Exploring the Adverse Impact of Smartphone Use on Young Individuals' Self-Esteem: A Structural Equation Modeling Approach based on Five Temperaments

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ABSTRACT

Excessive Smartphone Use (ESU) has emerged as a major social concern, with widespread reliance on smartphones and the Internet resulting in various detrimental effects. This research aimed to analyze the primary psychological factors that affect ESU among individuals using Structural Equation Modeling (SEM). Smartphone addiction levels were evaluated using the Smartphone Addiction Scale, along with five different temperamental traits, namely, Depressive, Cyclothymic, Hyperthymic, Anxious, and Irritable, using the Affective Temperament Measure. Self-esteem was examined using the Rosenberg self-esteem scale. Of 376 participants aged 16 to 23, 88.4% showed signs of ESU, with certain temperamental traits being more prevalent. Negative impacts were especially noticeable among women. Self-esteem levels were found to be 15.7% high, 23.8% moderate, and 60.5% low. The results emphasize the harmful effects of excessive smartphone use on emotional and cognitive well-being, particularly in those with lower self-esteem. This study highlights the need to understand these relationships and create strategies to mitigate the negative effects of smartphone overuse.

Keywords-Rosenberg self-esteem scale; self-consciousness; smartphone addiction; self-esteem; temperaments

I. INTRODUCTION

In the modern digital era, smartphones have become a vital element of our daily existence, changing the way people communicate, gather information, and entertain themselves. However, the surge in smartphone use has raised an important concern: smartphone addiction. This addiction is characterized by excessive or compulsive smartphone use that disrupts daily responsibilities and personal relationships and is now recognized as a serious psychological and social challenge. Research indicates that people, especially younger individuals, are increasingly dedicating several hours each day to their devices, often indulging in social media, gaming, or other non-essential pursuits. Although smartphones provide convenience and connectivity, their overuse can result in adverse effects, such as weak social interactions, decreased productivity, sleep problems, and increased stress and anxiety levels. The mental and physical wellness of an individual may suffer from excessive smartphone use. Excess cell phone use is a problem when it consumes so much free time that it begins to overshadow hobbies, occupation, learning, and other important aspects of daily life. The dread of losing a mobile device or not having access is one of their most revealing traits. Because of how common this fear is, it has been called "nomophobia". Providing behavioral therapy that prioritizes the resolution of Problematic Smartphone Use (PSU) early may improve children's psychological and emotional well-being [1].

Many studies investigated the resilience of people in light of pressure and dependence on smartphones, showing that the stress and perseverance of adolescents had a significant impact. According to [2], dependence on smartphones affects someone's standard of life in addition to being related to mental health conditions, and the degree of this habit exacerbates these issues. The results highlight the need for efforts and treatments to reduce dependence on smartphones. In [3], 59.87% of those surveyed were classified as mobile users according to the

Mobile Device Addiction Scale-Short Variant. In [4], the relationship between the compulsion to buy online and the dependence on smartphones was examined. The model in [5] was based on the stimulus-organism-response paradigm. In [6], the influence of self-control and dependence on smartphones was examined, achieving a 47% accuracy in predicting behavior resulting from smartphone use. In [7], the connections between school performance, sleep hygiene, and dependence on smartphones were investigated, employing the Smartphone Addiction Scale-Short Version (SAS-SV) and the Pittsburgh Sleep Quality Index (PSQI). The results showed that children may perform poorly academically if they have poor-quality sleep and have a harder time falling asleep due to ultraviolet radiation from smartphones. Furthermore, playing games and surfing the web on smartphones may keep users awake longer and make it harder to fall asleep. This may lead to inadequate rest, inadequate sleep, and detrimental effects on children's mood, cognitive abilities, and general well-being. In [8], the connection between smartphone use trends and dependence was examined by collecting timely information for a month according to the Smartphone Addiction Scale (SAS). The results showed that 29.6% of the pupils were addicted to their devices.

