Software Design Of Intelligent System For Monitoring And Preventing Smartphone Addiction

Agung Sediyono, Anung Barlianto A., Agus Salim, Gatot Budi Santoso

Abstract: This research proposes a computer software design of an intelligent system, which is capable of monitoring smartphone usage. This provides recommendations for parent, teacher, and other stakeholder, in an attempt to prevent addiction collaboratively. In addition, at least 80% of the 72.7 million internet subscribers in Indonesia utilize this gadget, and an over usage tends to lead to addiction. Meanwhile, several treatments have being applied in order to proffer solutions, and prevention has proven to be of great important, which is only effectively conducted by evaluating a set of precise behavior data, collected from the daily activities of the student. Furthermore, it is also possible to create new knowledge and make recommendations to parents or teachers, in an attempt to prevent this addiction. Hence, it is important to design computer software that is capable of collecting, processing, and making such suggestions.

Keywords: smartphones, addiction, intelligent system, intelligent recommender system, software design

1 INTRODUCTION

In Indonesia, over 80% of 72.7 million Internet subscriber use smartphone, especially for social-media interaction, chatting, music, and games [1]. This, further, has the potential to impact on peoples’ life, both positively and negatively. Previous research reported the propensity of this gadget usage to (1) lower students’ academic achievement [2], (2) cause depression, shyness, and sleep disturbances [3]; (3) impact on their physical health due to a marked decrease in body activities, e.g., walking and other sports [4][5]. Meanwhile, it also has some benefits, which include the elevation of a students’ critical thinking capacity [6] and further improve academic achievements [7]. Prior studies also agree with the existence of positive impacts on intellectual accomplishment, in cases where addiction conditions are not encountered. Several factors influence smartphone user to develop addiction, which includes overuse, social-media relationship maintenance, and withdrawal from community [8]. Moreover, children tend to have higher possibility to be addicted in instances where (1) parents’ education/income/age seems higher, (2) in dual-income family setting, (3) when the parents use smart phones, (4) applying permissive childrearing styles, and (5) positive attitudes towards the smart phone [9]. In addition, several computer software have already been released, e.g., Norton Family Primier PhoneSheriff, and ESET [10], as well as Offtime, Moment, BreakFree, FlipD, and AppDetox. [11]. However, the drawbacks of these applications include private domain and the inability to record historical behaviors, as well as treatments for preventing smartphone addiction. Therefore, no public information is made available for the general behavior of users.

