Digital Therapeutics (DTx) Development Using Generative AI for Preventing Relapse in Online Gambling Addiction

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Submitted to: JMIR Mental Health
on: March 15, 2025

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Abstract

Background: Online gambling presents a high risk of addiction due to its accessibility, anonymity, diverse game offerings, and immediate rewards, leading to compulsive gambling behaviors. Traditional methods of preventing online gambling addiction primarily focus on blocking and regulation. However, illegal gambling sites continuously evade detection through domain switching and bypass techniques, necessitating more effective intervention strategies.

Objective: This study aims to develop a Digital Therapeutics (DTx) system to prevent relapse in online gambling addiction. The proposed system integrates real-time intervention mechanisms, providing users with personalized warning messages and images when they attempt to access gambling websites.

Methods: A comprehensive review of prior studies was conducted to examine the effectiveness of warning messages in addiction prevention and methodologies for classifying general and gambling-related websites. A text-based deep learning model was developed to identify online gambling sites, and its classification performance was evaluated. Additionally, generative Al models (GPT-4o and DALL•E 3) were employed to create personalized warning messages and images tailored to users at risk.

Results: The developed system effectively detects gambling-related websites and delivers real-time behavioral interventions through customized warning messages and images. The model achieved high classification accuracy while demonstrating a 28.3% improvement in inference speed compared to existing models. The integration of personalized warnings showed potential in reducing gambling relapse risk.

Conclusions: This study introduces a novel DTx-based approach to online gambling addiction prevention, shifting from conventional site-blocking methods to personalized Al-driven interventions. Future research should focus on experimental validation by comparing control and treatment groups and analyzing long-term behavioral changes. Additionally, the proposed system holds promise for application in various behavioral addiction treatments, expanding its potential impact beyond gambling addiction.

(JMIR Preprints 15/03/2025:73630)
DOI: https://doi.org/10.2196/preprints.73630

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Original Manuscript

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Keywords: Online gambling addiction; Digital therapeutics; Warning message and image.

Introduction

Background

With the rapid proliferation of internet-enabled devices and the ever-increasing penetration rate of online technologies, human interaction with digital spaces has grown remarkably close. This closer connection, while offering numerous opportunities for communication, entertainment, and commerce, has also given rise to a new set of social challenges. One of the most pressing among these is the expansion of traditional gambling activities into the virtual realm. Whereas gambling used to be restricted primarily to physical venues, today's internet infrastructure allows users to log in and bet on various platforms with unprecedented ease. This shift to online gambling has, in turn, accelerated the risk of gambling addiction, as individuals can access sites anonymously and play continuously without the typical limitations of offline establishments. In particular, as gambling, which was previously conducted offline, expands to the online space through the Internet, the risk of gambling addiction is increasing due to convenient accessibility. Anonymous and continuous

operation of gambling sites are acting as factors that make it difficult for users to escape from gambling addiction [1].

Illegal online gambling programs are avoiding tracking and blocking through periodic domain changes and the use of overseas servers. Due to this persistence, the total sales of illegal gambling tends to constantly increase each year. Internet gambling sites attract users through banner advertisements on illegal content distribution sites, and by creating a large number of factory-generated fake accounts on various Internet sites and social media, online gambling sites are promoted through comments and posts through fake accounts.

In this situation, it is practically difficult to block and crack down on online gambling sites, and the prevention of recurrence of gambling addiction subjects is structurally limited. Treatment subjects have easy access to online gambling and are easily exposed to online gambling advertisements, which is greatly restricted from recurrence treatment in the modern active online activity environment. Therefore, there is a need to break away from the existing method of blocking online gambling sites. Therefore, this study aims to propose a Digital Therapy (DTx) to prevent recurrence of online gambling addiction beyond the existing method of preventing recurrence.

In addition, treatment subjects for gambling addiction often have a reduced ability to recognize addiction and lack willingness to treat, so voluntary participation in treatment is limited. Therefore, the DTx system of this study allows subjects to receive continuous treatment intervention regardless of time and place through high accessibility, so that it can effectively operate in their involuntary treatment environment.

The digital treatment solution proposed in this study presents new possibilities for gambling addiction treatment and provides an innovative approach that goes beyond the existing limits through real-time monitoring and individual customized intervention. As a digital treatment device with high accessibility, it will enable continuous treatment intervention for patients without restrictions on time and place, also provides practical help to patients who have difficulty participating in voluntary treatment. This will prevent recurrence of gambling addiction while increasing the patient's treatment continuity, thereby positioning it as a powerful tool to expect more positive treatment results in the long run. Furthermore, the system is expected to be applied not only in gambling addiction treatment but also in various addiction treatment fields, suggesting a new paradigm in addiction management.

