benim gözlemimle de uyuşuyor, bu kısmı tutarlı. Burada en çok kullanacağım bilgi sürüş teknolojilerine güveni olurdu. Teknoloji kullanım alışkanlığına dair bilgi ise genel olarak kullanacağım bir bilgi olurdu. Özellikleri kısmında yazan bilgileri şu şekilde kullanırdım. Olgunlaşmış bir ürün fikri üzerinden teknoloji kullanım alışkanlığı çok olanla az olan personalar arasındaki farklar nasıl diye kıyas yapmak veya kullanılabilirliğe dair geliştirmeler önermek için kullanabilirim. Mesela etrafta otobüse yaklaşan şeyleri sense eden ve sürücüye bir şeylere öneren bir sistemden bahsetmiştik ya, o sisteme karar verme aşamasında dönüp şakacıya danışabilirdik. Sürüş teknolojilerine neden güvenmediğini anlayıp, aynı zamanda konsept olarak geliştirdiğimiz bir şeylere güvenip güvenmediğini sorardım. Tabii personadan böyle bir bilgiyi net olarak alamazdım ama buradaki

bilgiler doğrultusunda bazı teknoloji önerileri hakkındaki yorumlarını almak için yeniden bu arkadaşlara ulaşmak isterdim. MeKp25

2MeK Position: 66 - 66

Sürüş videolarının ayrı bir sayfada olması iyi çünkü asıl data data kısmı orası. Önce UJM'de overall bilgiyi alıyoruz, sonrasında detaya inmek istediğimizde karşımıza yönlendirmelerle birlikte detaya inmeyi facilitate eden/kolaylaştıran bir ara yüz çıkıyor. Ama bu aralar daha az bilgiyle çalışmaya yeltendiğim için UJM'nin olduğu taraf bana daha uygun geldi. Videoların olduğu sayfadaki videoların haritalarla olan ilişkilerini kuruyorum ama nasıl kullanabileceğimi bilmiyorum. Benim için videoda ilgimi çeken bir şey varsa oradan bir screenshot alarak UJM'ye koymak daha ortamı anlatan bir şey oluyor. Yani sadece köpek varmış bilgisinden ziyade köpek nereden nereye geçiyormuş bilgisinden dolayı ekran görüntüsü alıp UJM'ye yapıştırmayı tercih ederdim. Videolara ihtiyacım olduğunda dönerdim. Ama bunların hepsi dediğim gibi senin bu önerdiğin şeyin (Tool/metod) olanak vermesinden dolayı. MeKp28

2MeK Position: 74 – 74

P. 3SG Synopses

Şakacı Persona: Şakacı personasıyla başlamak isterim çünkü belki diğer videolarda agresiflik vardır, sabah sabah istemem. SGp4

3SG Position: 13 - 13

Personada Güvenli sürüş yetenekleri denilince yol vermeyi değil karlı havalarda araca hâkim olabilmeyi anlarım. Bu da algısının yüksek olmasını gerektirir. Algı motor yetenekleri zayıfken güvenli sürüş yeteneklerinin yüksek çıkması çelişkili geldi. Nasıl ölçülüyor bunlar? [AK: DBQ ile] SGp4

3SG Position: 17 - 17

Video seçerken (GIF'lere bakarak) "sürüş sırasında gözlem yapmayı isterim. Bu yüzden molada olduğu videoyu izlemeyeceğim. Şakacı 1'de GIF'te sürüş sırasında telefona bakıyor, bunu izlemeyi isterim". SGp4

3SG Position: 18 - 18

ŞAKACI 1: Sürücünün araca bindikten sonra ilk işi elindeki eşyaları koyacak bir yer araması, üstünü çıkarıp asması. SGp5

3SG Position: 19 - 19

Telefona bakarak araç kullanıyor olması problem. Sürücünün teknolojiye ihtiyacı var. Telefon ekranına basmasına gerek kalmadan kullanabileceği, dikkatlerini en az dağıtacak ekipmanlarla telefonlarını kullanabilirler. Çünkü 10 saat buradalar ve hiçbirimiz çalışırken hayattan 100% soyutlanmıyoruz. Adamdan soyutlanmasını bekliyorsak telefonları komple kapatıp denetlememiz lazım. Beklemiyorsak da uygun bir ekipman sağlamamız gerek. SGp5

3SG Position: 21 - 21

Gösterge panelinden kendi yansımasını görüyor, yansıma problem, istediği bilgileri ekrandan alamayabilir. SGp5

3SG Position: 22 - 22

Sağa dönüş yaparken yayaya kornayla selam vermesi çok tehlikeli. Direksiyon elinden kaysa gitti, farkında değil. Korna çaldığı için yayanın hareketini durduruyor. Bu da otobüsün geçebileceği alanı daralttı. SGp5

3SG Position: 23 - 23

Sürücünün bilinçlenmeye ihtiyacı var. Kendisi ve dışarıdaki insanlar için sorumluluğunun ve nelere sebep olabileceğinin farkında değil. SGp5

3SG Position: 24 - 24

Göz hareketlerini, nereye baktığını gösteren bir kayıt olması çok tehlikeli ya :) (ifşa olmak) SGp6

3SG Position: 30 - 30

UYANIK 2: Uyanık 2'nin göz hareketleri çok hızlı, hızlandırılmış video mu? Videonun hızlandırılmamış halinde de çok hızlı Şakacı'ya göre. SGp7

3SG Position: 31 - 31

İhtiyar Persona: İhtiyar personasının fotoğrafından otobüsün koç tipi olduğunu, diğerlerinden farklı olduğunu fark ediyor. Neden ihtiyarın kullandığı otobüs farklı? SGp8

3SG Position: 37 - 37

Koç tipi yüksek olduğu için uygun değil. Öğrenciler kullanıyorsa fark edilmiyordur da öğretmenler de kullanıyorsa zorlanıyorlardır. Her seferinde basamak çıkmak durakta bekleme sürelerini uzatıyordur. SGp8

3SG Position: 38 - 38

Sürücüler değişiyor, aynı otobüslere dedike değiller değil mi? (Değiller) SGp8

3SG Position: 39 - 39

Sürücülerin arka arkaya bu kadar değişik türde araç kullanmaları çok sağlıklı değil. Bu araçların manevra yetenekleri ve teknolojileri farklı. Koç tütündekinin konforuna alışan sürücü klas 1'e uyum sağlamakta anlık zorlanabilir. SGp8

3SG Position: 40 - 40

İhtiyar'ın yolcularla iletişimi ne iyi ne kötü. Yaşıyor gidiyor kafasında bir adam bu biraz. Orta karar cevaplar vermesi, teknoloji kullanımına ben bilmem demesi ya da fotoğraftaki bakışı bana bunu düşündürmüş olabilir. Kendimi röportaj yapanın yerine koydum, kendi tecrübemden de bu çıkarımı yapmış olabilirim. Sürekli orta karar cevapları veren, röportaja isteksiz, üstüne düşünmeyecek kadar hayatı boşlamış olduğunu düşündüm. Zaten yaşlanmış abimiz, işim bitsin de gideyim diyor izlenimi veriyor. SGp9

3SG Position: 41 - 41

İhtiyar 2 hat tabelasını ilk önce düzgün yerleştirmişti ama tekrar kalkıp yamuk yerleştirdi. Acaba dışardan görünmesini sağlamak için mi? Silecekler tabelanın okunacak yazıya engel olabilir. Torpidodan cama yansıyan ışığı kesmeye çalışıyor da olabilir. Bulamadım. SGp10

3SG Position: 46 - 46

Hat tabelasını gösterecek, sürücüyü uğraştırmayacak, görüşünü kapatmayacak bir gösterge paneline ihtiyacı var. SGp10

3SG Position: 47 - 47

Uyumlu Persona: Uyumlu için yaşlı yazıyor ama fotoğrafta yaşlı durmuyor. Videoda sürücünün elinde yüzük vardı. Persona fotoğraflarının gerçekten de videodaki sürücülerin fotoğrafları olmasını isterim. Foto kafamda bir şey canlandırırken Persona yazıları farklı bir şeye işaret etmemeli, uyumlu olmalı. SGp10

3SG Position: 48 - 48

Personaların sağlık problemlerini karşılaştırarak pattern arıyorum. Sürücülerin ne problemi olur diye sorsalar hiçbir şey bilmeden eklem, kalp-damar, şeker problemi olur derdim. Bizim kültürdeki yeme içme alışkanlıklarının yanı sıra meslekleri de kolay değil. SGp11

3SG Position: 49 - 49

UYUMLU 5: Uyumlu 5 aynaya ve aracın içine hâkim, sürekli kontrol halinde. Şu ana kadarki gözlemim personanın dalgınlık skoruyla bağdaşmadı. SGp12

3SG Position: 54 - 54

Durak bilgilendirme sistemi gerekli. Araç binen yolcunun telefonuyla eşleşebilir veya hangi durakta olduğunun bilgisi anlık olarak otobüs içindeki bir ekrandan paylaşılabilir. Şimdi yolcu çok arada bırakılıyor, sürücünün de yolcularla çok fazla muhatap olması gerekiyor. SGp12

3SG Position: 55 - 55

Metrolarda durak takip sistemi var ama otobüslerde – yenilerinde bile- çok yok. Çünkü durakların sisteme işlenmesi gerekiyor bu otobüsler ise sürekli güzergâh değiştiriyorlar. Belki otobüs duraklarının sisteme entegre olması lazım. Bu da alt yapı yatırımı gerektiriyor. Bu yatırımı yapmak yerine nasılsa çocuklar soruyor, sürücüler de söylüyor gözüyle bakıyorlar. Bizim sattığımız otobüslerde bu teknoloji talebi gelmiyor. Ama bunun sonucunda adam günde belki 50-100-200 kere aynı sorulara maruz kalıp şişiyor. Uyumlunun böyle tepki vermesi normal. SGp12

3SG Position: 56 - 56

Uyumlunun diksiyonunda sıkıntı var ne dediğini anlamıyorum, neyden şikâyet ediyor? SGp13

3SG Position: 57 - 57

Teknokent sonrası yollar çok bozuk, sürücüler bu yollardan sürekli geçerken sarsıntıdan, sesten yoruluyorlardır, psikolojik rahatsızlık veriyordur. Aracın kullanım ömrünü ve bakım maliyetini olumsuz etkiliyordur. Böyle kapalı bir sistemde, kampüste yolların daha iyi olmasını beklerdim. SGp13

3SG Position: 59 - 59

Bezgin Persona: Bezgin sürüş teknolojilerine güveniyor, bunu okuduğumda fotoğraftaki araç ne diye bakıyorum. Bezgin koç türü bir Mercedes'e biniyor, iyi teknoloji bir araç. Güvenmesi normal geliyor. SGp14

3SG Position: 64 - 64

Bezgin personanın Parfüm alerjisi ve kronik sırt ağrısı gibi işini yapmaya engel olan veya işini yaparken mutsuz olmasına neden olabilecek hastalıkları varken mesleğe devam etmesi işiyle öylesine bir ilişki kurmasına neden oluyor olabilir. Ayrıca ringi bir an önce bitirmeye çalıştığı için ihlal ve hatalar yapıyor olabilir. Persona fotoğrafı da o ruh halini yansıtıyor. SGp15

3SG Position: 65 - 65

FİNAL SORULAR: Sürücü deneyim haritasından (UJM) çıkarımlarımla videolardan çıkarımlarımın (induction) hem örtüştüğü hem de örtüşmediği yerler vardı. UJM'deki olumsuz ifadeleri okuduğumda İstanbul'da bir toplu taşıma servisinden bahsediliyormuş gibi geldi. Videoları izlediğimde buradaki trafiğin daha sakin olduğunu gördüm. UJM'deki otobüsü boşaltıp yedek otobüse göçmek gibi sorunların etkileri şehir trafiğindeki kadar büyük olmaz. UJM'de buranın daha stresli bir ortam olduğunu düşünmüştüm. SGp18

3SG Position: 77 - 77

Ben Personaların aile hayatlarından da bir şeyler görmek isterdim. Saat kaçta işe geliyorlar, kaç saat işte kalıyorlar, bunun ne kadarında aktif olarak araç kullanıyorlar, seferler ne kadar zaman alıyor, günde kaç sefer yapıyor gibi bilgileri de görmek isterdim. SGp18

