

A Novel Feature-Based Evaluation Scheme for Managing Excessive Smartphone Usage

¹Monica Christoforou, ²Klimis Ntalianis, ³Vasiliki Kikili, ⁴Filotheos Ntalianis, ⁵Nikolaos Mastorakis

¹Open University of Cyprus, 3, Giannou Kranidioti Ave., 2220, Latsia, Nicosia, CYPRUS

²Department of Business Administration, University of West Attica, Egaleo, Athens, GREECE

³Ministry of Education and Religious Affairs, Directorate of Primary Education, Athens, GREECE

⁴Department of Business Administration, University of Piraeus, Piraeus, GREECE

⁵Industrial Engineering Department, Technical University of Sofia, Sofia, BULGARIA

Abstract— Mobile phones have become an integral part and useful tool in people's daily lives. However, there are many issues related to the wrong usage of smartphones. In the literature it has been largely shown that the problematic smartphone use has severe impacts on several parts of users' daily lives. In particular users suffer both psychologically and physically. Simultaneously, it appears that users are led to a sedentary life, while reducing their physical activities. Therefore, new studies and solutions are necessary to encourage and help users in reducing the time of using their mobile phone, for a healthier and better daily life. This paper evaluates the attitude of users in accepting new features in time management applications. It particularly it investigates which smartphone time-protection features are more helpful to assist users control the time they spend, using their devices.

Keywords— Excessive / Problematic smartphone use, Smartphone addiction, user assistance, feature evaluation

1. Introduction

MOBILE phones are used extensively by people in their daily lives, due to their multi-functionality. While these devices can help people do much more work, their compulsive use can interfere with work, school, relationships, personal life, free time etc. When people spend more time on Instagram, Facebook, Twitter etc. or to play games than interact with others, this attitude may cause psychological and physical side effects. These negative consequences in everyday lives should awaken users to re-assess their use of technology.

Smartphone addiction, also called “nomophobia” (fear of being without a mobile phone), is often related to Internet, apps and games overuse. This addiction can encompass a variety of impulse-control issues, including:

- (a) Virtual relationships: through social networking, dating apps, texting, and messaging.
- (b) Information overload: through web surfing, watching videos, playing games, or checking news feeds.
- (c) Cybersex addiction: through watching of pornography, sexting, etc.
- (d) Other compulsions: such as gaming, gambling, stock trading, online shopping, or bidding on auction sites.

Periodically, several researches and studies have investigated the problematic smartphone use and the potential negative consequences that it can cause in users' lives. The thoughts and conclusions presented in specific studies vary, while

evaluating different features in smartphone apps. In this paper novel smartphone time-protection features are evaluated in order to assist users control the time they spend using their devices. In particular screen lighting and personalized rewarding are introduced through a conceptual new smartphone application. Results show the promising performance of these new features.

The paper is organized as follows: Section II presents related work, while Section III provides research prerequisites. Experimental results are presented in Section IV, while Section V concludes this paper.

2. Related Work

According [1], 20.1% of college students reported symptoms of problematic smartphone use, which was associated with alcohol problems, impulsivity, anxiety, and symptoms of depression. Another study of students at the University of Nigeria found that problematic smartphone phone use may be connected with loneliness, extroversion and low self-esteem among students [2].

In addition to the physical and mental consequences that problematic smartphone phone use may cause on students, it can also affect their academic performance. According to the results of a study, which compare Australian and Korean students, regarding the negative consciousness of problematic smartphone use on their academic performance, there is a correlation between phone use and excessive mobile phone use [3].

According to Lewis Mitchell and Zaheer Hussain, there has been a link between problematic smartphone use and impulsivity, as well as an excessive pursuit for reassurance,

while age and impulsivity are important factors in the excessive mobile phone use. In detail, young people were more likely to show symptoms of problematic smartphone use [4]. Consequently, excessive mobile phone use seems to affect younger ages as well. On a sample of 1,258 high school students in China, a study found a connection between phone addiction, anxiety, and depression. More specifically, the greater was the mobile phone dependence, the more intense were the feelings of anxiety and depression [5]. The research above indicates that the mobile phone overuse by young people affects their daily lives, decreasing their free time and causing them negative emotions.