Prior work

Hazardous Site/Unlawful Gambling Site Discriminant Model

Noting that advertisements on various harmful sites lead to illegal gambling sites, URLs connected to external sites were collected by accessing various harmful sites. The collected 12,000 URLs showed 42% as harmful sites containing advertising banners, 28% as actual gambling sites, and 30% as sites containing or unrelated to advertising. As a result of building learning data through HTML and keyword extraction (OCR) collected from the first page of each site and the membership page, and learning a model that classifies it into three gambling sites/advertisement sites/non-related sites, we were able to create a model with 96.4% accuracy. In order to detect the characteristics of changing harmful sites, the trend is identified by analyzing the derived keywords in time series through XAI technology. It detects the emergence of new keywords or changes in which existing keywords become meaningless. The detected harmful and gambling sites can be used to collect URL again, continuously expanding the scope.

Address bypass Tracking and Monitoring

In order to track illegal sites bypassing through address changes based on inferred rules, high-speed static crawling can be used to search for predicted URLs to collect the survival or content of web servers, and if access is successful, it can be checked whether harmful sites are being bypassed based on HTML similarity.

Mechanisms and Addiction Treatment Strategies for Gambling Addiction

According to a previous study that analyzed the mechanisms of gambling addiction in psychiatric and neurological terms, gambling addiction is a form of behavioral addiction. Gambling addiction shares a neurological mechanism similar to drug addiction and poses a risk of being quickly re-addicted. This similarity suggests that exposure to gambling triggers and cues can rapidly reignite addictive urges, much like the way drug cravings can be triggered by exposure to paraphernalia or environments associated with substance use.

In addition, a previous study that analyzed treatment strategies to solve the problem of gambling addiction was also reviewed. Research has shown that a self-management strategy is an effective intervention method for gambling addicts to control their gambling behavior. Self-management often emphasizes daily or routine check-ins and active monitoring of one's triggers, urges, and strategies for avoidance or harm reduction. By empowering individuals with the tools to recognize early warning signs of potential relapse, self-management can be instrumental in reducing gambling frequency or preventing a return to harmful patterns.

Next, it was confirmed that the risk of recurrence of addiction differs according to the stage of gambling addiction. In particular, this study determined that maintenance addicts, which are the last of the five addiction stages, would be suitable for the algorithm of this study. Addicts at this stage will remain resistant to the temptation of gambling throughout their lives, maintaining the change to gambling. However, it is also the stage where they are most confident and experience a regression to the previous stage because they are careless [2]. In other previous studies, addicts at the maintenance stage are aware of the desire for gambling, but they are not perceived as destructive to them, and coping strategies and skills at the individual level are useless in disorderly situations where confusion persists [3]. At the same time, in order to prevent the recurrence of maintenance addicts, it was concluded that it would be necessary to continuously remind individuals who entered rehabilitation setting that they were on the long road of rehabilitation by appropriately using text messages and group KakaoTalk [3].

In other words, addicts at the maintenance stage need to be continuously aware of the rehabilitation process due to the end of the treatment process, lack of continuous awareness of the rehabilitation process, and have a high risk of negligence due to the difference in confidence, so continuous awareness and ventilation of treatment are required. The act of "ventilation" here emphasizes the importance of creating recurring opportunities to release, process, or address any lingering urges or psychological stresses. For example, maintenance addicts may benefit from frequent reminders about the negative outcomes of gambling, as well as regular check-ins (through a counselor, peer support network, or digital messaging) that validate their progress and reaffirm the long-term objective of abstinence.

Therefore, the research team expects to print personalized warning phrases and images when accessing gambling sites to provide continuous ventilation to maintenance addicts, and to effectively recognize rehabilitation and pregnancy to maintenance addicts just before the recurrence of gambling

addiction. By tailoring these warning images and statements to individual patterns, histories, or triggers, the intervention could disrupt the automatic cycle of gambling behavior. These persistent, context-specific cues remind individuals of both the risks associated with gambling and their commitment to sustained recovery.

