



**CZECH TECHNICAL
UNIVERSITY
IN PRAGUE**

F3

**Faculty of Electrical Engineering
Department of Cybernetics**

Bachelor's Thesis

Design of Therapeutical Application for Digital Addiction Reduction

Erik Gadireddi

Open Informatics - Computer and Information Science

January 2022

Supervisor: doc. Ing. Daniel Novák, Ph.D



BACHELOR'S THESIS ASSIGNMENT

I. Personal and study details

Student's name: **Gadireddi Erik** Personal ID number: **474485**
Faculty / Institute: **Faculty of Electrical Engineering**
Department / Institute: **Department of Cybernetics**
Study program: **Open Informatics**
Branch of study: **Computer and Information Science**

II. Bachelor's thesis details

Bachelor's thesis title in English:

Design of Therapeutical Application for Digital Addiction Reduction

Bachelor's thesis title in Czech:

Návrh terapeutické aplikace pro snížení digitálních závislostí

Guidelines:

- 1) Make a literature review about digital addictions and current solutions on the market.
- 2) Design a mobile app to help reduce addiction on new media .
- 3) Test the application on 5 users at least.

Bibliography / sources:

- [1] K. Lukavska, The effects of parental control and warmth on problematic internet use in adolescents: A prospective cohort study, Journal of Behavioral Addictions, 2020.
- [2] K. Lukavska, The immediate and long-term effects of time perspective on Internet gaming disorder, Journal of Behavioral Addictions, 2020.
- [3] Vondrackova, P., & Gabrhelík, R. (2016). Prevention of internetaddiction: A systematic review.Journal of Behavioral Addic-tions,5(4), 568–579.

Name and workplace of bachelor's thesis supervisor:

doc. Ing. Daniel Novák, Ph.D., Analysis and Interpretation of Biomedical Data, FEE

Name and workplace of second bachelor's thesis supervisor or consultant:

Date of bachelor's thesis assignment: **14.09.2021** Deadline for bachelor thesis submission: **04.01.2022**

Assignment valid until: **19.02.2023**

doc. Ing. Daniel Novák, Ph.D.
Supervisor's signature

prof. Ing. Tomáš Svoboda, Ph.D.
Head of department's signature

prof. Mgr. Petr Páta, Ph.D.
Dean's signature

III. Assignment receipt

The student acknowledges that the bachelor's thesis is an individual work. The student must produce his thesis without the assistance of others, with the exception of provided consultations. Within the bachelor's thesis, the author must state the names of consultants and include a list of references.

Date of assignment receipt

Student's signature

Acknowledgement / Declaration

I would like to thank my supervisor, doc. Ing. Daniel Novák, Ph.D., for his patience, helpfulness, and specialist and technical knowledge, which helped me during the design and implementation phase of the thesis.

Lastly, I am grateful for my family's and girlfriend support during my studies.

I declare that the presented work was developed independently and that I have listed all sources of information used within it in accordance with the methodical instructions for observing the ethical principles in the preparation of university theses.

Prague, date 4. 1. 2022

.....

Abstrakt / Abstract

Cílem této práce bylo jednak seznámit účastníka s problémem digitální závislosti a jeho možnými řešeními, a dále vytvořit aplikace pro iOS prostředí, které by rodičům a dětem pomohla vyvarovat se této závislosti. V rámci návrhu aplikace byla použita doporučení z expertní literatury a poznatky z jiných současných aplikací. Výsledkem této práce je fungující aplikace z hlediska funkčních požadavků, avšak je nutné vzít v potaz nedostatek účastníků pro statisticky významné závěry týkající se snížení digitální závislosti v praxi.

Klíčová slova: digitální závislosti, mobilní aplikace, rodičovská kontrola, teorie rodičovské mediaci, prevence

Překlad titulu: Návrh terapeutické aplikace pro snížení digitálních závislostí

The thesis aims were to acquaint the reader with the problem of digital addiction and the possible solutions, then create an application for the iOS operating system that would help parents and children to prevent this problem. The recommendations from expert literature were used during the application design phase and findings from several similar applications. The result of this work is an application that satisfies the functional requirements; however, it is necessary to point out the limited number of participants in the study for a statistically significant conclusion on the topic of reduction of digital addiction in practice.

Keywords: digital addiction, mobile application, parental control, parental mediation theory, prevention interventions

Contents /

1 Introduction	1	5 Application design	12
2 Problem definition	2	5.1 Onboarding	12
2.1 Digital addiction	2	5.2 Sessions	12
2.2 Negative impacts on health	2	5.3 Rules	13
2.2.1 Sleep deficiency	2	5.4 Profile	13
2.2.2 Depression	3	5.5 Digital media plan and report	13
2.3 Prevention interventions for digital addiction	3	5.6 Navigation	14
2.3.1 Parental Mediation theory for Digital Age	3	6 Implementation	15
2.3.2 Primary prevention recommendations for children and adolescents	4	6.1 Data model	15
3 Analysis of mobile apps for digital addiction	5	6.2 ViewModel states problem	15
3.1 Design features of parental control apps on Android	5	7 User testing	19
3.2 Screen Time (iOS)	5	7.1 Screener	19
3.3 Applications using Mo- bile Device Management (MDM)	6	7.2 After testing questionnaire	19
3.3.1 Qustodio Parental Control App (iOS)	6	7.2.1 Close-ended questions	20
3.3.2 Kaspersky Safe kids with GPS (iOS)	6	7.2.2 Open-ended questions	21
3.3.3 Screen Time Parental Control (iOS)	6	7.3 Evaluation of results	21
3.3.4 Screen Time Family Control (iOS)	6	7.3.1 Answers of participants from screener	22
4 Analysis of mobile app	7	7.3.2 Answers of participants from the after-testing questionnaire	22
4.1 Programing language	7	8 Discussion	24
4.2 Minimal support of operat- ing system version	7	9 Conclusion	25
4.3 Frameworks	8	A Abbreviations	27
4.3.1 SwiftUI	8	References	28
4.3.2 UIKit	8	B User-testing Instructions in Czech	30
4.3.3 Combine	9	C Screenshots of application from Iphone XR	31
4.4 App architecture design paradigm	9	D Structure of the CD files	37
4.4.1 Model-View-ViewModel	9		
4.5 Limitations for develop- ment of features in Apple ecosystem	10		
4.6 Requirements	10		
4.6.1 Functional requirements	10		
4.6.2 Non-functional re- quirements	11		

Tables / Figures

2.1 Recommendations for pediatricians in primary prevention	4
7.1 Screener answers	22
7.2 After-testing questionnaire answers - part 1	22
4.2 MVVM data-flow diagram	9
4.3 MVVM code dependency diagram	9
4.4 SwiftUI data flow	10
5.1 Rules module navigation	13
5.2 Digital media plan diagram of usage	13
5.3 Application general navigation	14
6.1 Data model	15
7.1 Graph representing percentage of different answers for close-ended questions	22



Chapter 1

Introduction

In the current 21st century, the rapid development of the internet and the rise of versatile computing devices (such as smartphones, tablets and laptops) enabled individuals to access information, entertainment and instant connection with others like never before. Nevertheless, it brought new challenges for parents and their children to use this technology appropriately and avoid all the adverse effects.

Thus, creating a mobile application to improve this state makes sense. The thesis aims to develop a mobile application to reduce or prevent digital addiction in children with the parent's help. The application implementation is for the iOS operating system based on the author's choice.

Chapter 2

Problem definition

This chapter describes the problem of digital addiction in the context of current academic research. Then, several medical issues are detailed related to digital addiction. Last but not least, the prevention interventions for digital addiction section, which summarizes the best practices in the area. Finally, the last part compares and analyses the mobile applications for parental control apps and apps related to digital addiction.

2.1 Digital addiction

The term *digital addiction*(DA) is very problematic to define due to the missing consensus in academic literature. In general, the conceptualization of digital addiction is based on harmful effects caused by the behaviour, usage patterns, or a specific digital device [1],[2].