In addition, there were observed negative psychological as well as negative effects on physical health effects on children and adolescents. For example, a research of a sample of 916 children, found that the smartphone use is associated with pediatric dry eye [6]. Another report investigated the relationship between smartphone use and musculoskeletal discomfort. The sample consisted of schoolchildren in Taiwan, who, due to the versatility of their mobile phones, spent a significant amount of their daily time using them. As a result, they felt pain in various parts of their body, such as back, shoulders and neck pain [7]. Therefore, the problematic smartphone use is likely to lead to a sedentary life and a reduction in outdoor activities.

A survey to physiotherapy students discovered that 30% of the students used their mobile phones more than six hours a day. Moreover, almost half of them checked their smartphones five minutes after waking up in the morning and that causes stress [8]. In addition, a study of 815 young people regarding using their mobile phones during the night found that 12% of the sample used their mobile phones in the middle of the night, while 41% interrupted their sleep. People who reported sleep interruption had on average shorter sleep duration and greater body mass [9]. In another study, it was examined whether the participants, experienced imaginary sensations related to mobile phones, such as vibration or sound that did not exist. The findings showed that 60% of the students had experienced the sensation of phantom vibration, while 42% felt the sensation of phantom sound, which were related with the excessive mobile phone use [10].

Panova and Carbonell, after studying and analysing existing studies, concluded that, although most research studies indicate the existence of addiction in mobile phones, there is an insufficient evidence to support the concept of “*addiction*”. Thus, they suggest that studied technological behaviours, can be best described by the term “*problematic use*” [11]. Also, according to Ellis’s study, the newest generation of psychometric tools, which are intended to evaluate the use of smartphones, are unable to detect technology-related experiences or behaviours. As a result, many inferences about the psychological influence of the use of technology, remain unsupported [12].

Therefore, it is obvious that there is a need to found practices to reduce mobile phone usage and encourage young

people to participate in outdoor activities. Currently, there are various applications on the market that aim to help users to reduce the excessive mobile phone usage. This paper proposes a mobile application which will endeavour to improve the users’ daily time management.

The proposed application will allow the user to set the maximum desired limit of mobile phone usage per day. Every time the smartphone is used, the equivalent time from the daily limit will be deducted and the remaining time will be calculated by the application. Along with the subtraction of time, there will be also analogous decrease of the brightness of the mobile phone screen.

For each minute of mobile phone use, the corresponding credits will be deducted, which will vary depending on the type of application used. In addition, there will be a category for rewards activities. Upon completion of a process in this category, points will be credited to time and screen brightness analogically. Finally, there will be the recording of daily, weekly, and monthly statistical reports, for the smartphone use, the time usage of the phone, the activities, and the rewards.

3. Research Prerequisites

In order to deal with the issue of the problematic mobile phone use, a smartphone application was conceptually designed, which introduced two novel features: screen lighting and adaptive activity treatment. More specifically, the application offers:

- (a) a decreasing brightness feature of the screen, which helps users realize the remaining daily phone usage time
- (b) different treatment of each mobile phone activity, depending on its type. For example, for every minute that corresponds to the unlocking of the screen, a half point is deducted, while for every minute that is equivalent to opening and using an application, three points are deducted.

The design of the application is minimalistic with a light background. After the installation of the mobile application, the user selects the preferable maximum daily time limit of phone usage, up to five hours during a twenty-four-hour period. Also, it is possible, to exclude specific mobile usage tasks within the specified time limit, e.g. making incoming and outgoing calls and using the calendar. For the navigation to the different screens of the application, a menu is used. Each time the mobile phone is used, the initial daily time is deducted, as well as the brightness of the mobile screen. Each minute of use that is deducted, corresponds to a particular credit, which varies depending on the type of activity.