The study in [9] examined how smartphone dependence causes children and teenagers to acquire weight, using a mobile device use-derived BMI as an autonomous variable. Compared to female, male students reported higher rates of obesity. In [10], an AI-smartphone-based melancholy detection system was proposed, relating multidimensional depressive characteristics following the hallmarks of depressive disorders. According to this structure, 93.75% of the predictions were accurate. In [11], the addiction to excessive smartphone use and the Fear of Missing Out (FOMO) were examined, explaining approximately 18% (in testing) and 19% (in learning) of the diversity in the severity of PSU. In [12], the causes of smartphone dependence and the problems that accompany it were examined, showing a relationship between loneliness and self-regulation with smartphone dependence. Using structural equations and the partial least squares approach, the findings showed 86% accuracy.

Other studies have shown that isolation has an impact on aggressive actions and dependence on smartphones. In [13], data were collected using the Buss-Perry aggressiveness survey, the UCLA Depression Scale, the Mobile Phone Dependence Scale, and the Individual Information Form. In [14], approximately 36.6% of Chinese students were predicted to have Mobile Phone Addiction (MPA), which was significantly related to physical, emotional, and sleep issues. According to interaction analysis, there was a higher probability of developing these issues in university students with acute MPA who spent more than 40 minutes a day using their smartphones. The findings showed that lowering MPA and minimizing phone use can help with behavioral problems, including health and sleep-related issues. The results in [15] demonstrated that physical activity can indirectly and directly minimize smartphone dependency. This is because it increases self-esteem, which helps in the long run to address the problem and subsequently leads to the gradual development of healthy behaviors in daily life. In [16], simple linear regression modeling and random sampling were used on a self-regulation scale (α = 0.861) and a cell phone habit inclination scale (α = 0.849). The results showed that autonomy significantly affects the likelihood of developing electronic device dependence (β = -0.263, p < 0.05). Therefore, self-control can decrease the propensity to become addicted to smartphones. In [17], insufficient sleep and smartphone dependence were observed in more than 50% of the sample, and strong positive associations were found between SAS and PSQI scores and BMI, despite a substantial negative relationship between SAS scores and exercise levels. In adolescents and young adults, smartphone dependency was associated with poorer sleep quality, increased body mass index, and reduced time spent outdoors.

In [18], the connection between phubbing and cell phone dependency and Fear of Missing Out (FOMO) was examined. Women scored higher on the smartphone addiction scale (p < 0.05). Phubbing acted as a moderator in the relationship between FOMO and cell phone dependency. In [19], the prevalence of nomophobia among college students was examined along with possible determinants of it, such as demographics and smartphone use. Nomophobia was more common in women than in men (p <.001). The following factors were found to be predictive of nomophobia: sexual orientation, amount of device checks, calls, and messages made and received daily, and the number of texts sent daily. With these data, customized actions and assistance networks can be created to address the particular needs and challenges of these students concerning cell phone use and nomophobia. Finally, in [20], a deep reinforcement learning framework was proposed to predict mobile application use.

II. METHOD

A. Study Design

This study utilized a cross-sectional approach to investigate the link between smartphone attachment and self-esteem in young individuals aged 16 to 23 years during the winter break of 2024. A stratified random sampling technique was implemented to ensure representation across important demographic aspects, such as gender, socioeconomic status, and geographic region. The data collection process included structured surveys, self-report questionnaires, and comprehensive interviews aimed at assessing smartphone dependency, self-esteem, and self-awareness. Statistical techniques such as regression analysis and path modeling were employed, taking into account confounding factors such as parental influence, peer pressure, and access to digital media. Strict adherence to ethical guidelines was observed, including obtaining informed consent and maintaining confidentiality.

B. Participants

The study included a sample of 376 participants aged between 16 and 23 years of age from various school and college environments, all of whom had regular access to smartphones and digital media. A random sampling method was used, excluding individuals with mental or physical disabilities (such as blindness, deafness, or communication difficulties). The sample was organized to incorporate a variety of demographic groups, ensuring a complete representation. Alongside the quantitative surveys, a smaller group of 50

participants participated in qualitative focus groups and in-depth interviews, offering deeper insights into how smartphone use affected their self-esteem. The analysis also considered demographic factors such as family dynamics and academic stress.

C. Sample Size Calculation

The G-power program states that based on an effect size of $f_2 = 2\%$, an alpha inaccuracy of 5%, an effective power of 80%, and after accounting for 10 parameters to be input into the findings of the multivariate study, 255 was the minimum sample size required.