Several terms are suggested in academic literature to describe this phenomenon. These suggestions are Internet addiction (IA), compulsive computer use, Problematic Internet Use (PIU), Internet Use Disorder (IUD), smartphone addiction or Internet gaming disorder (IGD) as a type of behaviour related to digital addiction [1],[3]. There is no consensus if digital addiction is a mental health issue. Nevertheless, the IGD is classified as a condition requiring further research [4].

In the thesis, the definition of digital addiction was used as obsessive and problematic usage of digital media that does not necessarily need an active internet connection. The proposed diagnostic criteria for DA and models in literature are irrelevant and will not be part of this thesis.

2.2 Negative impacts on health

Several studies proved the correlation between the development of physical and mental problems with the frequency of using screens in children. The specific issues found were sleep deficiency, depression, obesity or attention deficit hyperactivity disorder (ADHD) [5].

2.2.1 Sleep deficiency

Sleep deficiency or sleep insufficiency are terms used to describe factors that reduce the quantity or quality of sleep. The needed amount of sleep for adults ranges from seven to nine hours per night. The children and teens need even more [6].

The consequences of sleep deprivation can be severe. Sleep has a fundamental role in the effective functioning of nearly all body systems. In particular, chronic sleep deficiency creates significant risks to physical and mental health, such as: cardiovascular disease, diabetes, obesity, immunodeficiency, hormonal abnormalities, pain and mental health disorders. Therefore, based on the facts stated before, sleep deprivation is generally associated with a greater overall risk of death and lower quality of life [6].

■ 2.2.2 Depression

Depression is a common and severe medical illness. It causes persistent sadness and loss of interest in the enjoyable activities of an individual. The difference between sadness and depression is that it must last at least two weeks and must represent a change in a prior individual level of functioning for a diagnosis of depression [4].

According to World Health Organization (WHO), depression is a leading cause of disability worldwide and significantly contributes to the overall global burden of disease [7].

■ 2.3 Prevention interventions for digital addiction

On the basis of the systematic literature review from 1995 to 2016, the applicable recommendations for the intended effective outcomes for effective preventive interventions are [2]:

- Only providing information about the negative consequences of risky behaviour is not enough and needs to be complemented with interactive interventions aimed at changing attitudes and developing selected skills for life.
- Effective prevention interventions should be complex; furthermore, they should focus on other risk behaviours.
- Effective prevention interventions should not target only individuals.

However, the literature on the prevention of digital addiction is scarce. In addition, there is a lack of published data on the effectiveness of specific prevention interventions and future research is needed in this area [2].

■ 2.3.1 Parental Mediation theory for Digital Age

Parental mediation theory describes how parents can prevent adverse effects on their children. Before the Internet era, the parental mediation theory was focused mainly on Television consumption. Currently, parental mediation theory for the digital age has three mediation strategies [8]:

- restrictive mediation
- monitoring
- active mediation

Restrictive mediation comprises of setting family rules and boundaries around online activities. Additionally, there is the optional use of software tools for restricting access or content of children. Monitoring in the perspective of the Internet gives importance to passive monitoring of children online activities. Active mediation is focused around an active dialogue between parent and child, where parents should guide, interpret and help explain child online harms and risks [8].

Furthermore, the American Academy of Pediatrics (AAP) organization recommends using a *family media plan*¹ tool in the restrictive mediation phase. A family media plan is a written document consisting of family rules per child or per the whole family for media use. This tool makes it easier to set up the rules between children and their parents, as it can become overwhelming to consider all pros and cons of different restrictions [9].

¹ <https://www.healthychildren.org/English/media/Pages/default.aspx>

2.3.2 Primary prevention recommendations for children and adolescents

Children and adolescents are at greater risk of digital addiction due to developing their standards and values during their formative years. As a consequence, the prevention interventions should be mainly focused on them [2].

The following primary prevention recommendations are derived from the recommendations on the use of digital technology from these organizations: WHO, AAP, Canadian Paediatric Society (CPS), Institute de France Académie des Sciences, Royal College for Pediatrics and Child Health (RCPCH) and Australian Government: Department of Health.

Development stage	Recommendation
0-18 months	Should not use of any digital media except video calls.
18-24 months	Should slowly discover quality content with parent guidance.
2-5 years	Should be allowed only 1 hour of quality content with clear rules, what to watch.
6-10 years	Needs rules and strong parenting patterns.
11+ years	Child still should have some restriction, but you should discuss creation of rules with them.

Table 2.1. Primary prevention of risky use of screens in the pediatric office [5]

The vital thing to see from the table 2.1 is that the recommendations are not static but rather dynamic. They should change over time with the development of the child.

In contrast with the theory and best practices from the field, most applications for restricting child devices on the android platform are more static. These applications offer only two strategies: blocking all contents and requesting access to every detail that child does on the device or no information and no restrictions [8].

Chapter 3

Analysis of mobile apps for digital addiction

The analysis of the apps consists of three parts. First are the findings on the design of features of apps for parental control on the Android platform. The second part shows the author's findings on several apps from the AppStore market and a review of their features.

3.1 Design features of parental control apps on Android

The recent paper described the systematic analysis of the design of 58 Android parental control apps and the effect of the specific features on the user experience between parents and children. The authors used mediation theory models such Parental Mediation theory for Digital Age (section 2.3.1) and Teen Online Safety Strategies Framework (TOSS) as the basis for investigating the application features [8].

Zone of best practice was identified based on mediation theory strategies (monitoring, restriction and active mediation), views on designs perceived positively by parents and children, and the additional features (such as means for children to inspect their restriction/monitoring policies). The study found three apps that fall into the *zone of best practice* area [8]: Screen Time Parental Control (section 3.3.3), Jiminy, and Kaspersky Safe Kids (section 3.3.2). The specific characteristics they fulfilled were [8]:

- High Feedback/ Transparency - Feature designs provide means of viewing restriction policies with additional explanation: why the rules were made and why accessing restricted content might be wrong for them.
- High Communications Support - Feature designs encourage communication around the restriction and monitoring policies or offer advice to parents.
- Medium Granularity - Feature designs that provide a middle ground between restrictions of children and effort from parents needed.

3.2 Screen Time (iOS)

The Screen Time app is the system application in the Apple ecosystem. It has monitoring and restriction functionality. The application gives the user precise time on categories of apps (such as work, entertainment or others) or specific application. In addition, it enables user to see the time of all devices logged in the same apple account (the so-called apple id). It can enable restriction of the child apple id linked to the parent apple id account. The restrictions can limit children's screen time, prevent explicit content on the web or limit built-in apps or features.

3.3 Applications using Mobile Device Management (MDM)

MDM enables parental control apps to securely and wirelessly configure devices by sending profiles and commands to the device. MDM capabilities include updating software and device settings, monitoring parental control app policy compliance, and remotely wiping or locking devices [10].

Parental control application that provides MDM settings for child account on iOS can track [11] :

- Device name
- Phone number
- Serial number
- Model name and number
- Capacity and space available
- iOS version number
- Installed apps

The MDM brings privacy risks for the parents and their children as parental control companies can misuse all the features and data from MDM once it is set up on the device.

The main difference between apps using the MDM settings for monitoring and the system Screen Time application is the source of truth of the data. The Screen Time application can access the system data and relevant stats from the first start of the device. In contrast, parental control apps can see only limited information provided after installing the MDM profile and creating the stats from the limited data obtained.

3.3.1 Qustodio Parental Control App (iOS)

The Qustodio¹ is a multi-platform (iOS, Android, Windows and others) parental-control application. It enables parents to monitor and restrict their children. The main features are app blocking, location monitoring (with geofencing), web filtering, and time management control.

3.3.2 Kaspersky Safe kids with GPS (iOS)

The Kaspersky Safe kids with GPS² has similar features to the Qustodio app. However, in contrast with the mentioned apps previously, it has an additional feature of recommendations from experts per restriction categories. This recommendation is possible to see when setting specific restrictions for a child. It is the closest thing to the active mediation mentioned in the section 2.3.1.

3.3.3 Screen Time Parental Control (iOS)

The Screen Time Parental Control³ is another application similar to the Qustodio app. In addition to Qustodio app features, it has a chore system, where the parent can reward a child with additional screen time when the chore is done.