3SG Position: 79 - 79

Miro board linkini tıkladıktan sonra çalışmanın sistemini anlamak, UJM'de yazılanlara bakarak izlenim edinmek, yönergeleri takip etmek çok anlaşılır şekilde kurgulanmış. Videoları izlerken nerede olduğumu, ne izlediğimi biliyor oluyorum. Bu çalışmada ne yapılmaya çalışıldığı hakkında bana fikir veriyor. Güzel kurgulanmış bir sistem. SGp18

3SG Position: 80 - 80

[İhtiyar Personasının fotoğrafını inceleyip, videodaki gibi bir yüzük arayıp bulduktan sonra] Mesela, persona fotoğrafındaki adam gerçek sürücü değilse ben bu adamı görmek istemezdim. Çünkü videodaki sürücü fotoğrafla çeliştiğinde algımı değiştiriyor. SG p.11

3SG Position: 88 – 88

Q. 4CB Synopses

İhtiyar 2'ün kornaya sinirlendiği için değil de selamlaşmak için basması bana yolcu olarak sevimli geliyor. Çünkü 1- sürücüler birbirlerini tanıdığı ve selamlaştıkları için kendini bir sistemin parçası gibi hissediyorsun ve daha güvende hissediyorsun. 2-sürücünün psikolojik durumu iyi ve mutlu bir sürücü tarafından taşınıyorsun diye iyi hissediyorsun. Ama tüm yolcular böyle hissetmeyebilir, o sırada iş yoğunluğu olan, kafası meşgul olan yolcular gürültüden rahatsız olabilirler. Bir de tabii korna bu amaç için üretilmediği için yanlış anlamalar olabilir. CBp4

4CB Position: 14 - 14

(İhtiyar 2 tabelanın yönünü değiştirmediğini hatırlayarak sağa dönüş sırasında ayağa kalkarak tabelaya uzanıp değiştiriyor) Bu çok bariz bir sorun tabii, sürüş sırasında sürekli başka şeylerle ilgileniyor, sürekli dikkati dağılıyor. Tabela uzakta, arada direksiyon ve dashboard var, ergonomi açısından zor görünüyor. Bir de sürücü kısa boylu olduğu için acaba tabelaya uzanırken ayağa mı kalktı, ayağı pedallara yetişebiliyor mu, ayaklarının yerini mi değiştirdi gibi şeyler düşünüyorum. Sürücünün bunu yapmaması lazım ama onun için de bu davranışı yapmasını gerektiren bir durumun ortaya çıkmaması lazım. Sürücü güne başlamadan önce, aracı aramak, yakıt durumunu düşünmek, aracın nerede olduğunu vs düşünmek zorunda kalıyor ve sanki bir mesai daha yapmış gibi oluyor. Tabelanın yönünü değiştirmeyi unutması çok normal. En basitinden bir app gibi bir şey olsa unutmayacaktı, ya da güzergâh bilgisi sürücünün bir şey yapasına gerek kalmadan kendiliğinden elektronik bir şekilde yazılı olacaktı. CBp4

4CB Position: 16 - 16

Video hızlı çekime geçince "bir karmaşa var burada… ha hızlı çekim olduğu için". CBp5

4CB Position: 21 - 21

Uyanık 4'ün ön kapıyı kapatmadan önce kapının süpürme alanında kimsenin olup olmadığını kontrol etmesi bana arka kapılar ve hatta kapıdan geçtikten sonra yolcuların yerleşmesi için beklemek gerektiğini hatırlattı. Mesela İsveç'te yolcuların hepsi binip yerlerine yerleşmeden otobüs hareket etmez. Yolcu ayakta bile olacaksa ayakta yerleşmesi beklenir. Yolcular arasında yaşlısı var, sakatı var, yürüteç kullananı var. Bu sadece yolcu konforu için, lüks için yapılmaz, yolcu güvenliği için yapılır. Tabii böyle davranmaya Türkiye'deki kimsenin sabrı yetmez ama tüm yolcuların kapıdan geçtiği, yerlerine oturdukları ya da ayakta yerleştikleri bilgisinin sürücüye iletilmesi ve yolcu güvenliğinin önemli olduğunun sürücüye anlatılması ihtiyaç olabilir. CBp5

4CB Position: 24 - 24

ŞAKACI 3: Video seçerken benim seçim kriterim kendi kişisel yolcu deneyimlerimle alakalı. Onlara bakabiliriz… şakacı :) ismini merak ettim. Bir de GIF'te otobüs dışında olduğu bir görüntü var. Otobüs dışında ne var merak ettim. CBp5

4CB Position: 26 - 26

Aaa, çok ilginç Şakacı 3 yolcular içerideyken mola veriyor. İçerideki herkes biliyor mu bunun mola anı olduğunu? (evet) Ama ben yeni bir yolcu, bilmeyen bir kişi olabilirim. Sürücü otobüsün içinde arkaya dönüp mola veriyorum diye sesleniyor ama binmeden ya da bir durak önceden haberim olsa daha iyi olurdu. Burada sürücü açısından değil ama yolcu açısından bir bilgilendirme sistemine ihtiyaç var. Belki yolcu olarak mola sırasında otobüs içinde beklemek yerine yürümeyi seçebilirdim, belki o sırada gideceğim yere varırdım bile. CBp6

4CB Position: 28 - 28

(Şakacı 3)KKM durağından ayrılırken karşıdan gelen güneş yol üzerinden kuvvetli bir yansıma yapıyor; aynı anda soldan bir yaya karşıdan karşıya geçerken otobüse doğru yürüyor. Sürücü yayaya yol vermiyor ve sanki otobüs, kendisi de yayanın

yanından geçen başka bir yayaymış gibi geçiyor. Bu davranış çok tehlikeli ve yanlış; o yaya görme engelli olabilirdi, ya da bilişsel bir rahatsızlığı olabilirdi. Tüm sakatlıklar tekerlekli sandalye gibi gözle görülebilen rahatsızlıklar değiller. Sürücünün sürekli bu hatırlatmaya ihtiyacı var; "dikkat yaya var" şeklinde -Google glass gibi- AR uyarıları verilebilir. Sürücü yaya var uyarısına aldırış etmeyebilir ama ikinci üçüncü vs uyarıdan sonra sürücünün dikkatinin tekrarlı bir şekilde yayaya yönlendirilmesi sonucunda sürücü de öğrenmeye başlayacaktır ve davranışı değişecektir. Diğer bir alternatif otobüsün kontrolü ele alıp otomatik olarak frenleme yapması ama o da farklı tehlikelere yol açabilir ve o konuda çok bilgim yok. O yüzden otobüsün kontrolü ele almasını öneremeyeceğim. Sonuç olarak sürücünün dikkatinin sürekli olarak yol üzerindeki öncelikli güvenlik sorunlarına yönlendirilmesine ihtiyaç var. CBp6

4CB Position: 30 - 30

Bezgin 4 eğitim cepli durakta yolcu alırken bir yolcu otobüsün güzergahıyla ilgili soru soruyor. Burada yine ciddi anlamda yolcu yönlendirmesi eksik. CBp8

4CB Position: 36 - 36

Bu çalışmadaki datada bir sürü tasarım problemi var ve problem olarak tanımlanacak şeyler, neyi tasarlayacağına bağlı olarak değişir. Odaklanacağımız konu kampüs içi toplu taşıma servis tasarımıysa yolcu yönetimi ve bilgilendirmesi, yolcuların nereden nereye gidebileceklerini takip edip bilebilecekleri -belki de araç içine yerleştirilmiş- güzel bir yönlendirme sistemi tasarlanabilir. Ama bir yandan da sürücü sürekli yolun sınırlarına dikkat ediyor ve diğer araçlara bakıyor. Sanki bir şeylere çarpmaktan endişeleniyor gibi. Sürücüye sınırları işaret eden, ona sürüş sırasında biraz daha güvenlik hissi verebilecek Google glass gibi, gideceğin yol bu, sınırları/uç noktaları şu gibi bilgilendirme yapan AR görsel bir sistem tasarlanabilir. CBp8

4CB Position: 39 - 39

Personaları ve Bezgin, Bıçkın, İhtiyar gibi isimleri olmasını beğendim çünkü benim bu çalışmaya ayırdığım kısıtlı zamanda beni yönlendirerek hızlı karar vermemi kolaylaştırıyor. Yani bir an önce sadede gelmek istiyorsak ve problemlerle ilgili hemen tepki verilmesini bekliyorsak bu tarz yönlendirmeler işi kolaylaştırıyor. İsminden nasıl biri olduğuyla ilgili bir fikrim oldu, sağlık problemlerini gördüm, videolarda da buna yönelik şeyler göreceğim diye düşündüm. Ama bütün videoları tarafsız bir şekilde izleyip problemleri saptayacağım diyecek biriysem isimler gereğinden çok yönlendirici gelebilir. Projeye ne kadar zaman ayrılabileceğine göre isimlere verilen tepkiler değişebilir. CBp10

4CB Position: 48 - 48

UJM'nin loop şeklinde tasarlanması basamak basamak takip etmeyi kolaylaştırarak daha az göz korkutucu :) olmasını sağladı. Alışık olduğumuz A noktasından B noktasına doğrusal olarak giden ve uzuuun uzuun devam eden UJMler hem göz korkutuyor hem de nerede kaldığını kaybedebiliyorsun. Belki burada sürücü zaten bir loop içinde gittiği için UJM'yi bu şekilde kurguladın ama bu kurgu başka alanlardaki UJMlere de uygulanabilir. Kullanıcının journey'i başladığı yerde bitirmesi iyi fikir. CBp12

4CB Position: 55 - 55

Sürücü videoları frame'lerine geldiğim zaman, genel UJM'den daha detaylı, granüler bir bilgi seviyesine ulaştığımı hissettim. CBp12

4CB Position: 56 - 56

GIF'ler ve Vimeo, yani GIF'ten bakarak video seçebilmek çok iyiydi açıkçası. CBp12

4CB Position: 57 - 57

Sürücü profil isimleri bir yandan ön yargı yaratabilir ama yapıyorsa yapsın; Ahmet Mehmet gibi isimlerden daha akılda kalıcı ve bilginin içinde yolumu bulmama yardımcı oluyor. CBp12

4CB Position: 58 - 58

Videolar üzerindeki göz izleme işaretçisini çok iyi buldum ama hızlı çekimlerde daire de çizgiler de sürekli oynadığı için biraz lazerle oynatılan kedi gibi başım döndü :) belki zaten bu sürücünün de yaşadığı bir şeydir, belki videolardaki işaretçi rengi kırmızı yerine sarı gibi kolay takip edilen bir renk seçilebilir, ya da bakışının her türlü detayını gösteren çizgiler yerine daha smooth çizgiler şeklinde gösterilebilirse baş döndürücülüğü azalabilir. CBp12, 13

4CB Position: 60 - 60

Böyle bir çalışma sağlık sistemi için tasarımda da çok güzel olabilir. Mesela anesteziolojistin baktığı açıdan ameliyatları izleyebilmeyi isterdim. Genelde ameliyathanede oturup onları gözlemliyoruz ama hep dışarıdan gözlemliyoruz, akvaryum izler gibi. Bu şekilde izlemek ise o kişinin ayakkabısının içine girebilmek, kendini onun yerine koyabilmek gibi oluyor. Böylesi daha güzel bence. CBp12

4CB Position: 63 – 63

R. 5FuA Synopses

Otobüs sürücüleri göz izleme kayıtları yapmanı nasıl kabul ettiler merak ettim. FuA3

5FuA Position: 4 - 4

Mesela dinlenme alanından otobüse geçerken aracı nerede bıraktığını hatırlamaması problemi çok dikkatimi çekti ve bir farkındalık yarattı. Bu problem bizim firmamızın şu yüzden ilgisini çeker: biz bir filo satışı yaptığımızda örneğin 100-120 adet araç veriliyor ve o filoda ellerindeki var olan araçlarla birlikte toplamda 400-500 tane araç olabiliyor. Bu araçlar zaman zaman büyük garajlarda bir araya geliyorlar ve araçlar kurumsal grafiklere sahip oldukları için birbirlerinin aynı görünüyorlar. Dinlenmeden gelen sürücünün bu aracı nasıl bulacağı gerçekten de bir problem olmalı aslında ve küçük bir yatırımla da çözüm üretilebilecek bir problem. Çözüldüğü zaman kullanıcısını da mutlu edebilecek bir problem. Bu sebeplerle bu problemi sevdim. Zaten herkesin akıllı telefonu var, buna çok kullanışlı, basit bir çözüm üretilebilir. FuA8