TABLE I. DEMOGRAPHY OF THE EXPERIMENT'S POPULATION

Variables	Frequency
Participants	376
Gender	
Male	156(41.4%)
Female	220(58.5%)
Marital status	
Single	151(40.1%)
Married	62(19.3%)
Level of Education	
School education	87(23.1%)
College education	138(36.7%)
Smartphone use hours	
1-2 hrs	56 (14.8%)
2-3 hrs	259 (68.8%)
3-5 hrs	49 (13.0%)
5-10 hrs	12 (3.19%)

D. Questionaries and Survey

Each participant attended a confidential survey session that lasted between 20 and 30 minutes. The survey included several sections, starting with inquiries about the participant's gender, age, marital status, employment status, educational level, and duration of daily smartphone usage. Some questions were:

- "How frequently do you check your smartphone notifications?"
- "Do you feel anxious when you are without your smartphone?"
- "Does your smartphone use disrupt your academic performance?"
- "Overall, I am satisfied with myself." (Self-acceptance)
- "I often feel sad or down." (Depressive)
- "I tend to feel anxious in unfamiliar situations." (Anxious)
- "I frequently reflect on my own emotions." (Self-consciousness)

E. Smartphone Addiction Scale (SAS)

SAS is a smartphone dependence scale that has 33 categories and 10 criteria. It is ranked on a proportional five-point scale (1 being strongly disagreeing and 5 being highly agreeing) [21]. High demands, everyday life disruptions, connections founded on the Web, misuse, departure, and endurance are the ten variables. A SAS rating is obtained by adding the results from each of the ten parts. SAS values can vary between 100 and 380, with greater numbers denoting greater dependence. Cronbach's alpha for the entire scale was 0.948. This study had an accuracy of 90% and a precision of 96%, respectively. For this investigation, this scale showed high accuracy (Cronbach's alpha = 0.87).

F. Psychological Temperaments Scale

The thirty self-evaluation questions that make up this rating system can be divided into five sections: Nervous, Cyclothymic, Hyperthymic, Depressed, and Restless. Rating scales of five points, extending from 1 (not, at any point) to 5 (extremely much), were used for all replies. Higher subscale ratings indicate greater manifestations of the corresponding temperament [22]. Each component rating goes from 5 to 30. The following were Cronbach's alpha values for every component: Depressed (0.816), Cyclothymic (0.886), Nervous (0.896), Restless (0.804), and Hyperthymic (0.874).

G. Rosenberg Self-esteem Scale

The 10-item Rosenberg Self-Esteem Scale (RSES), which focuses on the good and bad ideas that individuals have about themselves, is a measure of confidence. The scale of responses was 1 for strongly disagreeing and 5 for strongly agreeing [23]. Higher scores indicated higher levels of self-esteem (Cronbach's alpha was 0.824).

H. Self-Consciousness Scale

The Self-Consciousness scale evaluates a person's awareness of himself in both social and personal situations. It focuses on three main aspects: public self-consciousness (awareness of how others view him), private self-consciousness (awareness of his thoughts and feelings), and social anxiety (discomfort in social settings stemming from a fear of judgment). This scale is commonly used in social psychology to study self-awareness and social behavior [24].

TABLE II. CONFIRMATORY FACTOR ANALYSIS OF SAS SCALE COMPONENTS

Variable	Coefficient	Std. error	*p*
1. How often check your smartphone notifications?	1		
2. Do you have any smartphone usage limitation?	0.529	0.856	<0.001
3. Is smartphone usage affecting your academic work?	0.324	0.685	<0.001
4. How many hours do you spend on your smartphone?	0.758	1.324	<0.001
5. Do you engage in phubbing behavior?	0.526	1.202	<0.001
6. Do you engage in online shopping?	0.723	1.068	<0.001
7. How much time do you spend for gaming on your smartphone?	0.514	0.998	<0.001
8. Do you feel any physical discomfort while using your smartphone?	0.845	1.074	<0.001
9. Do you feel any mental discomfort while using your smartphone?	0.633	1.105	<0.001
10. Are you always active on any social media platform?	0.767	1.088	<0.001

Cronbach's coefficients were 0.88 initially and 0.74 during a retest, indicating a good level of reliability. The initial set of items was assessed using a Likert scale with five points. It was

divided into three categories: anxiety about social situations, public sense of self, and self-consciousness introspection.