¹ <https://www.qustodio.com/>

² <https://www.kaspersky.cz/safe-kids>

³ <https://screentimelabs.com>

Chapter 4

Analysis of mobile app

This chapter describes the overview of technologies, requirements and application design patterns, before the implementation of the application. First part is focused on development technologies as programming language, frameworks and minimal operating system version. The second part describes application architecture and functional and non-functional requirements of the application.

4.1 Programming language

For developing application on iOS, there are two programming languages to choose from Objective-C or Swift. The Objective-C¹ was created in early 1980s and it is general-purpose, object-oriented language. The Swift² language was first released in 2014 as a replacement for the Apple's Objective-C. Thus it has all the features of Objective-C with addition to modern features of programming languages.

In contrast to Objective-C, Swift has necessary abstraction and better syntax, that is easier to understand and more error-prone [12]. Furthermore Swift language is open-sourced and it has active community making proposals for evolution of Swift. Both programming languages support multi-platform development on iOS, MacOS, TvOS and WatchOS. The popularity across developers is in favor of Swift instead of Objective-C based on Stack-Overflow survey in 2021 [13]. For that reason, the application implementation used Swift.

4.2 Minimal support of operating system version

Choosing the minimal support version of iOS is essential to determine on which user's devices will be the application compatible. The decision should be made based on frameworks and tools, that we want to use for development. Above all, we should consider the percentage of users using various versions.

The 85% of all iOS devices used iOS 14 on the June 4, 2021 (figure 4.1). The devices with lower than iOS 13 were only 7%. Furthermore, 90% of all devices introduced in the last four years use iOS 14. The percentage of all devices that use iOS lower than 13 is 2%. According to these facts we would focus minimal support of the application to iOS 14.

¹ <https://developer.apple.com/library/archive/documentation/Cocoa/Conceptual/Programming-WithObjectiveC/Introduction/Introduction.html>

² <https://www.swift.org/about/>

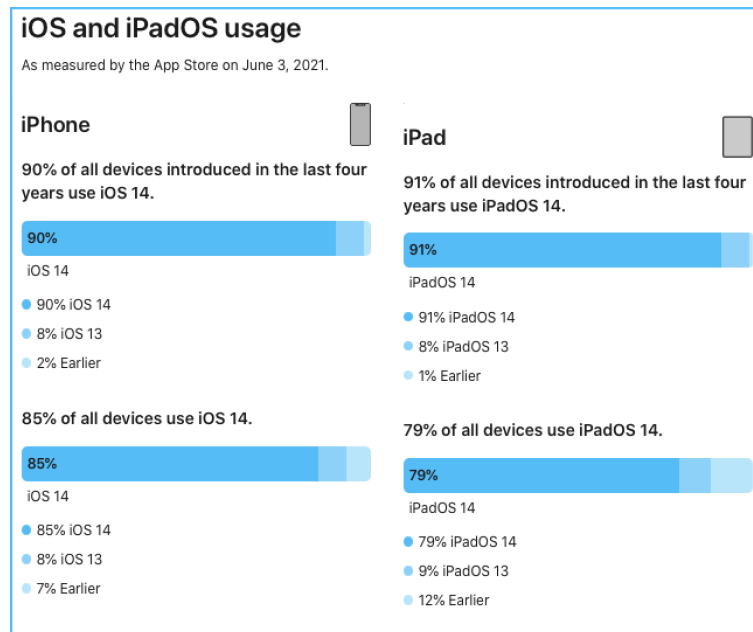


Figure 4.1. iOS and iPadOS usage measured by the App Store on June 3, 2021

4.3 Frameworks

Frameworks are self-contained, reusable chunks of code and resources, that can be imported and shared across apps. Besides, framework can be shared across TvOS, MacOS, iOS and WatchOS in Apple ecosystem. In different languages there are various names for the same term such as gem, jar, package and node module.

4.3.1 SwiftUI

The SwiftUI³ is recent declarative framework for user interface. The main benefit is less boilerplate code than with UIKit. In addition to it has built in Model-View-ViewModel (MVVM) architecture. In contrast, it has three cons [14]: there is limited iOS version coverage compared to UIKit, for example, main class `UIActivityViewController` for sharing content from application is not part of SwiftUI and needs to be implemented from UIKit, there is limited adoption from community as the lowest supported version is iOS 13, and simply by virtue of being significantly newer, has significantly fewer solutions to common problems available.

Even though there are several drawbacks, the core implementation of application utilized mainly SwiftUI framework.

4.3.2 UIKit

The UIKit⁴ is imperative framework for constructing and manage graphical, event-driven user interface. It was introduced in 2008 and it supports iOS 2 and higher versions. The structure of UIKit apps is based on Model-View-Controller(MVC) design pattern.

³ <https://developer.apple.com/documentation/swiftui/>

⁴ <https://developer.apple.com/documentation/uikit/>

4.3.3 Combine

The Combine⁵ framework provides declarative approach for how app processes events. Combine's aims to introduce a new language to Swift ecosystem, that helps to bring more structured way into the chaos of asynchronous programming.

4.4 App architecture design paradigm

The frameworks such as SwiftUI and UIKit are designed in a way that it should follow some techniques, design patterns and organization of code to work properly. The collection of all these things is called architectural design paradigm. As mentioned in the section 4.3 UIKit and SwiftUI uses different architectural design paradigm. However, MVVM must be adhered to for SwiftUI to work properly. Thus, in the following section I will describe the MVVM paradigm.

4.4.1 Model-View-ViewModel

Model-View-ViewModel or Presentation Model is an architectural pattern introduced by Martin Fowler. The pattern proposes separating the user interface, behaviour, and state into view, view-model, and model [15].

Representation of the MVVM data flow is in figure 4.2. The view-model has the dynamic state and behaviour of the presentation. In other words, it is not necessary to have every information in the view-model, but only the information, which may be changed by user interaction. The view only controls the way how the view-model state is rendered. The model is only a data layer modified by the view-model and read-only for view. The last crucial part of having a working MVVM is the synchronization code between the view and its view model, which enables the update of the view when the view-model changes. The synchronization is also called data-binding [15].

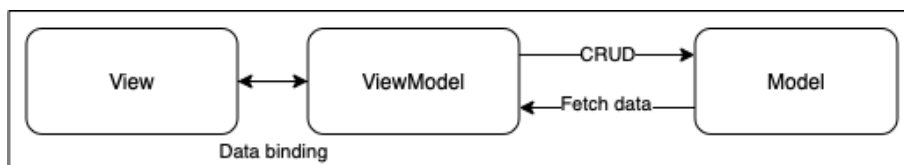


Figure 4.2. MVVM data-flow diagram

From the perspective of code dependency visualized in figure 4.3, it has three strict rules that programmers must follow to adhere to this paradigm [16]:

1. The view has reference to view model instance, but not the other way around.
2. The view-model has reference to the model, but not the other way around.
3. The view cannot have a reference to the model, and the model cannot have a reference to the view.

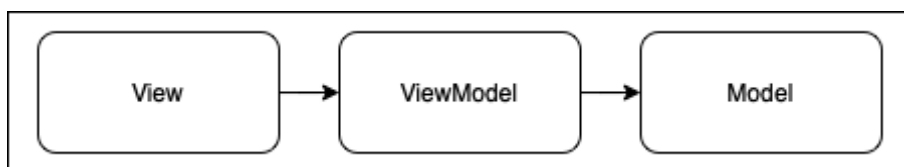


Figure 4.3. MVVM code dependency diagram

⁵ <https://developer.apple.com/documentation/combine/>

In the SwiftUI framework data flow in figure 4.4, there can be found several parallels just with different names: the view-model is the state, the view is a function of the state, and action is the user-interaction propagated to the view-model.