The conducted research aims at finding out whether the proposed application can be considered reliable and useful by mobile phone users, to help them reduce their mobile phone usage. In addition, it is examined whether the problematic smartphone use affects users’ daily lives. In order to answer these questions, the mixed method research was used, which combines quantitative with qualitative analysis. The questionnaire was designed using the *Google Forms tool* [13].

The questionnaire consisted of two parts: in the first part

general questions were asked regarding demographic data and questions for mobile phone users in general. In the second part the questions were related to the proposed application. Specifically, the second part includes the *SUS (System Usability Scale) Questionnaire*, which is renowned for its validity and reliability. It consists of ten questions and users were asked to rate each question on a scale of 1-5 if they agree or disagree [14]. In addition, a number of indicative screens from the application were presented to the participants, to facilitate a better understanding of the interface of the application and its functions.

4. Experimental Results

The sample of participants for this research was random and consisted of 126 adults, regardless of profession and level of education. Gathered data were analysed using the *IBM SPSS Statistics package* [15].

The method of descriptive and inferential statistics contributed to the summary presentation and interpretation of research results and the extraction of useful conclusions. The sample of 126 people that was selected to complete the survey questionnaire, can be considered satisfactory in this case. According to Avouris, Katsanos, Tselios and Moustakas, when the total sample consists of eighty people, then the confidence interval is estimated at 95% with a margin of sampling error of almost 10% plus or minus [14]. Regarding the gender of the participants, women were more than men with a percentage of 60.32% and 39.68% respectively. However, regarding the age of sample, the 36-45 age group prevailed compared to the other age groups in the sample by 45.24%. By considering that this age group is the average of all ages, then their opinion is likely to be representative of the sample.

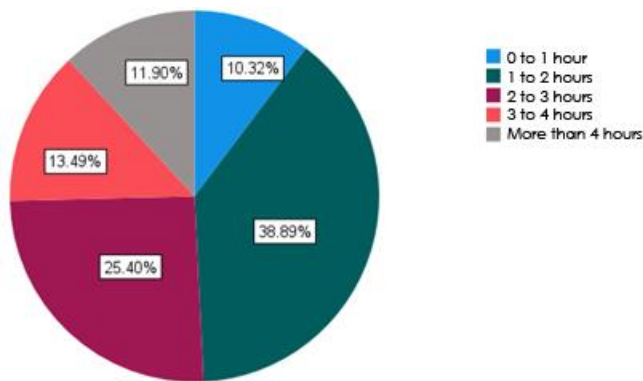


Fig. 1: Duration of mobile phone use per day.

Regarding the diversity of the sample, it appears that the sample consists of people with different social backgrounds. More specifically, most of the participants (34.92%) gave a neutral answer when they were asked if they were aware with new technologies. While the rest of the participants answered in equal percentage to the other options. Further, regarding the time of mobile phone use per day, most (38.89%) answered one to two hours per day. However, there was a satisfactory number of participants who answered all the other options.

Another example that shows the diversity of the sample is the question related to how much free daily time the participants have. The time was divided into groups. It was found that the participants answered almost equally to all the groups.

In addition, it is worth noting that, the results of the research, shows that most of the participants are positive towards the use of this kind of applications. This was evidenced by the answers given to the question on whether they would try such mobile application to prevent mobile phone overuse. Most of them gave an affirmative answer.

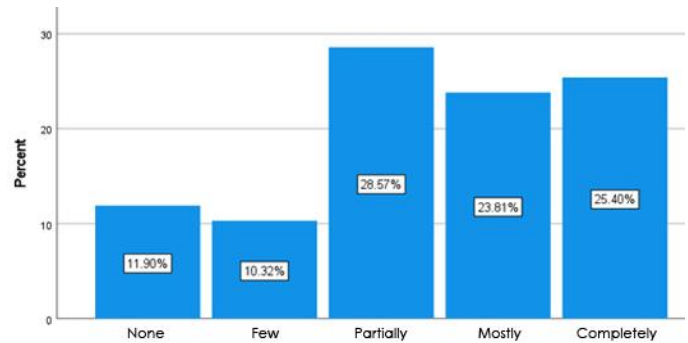


Fig. 2: Responses to the question whether they would try such mobile application to prevent mobile phone overuse.