5FuA Position: 8 - 8

Uyumlu4 videosundaki hızlı yerler aracın hızlı gidip gitmediğini anlamamı engellediği için beni gerdi çünkü neticede yavaş gitmesi gerekiyor. FuA17

5FuA Position: 22 - 22

Sen sürücülerin cluster'dan ziyade yola baktıklarından bahsedince dikkatimi çekti, Uyumlu4 gösterge saatine belki de hiç bakmadı, aracın kaçla gittiğiyle hiç ilgilenmedi. Bu kadar yayanın olduğu, zaman zaman trafiğin sıkıştığı bir ortamda hız saatine çok sık bakılmalı gibi geliyor. Belki limit aşıldığında sesli uyarı veriyordur dedim ama hiç ses de duymadım. Yani instrument panel ile çok az iletişim kurdu. Üzerine seninle yoğun iletişim kurması da dezavantajdı. FuA18

5FuA Position: 24 - 24

Bu sürücülerin kullandıkları otobüslerin araç sınıfları farklı anladığım kadarıyla, Bezgin'in kullandığı araç servis/turizm otobüsü kıvamında (evet). FuA19

5FuA Position: 27 - 27

Bezgin3'ün genel itibarıyla iyi bir sürücü olduğunu düşünüyorum ama bu da süratini kontrol etmek için hız saatiyle temas kurmadı. FuA20

5FuA Position: 35 - 35

Bıçkın3 Demiraylar kavşağından döndükten sonra yolcu aldı ve duraktan ayrıldı. Bu sırada karşıdan başka otobüs geliyor. Hmm, ikisi de kaldı orada, sorun nasıl çözülecek? Sürücü bu kaygıyı her gün yaşadıklarını çok bezgin ama suçlayıcı olmayan bir ses tonuyla söylüyor. Sürücü baya kötü hissediyor şu an. Otoparkın silinen çizgilerinin yenilenmemesinden dolayı daha az araç park edilebiliyor olması gibi bir durum. Problem çözülebilecekken çözümsüz bırakılıyor, sürücüden kaynaklanmıyor, yola kuralsız park eden otomobillerin ve yol genişliğinden kaynaklanıyor. Sürücü bu durumu kanıksamış, dolayısıyla sitemi sisteme sanki. Üzüldüm arkadaş için, yalan yok, epey zorlandı. FuA24

5FuA Position: 41 - 41

UJM, kullanıcının nerede ne düşündüğünü ve rahatsızlığını anlatarak probleme dair net bir bilgi verdi ve kullanıcıyı anlamama yardımcı oldu. Ki zaten video falan izlemeden konu hakkında yorum yapabilmemi sağladı. FuA28

5FuA Position: 48 - 48

Personalar tipik insanları yansıtıyor bence, onu çok net geçirdi bana ve profili net bir şekilde aktarıyor. Zaten bunlara bakarak bende merak uyandıran profilleri seçtim. FuA28

5FuA Position: 49 - 49

Uyumlu personası ilgimi çektiği için videolarını izlemek istedim. İsmi Uyumlu olunca, eğitim seviyesi yüksek, yaşı ileri ve dalgınlıklar hariç olumsuz davranışları da diğer sürücülere göre az olunca videodaki sürücü daha uyum sağlayan düzen insanı olur, aracı daha kontrollü sürer diye düşündüm. Ama videolarda Bezgin daha uyumlu sürerken Uyumlu daha bezgin sürüyordu. FuA28

5FuA Position: 50 - 50

Personalara Bezgin, Uyanık, Bıçkın gibi isimler vererek akılda kalıcı olmalarını istiyorsun diye düşündüm ama sürücülerle empati yaptığımda bana o isimlerin verilmesini hiç istemezdim. Çünkü bazı isimler pek pozitif anlamlı değil. Mesela Uyanık trafikte hatalı sollama yapacakmış, gördüğü bir avantajı kullanacakmış, risk alıp ihlal yapacakmış gibi bir his uyandırdı ve o yüzden onun videoları ilgimi çekmedi, izleyip gerilim yaşayayım istemedim. İhtiyar ismi de bir sürücü için pek pozitif değil. Çok sık hata yapabileceğini, reflekslerinin zayıf olabileceğini düşünürüm. İsmi Bıçkın olan biri asi davranabilir, insanlara dalaşabilir, yolculara/yayalara/diğer araçlara karşı dominant olmak isteyebilir. Bezgin yapması gereken bazı işleri yapmaktan imtina edebilir, durağı pas geçebilir. Bu kadar çok kamunun ve trafiğin içinde olan birinin bezgin olmasını istemezdim. (Bu isimlerdeki sürücüler gerçekten de böyle davranışlar gösterdikleri için o isimleri verdim AK). FuA29

5FuA Position: 51 - 51

Videolardaki sürücülerin cluster'la ilişkileri zayıftı. Bu araç bir otobüs olduğu için ve kampüs içi olduğu için sürücülerin hızlarını kontrol etmek için hız saatine bakıyor olmaları gerekir. O kısmı kontrol etmeye yönelik bir şeyler olabilir ama sadece ADAS gibi değil, sürücünün denetlendiğini hissettirecek bir detay düşünülebilir. Senin demin anlattığın gibi, hani son durakta tabelayı ters çevirmesi gerekiyormuş ya son durakta. Sürücüye sorduğunda bizim için onlar sorun değil demiş ama yolda giderken çevirmeyi unutmuş. Aynı buna benzer olarak her şeyi yapar görünürken atlanan birçok nokta vardır. Bu durumların fark edilmesi çözülmesine yol açabilir. FuA33

5FuA Position: 55 - 55

Çalışmaya katılımım sırasında sorun yaşadığım yer olmadı, videoları öncesinde izlemek için zaman ayıramadım onun için de kusura bakma. Workshop sırasındaki 2 saat de çok keyifliydi benim için. Çalışmanın çıktılarını, çalışmayı nereye bağlayacağını çok merak ediyorum, en kısa zamanda duymak, dinlemek, okumak ümidiyle diyorum. FuA35

5FuA Position: 58 – 58

S. 6EC Synopses

(AK: otobüsün sürücüsü Sunshine'a girip seslenmiştir ve otomobilin sürücüsünü bulamamıştır dedin, peki bu durumda problemi çözmek için yaklaşımımız ne olabilir) ilk önce yapacağım şey problemin sıklığını sorgulamak olurdu. Ayda bir veya iki ayda bir olan bir şeyse bu bir aksaklıktır, doğal afettir. O yüzden buna masraf yapıp trafik düzenlemesi yapmaya gerek olmayabilir. İşte otobüs sürücüsü Sunshine'a gidip diğer sürücüye bakacak, belki sürücü oradan çıkacak. Ama haftada bir olan bir şeyse ve haftada bir oraya otobüs gönderme ihtimali doğuyorsa, bu problem daha trafik düzenlemesine giriyor, sanırım başka türlü bir yatırım yapmak gerekiyor. ECp4

6EC Position: 7 - 7

(AK: Sunshine'a park eden araç meselesinde seni bir çözüm için adım atmaya iten ya da itmeyen nedenleri anlamaya çalışıyorum; "attığımız taş ürküttüğümüz kuşa değer mi" gibi bir şey mi var kafanda?) Şöyle: bu UJM bana qualitative datayı veriyor hakikaten, böyle o sürücünün gözünden nokta atışı peak problemleri görüyorum ama burada görmediğim şey ise rakamsal data, yani problemlerin sık olup olmadığı gibi şeyler. Yani o iki tür datayı üst üste koymak isterim. ECp4,5

6EC Position: 8 - 8

DİNGİN 5: Dingin5, metro tampon çarpma tabii başlık itibariyle çok ilgi çekiciymiş, merak ettim. Ben izninle bunu açıyorum. ECp10

6EC Position: 28 - 28

Dingin5 koltuktan bu kadar sessiz ve rahat kalkabildiğine göre emniyet kemeri takılı değildi. ECp10

6EC Position: 30 - 30

Dingin 5 ayakta ceketini katlayıp asarken dışarıdaki bir yolcu otobüsün ne zaman kalkacağını soruyor. Dingin1 soruyu soran yolcuya saatin kaç olduğunu soruyor. Yolcu cevabı verdikten sonra Dingin otobüsün 7 dakika sonra kalkacağını söylüyor. Bu Bezgin3'teki probleme benziyor, sürücü otobüsün saat kaçta kalkacağını biliyor ama o an saatin kaç olduğunu bilmiyor. Ya da saatine bakmaya üşendi belki ama nasıl diyeyim… o andaki akışla, devam eden hayatla schedule ayrı yerlerde duruyor, kafasında 7 dakika sonra kalkacağım bilgisindense 13:46'da kalkacağım bilgisi var gibi bir izlenim verdi. ECp10

6EC Position: 31 - 31

(Dingin5 arkadan gelen otobüse yolu açmak için birkaç manevra yapmak durumunda kaldı. Otobüs geçtikten sonrasında kapıları açtı ve derin bir nefes aldı.) sürücü hayattan bezdi azıcık. Ya birinin çok mahreminde gibi hissediyorum kendimi, gergin bir şeymiş. Tasarımcı olduğum için kullanıcıları gözetlemek ya da önceden kaydedilmiş bir şeyleri izlemeye alışkınım ama bir yandan da sürücünün bu derin nefes alması tek başına yaptığı, kendi içinde, kafasında yaşadığı bir şeydi ve biz de ona şahit olduk ya… Kamera da gözünde olunca da iyice gözetliyormuşuz gibi geldi. Bu kayıt yıllar sonra bile bir yerde duracak ve tekrar izleyeceğiz. Otobüs kullanma prosedürünü görmek bir nebze daha gözlem yapmaya açık ama o nefes çok kişisel bir şeydi. Belki aklına yıllar önce yaşadığı utanç verici bir an geldi ve ona şahit olduk. Mesela bizim ürünümüz yazılım olduğu için sonrasında kullanıcının hareketini kaydettiğimiz videoları çok izliyoruz. Ama onun içinde buradaki nefes verme gibi kişisel şeyler olmuyor, ekran üzerindeki hareketleri ve tıkları kaydediliyor. O yüzden bu değişik geldi. ECp10,11

6EC Position: 34 - 34

(Dingin5'in iç çekmesini özeline girmek olarak değerlendirdin, sizin yaptığınız araştırma daha task centered mı?) öyle denilebilir. Aslında bu data da öyle ama arkadan gelen o ses ya da arada sıkılınca birazcık sola bakıyor olması falan derinlik katıyor. Etik olarak katılımcının böyle bir anına şahit olmak yanlış gelmiyor, tersine çok kıymetli bir şey olduğunu düşünüyorum. Oradan ne kadar bir şeyler

çıkarabilirim bilmiyorum ama canlı olarak orada olsaydım “abi ne oldu, neye sıkıldın, arkadaki otobüs zamansız mı geldi” falan diye deşmek isterdim. Öyle sadece dikkatimi çekti. ECp11