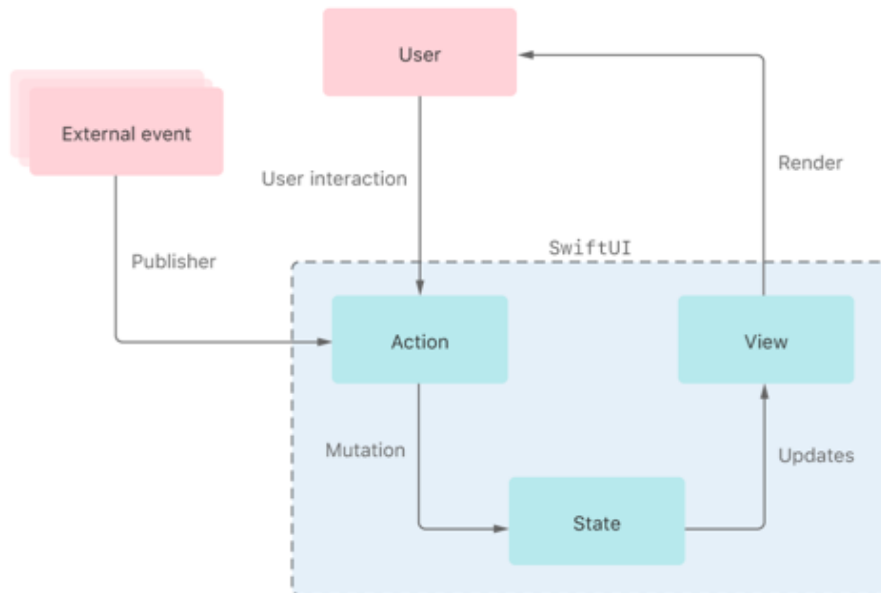


Figure 4.4. SwiftUI data flow

4.5 Limitations for development of features in Apple ecosystem

It was not possible to use MDM services in the designed application due to legal reasons. Particularly application that uses MDM services needs to be created by a company or enterprise [17].

4.6 Requirements

The second chapter describes the problem of digital addiction and recommendations from experts or health organizations. The third chapter reviews the Android applications of best practice from the systematic review and the similar apps on the iOS platform.

In this section, all these discoveries are utilized to define the functional and non-functional requirements of the application.

4.6.1 Functional requirements

- The application can work without an internet connection.
- The application enables the creation of a parent account.
- The application enables the creation of a child entity under the parent account.
- The parent can add multiple children and switch between them.
- The application has active mediation in some form.
- The application should have restrictions for children.
- The application should have some monitoring ability, at least manual input from the parent.

- The application should offer a report feature as feedback for the parent.
- The parent can add, edit, delete restrictions per child.
- The restrictions should be categorized based on type.
- The parent can create custom restrictions or pick recommended restrictions.
- The application list of different restrictions is sharable.
- The user can delete the account and remove all the personal information in the app.

■ **4.6.2 Non-functional requirements**

- The application will support the iOS platform.
- The application will support iOS 14 or higher.
- The application will use JSON format for storing data.

Chapter 5

Application design

Before designing the application, it was necessary to consider all the relevant functional and non-functional requirements from section 4.6.

When the user opens the application for the first time, onboarding is shown. The onboarding welcomes the user and helps him understand the app and do the initial set-up for the application. Once the user finishes all the onboarding stages, he/she can access the application's content.

The application content consists of several functional parts: sessions, digital media plan, rules, and profile. The central part of the application will be the sessions module, which has active mediation and restrictive mediation role for parent and child. After completing a certain number of sessions, there will be gradually unlocked content in other modules, or new modules will appear. It should help parents and children get step by step to learn new skills and pieces of information.

The other essential module in the application is the digital media plan module. It serves as a summary of restrictions and evaluation tool of compliance with the rules per child.

The following module is the profile module consisting of the daily report with stats and history of reports. Furthermore, this module has settings of the application. Unfortunately, the application cannot use the MDM services, so the monitoring needs to be done manually by a parent.

5.1 Onboarding

As mentioned in the introduction of the chapter, onboarding has two functions. The first is to give users relative information. Additionally, help him understand what the app offers and how to use it. The second is to help with the initial setup of the application. That means to enable users to use their already existing accounts or register the user and create at least one child entity.

5.2 Sessions

The sessions module consists of several sessions, but only one is accessible via the user interface at the time. Once one session is done, the next one appears. The individual sessions focus on a specific topic to learn new skills or problems related to a child's upbringing in the digital age. The session always has an informative part, which introduces the user to the problem or topic. In some instances, there is also an interactive part where the parent should cooperate with the child. The input from the interactive part is propagated to the rules module. The sessions module follows the findings from section 3.1 and tries to use the mediation strategies not independently but rather in a combined manner. In other words, the parent gets tips on restriction or how to start a dialogue with the child.

5.3 Rules

The rules module serves as a tool to view, add or edit restrictions per child. Furthermore, the parent can create his custom restrictions if he wants. The restrictions are clustered into lists per category. The navigation in the module is centred around these lists, as is shown in figure 5.1 .

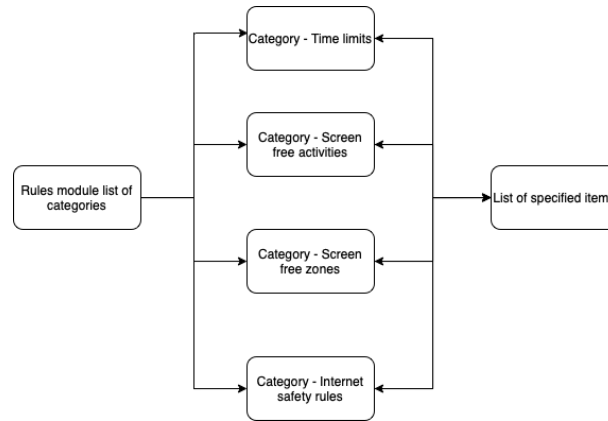


Figure 5.1. Rules module navigation

5.4 Profile

In the profile module, the user can look at his account or list of children. In addition, the user can contact support via email.

5.5 Digital media plan and report

Digital media plan module is inspired by the *family media plan* mentioned in section 2.3.1. The digital media plan consists of swipeable cards that show categorized restrictions and recommendations once the user finishes all sessions per child. Once parents have this summary for a child, they can use the digital media plan for routine evaluation of the rules of the child as shown in figure 5.2. After the evaluation, the stats are saved to the report module, which keeps the history of all finished evaluations and can be opened later in profile module.

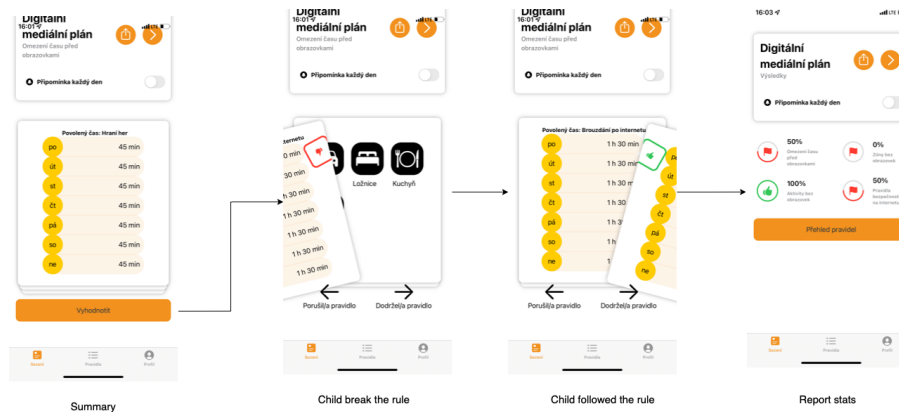


Figure 5.2. Digital media plan example usage

5.6 Navigation

The application navigation needs to be fluent and clear for the user. In addition, the navigation should support the purpose of the application. Based on the complexity of the application, the combination of hierarchical and flat navigation was chosen. The concrete design is in figure 5.3.