Additionally, more than half of the participants stated that they would use such applications. However, some stated that those applications were not useful to them, and a very small percentage of the sample said they would not use them at all.

The dependent quantitative variable, which in this research refers to the score of the SUS questionnaire for the application. The proposed application does not follow the normal distribution. Therefore, the non-parametric tests were used to evaluate the various hypotheses. The cases that show that there is a statistically significant correlation or difference for the variables are presented below in this article, in order to infer conclusions.

The first example in which the statistically significant correlation applies is the association between the daily mobile phone use with age. The negative value of the correlation coefficient indicates that the variables are moving in opposite directions. Cohen indicates the value 0.3 in average correlation levels, which exists approximately in this example with a value of -0.392 [14].

Another case in which the null hypothesis was rejected is the existence of a statistically significant correlation between the daily time of mobile phone use and the participants' daily free time. This result is considered important for the present paper, as it is related to the research question, whether the overuse of smartphones affects the daily life of individuals.

For the purposes of this research, non-parametric tests were used. Specifically, a comparison was made between the score of SUS questionnaire and the answers given to the question on sample's opinion about such applications. It appears that there is a statistically significant difference between the SUS score for the proposed application and the pairs *"I would not use them / maybe - I would use them"*, *"I do not find them useful -*

I would use them”.

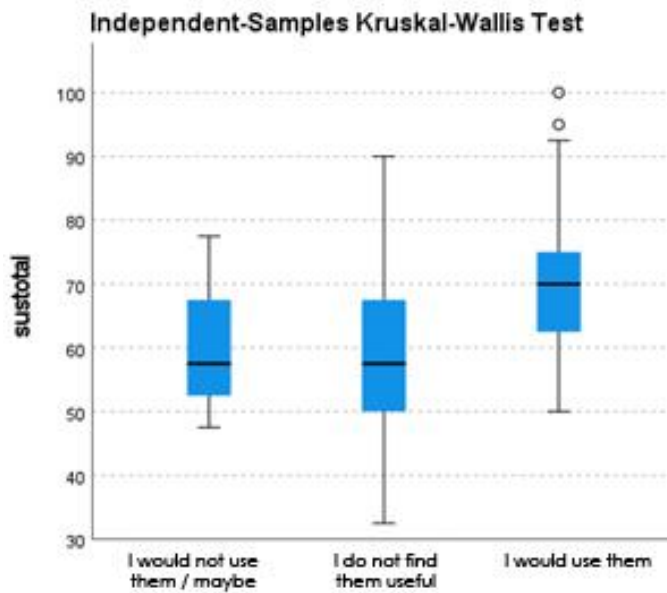


Fig. 3: Comparison of the SUS score for the proposed application between those who would use such applications, those who do not (or maybe) use them, and those who do not find them useful.

Finally, a statistically significant difference is found in the score of the SUS questionnaire about the proposed application between the men and women who participated in the survey. More specifically, the average SUS score of women was higher than the average score of men.

The results of the *SUS Usability Scale Questionnaire*, which consists of 10 questions, are as follows: the average score of the participants for the proposed application was 64.58%, with a maximum value of 100% and a minimum of 33%. According to Bangor, the average score of the SUS questionnaire is around 70.

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
sustotal	126	33	100	64.58	13.224
Valid N (listwise)	126				

Fig. 4: SUS score statistics for the proposed application.

Figure 5 shows the comparison between different scores values with the average score of the SUS. Therefore, the average score for the proposed application, which is 64.58%, according to the adjective rating scale, ranges between “OK” to “GOOD”. According to the acceptability scale, the score is set at the high acceptance marginal. However, irrespective of the applicable scale, the SUS score is considered complementary and it should be combined with other results to evaluate the usability of each application [16].

In addition, in this case, participants found it difficult to evaluate the existing application. The reason is that the application was not implemented to be able to use it.

Therefore, their judgment was formed based on the description of the application, as well as of some screens/interfaces which were included in the questionnaire.