Gambling stage-by-stage case study and research suitability determination

In a previous study, which conducted 12 in-depth interviews with 10 people in the recovery stage of gambling addiction for 3 years, the characteristics according to the stage of change of gambling addicts were classified based on the population of the study participants, sociological characteristics, gambling- related specialties, and their remarks [4]. In the early stages of the study, the participants lost the trust of their families by gambling repeatedly, but they did not recognize this as a problem and showed the characteristic of continuing gambling with the thought that "it should be okay this time", and began to decide to stop gambling with the realization of the economic and family losses caused by gambling [4]. In the next stage, the cases of preparation and implementation, economic loss, family distrust, and individual resolutions and actions to overcome them are prominent, and in particular, in order to stop gambling, they start to show active actions such as talking with their families and visiting counseling institutions to stop gambling as they feel a change in their interactions with their families. In the final maintenance stage, it was observed that the most common cases were avoiding gambling-related situations and environments in order to continuously maintain gambling [3]. In other words, they thoroughly avoided gambling-related situations and showed the characteristics of adjusting the living environment so as not to be exposed to temptation. Therefore, this study is considered to have the greatest treatment effect in the maintenance stage because the image and warning text are primarily prevented from showing the gambling website in the maintenance stage. In conclusion, it is judged that the digital treatment implemented in this study is most effective to apply it to gambling addicts who correspond to the maintenance stage during the gambling stage.

Table 1. Comparison table of the prior work.

Title	Published	Characteristics	Dataset	Limitations
Implementation of Illegal Gambling Site Detection and Monitoring System Architecture	Papers of the 2023 Korea Comprehensive Computer Science Conference	- By paying attention to the connection between various harmful sites and illegal gambling sites, data collection of illegal gambling sites through crawling - Identify trends by analyzing keywords derived through XAI technology in a time series to detect the characteristics of changing harmful sites - Use static crawling to navigate to predicted URLs to track illegal sites bypassing through address changes	Keywords in the image extracted using HTML and OCR collected from the first page of the site and the membership page (1700 gambling sites, 1000 advertising sites, 1000 non-related sites)	In order to collect data, it has been used that advertisements on various harmful sites are connected to illegal gambling sites, but there is no system to block illegal gambling advertisements themselves.

Reliability Verification Techniques of BERT-based Hazardous Site Classification Model Using XAI	Papers of the 2024 Korea Computer Science Conference	- XAI enables interpretation of the black box type judgment results to verify the reliability of the classification model - Overcoming the limitations of traditional methods that are difficult to detect new sites because they detect through similarity of existing sites - Extracting keywords present in simple HTML and using BERT, one of LLMs, to improve accuracy by considering the context between keywords without using traditional AI models such as XGBoost - By linking two models to classify normal and harmful sites and classify gambling sites from classified harmful sites, false positives are reduced	After collecting HTML of normal and harmful sites, extracting keywords, filtering them based on the frequency of specific keywords, limiting the number of keywords to 50 or more for each site or removing sites with fewer than 15 keywords. Use 838 "normal," 6,754 "gambling," 1,084 "webtoons," 2,000 "Torrent," and 8,453 "adults."	Rapidly increasing number of parameters compared to past classification models
Web site classification method and XAI-based keyword trend analysis technique for gambling site search	A Collection of Academic Presentation Papers by the Korea Information Society	- Use XAI to explore key keywords to identify and remove unnecessary keywords, enabling efficient data preprocessing - Analyzing trends in gambling sites by tracking changes in the contribution of keywords over time - It takes a long time to derive the Shapley value of SHAP, which is XAI's technique, so use simple XGBoost rather than complex models	Using Selenium-based dynamic crawling technology, HTML and image files are collected. HTML removes meaningless tags and extracts only text within the tag, and images are extracted by OCR analysis using Google Vision API	Short data collection time makes it difficult to capture major changes in key keywords over time
What to target in cognitive behavioral treatment for gambling	2022 BMC Psychiatry	For the successful treatment of CBT for gambling addiction, Gambling Pathways Questionnaire (GPQ) is used to divide the	20 Swedish adult patients diagnosed with gambling disorder and undergoing	- Small samples, may have limitations in generalizing results - Relying on subjective