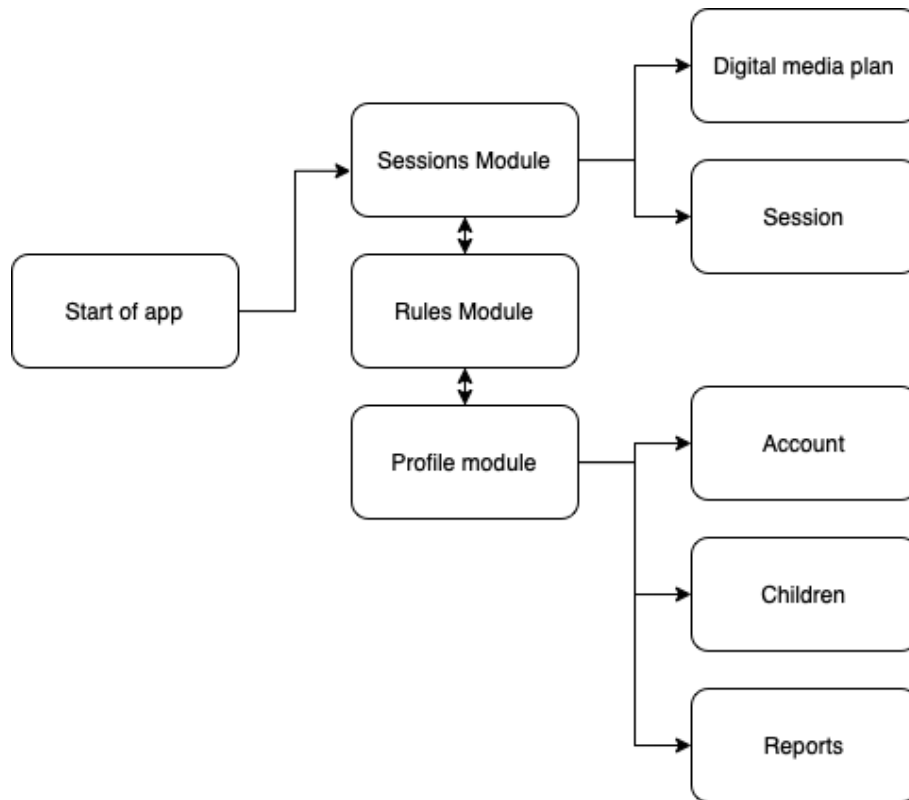


Figure 5.3. Application general navigation

Chapter 6

Implementation

The implementation of the application was focused on the user interface and the definition of necessary classes(reference types) and structs(value types). The application was first implemented as an offline application to prevent rejection from Apple. The first implementation was the user-testing version. The second version with the backend could not be finished on time. However, it introduced necessary refactoring of code and challenges during development.

6.1 Data model

The consists of two classes: user and kid. The user and kid represents standalone documents. All the other classes are parts of one particular kid document.

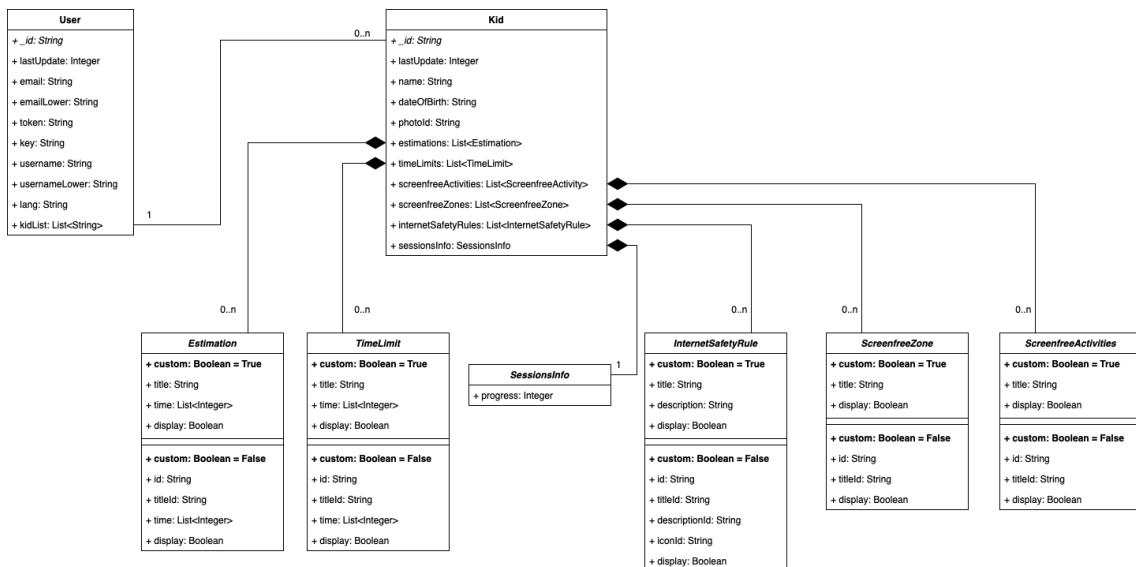


Figure 6.1. Data model

6.2 ViewModel states problem

One of the challenges was the additional states of the UI. The state of the UI was based on several properties, and with the additional states as update and loading resources, it became more problematic to maintain and change. Furthermore, the unexpected states were the even more outstanding issue. The solution was to work out all possible states and all possible actions that trigger state transitions and make them explicit. Thus the finite-state machine was implemented for this reason in some ViewModels. An example of the implementation can be seen below:

```

extension ChildrenService {
  class StateMachine: StateMachineProtocol {
    enum State {
      case initial
      case loading
      case publishingChanges
      case finished
      case failed(error: ChildrenError)
      var description: String {
        switch self {
          case .loading:
            return "loading"
          case .initial:
            return "empty or initial"
          case .finished:
            return "finished"
          case .failed(error: let error):
            return "Failed \ \(error.localizedDescription)"
          case .publishingChanges:
            return "Publishing changes (can be remove add or
other)"
        }
      }
    }
  }

  enum Event {
    case onAppear
    case update
    case success
    case failure(error: Error?)
  }

  enum ChildrenError: String, AlertError {
    case general
    case backendError
    case noChild
    var errorDescription: String? {
      switch self {
        case .general:
          return "General Error"
        case .backendError:
          return "Backend Error"
        case .noChild:
          return "No child error"
      }
    }
  }

  var id: String {
    self.rawValue
  }
}

```



```

private(set) var state: State {
    didSet {
        stateNotifier.send(self.state)
    }
}
let stateNotifier: PassthroughSubject<State, Never>
let statePublisher: AnyPublisher<State, Never>

required init(state: State) {
    self.state = state
    self.stateNotifier = PassthroughSubject<State, Never>()
    self.statePublisher = self.stateNotifier.eraseToAnyPub-
lisher()
}
@discardableResult func tryTransformation(_ input: Event) ->
Bool {
    guard let newState = transform(input) else {
        return false
    }
    state = newState
    return true
}

func transform(_ input: Event) -> State? {
    switch state {
    case .initial:
        switch input {
        case .onAppear:
            return .loading
        default:
            return nil
        }
    case .failed(_):
        switch input {
        case .onAppear:
            return .loading
        default:
            return nil
        }
    case .loading:
        switch input {
        case .success:
            return .finished
        case .failure(_):
            return .failed(error: ChildrenError.general)
        default:
            return nil
        }
    }
}

```

```
    }
    case .finished:
      switch input {
      case .update:
        return .publishingChanges
      case .onAppear:
        return .loading
      default:
        return nil
      }
    case .publishingChanges:
      switch input {
      case .success:
        return .finished
      case .failure(_):
        return .failed(error: ChildrenError.backendError)
      case .onAppear, .update:
        return nil
      }
    }
  }
}
```

Chapter 7

User testing

The user testing's main aim was to verify the application's functionality and if the users would use the application with their child. The user-testing consists of two phases: The first phase is finding suitable testers based on requirements. The second phase is testing the application by them.

The six participants fulfilled the requirements based on the screener 7.1. Then all of them received the instruction for user-testing C. Only five participants sent the after-testing questionnaire at the end of the user-testing more in 7.3.

7.1 Screener

A screener was created to find participants that are the best fit for our user-testing study. The required characteristics for the participant are a parent who has a child between 0-18 years old, uses an iOS device with an operational system 14 or higher and accepts the anonymous publication of responses.