Advance application SAM proposed by [12] is capable of recording and visualizing student smartphone behavior, although clinician are needed to proffer recommendations, based on the lack of parent and teacher contribution. This, further, makes it difficult to implement in environments where the user have limited skill related to inferring knowledge from data visualization. In addition, the human behavior, both individually, and a group of users, is important to provide information to support the creation of institutional or public policy, in term of preventing smartphone addiction. Therefore, [13] proposed software requirement specification of an intelligent system is recommended for monitoring and aversion, capable of providing suggestions to parent, teacher, and other stakeholders. This paper, therefore, presents the software design of its requirement, which consists of architectural and functional designs in a class diagram form. A research on identifying the relationship between smartphone usage behavior and addiction was conducted [14], which concludes a positive predictive influence. Meanwhile, it was reported addictions to be related to longer duration of use on a typical day, a reduction in the time before the first handling in the morning, and also the exploitation of social networking application [15]. Furthermore, a research showed daily use count correlates for potentially addicted consumers, although the times did not align [12]. Based on these researches, it was, therefore, concluded that attribute of the addiction metrics were time, duration, and frequency of use, as well as type of apps assessed. Furthermore, a comprehensive research [16] revealed the risk factors with significant impact to include (1) the female gender, most especially the functions of online chat, (2) the purpose of use, which include habitual, pleasure, communication, games, stress relief, ubiquitous trait, and loneliness, (3) problematicatic application, including preoccupation, tolerance, lack of control, withdrawal, mood modification, conflict, lies, excessive use, and loss of interest, and (4) parental attitude regarding smartphone use, encompassing punishment. Moreover, [17] revealed the statistically significant influence of depression, anxiety and insomnia, as well as economic social support, while [18] reported lonliness and stress. Several application have previously been released to prevent smartphone addiction, e.g., parental software with the capacity to monitor and interrupt application usage, including (1) Norton Family Primier, which tracks location, web-filtering, and blocks functions, (2) PhoneSheriff with...
the time limit control, extensive browsing and texting logs, and location features. (3) ESET, which filters websites, manages application, and trails whereabouts faster. In addition, it is only applied in the family scope, where prevention is based on rules that are possibly broken on instances where changes occur in the functional environment. Furthermore, there are no historical data on behavior while using smartphones, hence, implementing dynamic treatments are not possible [10]. Conversely, several forms are dedicated in the prevention of smartphone addiction, e.g., Offtime, Moment, BreakFree, FlipD, and AppDetox. These are used and configured individually by the owner with the settings of limiting application usage time, filtering website and communication, as well as family tracking. In addition, BreakFree is specifically able to provide a score of addiction. [11]. Advance applications for recognizing smartphone user behavior of students, proposed by [19] are capable of recording usage through the installation of mobile applications, which is, therefore, sent to a server, with attributes of its name, time and duration of use. Supported by pattern analysis tools, clinicians are able to make suggestions, which are subsequently sent back to the end user. Therefore, the despondence of this research is based on [20], in order for students' smartphone behavior to be mapped in the classification of addictive and non-addictive. Unfortunately, no conclusion about this pattern characterization exists, while this application is not easy to use, especially for people with no data science capability, including ordinary parents and teachers. This is way, [13] proposed the intelligent recommender system (IRS), which is able to provide recommendations, either to parents or teacher, in order to take the necessary actions towards student or children with the tendency to be addicts. According to [21], IRS consists of (1) knowledge acquisition, which is a learning process from raw data for resulting relevant Information to objective IRS implementation. (2) Knowledge modeling defines the paradigm of comprehension representations, including ontologies, fuzzy rules, conceptual maps, etc. (3) Reasoning mechanisms that are also used, which include induction, abduction, and deduction, where each method is applied in different task. (4) Conducting a verification process. Based on [22] the goal of abduction, which is to explore data, find a pattern, and suggest plausible hypothesis, deductions are aimed at refining hypothesis that is based on other reasonable premises, and induction is the empirical substantiation capable of being used to verify and predict things.

2 RESEARCH METHODOLOGY
Software design methodology is a part of development, which realizes the requirement. In addition, global design is presented by the architecture, and detail design is shown in static and dynamic models. Furthermore, this report presents the design of software, using UML 2.5 standard, consisting of (1) architectural and (2) functional types in class, and sequence diagram. However, due to the limitation of pages, sequence diagram is excluded from this article.

2.1 USER REQUIREMENT
Overcoming smartphone addiction in a student environment requires that parent, teacher, and institutions collaborate through direct treatments or policies. Therefore support is required in making accurate outcomes, with the need of tool that possess capabilities:
- The provision of data and information on smartphone usage behavior of children/student
- Creating a benchmark amongst students, individually or in groups, as well as institution or areas of authority.
- provide recommendation

This tool is realized, using computer software is easy and friendly [13].

2.2 DESCRIPTION OF SYSTEM
Realizing the goals of a system, with the propensity to provide treatment suggestions to parent or teacher, for preventing smartphone addiction, requires the following capabilities [13]:

1. A record of students' behavior while using a smartphone, involving application handling [12,14,15], location and mobility tracking, personal gestures, and the gadget resource used. This, further, tracks non-smartphone practices, as mentioned in [16,17,18]
2. These are collected and saved in one place.
3. The behavior is, therefore, visualized, with the probability of being abduction reasoning [22], hence, parent, teacher, and other stake holder are easily enabled to interpret and manipulate the data, in order to create and provide intuitive suggestions. This mechanism is assumed to be critics and expert knowledge sources [21].
4. Individual or group activities of students are monitored and interrupted, in order to ensure proactive actions are taken to prevent addiction.
5. Learning based on smartphone usage, historical data and teacher’s or parent’s suggestion are recorded, therefore, providing better treatment plans realized using IRS, as seen in [21]
6. Public information related to general behavior towards using smartphone is delivered subsequently.