I. Peer Relationship Scale

This scale was designed to examine the relationships between teenagers and their peers. There were 18 elements in total and four different subscales: Dedication, Confidence and Identity, Self-examination, and Fidelity. A total of five points were awarded for each item [25].

J. Social Avoidance and Distress Scale (SADS)

Composed of 28 true or false items, SADS measures many components of social nervousness, such as anxiety, discomfort, dread, and avoidance. The will to flee or the practice of intentionally avoiding social situations, conversations, or interactions with other people is known as societal rejection [26]. The initial findings were collected using hands-on sight of the students and interviews. All subjects participated in vigorous exercise and completed the survey for research and measurements. Three steps were involved in information handling: data collection, programming process, and proofreading. The modification procedure was initially carried out to ensure that data collection was comprehensive. The investigator went through the programming process, which involved giving codes to the characteristics that were collected based on the relevant criteria. Finally, the data were input into an electronic platform for examination. The analyses used in this study included univariate, bivariate, and multivariate techniques.

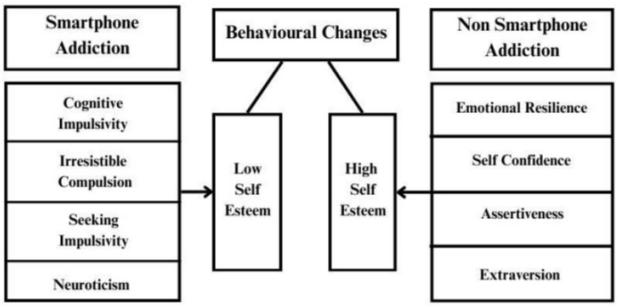

Fig. 1. Smartphone association with self-esteem.

Figure 1 shows the framework of this study. Characteristics that include cognitive impulsivity, impulsive urgency, sensation-seeking impulsivity, and neuroticism are associated with reduced self-esteem among smartphone addicts, resulting subsequently in unfavorable behavioral changes. Mild smartphone users typically display traits such as emotional stability, self-confidence, assertiveness, and extraversion, which promotes higher self-esteem and leads to more favorable behavioral outcomes. Standard deviation and averages were employed for numerical factors such as age, GPA, and overall scores for depression, anxiety, and the mobile device addiction measure. Regression methods were employed to investigate the correlations between mobile phone use and other indicators. To assess differences in categorical variables between the various groups, the t-test for independence and one-way ANOVA were applied to evaluate the averages within each group, along with Chi-square and Fischer's precise tests.

III. RESULTS AND DISCUSSIONS

A. Statistical Analysis

Data processing and analysis were performed using the Jamovi tool, which included characterizing respondents' demographics, calculating the median value of self-addiction, and evaluating the likelihood of smartphone dependence [27]. Additionally, the relationship between the two parameters and demographic data was examined using Pearson's correlation coefficient, and the impact of the regulations on the tendency of mobile participants was evaluated using basic linear regression modeling [28]. A presumption test was also used to confirm that the data had a standard and regular dispersion before any sort of analysis. The categorical parameters (age, sex, married status, universities, and college enrollment period) were described using rates and proportions.

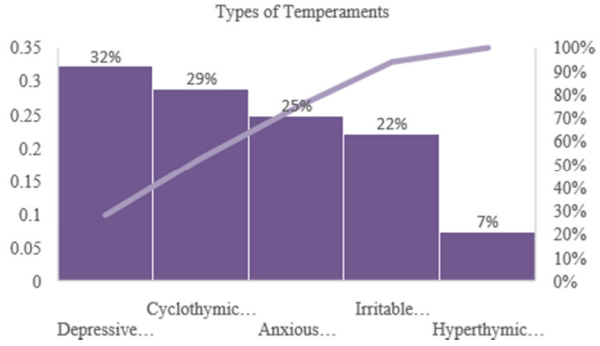

Fig. 2. Types of temperaments.

B. Confirmatory Factor Analysis

The predicted Root Mean Square Error of Approximation (RMSEA) was 0.08 with a confidence range of 0.081-0.110, indicating a suitable ft, and the Confirmatory Factor Index (CFI) was 0.918, demonstrating an appropriate fit. Table II shows the coefficients with standard error and the p-value of the immediate consequences between the parameters.