1. Are you a parent?
 - Yes
 - No
2. Is your child aged between 0 - 18 years?
 - Yes
 - No
3. Do you have a smartphone(iPhone) with iOS 14 or higher?
 - Yes
 - No
4. Do you have any experience with applications focused on digital addiction or parenting?
 - Yes
 - No
5. Do you agree with the anonymous publication of responses from a survey?
 - Yes
 - No

7.2 After testing questionnaire

Participants received an after-testing questionnaire six days after the first instructions. The questionnaire was divided into two parts.

The first part 7.2.1 consisted of closed questions that could be quantitatively evaluated. The questions were related to user experience, application functionality, and the value proposition of our application.

The second part 7.2.2 consisted of open questions to gather more descriptive feedback on specific features, issues with the application, or overall experience.

7.2.1 Close-ended questions

1. The application was straightforward to use after the initial installation and onboarding (introduction).
 - A) Strongly disagree
 - B) Disagree
 - C) Neither agree nor disagree
 - D) Agree
 - E) Strongly agree
2. Using the application was easy and intuitive.
 - A) Strongly disagree
 - B) Disagree
 - C) Neither agree nor disagree
 - D) Agree
 - E) Strongly agree
3. The application worked without issues and as I expected.
 - A) Strongly disagree
 - B) Disagree
 - C) Neither agree nor disagree
 - D) Agree
 - E) Strongly agree
4. I found sessions helpful for getting relevant information when creating guidelines for a child.
 - A) Strongly disagree
 - B) Disagree
 - C) Neither agree nor disagree
 - D) Agree
 - E) Strongly agree
5. The digital media plan of the child was easy to evaluate.
 - A) Strongly disagree
 - B) Disagree
 - C) Neither agree nor disagree
 - D) Agree
 - E) Strongly agree
6. If I wanted to help with the adverse effects of digital technologies or educate my children about using digital technologies, I would use this application.
 - A) Strongly disagree
 - B) Disagree
 - C) Neither agree nor disagree
 - D) Agree
 - E) Strongly agree
7. I would recommend this application to a friend.
 - A) Strongly disagree
 - B) Disagree
 - C) Neither agree nor disagree
 - D) Agree
 - E) Strongly agree

7.2.2 Open-ended questions

1. What was your worse issue when using the application?
2. What did you like specifically about the app?
3. What did you dislike about the app specifically?

7.3 Evaluation of results

The close-ended answers showed the general opinions about the functionality of the application and the value for parents. The open-ended answers point out the application's implementation strong and weak sides. In general, it did not make sense to use statistic analysis as the number of users was very low. Thus, user-testing has a more qualitative side than quantitative. Participant 6 did not fill the after-testing questionnaire. Thus there is one less answer in the after-testing questionnaire compared to screener answers.

Overall the participant's answers were relatively positive or neutral in the close-ended answers (figure 7.1). The most negative feedback received was question 7 (I would recommend this application to a friend.). The second most negative feedback had question 3 (The application worked without issues and as I expected.). After investigating open-ended questions of participants 1,2, and 5, the most probable cause might be a missing translation of string/asset or not intuitive enough digital media plan. Missing strings in the English translation caused the specific string localization issue, which participant 1 mentioned in open-ended question 1 (What was your worse issue when using the application?). This issue was fixed after the user-testing by adding the missing strings.

The third open question (What did you dislike about the app specifically?) was positively answered by participants 3 and 4, which suggests that they did not face any issues. On the other hand, participants 1 and 5 found the graphical design needing improvements.

The last specific issue from the open-ended questions was connected with the digital media plan export feature. After investigating the issue, the cause was the system dark mode functionality, which changed the background in the exported photo of the digital media plan.

Most participants positively evaluated question 4 (I found sessions helpful for getting relevant information when creating guidelines for a child.) related to the active mediation feature. That could mean that the application is going in the right direction in the parental control applications market.

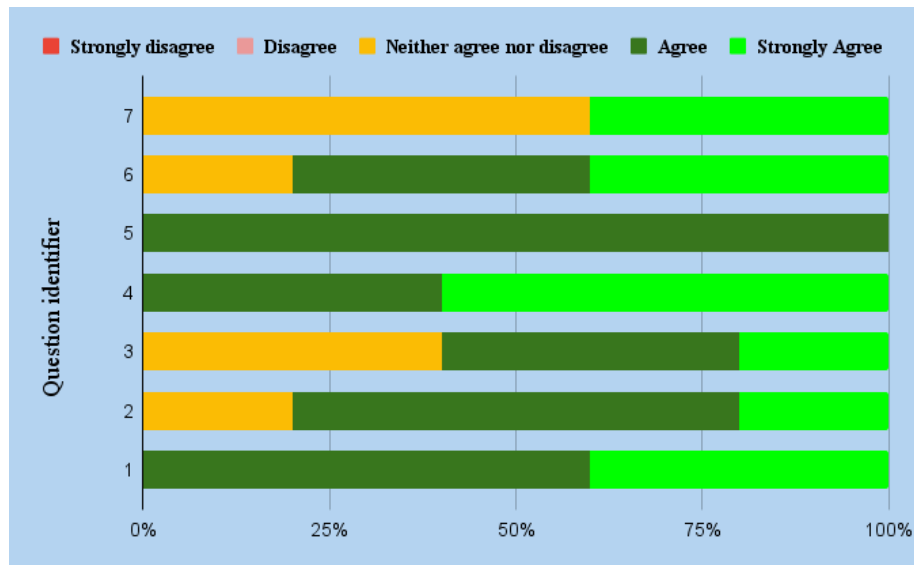


Figure 7.1. Graph representing percentage of different answers for close-ended questions

7.3.1 Answers of participants from screener

Participant ID	Q1	Q2	Q3	Q4	Q5
1	Yes	Yes	Yes	No	Yes
2	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	No	Yes
4	Yes	Yes	Yes	No	Yes
5	Yes	Yes	Yes	No	Yes
6	Yes	Yes	Yes	No	Yes

Table 7.1. Answers from screener

7.3.2 Answers of participants from the after-testing questionnaire

Participant ID	Q1	Q2	3	Q4	Q5	Q6	Q7
1	D	D	C	E	D	D	C
2	D	C	D	D	D	C	C
3	E	E	E	E	D	E	E
4	E	D	D	D	D	E	E
5	D	D	C	E	D	D	C

Table 7.2. Answers for closed questions

Below are answers from the open-ended questions.

Participant 1

1. It seems to be written in imperfect English and even though the app was supposed to be in English, certain parts of it were in Czech.
2. It's easy to use, intuitive, informative.
3. The design could be better and the text needs proofreading.

■ Participant 2+¹

1. I did not understand card at the end, how to evaluate my digital medial plan.
2. simplicity of sessions and the informative character
3. Grafical desing will need improvements, but this version is ideal for the testing.

■ Participant 3+

1. Nothing
2. I liked the graphical design and straightforward navigation.
3. Nothing

■ Participant 4+

1. There was none.
2. intuitivity and clarity
3. I did not find anything yet, that I would dislike.

■ Participant 5

1. Some images with text was not translated into Czech (sessions day 4).
2. I liked the sessions.
3. The exported digital media plan did not look well.

¹ Symbol + represents that the participant did not answer in English, and the author of the thesis translated it.




Chapter 8

Discussion

The gathered results from user-testing verified that the application was easy to use and had added value for the participants. In particular, the users agreed or strongly agreed that the active mediation feature was helpful. This fact corresponds with the theoretical literature in chapter 2, which mentions a need for more active mediation features in parental applications.

Nevertheless, more participants and longitudinal studies would be needed to properly statistically verify the effects of the application on the reduction or prevention of digital addiction in children or parents.

Consequently, future work regarding the application may include data collection and analysis. Furthermore, this data would help verify the recommendations and new prevention interventions for clinical practice.



Chapter 9

Conclusion

The final chapter concludes this thesis's theoretical, practical part and accomplished goals of the thesis.