These functionalities are realized using six software packages, including (1) student mobile data acquisition; (2) information collector, (3) visualization, and (4) intelligence system, as well as (5) parent application, and (6) teacher treatment. Therefore, the architecture of system is depicted in Figure 1. [13].
values close to 1 indicate the interactive use of cyber applications, which is verified using the gesture behavior.

### TABLE I

**MEASUREMENT MATRIC AND ITS SOURCE**

<table>
<thead>
<tr>
<th>No</th>
<th>Quantity</th>
<th>Source and Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Apps usage duration and timing</td>
<td>UsageStatManager class: first and last time of statistics, package name, total time in foreground, and last time use.</td>
</tr>
<tr>
<td>2</td>
<td>Student loyalty on Apps</td>
<td>PackageManager class: first install time, last update time, version name, and package provider info.</td>
</tr>
<tr>
<td>3</td>
<td>Student motoric intensity</td>
<td>Gesture class: x, y position and timestamp of stroke.</td>
</tr>
<tr>
<td>4</td>
<td>Student environment type and movement</td>
<td>LocationManager class: latitude, longitude, timestamp, bearing, altitude, and velocity</td>
</tr>
<tr>
<td>5</td>
<td>Student online activity</td>
<td>NetworkStatManager: Rx and Tx Byte, type of network, and level of network traffic</td>
</tr>
<tr>
<td>6</td>
<td>Student concern on smartphone performance</td>
<td>StorageStatManager: free and total byte, apps byte, and cache byte; and Unix system in /proc/stat file</td>
</tr>
<tr>
<td>7</td>
<td>Student concern on smartphone quality</td>
<td>DeviceManager: screen config</td>
</tr>
<tr>
<td>8</td>
<td>External Critics and Suggestion</td>
<td>Teacher, Parent, and other stake holder Physical and Psychological medical noted of student: depression, anxiety and insomnia, familial social support, stress, and loneliness.</td>
</tr>
<tr>
<td>9</td>
<td>Non-smartphone metrics</td>
<td>UsageStatManager class: first and last time of statistics, package name, total time in foreground, and last time use.</td>
</tr>
</tbody>
</table>

Furthermore, storage data are possibly fetched from StorageStatManager, including free and total byte, as well as apps, and cache types. Meanwhile, the memory and CPU data are retrieved from the statistic file of Unix system, located in the /proc/stat file. Conversely, storage, memory, and CPU utility are able to measure the concern of students, which include the performance of the smartphone, related to the level of attention paid to it. Device configuration is only additional information to estimate the configuration, e.g. screen dpi, while the Dimension and attributes data acquired are presented in Table 1. Critical issues: Data acquisition from mobile phones faced several critical issues, including privacy, limited resource, especially based on memory and storage, limitation in network connection, and minimum SDK versions amongst the student smartphones. It is possible to offer the privacy challenge, either to students themselves, parent, or teacher, in context of the school policy, therefore, restraining the guarantee of proper conduction. This is why during the design data acquisition packages ought to run under other applications with valuable items for student, e.g. learning management systems or online assignment from teachers, requiring the approval of parent. Better quality of network connection tends to lower storage space needed by data acquisition package, because of the enhanced probability of being sent to the data center directly. However, cases of poor network connection lead to the saving of data statistics in temporary databases of.
smartphones. Meanwhile, circumstances of long-term disconnected web cause temporary storage space to grow, up to the point where it becomes full, which is annoying to student. This is, therefore, the reason why a policies ought to be designed during the occurrence of similar situations, e.g on obtaining data acquisition in the on-off mode (sampling mode), subsequently filling the data from an interpolation process for the missing Information during the off-time. It is possible to resolve SDK version issue by developing and deploying different minimum version Apps. Therefore, if this approach is taken, some data acquisition attributes get lost, e.g., the minimum SDK 21-22 for Lollipop losses storage data when StorageStatManager is added at the API level 26 (Oreo). Hence, one of the following approach should be chosen: (1) minimum SDK that most student have, which only uses the available data for supporting visualization and IRS, subsequently upgrade the package accordingly; or (2) selecting the minimum version where all features are possibly fulfilled, and further using common data possessed by most students. Furthermore, this approach requires the package to be capable of detecting the version of android, which only collecting the available data features.