6EC Position: 35 - 35

Bu çalışma sürücülerle ilgili, acaba senin çalıştığın alanda böyle bir çalışma olsaydı farklı şeyler düşünür müydün, tercih eder miydin? Kendi çalıştığım alanda da böyle bir çalışma olmasını, kullanıcıya o an canın bir şeye mi sıkıldı diye sorabilmeyi isterdim. Biz HotJar diye bir program kullanıyoruz. Bu program web sitemize gelen insanların Mouse pointer’ını video şeklinde kaydediyor. Bir de o program kendince ilginç olan noktaları -senin bu videoları kesmen, yavaşlatman gibi- kendi kendine ayırıyor. Dolayısıyla tüm kaydı değil sadece ilginç olan o noktaları izliyorsun. Bu aslında düşündüğünde sürücünün iç çekmesini kaydetmekten daha büyük bir etik problem çünkü kullanıcılar kaydedildiklerini bilmiyorlar ama tüm şirketler bunu yapıyor. Mesela videonun bir yerinde mouse 20 saniye kadar duruyor, muhtemelen kullanıcı orada bir şey düşünüyor ama belki senin ürününle ilgili bir şey düşünmüyor, arkadan birisi seslenmiş oluyor falan. Bu kayıttaki sanki onu görüyorsun, data o bilgiye ulaşmaya daha yakın. Sürücü iç çekince bana oradan başka veri geldi diye düşünüyorum. Ama bir yandan da sen sorunca bizim elimizde böyle bir kaynak olsa nasıl olurdu diye düşündüm ve korkmadım değil. Bu çalışma o açıdan bana ölçeklenebilir gelmedi. Her bir kullanıcının böyle bir kaydını izlemek çok resource intensive bir şey olurdu diye düşündüm. ECp11,12

6EC Position: 36 - 36

Dingin5’de yolcuların sürücüye sormak yerine haritalara bakmaları sürücüye yardımcı olabilir. Kampüste duraklarda senin Miro’ya koyduğuna benzer haritalar vardı. Çünkü sürücüye her seferinde birileri bir şeyler soruyorsa bıkmakta, üşenmekte haklıdır. Bir süre sonra cevap vermekten yoruluyordur. ECp13

6EC Position: 38 - 38

Uyanık3 videosu tenis kortlarından KKM'ye giderken başlıyor. Allaaaah, yalnız… :)) [videoda çok fazla hareketlilik olmasından ürkmüş gibi bir tepki veriyor AK] KKM durağına yanaşırken ne kadar hızlı durdu diyecektim, video hızlandırılmış. ECp13

6EC Position: 42 - 42

Uyanık3 KKM'den sağa A1'e dönüş sırasında sağda dönemecin daha iç kısmında bekleme yapan 2 tane otomobil var. Videodaki göz izleme işaretçisi de sürücünün o araçlara çarpmadan dönüş yapıp yapamayacağını sürekli olarak sağ ön aynadan kontrol ettiğini gösteriyor. Ama dönemecin hemen arkasında bir yaya geçidi var ve göz izleme işaretçisi yolun kısmına hiç uğramıyor. Sürücü sadece aynaya bakıyor gibi görünüyor ama muhtemelen çevresel bir görüşü de vardır sürücünün. Yaya geçidi de sürücünün eşit derecede odaklanması gereken bir yer çünkü mesela sol taraftan bir yaya yaya geçidinden geçmeye başlayabilir [Uyanık dönüş sırasında uzun süre sağ aynaya bakıyor ama ara ara yaya geçidine de sıçrıyor bakışı; ayrıca evet insanın çevresel görüşü harekete çok duyarlı ve soldan bir yaya çıksa sürücü bu bakış paterni ile yayayı detect edebilir diye düşünüyorum ama bunun bir kanıtı var mı bilmiyorum AK]. Yaya geçidinden bir yaya geçse sürücünün bunu fark edebileceğini ben de tahmin ediyorum ama bu tarz profesyonel sürücülük veya iş makinası operatörlüğünde "kural olarak yaya geçidinden geçerken oraya bakmak gerekir" gibi bazı prosedürler vardır diye tahmin ediyorum ama gerçekte bu kurallar ne kadar çalışıyor bilmiyorum [göz izleme işaretçisi aslında yaya geçidine uğradı ama sanırım EC fark etmedi bunu, ya da daha uzun süre bakması gerektiğini düşündü AK]. ECp14

6EC Position: 44 - 44

Uyanık3 otobüse binen yolcunun sorusuna cevap verirken ona "canım" dedi galiba, canım da denmez ki :))) Sürücünün ses tonundan canım diye hitap etmesinin kötü bir yerden gelmediğini anlıyorum tabii ama neyse, öyle oluyor herhalde, yapacak bir şey yok. (Sürücü hocam dedi ama ses kalitesi yüzünden canım diyormuş gibi anlaşıldı). Bu sürücü otobüse binenlerin suratlarına ne kadar çok bakıyor, teker

teker herkese baktı. İniyor “canım” (iğneleyici ses). Her binen yolcu bir şey soruyor, belli ki bu bilgi bir yerde varsa bile öğrenciler açısından yeterli değil. ECp15

6EC Position: 49 - 49

Uyanık3’te daha çok insan etkileşimi vardı. Yolculardan sürekli şuraya gider mi, buraya gider mi şeklinde sorular geliyor. Hakikaten de belki yolcuların bilgi aldıkları yerler ihtiyacı karşılamıyor, rotayı gösteriyor ama yolcuların aslında evet hayır cevaplarına ihtiyaçları var. “KKM’ye gitmek istiyorum, en yakın hangi ringe saat kaçta binebilirim” gibi sorulara cevap almak istiyorlar. ECp16

6EC Position: 52 - 52

Uyumlu3 diğer sürücülere nazaran kabine daha çok baktı, sanırım otobüsün içi kalabalık olduğu için. Diğer sürücüler iç aynalara pek bakmıyorlardı. ECp18

6EC Position: 58 - 58

Uyumlu3’ün sürüş sürecinde yolcularla çok iç içe olması çok dikkat çekici. Araç hareket halindeyken de durakta beklerken de sürücüye sürekli bir şeyler soruluyor. Sürücü hakikaten de sadece otobüs kullanmıyor, kabinle çok fazla iletişimi var. Ama bu sürücü hem kabine hem de etrafına karşı çok dikkatliydi, hareket eden her şeye baktı. Kendi kendine giden bir otobüs olsa onun algoritmasının da bu sürücü gibi davranmasını isterdim. ECp19

6EC Position: 63 - 63

Uyumlu3’ün kabin içine çok fazla bakma nedeni senin dediğin gibi sarsıntıdan yolcular etkileniyor mu diye kontrol etmek olabilir ama belli ki sürücünün kabinle ilgili kafasına takılan bir şeyler var, sık sık baktı oraya. Belki otobüsün içi kalabalık olduğu için refleksten baktı; orta aynada sürekli hareket eden bir güruh var ve gözü takılıyor oraya. Otobüs boş olsa belki bakmayacaktı. Bu yüzden belki de otobüsün bu kadar kalabalık olmaması lazım. Sürücünün yanındaki kalabalık insan grubu sağ

aynayı görmesini de engelliyor bazı yerlerde. Sürücü bundan geriliyor ya da endişe duyuyor olabilir. Belli ki bu saatte bu ringe çok fazla yolcu düşüyor. ECp20

6EC Position: 65 - 65

Uyumlu3'te bir iki yerde durak cebi olmaması fazladan iş yükü bindiriyor olabilir. Sürücü tam olarak nerede duracağını bilemiyor, kaldırımdan aşağı taşan yolcular sürücüyü geriyor. Rektörlük önündeki durakta araçlar park ettiği için kullanılamayan cep var, orada kaldırımda değil de yolun üzerinde bekleyen bir yolcuyu sürücü haklı olarak uzun süre süzdü. Durağa yanaşırken yolcuya yandan sürtmemek için süzdü ama bir yandan da içerisi kalabalık olduğu için durağa yanaşırken yolcuya ne kadar yaklaştığını göremiyor da sonuç olarak sürücü durağa çok hassas yanaşamadı. Normalde belediye otobüsleri durak platformuna yanaşırlar ki örneğin engelli yolcular otobüse binebilmek için zıplamak zorunda kalmasınlar. Ama ringde çok öyle bir şey yaptığını zannetmiyorum. Uyumlu3 durağa yanaşırken muhtemelen endişeliydi ama yol üzerinde duran yolcuya zarar vermemek için durağa çok hassas yanaşamadı. ECp20

6EC Position: 66 - 66

Dürüst olmak gerekirse personalar bana çok fazla bir şey ifade etmedi. Belki 7 tane olması fazla geldi, örneğin biri daha agresif biri daha uyumlu 2 tane olsaydı kafamda bir yerlere daha fazla oturabilirdi ama 7 ayrı çeşit personayı daha sonra bir yerlerde kullanmak üzere hatırlayamadım. Personaların içlerinde verdiğin parametreler de hatırlamam için biraz fazlaydı. Ama bu benim ayırdığım vakitle de ilgili olabilir, daha fazla vakit ayırabilirdim. ECp23

6EC Position: 73 - 73

Videolar çok ilginçti. Aslında çok benzer şeyleri kullanıyoruz. Bizdeki Mouse tracking'in daha zengin bir hali gibiydi. Böyle karmaşık bir iş yapan bir kullanıcının gözünden izlemeyi bayağı beğendim. Videoların bir montajdan geçmiş, bazı kısımlarının hızlandırıp yavaşlatılmış olması bana çok iyi geldi. Bu işi bir şirkette yapıyor olsaydık bir UX araştırmacının kesinlikle yapmasını

isteyeceğim ve yapmasından mutlu olacağım bir şeydi. Dikkat çekici yerlerin işaretlenip yavaşlatılması süreci optimize etmiş. ECp23

6EC Position: 74 - 74

GIF'lerle ilgili bir düşüncem açıkçası yok. Videolar zaten 2-3 dakika kadar ve izlemek çok zaman almıyor. Sanırım o yüzden 4 tane GIF'e bakıp bir karar verme ihtiyacı duymadım, doğrudan videoya giderek izlemeyi tercih ettim. ECp23

6EC Position: 75 - 75

Çalışma sırasında sorun yaşadığım yer olmadı, sadece personaları utilize etmediğimi hissediyorum. Onların bir esprisi vardıysa onu videonun bir kenarına overlay etmek hep orada dursun ve bakılsın açılarından iyi olabilir ama onları bilmek kadar da önemli değil diyorsan bence problem değil, göz gezdirdim ama hatırlayamadım. Bir de mesela son persona, benim de uyumlu bulduğum bir personaydı ama personaları çiğ datayı izledikten sonra biz çıkarıyoruz ya, önden o personayı bilmek ne kadar fayda verirdi çok kestiremedim. Ama görmediğim bir şeyler olabilir tabii. ECp24

6EC Position: 77 - 77

Çalışmada sunulan videolar çok açıklayıcıydı bence ama bir dip not olarak ben ODTÜ'deki context'i, durakların yerlerini falan biraz biliyorum. Tamamen yabancı birine izletirken belki bağlamı dataya yedirmek, overlay etmek iyi olabilirmiş. Onun dışında bu Miro süreci, adımlar, başta koyduğun bilgiler falan benim için son derece açıktı, bir problem yoktu benim açımdan. ECp24,25

6EC Position: 78 – 78

T. 7IT Synopses

Eski tecrübeme dayanarak şunu söyleyebilirim ki otobüs tasarımında kullanıcı ihtiyaçlarına karşı çok hassas olunmuyor. Bunun nedeni de Türkiye'de -diğer ülkelerde nasıldır bilmiyorum- toplu taşıma araçları satın alınırken seçimi sürücüler ya da yolcular yapmıyor. Otobüs satın alacak kurumlardaki söz sahibi kişiler, alım yapacakları firmalardaki satış ekipleriyle ve ihale yoluyla firmaları karşılaştırarak satın alma sürecini tamamlıyorlar. Bu sürece dahil olan söz sahibi kişiler yolcuları veya sürücüleri düşünmeden kararlar alabiliyorlar. Otobüs üreticileri de de o kişilerin isteklerini karşılayacak şekilde ürün geliştiriyorlar. Bunun üzerine bir de, ne yolcular ne de sürücüler sorgulamayan insanlar olunca toplu taşıma otobüsleri gerektiği gibi tasarlanmıyor. Yolcular ve sürücüler kendi kendilerine şikâyet edebiliyorlar, ama o aracı kendisine reva gören karar mekanizmalarını sorgulamıyor. Bu sorgulanmama üstünkörü tasarımlar yapılmasına neden oluyor ve firmalar şımarıkça kararlar alabiliyorlar. Yani en başta yolcu ve sürücüler hesap sormaya başlarsa alım kararı veren insanlar kullanıcı odaklı düşünmeye başlayabilir, bunun sonucunda da firmalar tasarıma ve mühendisliğe önem verebilir ITp3,4