TABLE I. RESULTS OF SMARTPHONE ADDICTION AND CORRELATION COEFFICIENTS

Variables	Smartphone Addiction	*p*
Gender	**Mean ±SD**	0.886
Male	31.73±9.12	
Female	31.04±7.52	
Marital status		0.142
Single	31.12±6.25	
Married	28.14±7.58	
Levelof Education		0.723
School education	30.26±8.43	
College education	28.16±8.52	
	Correlation coefficient	***p***
Depressive	0.322	<0.001
Cyclothymic	0.289	<0.001
Hyperthymic	0.074	0.041
Anxious	0.248	<0.001
Irritable	0.221	<0.001
Self-esteem	-0.246	<0.001
Self-consciousness	-0.298	0.053

C. Multivariate Analysis

When contrasting multiple variables at once, multivariate evaluation is similar to bivariate evaluation. For multiple variables, a three-dimensional model can be developed to investigate their connections (also called tri-variate evaluation) [29]. Regardless of the type of factor, it produces a single large graph that compares the variables that were chosen with each other in a set of scatter graphs and histograms, also known as a distribution matrix [30]. Significantly greater dependence on smartphones was associated with higher temperaments such as Depressed (r = 0.322), Cyclothymic (r = 0.289), Irritable (r = 0.221), and Anxious (r=0.251), whereas significantly less smartphone dependence was associated with better self-esteem (r = -0.246). A total of 376 adolescents, with a mean age of 31.73 (0.86) years, made up the research population. Variables had the following means and standard deviations: self-esteem (27.22 ±5.16), irritable temperament (17.32 ±6.17), stressed temperament (18.12 ±6.71), cyclothymic temperament (16.25 ±5.92), depressive temperament (29.13 ±9.54), hyperthymic temperament (15.13 ±5.13) and dependence on smartphones (26.86 ±7.31, median= 30). The findings demonstrate a substantial adverse relationship between smartphone use and self-esteem and self-consciousness (MR = -0.547, p < 0.05). Additionally, a strong negative association (p < 0.05) was found between self-esteem and self-consciousness and dependence on smartphones. A significant correlation (r = 0.246, p < 0.05) was found between self-esteem and smartphone dependence, as well as another (r = -0.298, p < 0.05) between being self-conscious and smartphone dependence.

D. Structural Equation Modelling (SEM)

SEM is a useful method for multivariate data analysis, incorporating several variables that are both independent and dependent, as well as hypothetical latent concepts, which are collections of observable data, in contrast to standard regression approaches [31]. This technique enables experts to assess hypotheses even in situations where clinical trials are not feasible by jointly testing the predetermined associations between observable and hidden variables. The visible variables in the proposed SEM had a normal distribution, according to skewness and kurtosis values [32]. The distribution pattern should be near normal if the values of skewness and kurtosis are less than three and ten, respectively. Most of the variables in this investigation had kurtosis values less than 3.6 and skewness values less than 1.62.

E. Hypothesized Model Modification and Validation

Maximum likelihood estimation was selected to estimate parameters since it is suitable for validating a structural equation framework in cases where multivariate homogeneity is not a problem [33]. The chi-square value x^2 of 245.233 (p <.001) was obtained from the goodness-of-fit examination of the theoretical framework. The significance level was less than 0.05. Therefore, the resultant null hypothesis was dismissed. Other goodness-of-fit criteria were also considered, as rejecting x^2 is a valid but not a strict requirement for accepting a predictive model. The investigation yielded satisfactory results in terms of goodness of fit, with a GFI of 0.941, an AGFI of 0.912, a TLI of 0.947, and an RMSEA of 0.067. The CFI was 0.989. Furthermore, considering the IFI of 0.983 and an NFI of 0.955, both metrics exceeded the suggested thresholds (≥0.90). The suggested range (0.5 < PCFI < 0.9) was met and the PCFI was 0.836. A successful model fit was demonstrated by comparing each of these fitting indexes with its suggested values. As a result, the hypothetical framework satisfied all the requirements for an ideal framework.