3.2 DATA COLLECTOR

Data Collector package is the simplest in this system, with the function to parse URL request from mobile devices, and subsequently manage to save and obtain data to and from the database system. In addition, properties of class diagram are replicated in Student Data Acquisition, where suggestions from parent and teacher, as well as additional table representation handle the system administrations and data categorization, as shown in Figure 3.

Critical issues: Data collector faced several critical problems, including time synchronization among student smartphone, unique identity of data among their data, and the large geographical scope. Time synchronization challenges appear at moments of aggregation or benchmark of smartphone usage behavior amongst students, individually, or in group. This error tends to be greater for slimmer interval, e.g., collecting daily seems to be prone to greater degree of error than yearly. Hence, the software package ought to request student to synchronize with server time in the data center. Unique identity issues originate from distributed applications, and single placement. Therefore, two unique data identities are needed, including those (1) among students and (2) for those using different smartphone or SIM number. Meanwhile, these are possibly solved through the use of UUID (Universal Unique Identifier), and Java util possesses this class, used for generation, in instances where SQLite version is not support yet. This can also be answered by commencing the registration of students before running the application.

Geographical issues originate from huge collection and also the heterogeneity of data quality services, e.g., instances where the system is used in the entire country of Indonesia, which requires a huge data center resource, especially in the aspect of storage capacity. This issue is, therefore, solved by distributed hierarchical data center architecture. Furthermore, resolving this challenge is also achievable by sampling data acquisition in poor network connection located within the critical issues section.

3.3 DATA VISUALIZATION

Data Visualization package envisages the smartphone usage behavior of students, individually or in groups, hence, stakeholders easily interpret and draw conclusions from friendly optical presentations. In addition, it also has the following functional capabilities [13]:

1) Stakeholders (parent or teacher) log into the system first, in an attempt to observe the characteristics of smartphone usage behaviors, either individually or in groups of students.
2) After succeeding, they are able to explore the presentation of application usage map, as well as its trajectory, and a list of favorite applications.

3) At this point, it is also possible to choose one on the list, which is explored in details, e.g., when and where it was used or how much of the smartphone resource was used.

4) They are also able to access the handling of historical applications in daily, weekly, or monthly activity formats.

5) Stakeholders, therefore, explore the storage and network usage.

Data Visualization is implemented using a web-base application, providing it enough space. Meanwhile, based on Table 1, 9 measurement dimensions are observed to have nearly 35 attributes, therefore, emphasis is laid on the need to design a structured format, with a level of correlation to the level of student smartphone addiction. This visualisation design will explain in detail in next article.

3.4 INTELLIGENT SYSTEM

Intelligent system package possesses functional capabilities as follows [13]:

1) Select meaningful information from any data type, using selected learning algorithms, which in this case involves smartphone usage behavior, including student location and mobility, application usage, gestures, the resources used, suggestion from teachers and parent, as well as data retrieved from the environment, which encompasses current issues in uncluttered media.

2) Knowledge models are subsequently built from meaningful data collection.