7IT Position: 7 - 7

Bazı ticari araçlardaki satın alma ve ürün geliştirme süreçlerininin etkileri kendini ürünlerde gösteriyor. Otomobillere baktığınız zaman ergonomi ve tasarım çok ilerideyken, otobüs gibi ticari araçlarda bunu göremiyoruz. Kamyon ve kamyonet gibi ticari araçlarda sürücü araç sahibi olmasa bile aracın alınmasında söz sahibi ve firmalara ceza kesilebiliyor. Dolayısıyla bu araçları üreten firmalar şımarıklık yapamıyor. Kamyon kamyonet gibi ticari araçlarda da sürecin ne kadar iyi olduğu tartışılır ama toplu taşıma araçlarıyla arasında uçurum var. Toplu taşımada ne yazık ki sorgulama mekanizması olmadığı için ürünlerin tasarımları gerektiği kadar

geliştirilemiyor. Toplu taşıma araçlarının aksine askeri araçlarda alım ve ürün geliştirme kararları çok daha ciddi bir şekilde alınıyor. Askeri araçlarda kimsenin hata yapma lüksü yok. ITp4

7IT Position: 8 - 8

Mesela fabrikalardaki gece güvenlik görevlilerinin saat başı tur atma sistemi vardır. Görevli oturduğu yerde sabaha kadar oturmasın, fabrika etrafında dolaşıp kontrol etsin diye akbil benzeri bir cihaz verilir. Fabrikanın çeşitli bölgelerinde de bu cihazı basacağı,okutacağı noktalar vardır. Buna benzer bir sistem -akbil benzeri ya da telefon uygulaması şeklinde- sürücüler için de uygulanabilir. Bu sistem ring sonrası aracın yakıtı azaldıysa yakıt doldurmadan dinlenmeye gitmesini engellemek için de kullanılabilir. Böylelikle aracı devrederken yapılması gereken işler yoluna koyulur. Her seferinde aracın yıkanması gerekmeyeceği için belki o iş için kullanılmaz, yıkanma kararını durak şefi verir, böylece aracı yıkamak sürücüler arasında çekişmeye yer bırakmadan çözülür. Hem de araç bir sonraki sefere hazır olur, seferler aksamaz. Üniversite yönetimi yolların kuralsız park eden araçlar ya da çöp tenekesi yüzünden oluşan açıklığı-tıkanıklığını takip edip belki jandarmayla konuyu halleder, sürücülere bırakmaz. Biz ortadoğu toplumlarında kağıt üzerindeki kuralların hayatı düzenleyeceğini düşünürüz ama kuralları uygulamayız. Ne yazık ki bize böyle çomak dürtmek gerekir. Bu şekilde gözetleme yapılırsa öğrencilerin kuralsız park etmemeleri için de caydırıcı olabilir. ITp6

7IT Position: 15 - 15

Videoları izlemek için persona seçerken: bir kere ilk olarak UYANIK'ı seçmek isterim. Hem en renklilerinden biri o olacaktır, hem de bizim (Türkiye) yollarımızda bolca olan bir karakter çeşidi :) kural dışı hareketleri gösterme ihtimali fazla ve en fazla tasarım ihtiyacı olabilecek kişi uyanık olacaktır; risk katsayısı daha yüksek diye düşünüyorum. ITp7

7IT Position: 18 - 18

Uyanık2 bu araç otobüs olduğu için çok iyi algılayamıyor olabilirim ama sanki soldaki şeride sarkıyor, şerit değiştiriyor gibi geliyor. Benim gözüm otomobil kullanımına alışık olduğu için bana öyle geliyor olabilir, o yüzden çok emin olamıyorum. ITp10

7IT Position: 25 - 25

BEZGİN 4: Bezgin4'ün sol dikme üzerinde sürücünün görüşünü kısıtlayan bir şey var, o ne? (Geri görüş kamerası ekranı). Orada görüş problemi yaratıyor, doğru yerde değil. ITp13

7IT Position: 32 - 32

Sürücü personalarının kilolarını fotoğraflardan bir miktar tahmin edebiliyorsunuz ama kilo bilgisi eklenebilir. Bazı boylarda bazı kilolar sorun değilken bazı boylarda sorun yaratabilir. ITp17,18

7IT Position: 48 - 48

Sürücü personalarına kadercilik katsayısı gibi bir şeyler eklenebilir mi? Bu bilgiyi edinmek çok zor, farkındayım ama sürücülerin, yaptıkları hareketlerdeki inisiyatifin onlarda olduğu ve sorumlu oldukları bilinci olmalı. "İşte ne yapalım kaza oldu, olacağı varmış, kader-kısmet" diyen insanlar sürücü olursa, bu bakış açısındaki birinde çok fazla davranış iyileştirmesi sağlayamazsınız. Bu tür bir kadercilik bir sürü probleme dayanak oluyor ama o özellik sürücülerde nasıl tespit edilir bilmiyorum. Bunu personaların bir eksikliği olarak görmüyorum ama bence sürücüdeki en önemli özellik ne yaptığının, nelere yol açtığının bilincinde olması [AK: katılımcının burada bahsettiği özellik psikolojide "locus of control" olarak geçiyor. "Internal locus of control" vs. "external locus of control". "External locus of control" olan kişiler kendilerinin hayat akışına çok fazla etkileri olmadığını düşünen insanlar ve bu insanlar yarı otonom araçları kullanırken daha fazla güveniyor ve otomasyonun "fail" ettiği durumlarda kazaya daha yatkın oluyorlar]. ITp18

7IT Position: 49 - 49

Personalardaki olumlu özellik örnekleri görmek fikir verdi ama daha fazla örnek olmalıymış, bu liste başlamış da bitmemiş gibi geldi. ITp18

7IT Position: 50 - 50

Araştırma bulgularının bu şekilde sunulmasıyla ilgili neler düşünüyorsunuz? UJM'deki sürücülerin iç konuşmalarını çok olumlu buldum. Hem olayla ilgili bilgi var hem de "sürücü şu an ne düşünüyor, rahatsızlığı ne" gibi bilgiler var. Bu iç konuşmaları aktarmak sürücüyü bir robottan insana dönüştürüyor ve bir film seyrediyor gibi karakteri kafamda canlandırıyor, ete kemiğe büründürüyor. UJM'deki iç konuşmaları yazan açıklamalar üzerlerindeki fotoğraflardan daha fazla ete kemiğe büründürüyor. Hani insan bir anlık değildir ya, bir fotoğrafta hitler gibi görünen bir adam aslında çok yufka yürekli çok saygıdeğer biri olabilir. Buradaki iç konuşmalar da o karakteri canlandırıyor. ITp19

7IT Position: 53 – 53

U. 8OB Synopses

Orta ayna arkadaki yolcuları görmek için kullanılıyor ama ön camda göz hizasına yerleştirildiği zaman sürücünün yol üzerinde olan bazı önemli durumları görmesini engelleyebilir. Ortada göz hizasının yukarısında veya otobüsün sağ üst tarafına yerleştirilebilir. OBp6,9,18

8OB Position: 8 - 8

(Bezgin1) durakta Arka kapıdan binen/inen yolcular uzakta kaldığı için yolcuların inip inmediğini veya başka yolcuların binip binmeyeceğini anlayabilmek için uzun süre sağ yan aynaya bakıyor. Ayna yerine ekranlar ve kameralar olabilir ve otobüs duraktayken inen/binen yolcuların görüntüsünü sürücünün daha rahat görebileceği şekilde yakınlaştırabilir. OBp12, OBvideoNotes 00:00:29

8OB Position: 17 - 17

Torpidoya gelen güneş ışığı ön cama yansıyor, otobüsün ön tarafında duran yolcuların yansımaları yol görüşünü engelliyor, güneş karşıdan sürücüye geldiğinde sürücünün görüntüsü dashboarda yansıyor, sürücü dashboardda ve elindeki telefonda kendi yansımasını görüyor. Bu yansımalar çok rahatsız edici. Otobüslerde yansıma önleyici cam kullanılması ya da sürücülerin polarize gözlük kullanması gerekir. Yansımalar çok farklı yüzeylerden geldiği için polarize gözlük daha etkili bir çözüm olabilir. OBp7, 10; OBvideoNotesBezgin1-00:00:22

8OB Position: 18 - 18

(Dingin 5) otobüsün kabinini yolcuların durduğu yerden ayıran yarım kapı çok kalın ve şık durmuyor. Kalın kapının iyi kilitlenmesi daha zor olabilir ve istenmeden açılma ihtimali artar. Fazla hacimli ve kütleli bir kapı yerine daha ince bir kapı olursa açıp kapama sırasında kırılma ihtimali azalır ve daha güvenli olur. OBp9

8OB Position: 19 - 19

Sürüş sırasında gözlem ve kayıt yapılmasına rağmen sürücü tek eliyle telefonla görüntülü görüşme yaparken tek eliyle de aracı kontrol ediyor. Bu bana gözlem yapılmadığında daha fazlasını yapabileceğini düşündürdü. OBp10

8OB Position: 20 - 20

Tasarımcı olarak biz sürüş sırasında telefonla görüşmesini teşvik etmemeliyiz ancak bir yandan da nasıl olsa biz çözüm getirmesek bile bazı çözümler geliştirerek ya da tek eliyle direksiyonu tutarak bu görüşmeleri yapacak. Hiç değilse dikkatini daha az etkilesin diye telefonunu eline almadan kullanabileceği bluetooth vs ile bir çözüm düşünülebilir. OBp10

8OB Position: 21 - 21

Sürücüler genel olarak dashboarddaki uyarıları çok ilgiyle takip etmiyor. Bir tanesinde kırmızı bir ışık yanıyordu. Benim arabamda böyle bir ışık yanarken rahatsız olur, yola devam edemem. Ya otobüsler kimseye zimmetli olmadığı için sürücüler sahiplenmeyip umursamıyorlar, ya da o ışık çok kritik değil. O kadar kritik değilse de kırmızı renk olmamalı. OBp11

8OB Position: 23 - 23

Bazı otobüslerin sürücü kabinleri tamamen kapalı oluyor ve yolcular sürücüyle hiç iletişim kurmuyorlar. Ancak bu ringlerde yolcular sürekli sorular soruyorlar ve sürücüler de sürekli aynı işi yapmaktan sıkıldıkları için yolcularla iletişim kurmak istiyor olabilirler. Bir yandan da uzun vadede iletişim kurmak yerine sürüşe odaklanmak istebilirler. Kapalı olursa sürücülerin kendilerine ait bir alanları olur, herkesle aynı havayı solumaz, ve daha memnun olurlar. OBp11,12

8OB Position: 24 - 24

(Bezgin 1 kapalı olan ve kullanılmayan geri görüş kamerasının ekranı) bu ekranın ne olduğunu anlayamıyorum. Kullanmadığı bir ekran sürekli yol görüşünü perdeliyor. OBp13

8OB Position: 25 - 25

Keşke görüşünü kapatan ekran daha iyi bir yere yerleştirilseydi ve tüm uyarı fonksiyonlarını içine alsaydı. Bu uyarı fonksiyonları indi bindi yapan yolcular, otobüs yolda giderken yakınından geçen yayalar ve diğer araçlarla çok yaklaştığı zamanlar için kullanılabilir. OBp13

8OB Position: 26 - 26

Otobüsten inen yolcular bazen otobüsün önünden yolun karşısına geçiyorlar ve otobüs görüşlerini kapattığı için eğilerek otobüsün arkasından araç geliyor mu diye yolu kontrol ediyorlar. Bu durumda yaya güvenliğini sağlamak için otobüs üzerine sensörler yerleştirilebilir ve arkadan gelen araç olup olmadığı yönünde yolcu bilgilendirilebilir. Bu bilgilendirme bir levha yardımıyla ya da yere lazer projeksiyon yansıtılarak yapılabilir. Amerika'daki okul otobüslerinde yolcular indiğinde otobüsün arkasından gelen araçların karşıya geçen öğrencilere çarpmasını engellemek için açılır kapanır bir levha ile diğer araçların otobüsün yanından geçmesini zorlaştırıyor. OBvideoNotes00:01:10