TABLE II. FIT INDICES AND MODEL EVALUATION CRITERIA FOR MODEL ASSESSMENT

Fit Indices	Criteria for fit	Model measure
x^2 (Chi-square)	≥0.05	245.233
df (degrees of freedom)		381
Chi-square	≤2	1.193
GFI (Goodness of Fit Index)	>0.9	0.941
RMSEA (Root Mean Square Error of Approximation)	<0.08	0.067
AGFI (Adjusted Goodness of Fit Index)	>0.80	0.912
NFI (Normal Fit Index)	>0.90	0.955
CFI (Comparative Fit Index)	>0.90	0.989
RFI (Relative Fit Index)	>0.90	0.926
IFI (Incremental Fit Index)	>0.90	0.983
TLI (Tucker Lewis Index)	>0.90	0.947
PCFI (Parsimony Comparative of Fit Index)	>0.50	0.836
PNFI (parsimony Normed Fit Index)	>0.50	0.845

Most of the participants had low self-esteem and were not very addicted to smartphones. In [34], people with strong cell phone addictions typically had a high sense of self-esteem. The relationship between smartphone dependence and confidence proved substantial, although modest, and single-directional teenagers' use of cell phones is driven by their search for personality, as it allows them to keep up with acquaintances and build new relationships [35]. Higher levels of self-esteem were associated with lower levels of dependence on cell phones, and lower levels of self-esteem were associated with higher levels of dependence on smartphones. These results show that teenagers who felt good about themselves were less likely to become addicted to smartphones. The link between smartphone dependence and self-esteem has been supported by prior research.

In Figure 3, X1 and X2 refer to cyclothymic attachment caused by mood disorders and family depression, X3 and X4 refer to anxious attachment caused by low self-esteem and fear of abandonment, and X5 and X6 refer to irritable attachment caused by sleep disturbances and feelings of being overwhelmed, respectively. Y1, Y2, and Y3 refer to the depressive attachment that is caused by inconsistent relationships, difficulty being with others, and poor self-image and self-hatred, respectively. Y4, Y5, and Y6 refer to hyperthymic attachment caused by a positive outlook and excessive enthusiasm, respectively. Y7 and Y8 refer to self-esteem attachment caused by the difficulty in trusting others and holding emotions, respectively. F3 and F4 refer to self-consciousness caused by feelings of unworthiness and difficulty accepting criticism, respectively. F1 and F2 refer to smartphone dependency caused by depressive attachment and anxious attachment, respectively. Parameters e1 to e18 denote measurement inaccuracy and are a typical AMOS indicator.

The findings indicate that strong smartphone dependence is associated with a lack of self-esteem. Adolescents with low smartphone dependency appear to have a high sense of self-esteem. Smartphone use can improve the quality of teen relationships, but parental oversight may be required to keep an eye on the increased use of smartphones [36]. Enhancing parenting strategies can also improve parent-teen connections by fostering better communication, which can help determine the appropriate amount of time for smartphone use. It is recommended that educational institutions focus on addressing the use of smartphones in the classroom. Universities and educational institutions should investigate different activities that boost teen self-esteem and relationships to help reduce the amount of time they invest in handheld devices. Universities may also help students use cell phones in more responsible ways. For example, they can help students use their mobile devices as an advantageous platform for creative expression and interests. Universities are also urged to design initiatives that facilitate more intimate connections between instructors and students [37]. They can talk about news and websites they can visit on their devices, as well as about things they view on social networking sites. Lastly, studies point to the need for long-term and case-control research to shed light on the reasons behind and implications of the youth population's link between cell phones and confidence.