The problem and motivation behind it were introduced in chapter 1. In chapter 2, the definition of the problem was established based on a health-related literature review. Furthermore, general practices and models for reducing or preventing the issue were summarized. In chapter 3, a literature review associated with mobile parental control applications was done. In addition, several iOS parental controls apps were investigated in detail. Subsequently, the findings from these chapters helped form the requirements for the application.

Chapter 4 interconnected the theoretical and practical part of the thesis via laying down the requirements and the technologies used to build the application. Afterwards, chapter 5 proposed the application design. Then in chapter 6 depicted the general implementation and concrete problems during implementation as a follow-up user testing was performed and evaluated in chapter 7 and discussed in chapter 8.

The main aim of the thesis was to create an application for the reduction of digital addiction. The secondary aims were to do a literature review about digital addiction and current solutions on the market, design a mobile app, and test the application on at least 5 participants. All of these aims were one by one accomplished in chapters 2-8.

The thesis contributes to applying the literature findings into a unique mobile application on the market.



Appendix A

Abbreviations

AAP	■	Academy Academy of Pediatrics
DA	■	Digital Addiction
IA	■	Internet addiction
IGD	■	Internet Gaming Disorder
IUD	■	Internet Use Disorder
MDM	■	Mobile Device Management
MVVM	■	Model-View-ViewModel
PIU	■	Problematic Internet use
WHO	■	World Health Organization



References

- [1] BASEL, Almourad, John MCALANEY, Tiffany SKINNER, Megan PLEVA, and Raian ALI. Defining digital addiction. *Psihologija*. 2020, Vol. 53, No. 3, pp. 237-253. ISSN 0048-5705. Available from DOI 10.2298/PSI191029017A. Available from <http://www.doiserbia.nb.rs/Article.aspx?ID=0048-57052000017A>.
- [2] VONDRÁČKOVÁ, Petra, and Roman GABRHELÍK. Prevention of Internet addiction. *Journal of Behavioral Addictions*. 2016, Vol. 5, No. 4, pp. 568-579. ISSN 2062-5871. Available from DOI 10.1556/2006.5.2016.085. Available from <https://akjournals.com/doi/10.1556/2006.5.2016.085>.
- [3] LUKAVSKÁ, Katerina, Jaroslav VACEK, and Roman GABRHELÍK. The effects of parental control and warmth on problematic internet use in adolescents. *Journal of Behavioral Addictions*. 2020-10-12, Vol. 9, No. 3, pp. 664-675. ISSN 2062-5871. Available from DOI 10.1556/2006.2020.00068. Available from <https://akjournals.com/view/journals/2006/9/3/article-p664.xml>.
- [4] ASSOCIATION, American Psychiatric. *Diagnostic and statistical manual of mental disorders DSM-5tm*. 5th ed ed. Washington, DC: American Psychiatric Publishing, 2013. ISBN 978-0-89042-555-8.
- [5] SLUSSAREFF, Michaela, and Kateřina LUKAVSKÁ. Technologies and children. *Pediatric pro praxi*. 2021-4-29, Vol. 22, No. 2, pp. 117-120. ISSN 12130494. Available from DOI 10.36290/ped.2021.021. Available from <http://www.pediatricpropraxi.cz/doi/10.36290/ped.2021.021.html>.
- [6] SUNI, Eric, and Alex DIMITRIU. *Sleep Deprivation*. Available from <https://www.sleepfoundation.org/sleep-deprivation>.
- [7] ORGANIZATION, World Health. *Depression*. Available from <https://www.who.int/news-room/fact-sheets/detail/depression>.
- [8] WANG, Ge, Jun ZHAO, Max Van KLEEK, and Nigel SHADBOLT. Protection or Punishment? Relating the Design Space of Parental Control Apps and Perceptions about Them to Support Parenting for Online Safety. *Proceedings of the ACM on Human-Computer Interaction*. 2021-10-13, Vol. 5, No. CSCW2, pp. 1-26. ISSN 2573-0142. Available from DOI 10.1145/3476084. Available from <https://dl.acm.org/doi/10.1145/3476084>.
- [9] PEDIATRICS, American Academy of. *Family Media Plan helps parents set boundaries for kids*. Available from <https://publications.aap.org/aap-news/news/9082>.
- [10] *Intro to mobile device management*. Available from <https://support.apple.com/guide/deployment/intro-to-mdm-depc0aadd3fe/web>.
- [11] *Managing Devices & Corporate Data on iOS*. Available from https://www.apple.com/business/docs/resources/Managing_Devices_and_Corporate_Data_on_iOS.pdf.

-
- [12] GARCÍA, Cristian González, Jordán PASCUAL-ESPADA, Cristina Pelayo G-BUSTELO, and Juan Manuel CUEVA-LOVELLE. Swift vs. Objective-C. *International Journal of Interactive Multimedia and Artificial Intelligence*. 2015, Vol. 3, No. 3. ISSN 1989-1660. Available from DOI 10.9781/ijimai.2015.3310. Available from <http://www.ijimai.org/journal/node/776>.
- [13] *Stack Overflow Developer Survey 2021*. Available from <https://insights.stackoverflow.com/survey/2021#technology-most-popular-technologies>.
- [14] HUDSON, Paul. *Answering the big question: should you learn SwiftUI, UIKit, or both?* Available from <https://www.hackingwithswift.com/quick-start/swiftui/answering-the-big-question-should-you-learn-swiftui-uikit-or-both>.
- [15] FOWLER, Martin. *Presentation Model*. Available from <https://martinfowler.com/eaaDev/PresentationModel.html>.
- [16] PERES, Rui. *MVVM with Combine Tutorial for iOS*. Available from <https://www.raywenderlich.com/4161005-mvvm-with-combine-tutorial-for-ios#toc-anchor-002>.
- [17] *App Store Review Guidelines*. Available from <https://developer.apple.com/app-store/review/guidelines/#mobile-device-management>.



Appendix B

User-testing Instructions in Czech

Instrukce k testování aplikace

Pro instalaci aplikace je nutné mít iOS 14+ nebo vyšší .

1. Nainstalování aplikace

Otevřete link <https://testflight.apple.com/join/MVGZaqmD> .

Poté se vám zobrazí 2 odkazy:

- První link je na instalaci aplikace Testflight, která je nutná pro instalaci beta aplikací. Tento krok není nutný pokud, již máte nainstalovanou aplikaci Testflight.
- Druhý link “Start Testing” otevře v Testflight aplikaci možnost instalace naší aplikace.

Po otevření druhého linku uvidíte naši aplikaci a můžete ji nainstalovat.

Po prvním spuštění budete požádáni o registraci a vytvoření vašeho dítěte v aplikaci.

2. Testování aplikace

Hlavní cíl testování je ověřit funkčnost aplikace. Vedlejší cíl je prevence negativních vlivů digitálních technologií (modul sezení a poté digitální mediální plán) u dětí za pomoci rodiče.

Požádal bych vás o co nejpoctivější používání aplikace a alespoň každý den projít jedno sezení s vaším dítětem.

Testování bude probíhat od 23.12.2021 až do 29.12.2021 a je možné ji používat i po skončení testování.

3. Vyplnění dotazníku po testování

Dne 29.12.2021 vám zašlu dotazník, ve kterém zhodnotíte aplikaci.

Pokud se vyskytne problém nebo dotaz neváhejte mě kontaktovat přes mail.