8OB Position: 28 - 28

Durakta bir yolcu bekliyor, sürücü otobüse binip binmeyeceğini anlamak için yolcuya bakıyor. Yolcu binmeyecekse ve inecek yolcu da yoksa durakta durması gerekmeyecek. Sürücünün bunun yerine yola odaklanmasını sağlayabilmek için otobüse entegre yapay zekâ yoldakilerin otobüse binmek isteyip istemediklerini tespit edebilir. OBvideoNotes Bezgin2-00:01:15

8OB Position: 36 - 36

Benim saptadığım problemler çoğunlukla görüş alanı ve aynalarla ilgili problemler. Yolcu indirme/bindirme sırasında sürücünün otobüsün kapılarını hem içeriden hem de dşarıdan görmeye ihtiyacı var. Bunun için aynaları kullanıyor ama belki sürücünün otobüsün etrafını 360 derece görmesini sağlayacak şekilde kameralar yerleştirilebilir. OBp7,15

8OB Position: 41 - 41

Ön kapıdan çok sayıda yolcu binerken sürücü bir yandan bu yolcuları kontrol ederken bir yandan da arkadan binen yolcuları sağ aynadan kontrol ediyor. Arkayı ve önü eş zamanlı göremiyor. Belki büyük aynanın üstündeki küçük aynadan bir miktar görüyordur ama çok uzakta kalıyor. Eş zamanlı olarak tüm kapıları kontrol edebilmesi için kamera ve ekranlar kullanılabilir. OBp15

8OB Position: 44 - 44

Bezgin 1 Videosunun Odtükent kaşısındaki duraktaki kısmı yavaşlatılmış olduğu için benden bir şey söylemem bekleniyormuş diye düşündüm. Yavaşlatılmış yerlere özellikle bakmaya çalıştım. Durakta bekleyenler otobüs onlara yaklaşınca geriye doğru yürümeye başlıyorlar, acaba çarpma ihtilinden mi korkuyorlar diye düşündüm. OBp8,9,16,17

8OB Position: 49 - 49

Otobüs yol üstündeki durağa yaklaşırken duraktaki yolcular adım adım geriye gidiyorlar. Otobüs şeridinde olmamasına ve sola doğru yolu ortalamış olmasına rağmen yolcular geriye gidiyorsa şeridinde gitse çarpma ihtimali mi var acaba? (TİM müdürü otobüsler normal hızda giderken bile yayalardan otobüsün hız yaptığına dair şikayetler aldıklarını, bunun nedeninin ise otobüslerin çok büyük olmalarından dolayı kenardaki yayaların otobüsün rüzgarını hissederek otobüsün hız yaptığını sanmaları olduğunu söylemişti) OBp16

8OB Position: 50 - 50

Sürücünün koltuğunu otobüsün ortasına doğru taşımayı denerdim. Bu, A postun görüş açısını kısıtlama etkisini azaltırdı. Sürücü sol tarafa sıkıştıkça oradaki kişisel eşyaları için ayrılan alan daralıyor. Bir de sürücü yola ortadan bakarsa otobüsü şeritten sola taşırma sorununa da iyi gelebilir. OBp19

8OB Position: 57 - 57

Otobüslerin nerede olduklarını ve duraklara ne zaman geleceğini gösteren sistemle sürücülerin sefer sürelerinin kontrol edilmesini önerirdim. OBp20

8OB Position: 63 - 63

Sürücünün sol tarafını daha etkili bir şekilde kullanabilmesi için bir alan bırakılması iyi olabilir. Ayrıca, şoförü otobüsün ortasına alırsak soldaki görüşünü kesen A dikmesini görüş üzerindeki olumsuz etkisini azaltabilir. Şoför sol tarafa sıkıştıkça, orada kişisel eşyaları için ayrılmış alanı kullanmak zorlaşıyor gibi görünüyor. Ayrıca, sürücünün kendisini daha ortada hissetmesi, şerit kontrolünü daha iyi yapabileceğini düşündürdü. Şimdiki görüş açısı sürücünün aracı sol tarafa doğru şerit çizgisini ortalayarak sürmesine neden oluyor olabilir. Ancak bu fikri gerçekleştirmek için tasarımı tamamlamak ve test etmek gerekir. OBp22

8OB Position: 65 - 65

Önerdiğim çözümlerde sensörler ve otonom teknolojiler var ama müşterinin de bunu talep etmesi gerekir. Bunun için de müşterinin tasarımdan anlaması ve ne istediğini bilmesi gerekir. Araç güvenliği için eklenen teknolojiler araç fiyatını artıracağı için istemeyebilirler. Nasılsa bu otobüsler ring için kullanılacak, mevcut olan teknolojiler yeterli diye düşünebilirler. OBp22, 23

8OB Position: 66 - 66

Endüstriyel tasarımcının müşterinin istekte bulunmasına gerek kalmadan dokunuş yapabileceği konular arasında ergonomi, gösterge paneli tasarımı ve A sütununun yeri gibi detaylar bulunur. Bu tür konularda müşterinin özel bir talepte bulunmasına gerek yoktur, çünkü bu tasarımın temel bir parçasıdır. Ancak fiyat artıran ve altyapı gerektiren teknolojilerin tasarıma eklenmesi müşterinin talebine bağlıdır. OBp23

8OB Position: 67 - 67

Videoları hızlıca bulma isteğim nedeniyle ilk Miro sayfasındaki bazı detayları gözden kaçırdım. Gözlükle gözlem yapmayı ve göz hareketlerini izlemeyi beğendim. Hatta bu yöntemi kendimiz uygulayabilir miyiz diye düşündüm ve hoşuma gitti. Videoları izlerken ise rahat bir deneyim yaşadım, rahat rahat durdurup not alabildim, videolar arasında rahat geçiş yapabildim. OBp23, 24

8OB Position: 70 - 70

Personaları anlamakta zorlandım. İsimleri (örneğin, bıçkın, dingin, şakacı) benim için çok anlamlı gelmedi. Bu isimlerle kişileri bağdaştıramadım. Örneğin, 'şakacı' personasını şakacı olarak algılayamadım; aracı sürerken telefonda görüntülü konuşma yaptığı için “laubali” olduğunu düşündüm. İsimlerinin neyi temsil ettiğini anlayamadım. İhtiyar personasının elinde belirginleşen damarlar dışında yaşlılığını gözlemlemekte zorlandım ve personaları tam olarak anlayamadım. OBp24

8OB Position: 71 - 71

Bu tür kullanıcı araştırması bulgularını tasarımcılarla bu şekilde paylaşmayı ve altyapıyı çok başarılı buldum. Bu videoları izlerken, bu yöntemi nasıl kendi projelerimize adapte edebileceğimizi düşünerek izledim. Ancak bu aşamadan sonra tasarım ekibiyle fikir üretme süreci daha önemlidir. Videolardan bazı ön bilgiler elde edebilirsiniz, ancak sizinle (araştırmacıyla) olan diyalogdan daha derinlemesine perspektifler kazandım. Kullanıcı araştırmasını biz de yapıyoruz ama biz o anda gözlemi yapıp, değerlendirip, raporlayıp geçiyoruz ancak bilgileri buradaki gibi kayıt altına almak ve daha fazla tartışmak araştırmadan elde edilen bilginin niteliğini artırabilir. OBp25

8OB Position: 72 - 72

Video üzerindeki göz hareketleri ve işaretçinin tasarım fırsatları tanımlamaya nasıl etki edeceğini düşündüğümde, bu işaretçinin sürücünün o an nereye odaklandığını daha iyi anlamamıza yardımcı olduğunu fark ettim. Gözlüğün linkini de istemeyi düşünüyorum, bizde uygulanabilir mi veya kullanıcılar tarafından kabul görür mü, bunu görmek isterim. Ayrıca, videolarda olan bir diğer güzel özellik, kameranın hareketlerinin yumuşak olmasıydı. Biz araç içine kamerayı sabitliyoruz ve bu durumda araç sarsıntıları kamerayı zangır zangır titretiyor. Bu videoları izlerken bu kamera hareketleri beni rahatsız etmedi. OBp25

8OB Position: 73 - 73

UJM kısmını atladım, ancak genel olarak bu yaklaşımın içinde bulunmaktan, çalışmaya katılmaktan keyif aldım. Bu yöntemin tasarım sürecine değerli katkılarda bulunacağını düşünüyorum. Ayrıca, tasarımcı olarak, kullanıcı araştırmalarına katılmak zorunda olmadığımızı düşündüm. Ama bir yandan da video üzerinden izlemek önemli olsa da yerinde gözlem yapmak da gerekli olabilir. Örneğin videoları izlerken sıklıkla otobüs etrafına çarpacakmış gibi hissettim. Ancak bu kamera açısından kaynaklanıyor olabilir ve direksiyonun başında olunca aslında o kadar da tehlikeli görünmeyebilir. Bu nedenle, tasarım sürecinde karşılaşılan sorunların gerçekte ne kadar önemli olduğunu ve düşünmediğiniz sorunların da sorun olabileceğini anlayabilmek için yerinde gözlem yapmanın faydalı olduğunu düşünüyorum. OBp25, 26

8OB Position: 74 - 74

Bezgin 1 - 00:00:29 - OB epey uzun bir süre bu aynaya bakılıp yolcunun henüz inip inilmediği/başka inecek olup olmadığı kontrol ediliyor. Öneri 1: Ayna yerine ekran kullanılırsa dijital zoom sayesindeki uzaktaki, aynada küçük gözüken yolcular daha rahat gözlemlenebilir. İniş ve biniş esnasında yan aynalar (ekranlar) otomatik zoom yapabilir. Öneri 2: İnmek isteyen yolcu tuşa basıyor. Bu sistemle kaç kişinin ineceği takip edilemiyor. Belki yerde ağırlık sensörlü bir alan yapılabilir ve inmek isteyen yolcular bu alana adım attıklarında tuş basmaya gerek kalmaksızın şöföre bildirim gidebilir. O alanda duran tüm yolcular indiğinde ise ağırlık sensörü şöföre "tüm iniş bekleyen yolcular indi" ibaresi gönderebilir ve belirsizlik ortadan kaldırılabilir.

8OB Position: 75 - 75

OB: X marka otobüsmüş. Buradaki kabin kapısı OB 19'da gördüğümün aksine daha ince olduğu için daha iyi olduğunu düşünüyorum. Bilmiyorum belki farkında olmadan arka planda bizim arabayı değerlendirdiğim için gözüme daha iyi görünmüş olabilir. Kabinin sol taraflarında sürücünün eşyalarını koyabilmesi için daha fonksiyonel kısımlar var. Burada kıyafet askısının formunu tam göremedim ama ayağa kalkmadan arkaya uzanarak kıyafetini asabildi. OBp10

8OB Position: 80 - 80

01:19:33 OB: Şurada sürücü bir şey yaptı, ona bir daha bakalım.... bir şeyi ileriye doğru itti, direksiyonun yan tarafında...Hım. Şu kol şey mi? herhalde fren sistemi gibi bir şey. El frenini mi ileri itiyor tam bilemedim ama. 01:20:19 OB Ama yeri güzel, pratikmiş. Herhalde durdu şu anda ki el frenini çekti burada. Orası el freni. Hı hı. Evet. OBp21

8OB Position: 81 – 81

V. 9MuK Synopses

(Bıçkın 1) Having been a passenger in a Turkish car is making me very anxious. He's not focused on the road Which is quite common in Turkey for drivers, but he's he spends way too much time looking away (çünkü hava sıcak olduğu için havalandırmayı açmaya çalışıyor ama bir türlü açamıyor). He is about the run someone over :)) MuKp5

9MuK Position: 5 - 5

Bıçkın 1 bir yandan otobüsü sürerken bir yandan (havalandırmayı açmak için) aracın arayüzüyle bu kadar çok ilgilenmemeliydi. Buna önlem olarak vehicle interface needs to be much more punitive. In addition, if there's common actions that need to be completed by the drivers, Maybe bring them much more closer to the forefront of the steering wheel. MuKp5

9MuK Position: 6 - 6

Bıçkın 1 videonun son kısmında karşıdan karşıya geçen yayayı görmedi ve çarpmak üzereydi, so that’s fun :) MuKp6