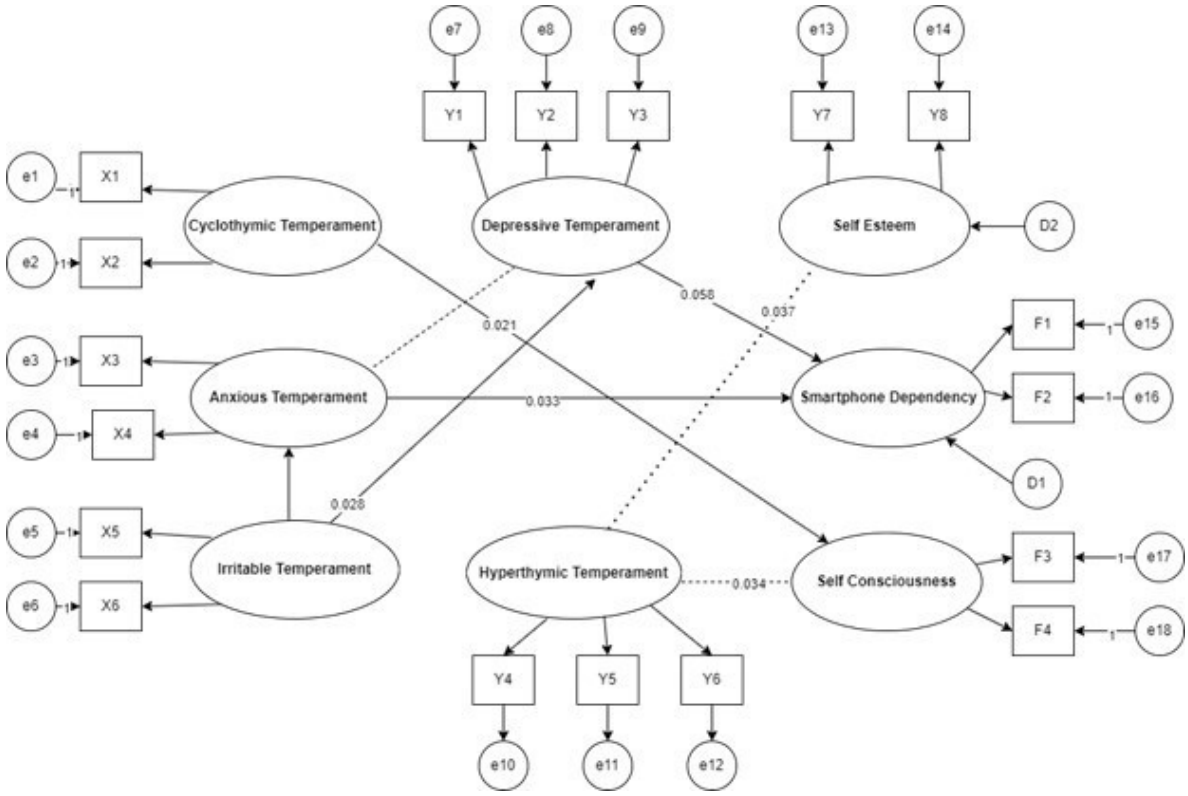

Fig. 3. Path diagram of the model.

F. Analysis of Mediating Model Effect

This study constructed 14 routes connecting different variables in the structural equation model. After examining statistically significant pathways, the paths were depressive temperament (β =0.058, p < 0.001), cyclothymic temperament (β =0.021, p < 0.001), anxious temperament (β =0.033, p < 0.001), irritable temperament (β =0.028, p < 0.001), hyperthymic temperament (β =0.019, p < 0.001), smartphone dependency (β =0.067, p < 0.001), self-esteem attachment (β =0.037, p < 0.001), and self-consciousness attachment (β =0.034, p < 0.001). The paths are connected from depressive temperament to smartphone dependency and anxious and irritable temperaments, from cyclothymic temperament to self-consciousness, from hyperthymic temperament to self-esteem and self-consciousness, from anxious temperament to smartphone dependency and depressive temperament, from irritable temperament to anxious and depressive temperament, from self-esteem to hyperthymic temperament, from self-consciousness to hyperthymic temperament, and from smartphone addiction to anxious, irritable and depressive temperaments. The model's final paths are shown in Figure 3. Using bootstrapping, this study performed an impact analysis to precisely comprehend the structural link inside the research framework and confirm its importance, as shown in Table V. Obsession with smartphones and frequent smartphone use were variables affecting the temperaments of adolescents. Both the direct and overall impacts on dependence on smartphones showed statistically significant differences between anxious and depressed temperaments. Significant variations were observed in the direct and overall impacts of hyperthymic temperament on the self-esteem and self-consciousness of young people [38]. With statistically relevant direct and overall

impacts, anxious, irritable, and depressed temperaments were the factors influencing teenagers' frequent use of smartphones. Furthermore, there were notable differences in the negative effects of anxious and depressed temperaments on the overuse of smartphones by young adults.