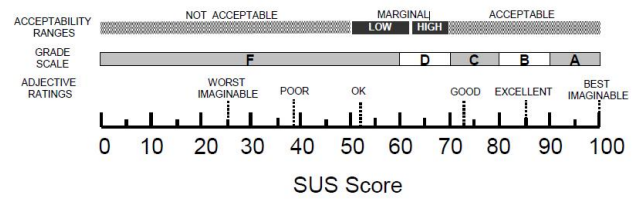


Fig. 5: Comparison between different scores values with the average score of the SUS [16].

This difficulty was also expressed in some answers to the open-ended question: “What you did not like about this application?”. Some participants answered that they should first use this application to form a complete view.

Further, a lot of participants did not like the function of the application that the screen brightness of the mobile is fluctuating. Additionally, some people did not like the reduction of points by unlocking the screen. However, many responded that they did not find anything negative in this application.

In addition, the participants were asked: “What did you like about this application?”. Some answered, “the reward points for specific activities”, some liked the design and usability, while others liked the daily time management function, as well as the mobile phone usage reporting system.

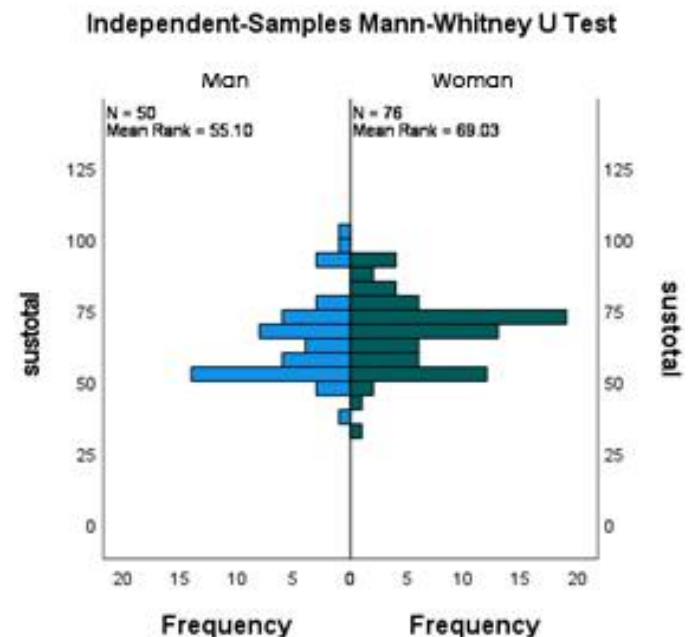


Fig. 6: Comparison of the SUS score for the proposed application between men and women

5. Conclusions and Future Work

The examination of the accessible literature suggests that the problematic smartphone use is a fact, which adversely changes the life of people. As a result of the problematic phone usage the users are physically and mentally affected.

Meanwhile, past studies have revealed that effective time management can assist lowering anxiety, thus improving the condition of life. [17]

The present research has shown that there is a positive reaction of several participants towards the use of such applications. At the same time, the average score of SUS by the participants who would use these applications was higher compared to the people who would not use them or those who may not be useful to them. This leads to the conclusion that there is an intention of mobile phone users to try new solutions to reduce mobile phone usage time and improve their daily time management. Finally, according to the analysis of the results, women rated the proposed application with a higher score than men.

As a result, of the rapid growth of mobile phone technology the abilities and capabilities of smartphones are increasing and improving. Therefore, the overuse of smartphones is a current and existing issue, which needs further research. In order to deal with the issues of phone time management and the negative effects of excessive smartphone use.

Acknowledgment

The authors would like to thank very much Interbit Research (<http://www.interbit-research.com/>) for its financial support to carry out this work. Special thanks to Vasilis Yfantis, Konstantinos Psarftis and Andreas Kener for their valuable comments and advices.