9MuK Position: 9 - 9

In addition to playing with his phone, Bıçkın 1 keeps playing with the dashboard and I can’t understand what he is doing. I expect anyone to be the best representation of a driver while being observed so he may be doing something important on the dashboard. MuKp6

9MuK Position: 10 - 10

Dingin5’s eyes seem to be moving much more faster than Bıçkın 1, his focal point seems to change quite a lot, is the video speed up? (no) MuKp10

9MuK Position: 18 - 18

It's quite hard to catch exactly what the conversation is about. The video speeds up and slows down, It can be a bit hard to hear the beginning and start of a conversation. MuKp14

9MuK Position: 36 - 36

This way of communicating user research findings seems fine. I think the videos - eye tracking and the way they break down the issues- were the most impactful. I found personas quite interesting, but I think user personas are somewhat controversial in the UX in general. MuKp19

9MuK Position: 48 - 48

Can you elaborate on your opinions about personas?] Alan Cooper, the inventor of user personas, used to work at Microsoft. His views of personas, is this only useful (?) so if you are selling fishing rods, does it really matter if the guy or the woman works in a bank, is married, has children? We need to use only the relevant information otherwise demographic information may not be useful at all. So with Şakacı, a person who likes joking, I'm not sure how much of an impact to the product that has, but Bıçkın, aggressive might be very relevant. If signifying that it's a high stress job is quite important, breaking personas into that bucket could be very useful. You have to be very careful about the categorization and meaningfulness behind the categorization because you may be collecting data that is irrelevant. MuKp19,20

9MuK Position: 49 - 49

Do you see irrelevant information in personas? Just the naming. Health is interesting when it comes to eyesight or hearing. It would be important in the context of driving. MuKp20

9MuK Position: 50 - 50

00:43:01 I think one thing that would be interesting. As as part of the system is If You, as the researcher, handing this over to a designer for the designer to have a

place where they can write their own notes, their observations, and then After they've finished observing the research, sitting with the researcher, and then bucketing The observations are sticky notes in categorization, so you know, it's like, how might we use like design sprints? They do that you know how might something like an activity like that. I think as a next step. Umm... Like I know Fig Jam is the tool that everyone uses now like Figmas, fig, jam, whatever. Or like in a room with significant feasible to be in the room anymore because of people. I think. So basically, having an activity for the designers to participate in that separates them from their Indesign environment so they can start thinking about this, you know. Otherwise what happens is designers try to come up with solutions like without really thinking about it and so having an activity that forces them to Think about the problem. I think it's quite... Could be quite helpful [...] yani Google da, biz design sprint yapıyorduk ve 1 hafta boyunca bu projenin üzerinde çalışıyorduk. evet vakit harcıyorsun ama bir product design için mecburen böyle yapman lazım. ilk aklıma gelen o, activityden sonrası ne oluyo? bu researchle tasarımlar nasıl bunun devamını getirebilir [...]

9MuK Position: 53 - 53

00:45:36 MuK2 Yeah, sadece bu dosyaları tasarımcılara verip ve onlardan ayrılmak biraz riskli olabilir. AK: neden? çünkü video izleyip ve bunun herşeyini okumazlar, insanların geneli. Önemli olan data noktalarını kaybedebilirler. onun için bi aktivity, ya da o tasarımcıların araştırmaları birlikte... şoförleri izlese, bence daha iyi olur. Meaningful knockdown... Önemli bir noktaya gelmek için, kaliteli bir noktaya gelmek için... yoksa dediğim gibi, şirketlerin kültürüne bağlı olarak, tasarıma, research'e beklenen önemi vermeyebilirler. onun için tasarım & research birbirine bağlı olması lazım, kelepçe gibi. yani engineering de öyle olması lazım. Ürün geliştirmek fabrikada üretim yapmak gibi bir şey değil. sen veriyosun [waterfall benzeri bir yapı uygun olmaz anlamında cümleler kuruyor, bir depertman işini bitirip diğerine aktarıyor, ilişkisi kesiliyor gibi olmamalı, agile olmalı]. tasarımcı da mock-up'ları veriyor, olmuyor işte öyle. onun için biraz daha aktif, beraber araştırmayı yapıp beraber sonuçları getirmeye... ondan sonra o

tasarımcıların bir mock gibi bir prototype yapıp tekrar kullanıcıların önüne koyup tekrar denemek, sonra tekrar onu yinelemek... bu sürekli bi process. IDEO'nun... çoğu bu teknik IDEO'dan kaynaklanıyor. bi odada çeşitli uzmanlar var, kimi engineer, kimi tasarımcı, kimi researcher, kimi yazar... bunlar farklı farklı disiplinleri bir araya getirip, daha çok kaliteli bir ürün ulaşabilirsin.

9MuK Position: 54 – 54

W. 10KU Synopses

Videolarını izlemek için persona seçerken şu konuda zorluk çektim: yetişkin, uzun, lise mezunu gibi bilgiler çok açıklayıcı olacak mı, devamında bize getirisi ne olacak emin olamıyorum. O yüzden çeşit olsun diye bir yetişkin, bir yaşlı, kısa, orta, uzun boylu, ilk öğretim, lise ve açık öğretimden birer tane isteyeceğim. KUp3

10KU Position: 8 - 8

Videoları haritanın aynı yerlerine gelecek şekilde seçmek istiyorum çünkü persona kişilikleri değiştiği için değişmeyen bir değişken belirlemek istiyorum. Ayrıca Sunshine civarında kaydedilen sürüşleri izlemek istiyorum, insan yoğunluğu daha fazla olur. ODTÜ trafiğinde yayalar pek olmadığı için Ankara trafiğine en çok benzeyeceğini düşündüğüm kalabalık kısımları görmek istiyorum. KUp3,4

10KU Position: 9 - 9

Farklı kamera açılarıyla aracın arka tarafını da görmek iyi olurmuş. Örneğin araç fren yaptığında arkadaki yolcular nasıl etkileniyor görmek isterdim. KUp5

10KU Position: 15 - 15

DİNGİN 3: Dingin birine göre gözleri çok hareket ediyor, motion sickness benzeri bir şey oldu bende. Benim beklediğim aracı durdurup, düğmelere basıp, sonra pencereyi açması, yani sırayla hareketleri yapması ama Dingin3 hepsini aynı anda, hem de araç hareket ederken yapıyordu. KUp7

10KU Position: 19 - 19

Dingin3 sağ aynaya bakarken tavşan logosu ekranın o kısmını kapattığı için baktı mı bakmadı mı göremedim. Görmek isterdim. KUp7

10KU Position: 20 - 20

Dingin3 İşbank'tan sağa dönen kavşakta sürücü görüşünün en önemli kısmını, yol üzerinde yayaların geçtiği kısmı orta ayna kapatıyor. Sanırım sonradan eklenmiş bu ayna. KUp8

10KU Position: 26 - 26

Dingin3 KKM durağından kalkmadan önce ön kapı önünde duran yolcuların ayaklarına bakıyor (Aynı olay Uyumlu4 videosunda da olmuştu, CB'nin videoyu izlemek istemesinin nedeni o olayı görmek istemesiydi). Kapı içeri doğru açılıyorsa daha önceden orada duran yolculara çarpmış olabilir, oradan bir alışkanlıkla yolculara çarpmasın diye kontrol ediyor olabilir. KUp8

10KU Position: 29 - 29

Uyumlu2 hava karardıktan sonra Sunshine durağına yanaştı ve yolcuları indiriyor. İnen-binen yolcuları kontrol etmek için sağ tarafındaki 3 aynayı kullanıyor. Ön camın tam ortasında göz hizasında ve sağ ön kapı üstünde yukarı köşede 2 tane içeriyi gösteren ayna var. Sağda dışarıda da dışarıyı gösteren bir ayna var. Sürücü orta aynadan kontrol ediyor ama o aynanın görüş açısı yeterli değil. Dış ayna görüntüsü de karanlık olduğu için inen binenleri oradan göremiyor ve sağ ön kapının üzerindeki aynadan kontrol ediyor. Ama bu ayna çok yukarıda olduğu için kafasını geriye doğru eğmesi gerekiyor ve bu çok natürel bir hareket değil. KUp11

10KU Position: 44 - 44

Uyumlu2 kasisten geçtikten sonra orta aynadan aracın içine bakıyor. Kasisten geçmek yolcuların dengesini bozmuş mudur diye kontrol ettiğini düşünüyorum, iyi bir şey. KUp11

10KU Position: 46 - 46

Uyumlu2 KKM durağındayken çok sayıda yolcu bindi, hava karardı ve ön kapıya kadar doldu otobüs. Yolculardan biri torpido üzerinde, sağ dış ayna hizasında konumlandırılan tutamaklara tutundu. Sürücü kapıyı kapattı, kapı otobüsün içerisinden kayarak kapandı. Sürücü sağ dış aynaya ve kapının önündeki yolculara uzun süre baktı ama hava karanlık olduğu için aynadan çok fazla bir şey göremedi, yolcular kalabalık olduğu için de Dingin3'ün yaptığı gibi yolcuların ayaklarından kapı önünün yolculardan arınmış olup olmadığını kontrol edemedi (KU29 bit'inde olduğu gibi). Sürücüye bilgi akışında bir sıkıntı var. KUp11

10KU Position: 48 - 48

Saptadığım bazı problemler fiziksel çözümlerle ya da kampüs aydınlatmasının iyileştirilmesiyle adreslenebilecek şeyler iken, bir yandan da bu işte insan faktörü çok fazla. Sürücü profillerinde ilköğretim ya da lise mezunlarını görüyoruz. Burada biraz daha bilinçli insan seçimine gitmek fiziksel olarak ürünü değiştirmekten daha mantıklı olabilir. Mesela ilk sürücünün benim okuduğum okulda sürücü olmasını istemiyorum açıkçası, çünkü tehlikeli bir durum yaratıyor. Sürücü seçiminde değişiklik yapılması ve sürücüler ODTÜ ortamına ayak uydurabiliyorlar mı diye iyi değerlendirilmeleri gerekiyor. KUp13

10KU Position: 54 - 54

Pat diye söyleyeceğim ama UJM'de yazan problemlerin ODTÜ sürücülerinin yaşamayacağı problemler olduğunu düşünüyorum. Ankara içinde olsa belki ama ODTÜ içindeki insanların davranışları daha medeni. Bu yüzden bu çalışma datasının kampüs dışından toplanmasını tercih ederdim, bu datanın gerçek hayatı yansıtmadığını düşünüyorum. KUp13,14

10KU Position: 57 - 57

Persona isimleri karakter özellikleri şeklinde olması bende bir beklenti/önyargı oluşturdu. Personanın ismi Dingin ama video başladığında gözleri çok hızlı hareket ediyordu. Ben öncesinde önyargısız yaklaşmak isterdim. KUp14

10KU Position: 58 - 58

Videolarda göz hareketlerini takip edebiliyor olmak çok faydalıydı ama sürücüyü de farklı açılardan da çekilmiş videoları görmeyi isterdim. Yolcuların olduğu kısımlar, yolcuların hareketleri ve nerelere tutunduklarını vs.de görmek isterdim. KUp14

10KU Position: 61 - 61

Bu çalışmadaki bilgilerin sizin iş akışınıza olumlu/olumsuz etkileri olacağını düşünüyor musunuz? Otobüs içinde gözlem yapma ihtiyacı hissediyoruz ve

videolardan bunları takip etmek faydalı oldu. Ama otobüs sadece torpido ve sürücü koltuğundan ibaret değil, arka taraftaki tutunma yerleri, yolcu koltuklarının rahatlığı, kullanılan malzemeler, temizlenmesi gibi konuları da öngörmemiz gerekiyor. Bu yüzden bir aracın 24 saatini görmek isterdim. Araçların bakımları nerede yapılıyor, kim yapıyor gibi şeyleri de görmek için araştırmanın genişletilmesi gerekiyor. Bizim işte otobüsleri sürücüler satın almadığı için birinci öncelik sürücülerin konforu olmuyor. İhale yöntemiyle satın alınıyor ve ucuz olması öncelikli oluyor. Düşük kalite malzemeler kullanılması, tasarım açısından üzerine düşünülmemiş olması ya da aceleye getirilmesi gibi sıkıntılı durumlara girilmesi bu yüzden. Bu çalışma bulguları çok faydalı bulunabilir ama isterde yoksa ve çok pahalı gelirse uygulanma ihtimali düşük olur ve opsiyon olarak sunulur. Firma olarak bize isterlerin olduğu bir belge geliyor. İlk hedefimiz o isterlerin karşılanması oluyor ve isterlerin dışında kalan şeyleri katma değer olarak sunabiliriz ama ilk hedefimiz o olmadığı için gerekli değil ama olursa güzel olur gözüyle bakılıyor. KUp14,15

10KU Position: 62 - 62

Çalışmada beni zorlayan bir şey olmadı. Öngördüğünüz gibi 1,5-2 saatte bitiriyoruz. İlk Miro board çok açıklayıcıydı, rahat bir şekilde doldurabildim. UJM’de şimdiki gibi tek fotoğraf yerine farklı açılardan ya da geniş açıdan ortamı görmek daha iyi olabilirdi. KUp15

10KU Position: 63 – 63

X. Consent Form for Driver Data collection

Kasım 2018

ARAŞTIRMAYA GÖNÜLLÜ KATILIM FORMU

Bu araştırma, ODTÜ Endüstri Ürünleri Tasarımı Bölümü Doktora öğrencisi Ayça Kınık tarafından Prof. Dr. Gülay Hasdoğan danışmanlığındaki doktora tezi kapsamında yürütülmektedir. Bu form sizi araştırma koşulları hakkında bilgilendirmek için hazırlanmıştır.