TABLE III. MODEL ESTIMATION RESULTS

Endogenous variables	Exogenous variables	β	S. E.	C.R.	R^2	Result
Depressive temperament	Smartphone dependency, anxious temperament	0.058	0.049	0.521	0.083	Support
Cyclothymic temperament	Self-consciousness	0.021	0.035	0.322	0.065	Support
Hyperthymic temperament	Self-consciousness and self-esteem	0.019	0.014	0.478	0.053	Support
Anxious temperament	Smartphone dependency, depressive temperament	0.033	0.028	0.568	0.061	Support
Irritable temperament	anxious and depressive temperaments	0.028	0.031	0.341	0.048	Support
Self-esteem	Hyperthymic temperament	0.037	0.026	0.213	0.060	Support
Self-consciousness	Hyperthymic temperament	0.034	0.023	0.465	0.088	Support
Smartphone addiction	Anxious, irritable, and depressive temperaments	0.067	0.052	0.823	0.096	Support

However, this research has limitations that make it unsuitable for concluding the causal connections between these variables. Due to time limitations, the survey was completed without assistance [39]. Thus, additional research is needed to utilize a variety of data collection techniques more longitudinally. To verify the model, a further study with a larger sample size is required. The results suggest that future studies should examine the latent risk and vulnerable user populations studied with the general population. Furthermore, the findings of this study cannot be generalized to university students elsewhere. Therefore, it is recommended to increase the sample size to improve the generalizability of the findings and produce more precise and thorough results [40].

IV. CONCLUSION

This research involved 376 students (41.5% males and 58.5% females) aged 16 to 23, to investigate the relationship between smartphone addiction and self-esteem by examining five distinct temperaments, namely depressive, cyclothymic, anxious, irritable, and hyperthymic, using SEM. The findings showed that females were more significantly affected compared to males. The proposed model showed excellent goodness of fit, validating its suitability for the study. The verification of the model indicated that the five temperaments, along with self-esteem and self-consciousness, are key factors that affect excessive smartphone use, achieving a prediction accuracy of 88.4%. It was discovered that 60.5% of the participants had low self-esteem with high smartphone dependency, 23.8% had moderate self-esteem, and 15.7% had a high sense of self-esteem with low smartphone dependency. Higher self-esteem and self-consciousness (β = 0.037) and (β = 0.034) were substantially correlated with a lower smartphone dependence, whereas a higher depressive temperament (β = 0.058) was strongly correlated with a greater smartphone dependence. This study employed SAS to emphasize the facilitative role of self-esteem in the relationship between depressed and hyperthymic temperaments and stressful smartphone use to explain the high prevalence of smartphone dependency among adolescents. Most participants reported high levels of smartphone dependence associated with lower self-esteem, and there were students with a lower level of smartphone dependence associated with a higher level of self-esteem.

This study, in line with previous ones, recommends that educators and lecturers should investigate different socially-based endeavors to boost students' self-esteem and social engagement considering these correlations. This could potentially aid in reducing the amount of time spent on smartphones. This can be supported by discussing research showing that face-to-face interactions may protect mental health and self-esteem.

ABBREVIATIONS AND ACRONYMS

PSU: Problematic Smartphone Use

ESU: Excessive Smartphone Use

SAS-SV: Smartphone Addiction Scale-Short Version

PSQI: Pittsburgh Sleep Quality Index

SAS: Smartphone Addiction Scale

UCLA: University of California Los Angeles

MPA: Mobile Phone Addiction

FOMO: Fear of Missing Out

DEEP-APP: Deep Reinforcement Learning Framework

RSES: Rosenberg Self-Esteem Scale

SADS: Social Avoidance and Distress Scale

RMSEA: Root Mean Square Error of Approximation

CFI: Confirmatory Factor Index

SEM: Structural Equation Model

GFI: Goodness-of-Fit the Indices

NFI: Normed Fit Index

IFI: Incremental Fit Index

TLI: Tucker-Lewis index

AGFI: Adjusted Goodness-of-Fit Index

PNFI: Parsimonious Normed Fit Index

PCFI: Parsimonious Comparative Fit Index

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