References

- [1] J. E. Grant, K. Lust and S. R. Chamberlain, "Problematic Smartphone Use Associated with Greater Alcohol Consumption, Mental Health Issues, Poorer Academic Performance, and Impulsivity," *Journal of Behavioral Addictions*, vol. 8, no. 2, pp. 335–342, June 2019.
- [2] C. U. Onuoha, "Problematic smartphone use and associated personality traits: A study of Undergraduate Students in a Nigerian University," *Ife Psychologia*, vol. 27, no. 1, pp. 139-150, March 2019.
- [3] H. Winkler, T.-H. Kim, L. Kardash and I. Belic, "Smartphone Use and Study Behavior: A Korean and Australian Comparison," *Heliyon*, vol. 5, pp. 1-8, July 2019.
- [4] L. Mitchell and Z. Hussain, "Predictors of Problematic Smartphone Use: An Examination of the Integrative Pathways Model and the Role of Age, Gender, Impulsiveness, Excessive Reassurance Seeking, Extraversion, and Depression," *Behavioral Sciences*, vol. 8, no. 74, pp. 1-13, 2018.
- [5] X. Yang, Z. Zhou, Q. Liu and C. Fan, "Mobile Phone Addiction and Adolescents' Anxiety and Depression the Moderating Role of Mindfulness," *Journal of Child and Family Studies*, vol. 28, p. 822–830, January 2019.
- [6] J. H. Moon, K. W. Kim and N. J. Moon, "Smartphone Use is a Risk Factor for Pediatric Dry Eye Disease According to Region and Age: a Case Control Study," *Moon et al. BMC Ophthalmology*, vol. 16, no. 188, pp. 1-7, 2016.
- [7] S.-Y. Yang, M.-D. Chen, Y.-C. Huang, C.-Y. Lin and J.-H. Chang, "Association Between Smartphone Use and Musculoskeletal Discomfort in Adolescent Students," *J Community Health*, vol. 42, pp. 423–430, October 2016.
- [8] A. Javaid, I. Yasir and F. Ahmed, "Prevalence of Smart Phone Use and Smart Phone Addiction Among Students of Doctor of Physiotherapy: A Cross Sectional Study," *Isra Medical Journal*, vol. 11, no. 3, pp. 180-183, May – Jun 2019.
- [9] N. H. Rod, A. S. Dissing, A. Clark, T. A. Gerds and R. Lund, "Overnight smartphone use: A new public health challenge? A novel study design based on high-resolution smartphone data," *Plos One*, vol. 13, no. 10, pp. 1-12, October 2018.
- [10] A. G. Mangot, V. S. Murthy, S. V. Kshirsagar, A. H. Deshmukh and D. V. Tembe, "Prevalence and Pattern of Phantom Ringing and Phantom Vibration among Medical Interns and their Relationship with Smartphone Use and Perceived Stress," *Indian Journal of Psychological Medicine*, vol. 40, no. 5, pp. 440-445, September-October 2018.
- [11] T. Panova and X. Carbonell, "Is Smartphone Addiction Really an Addiction?," *Journal of Behavioral Addictions*, vol. 7, no. 2, p. 252–259, June 2018.
- [12] D. A. Ellis, "Are Smartphones Really that Bad Improving the Psychological Measurement of Technology Related Behaviors," *Computers in Human Behavior*, vol. 97, no. 60-66, pp. 1-17, 2019.
- [13] Google Ireland Limited, "<https://www.google.com/>," 31 3 2020. [Online]. Available: <https://www.google.com/forms/about/>. [Accessed 21 12 2020].
- [14] Avouris, N., Katsanos, C., Tselios, N., Moustakas, K., Introduction to human-computer interaction, Athens: *Hellenic Academic Libraries Link*, 2015.
- [15] IBM, "<https://www.ibm.com/>," 20 11 2020. [Online]. Available: <https://www.ibm.com/products/spss-statistics>. [Accessed 21 12 2020].
- [16] A. Bangor, P. Kortum και J. Miller, "Determining What Individual SUS Scores Mean: Adding an Adjective Rating Scale," *Journal of Usability Studies*, vol. 4, no. 3, pp. 114-123, May 2009.
- [17] B. Aeon και H. Aguinis, "It's About Time: New Perspectives and Insights on Time Management," *Academy of Management Perspectives*, vol. 31, no. 4, pp. 309–330, November 2017.