Děkuji všem účastníkům za účast na testování,

Erik Gadireddi

Appendix C

Screenshots of application from Iphone XR

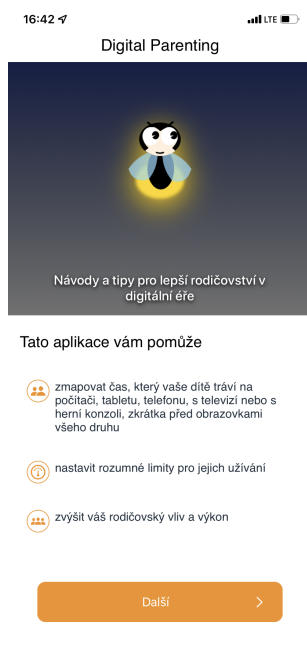


Figure C.1. First screen of application

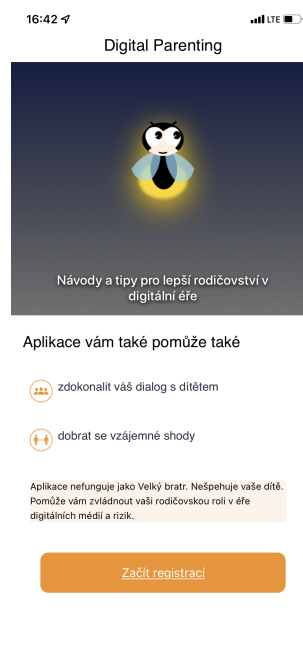


Figure C.2. Onboarding register



Figure C.3. Tutorial after registration



Figure C.4. Create child entity after onboarding

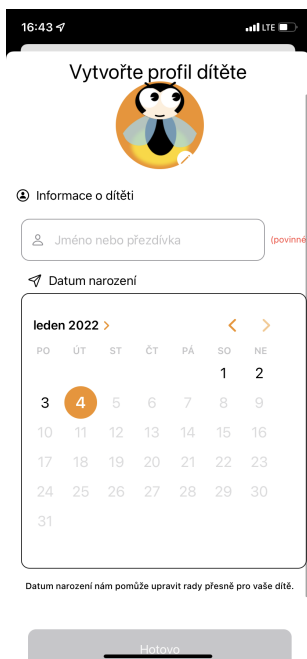


Figure C.5. Form to add child

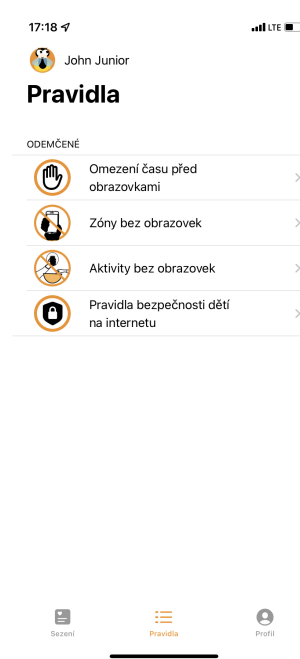


Figure C.6. Rules module

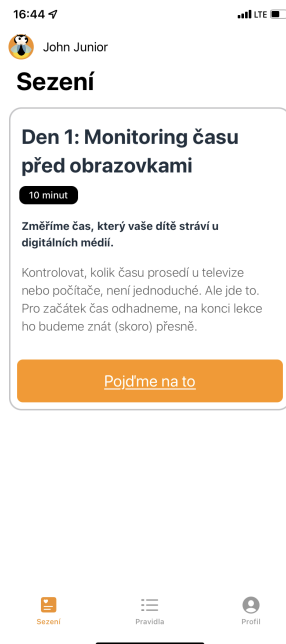


Figure C.7. Sessions module

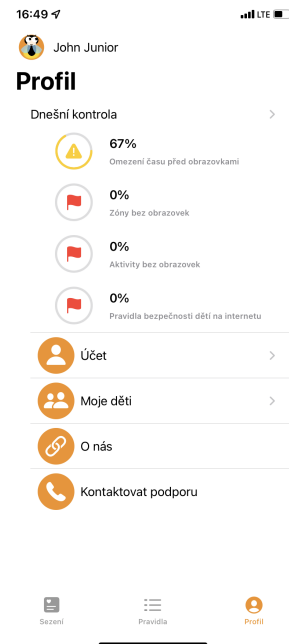


Figure C.8. Profile Module



Figure C.9. Session 1-1

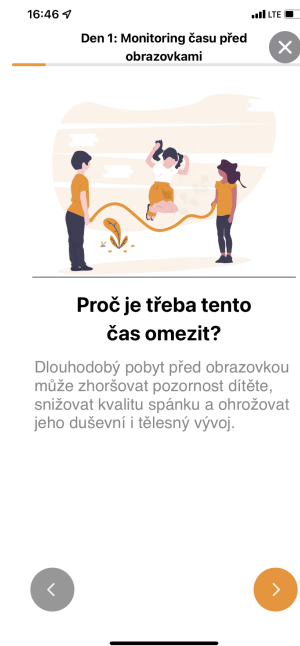


Figure C.10. Session 1-2



Figure C.11. Session 1-3

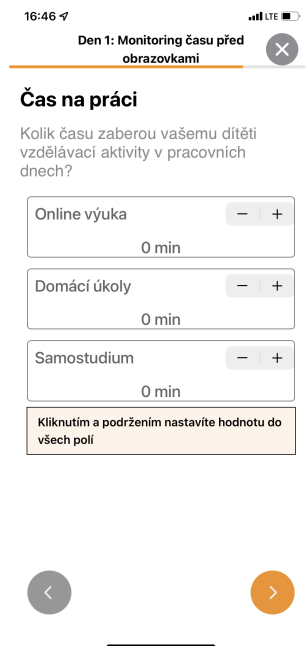


Figure C.12. Session 1-4

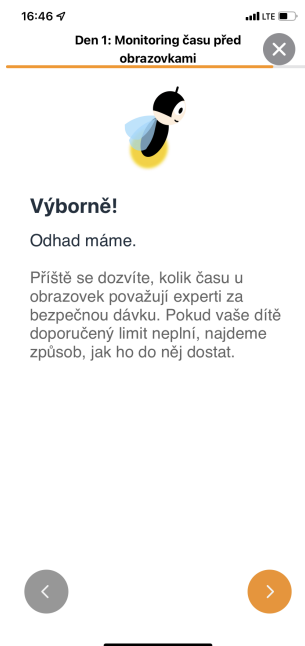


Figure C.13. Session1-1



Figure C.14. Session 2 - recommendations



Figure C.15. Session 4 - tips for dialog



Figure C.16. Session 2 - recommendations

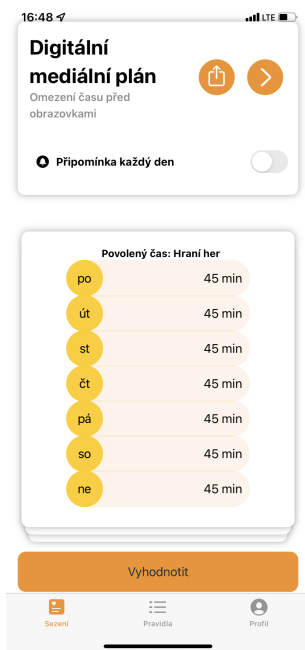


Figure C.17. Digital media plan - summary of restrictions

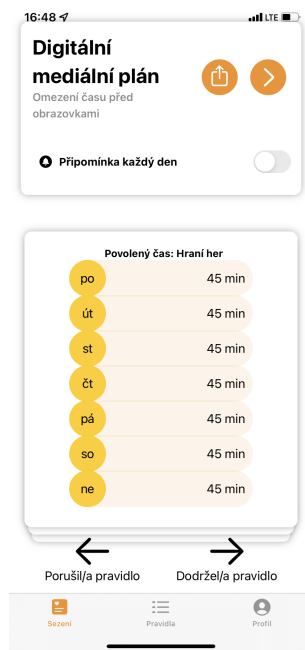


Figure C.18. Digital media plan - evaluate restrictions for child



Figure C.19. List of restrictions category zones



Figure C.20. List of restrictions category time limits

Appendix D

Structure of the CD files

```
CHANGELOG
Digital\ Parenting.xcodeproj ---- Project file
    project.pbxproj
    project.xcworkspace
    xcshareddata
    xcuserdata
LICENSE
OpenSourceLibrariesOrWork.txt
Readme.txt
Shared
    Assets.xcassets
    BackEnd\ Logic
    Constants.swift
    Core\ Scenes --- Main UI components
    DataObjects
    Debug
    DigitalParantingApp.swift
    Extensions
    MockData
    Protocols
    Styling ---- UI styling
    cs.lproj ---- Czech strings
    en.lproj ---- English strings
iOS
    Info.plist
```