3) Abduction reasoning is implemented to recognize the pattern of knowledge related to smartphone addiction, which is refined using deduction reasoning, and further, verify inductively before providing a recommendation, either to the parents or teachers.

4) Autonomous in initiating interactions with the environment

Based on functional capabilities, the system has to provide suggestions, therefore, intelligent recommendation system (IRS) is selected with a design explain in detail in the next article.

3.5 PARENT APPS

Parent Apps provide data and information to parents about the smartphone usage behavior of children, therefore, enabling the creation of benchmark with their peers. Therefore, in cases where parents possess more than one ward, and also when one child has more than one smartphone, all data collected to the database are seen with anonymous identity. In addition, there is also an option to make suggestions or ask the system to provide any recommendation, as presented in Figure 5.

By default, parent observe the smartphone behavior map of children, and are further enabled to explore in-depth, including length and location of mobile application use, gesture of interacting with the device, child mobility tracking, and chronological handling behavior, which could be on a daily, weekly, or monthly basis. Based on this behavior data and information, parent are able to make suggestions to their children, and if necessary, interrupt the activity they perform. Critical Issues: Parent Apps possesses several critical issues, which include proper data visualization, which makes them able to interpret and use virtual information easily, via personal smartphone android version. This project is implemented in a wide range of students, right from elementary school to higher education levels. Specifically, Indonesia citizens include Tertiary (64% – 74%), and the Higher Education (24.77%) participants, as well as HDI (58.6 % - 79.6 %). In addition, parent education level below higher education was observed to limit the capability of interpreting and comparing complex data, hence, designing data visualization ought to be started from simple informative to gradually complex forms. In addition, other alternatives involve designing personalized or grouped types. Furthermore, it is possible to resolve these issues, using the same approach as the data acquisition section, and another alternative is to provide suggestions for parents to view on website, explained in the Data Visualization Section.

3.6 TEACHER APPS

This package provides data and information on smartphone usage behavior of students. Therefore, enabling them to monitor and interact properly, and subsequently benchmark their behavior to the institution, district, province, or country scope. Teachers are able to provide suggestion, or ask the system to recommendation, and the Class diagram of this specific App is shown in Figure 6.
Fig 6. Class diagram of Teacher Apps

By default, teachers are capable of observing the behavior map of a group of students, as well as explore in-depth to the individual level, and, further, create a benchmarking activity. Based on data and information, they are able to make suggestions. Critical Issues: This App seems to have the same issues as the Parent type, thus, excluding education level issue, in instances where teachers generally have the minimum education of a diploma or undergraduate.

4 CONCLUSION AND FUTURE WORKS

This paper describes comprehensively the proposed software design for an intelligent system, aimed at monitoring and preventing smartphone addiction. In addition, the specifications are written based on three user requirements, which is subsequently realized into six software package, including Student Data Acquisition, information Collector, and Visualization, Intelligent Systems, Parent, and Teacher Application. Furthermore, the picture on the smartphones of both guardians, and the data center, ought to be designed properly. Moreover, personalized or grouped forms are preferred so far there is a wide range of parent education and HDI. Other issue to be further explored includes visualization dimensions, where the structured or reduced type are designed based on user oriented, hence, the need to assure quality of engagement between the software engineer and the end user. Meanwhile, the information used to drive the suggested Intelligent Recommendation System (IRS) includes three categories encompassing collaborative, content-based, and hybrid filtering. Furthermore, there are several algorithms for knowledge acquisition, and modeling, as well as reasoning and the verification process, which should be researched intensively, in order to select the proper one to build an IRS for preventing smartphone addiction.

5 ACKNOWLEDGMENT

The authors are grateful to RistekDikti and Lembaga Penelitian Universitas Trisakti for Research Grant No: SP DIPA-042.06.1.401516/2017 in Contract Grant No: 125/A/LPT/USAKTI/IV/2017

6 REFERENCES


Taiwanese university female students, Computer and Human Behavior, Vol. 28 Issue 6, 2012