Çalışmanın Amacı Nedir?

Araştırmanın amacı, göreviniz sırasında sürdüğünüz otobüslerin tasarımının iyileştirilmesi için gerekli olan bilgileri toplamaktır ve öncelikli olarak otobüsün sürücü kabiniyle ilgilidir. Sürücü kabini tasarımının, sürüş görevinizi güvenli bir şekilde yerine getirmenizi zorlaştıran noktalarını bulmaya çalışmaktayız.

Bize Nasıl Yardımcı Olmanızı İsteyeceğiz?

Araştırmaya katılmayı kabul ederseniz, sizden rutin kampüs içi ring sürüş görevinizi yerine getirirken bir göz izleme cihazı takmanız beklenmektedir. Bu cihaz bir gözlük şeklindedir ve kablo ile yaklaşık eliniz büyüklüğünde bir kayıt kutusuna bağlıdır. Bu cihazı takmanın herhangi bir gözlük takmaktan farkı yoktur, size herhangi bir rahatsızlık vermez. Cihaz bakmakta olduğunuz yerin video ve ses kaydını yapar. Böylelikle araştırmacı belirli görevler için sürücü kabininin hangi kısımlarını kullandığınızı görebilir. Aynı zamanda bakmakta olduğunuz yerde sürüşünüzü zorlaştıran başka unsurlar var ise bunları saptamayı sağlar. Çalışmanın bu kısmı yaklaşık 2 saat sürecektir.
Araştırmacı sürüş görevinin öncesinde ve sonrasında sürdüğünüz araçlarla ilgili ve o sürüşle ilgili karşılaştığınız zorlukları soracaktır. Daha sonra içerik analizi ile değerlendirilmek üzere cevaplarınızın video kaydı alacaktır. Sürüş sırasında dikkatinizi dağıtmamak için bu sorular sürüşten önce ve sonra, ODTÜ Taşıt İşletme Müdürlüğü dinlenme alanında sorulacaktır. Çalışmanın bu kısmı yaklaşık 1 saat sürecektir.

Sizden Topladığımız Bilgileri Nasıl Kullanacağız?

Araştırmaya katılımınız tamamen gönüllülük temelinde olmalıdır. Çalışmada sizden kimlik belirleyici hiçbir bilgi istenmemektedir. Sağladığınız veriler gönüllü katılım formunda toplanan kimlik bilgileri ile eşleştirilmeyecektir. Cevaplarınız tamamıyla gizli tutulacak ve sadece araştırmacılar tarafından değerlendirilecektir. Katılımcılardan elde edilecek bilgiler toplu halde değerlendirilecek ve bilimsel yayımlarda kullanılacaktır.

Katılımınızla ilgili bilmeniz gerekenler:

Çalışma, genel olarak kişisel rahatsızlık verecek sorular veya uygulamalar içermemektedir. Ancak, katılım sırasında sorulardan ya da herhangi başka bir nedenden ötürü kendinizi rahatsız hissederseniz çalışmayı yarıda bırakıp çıkmakta serbestsiniz. Böyle bir durumda çalışmayı uygulayan kişiye çalışmadan çıkmak istediğinizi söylemek yeterli olacaktır.

1/2

Araştırmayla ilgili daha fazla bilgi almak isterseniz:

Çalışma sonunda, bu çalışmayla ilgili sorularınız cevaplanacaktır. Bu çalışmaya katıldığınız için şimdiden teşekkür ederiz. Çalışma hakkında daha fazla bilgi almak için Endüstri Ürünleri Tasarımı Bölümü öğretim üyelerinden Prof. Dr. Gülay Hasdoğan ya da doktora öğrencisi Ayça Kınık ile iletişim kurabilirsiniz.

Yukarıdaki bilgileri okudum ve bu çalışmaya tamamen gönüllü olarak katılıyorum.

(Formu doldurup imzaladıktan sonra uygulayıcıya geri veriniz).

İsim Soyad	Tarih	İmza
	---/----/-----	

Y. Consent Form for Workshop Participants

Şubat 2022

ARAŞTIRMAYA GÖNÜLLÜ KATILIM FORMU

Bu araştırma, ODTÜ Endüstriyel Tasarım Doktora öğrencisi Ayça Kınık tarafından Prof. Dr. Gülay Hasdoğan danışmanlığındaki Doktora tezi kapsamında yürütülmektedir. Bu form sizi araştırma koşulları hakkında bilgilendirmek için hazırlanmıştır.

Çalışmanın Amacı Nedir?

Araştırmanın amacı, kullanıcı araştırması bulgularını paylaşma şeklinin, tasarım fırsatları tanımlaması üzerindeki etkilerini anlamaktır.

Bize Nasıl Yardımcı Olmanızı İsteyeceğiz?

Araştırmaya katılmayı kabul ederseniz, sürücü deneyim haritası inceleyecek ve sürüş videoları izleyeceksiniz. Ardından doksan dakikalık çevrim içi bir çalıştaya katılacaksınız. Çalıştay sırasında, deneyim haritası ve videolarda gözlemlediğiniz sorunlara yönelik en kötü durum senaryoları hazırlayacak ve bu senaryolara yönelik tasarım fırsatları tanımlayacağız. Daha sonra tematik analiz ile değerlendirilmek üzere görüşmenin video kaydı alınacaktır.

Sizden Topladığımız Bilgileri Nasıl Kullanacağız?

Araştırmaya katılımınız tamamen gönüllülük temelinde olmalıdır. Çalışmada sizden kimlik bilgisi istenmemektedir. Video kayıtları gizli tutulacak ve sadece araştırmacılar tarafından değerlendirilecektir. Katılımcılardan elde edilecek bilgiler toplu halde değerlendirilecek ve bilimsel yayımlarda kullanılacaktır.

Katılımınızla ilgili bilmeniz gerekenler:

Çalıştay, kişisel rahatsızlık verecek sorular veya uygulamalar içermemektedir. Ancak, katılım sırasında sorulardan ya da herhangi başka bir nedenden ötürü kendinizi rahatsız hissederseniz çalıştayı yarıda bırakıp çıkmakta serbestsiniz. Böyle bir durumda çalışmayı uygulayan kişiye çalışmadan çıkmak istediğinizi söylemek yeterli olacaktır.

Araştırmayla ilgili daha fazla bilgi almak isterseniz:

Çalıştay sonunda, bu çalışmayla ilgili sorularınız cevaplanacaktır. Bu çalışmaya katıldığınız için şimdiden teşekkür ederiz. Çalışma hakkında daha fazla bilgi almak için Endüstriyel Tasarım Bölümü doktora öğrencisi Ayça Kınık ya da öğretim üyesi Prof. Dr. Gülay Fatma Hasdoğan ile iletişim kurabilirsiniz.

Yukarıdaki bilgileri okudum ve bu çalışmaya tamamen gönüllü olarak katılıyorum.
(Formu doldurup imzaladıktan sonra uygulayıcıya geri veriniz).

İsim Soyad Tarih İmza

---/----/-----

Z. Ethics Committee Approval for Driver Data Collection

UYGULAMALI ETİK ARAŞTIRMA MERKEZİ
APPLIED ETHICS RESEARCH CENTER

ORTA DOĞU TEKNİK ÜNİVERSİTESİ
MIDDLE EAST TECHNICAL UNIVERSITY

DUMLUPINAR BULVARI 06800
ÇANKAYA ANKARA/TURKEY
T: +90 312 210 22 91
F: [illegible]
ueam@metu.edu.tr
www.ueam.metu.edu.tr

Sayı: 28620816 /

08 KASIM 2018

Konu: Değerlendirme Sonucu

Gönderen: ODTÜ İnsan Araştırmaları Etik Kurulu (İAEK)

İlgi: İnsan Araştırmaları Etik Kurulu Başvurusu

Sayın Prof.Dr. Gülay HASDOĞAN

Danışmanlığını yaptığınız doktora öğrencisi Ayça KINIK'ın **"Otobüs sürücüsü – araç etkileşimi ve iş akışı güvenliğini iyileştirmeye yardımcı olacak sürücü kabini tasarlama yöntemi geliştirmek"** başlıklı araştırması İnsan Araştırmaları Etik Kurulu tarafından uygun görülerek gerekli onay **2018-FEN-058** protokol numarası ile **09.11.2018 - 31.07.2019** tarihleri arasında geçerli olmak üzere verilmiştir.

Bilgilerinize saygılarımla sunarım.

AA. Ethics Committee Approval for Designer Data Collection

UYGULAMALI ETİK ARAŞTIRMA MERKEZİ
APPLIED ETHICS RESEARCH CENTER

ORTA DOĞU TEKNİK ÜNİVERSİTESİ
MIDDLE EAST TECHNICAL UNIVERSITY

DUMLUPINAR BULVARI 06800
ÇANKAYA ANKARA/TURKEY
T: +90 312 210 22 91
F: +90 312 210 79 59
ueam@metu.edu.tr
www.ueam.metu.edu.tr

Sayı: 28620816 /

15 ŞUBAT 2022

Konu : Değerlendirme Sonucu

Gönderen: ODTÜ İnsan Araştırmaları Etik Kurulu (İAEK)

İlgi : İnsan Araştırmaları Etik Kurulu Başvurusu

Sayın Prof. Dr. Gülay Fatma HASDOĞAN

Danışmanlığını yürüttüğünüz Ayşe KINIK'ın "Kullanıcı araştırması bulgularını paylaşma şeklinin tasarım fırsatları tanımlama üzerindeki etkileri" başlıklı araştırmanız İnsan Araştırmaları Etik Kurulu tarafından uygun görülmüş ve **0094-ODTUİAEK-2022** protokol numarası ile onaylanmıştır.

Saygılarımızla bilgilerinize sunarız.

CURRICULUM VITAE

Surname, Name: Kınık, Ayça

EDUCATION

Degree	Institution	Department
Ph.D.	Middle East Technical University	Industrial Design
MFA	Umea Institute of Design	Advanced Product Design
BS	Istanbul Technical University	Industrial Design

FOREIGN LANGUAGES

Advanced English, Beginner Spanish

PUBLICATIONS

Kınık, A. (2019). Improving Driver Experience for METU Campus Shuttle Buses. In N. A. G. Z. Börekçi, D. Özgen Koçyıldırım, F. Korkut, & Jones D. (Eds.), Proceedings of DRS Learn X Design 2019: Insider Knowledge (pp. 1023–1026). METU Department of Industrial Design / Design Research Society, UK. https://hdl.handle.net/11511/70409

Öztürk, İ., Mevsim, R., & Kınık, A. (2019). Ermenek Mine Accident in Turkey: The Root Causes of a Disaster. In Proceedings of the 20th Congress of the International Ergonomics Association (IEA 2018) (pp. 1019–1028). https://doi.org/10.1007/978-3-319-96068-5_114