disorder—A qualitative study of clinically relevant behavior		causes of gambling into three types, and a customized treatment for each type is presented	treatment	interpretation due to the nature of emotional research - It was targeted at people who had already participated in the gambling treatment program, so there may be selection bias - Study in Swedon, May Have Cultural Bias
Neural substrates of cognitive flexibility in cocaine and gambling addictions	The British Journal of Psychiatry (2018)	- A study that looked at gambling addiction as a form of behavioral addiction and analyzed the difference in cognitive flexibility compared to cocaine addicts - Evaluated as a meaningful study, confirming that gambling addiction and drug addiction share similar neurological mechanisms	- Functional Magnetic Resonance Imaging (fMRI) data - Gambling Addicts & Cocaine Addicts & Normal Population Data	- The relatively small sample size limits the generalization of the results - Other factors related to addiction may not have been sufficiently controlled
Effect of Graphic Warning Labels on Cigarette Packs on US Smokers' Cognitions and Smoking Behavior After 3 Months	JAMA Network Open (2021)	- An Analysis of the Effects of Warning Images on Behavioral Change in Smokers - Identify positive changes such as increased health concerns and reduced smoking volume when smokers use cigarette packs with warning images	Smoking behavior, changes in perception of smoking, and changes in intention to quit smoking	No significant changes in actual smoking behavior were observed after 3 months
The use of self-management strategies for problem gambling: a scoping review	BMC Public Health (2019)	- A Study on the Systematic Review of Self-Management Strategies to Solve the Problem of Gambling Addiction - Analyzing various self-management strategies used by gambling addicts to control their gambling behavior, suggesting effective intervention methods	Different self-management strategies, including self-exclusion, setting time and money limits, and cognitive approaches	Lack of analysis of people with complex social and health histories such as poverty, homelessness, and mental health problems
LoRA: Low-Rank Adaptation of	arXiv (2021)	- Efficient fine-tuning is possible by adding weight matrix	WikiSQL, MNLI-m, E2E NLG, MNLI, SST-2,	

Large Language Models		products that think and restore as low-dimensional when fine-tuning large-scale language models. - There is no additional inference time, learning only 0.01% of the number of parameters in large language models, fine-grained	MRPC, CoLA, QNLI, QQP, RTE, STS-B	
A Longitudinal Case Study on the Recovery Process of Gambling Addicts	Korean Social Welfare Studies Vol. 71 No. 3 (2019)	- A qualitative longitudinal study conducted 12 in-depth interviews with 10 people in the gambling addiction recovery stage for 3 years - Focus on each case in the context of family life, economic life, and gambling strategies	Gambling addicts and 10 men over the age of 20 who are willing to recover. Including various occupations, income levels, and family backgrounds	- Does not contribute to the recovery of substantial gambling addiction - The study was limited to 10 men in small and medium-sized cities in the metropolitan area, raising concerns about bias in the study
A Qualitative Study on the Process of Gambling Addiction-Including Simultaneous Phenomenon	Korean Journal of Social Welfare, Vol. 63, No. 3	By discovering the simultaneous phenomena that appear in the step-by-step process of gambling addiction, we study the characteristics that appear in the initial experience of gambling, the winning stage, the loss stage, and the despair stage	- Four men showing symptoms of gambling addiction were interviewed and recorded twice every three years - In addition, observation of gambling addiction treatment centers and conducting preliminary interviews	- Difficulty generalizing due to low number of participants - Research is confined to specific regions and cultural contexts. - Lack of quantitative data makes it irrelevant to say that in-depth quantitative analysis is absent
A Study on the Effectiveness of Gambling Addiction Education Programs: Focusing on the Theory of the Stage of Change	Graduate School of Kyungpook National University (2021)	- A Study on the Five Steps of the Theory of Gambling Change Stage - Presentation of the characteristics of the maintenance stage addict	- Using data from 2015 to 2020 of gambling addicts - It consists of 29 people in the experimental group and 34 people in the comparative group	
A Study on the Qualitative Content	Mental Health and Social Work Vol. 43, No.	- Suggestion of the cause and solution of gambling recurrence of dagger beats	In-depth interviews were conducted with 16 study	Failure to analyze interactions with family members, acquaintances, co-

Analysis of the Recurrence Experience of Gambling Addiction Behavior of Dagger Beat	2 (2015)	- Presents the need for continuous awareness and ventilation of the treatment process as a measure to prevent addiction recurrence of addicts in the maintenance stage	participants who had more than one year of experience in gambling addiction	workers, etc. who have social relationships other than those who are addicted to gambling

Methods

Dataset

The data to be collected is keyword data extracted from HTML. The researchers received data from the researchers who previously conducted related studies. It is a total of 17,535 website data, and a maximum of 50 pieces were collected for each data based on the frequency of keywords on the website. There are a total of three labels: normal, gambling, and advertising sites, with 6,191 normal sites, 5,077 gambling sites, and 6,267 advertising sites, and no data imbalance occurred. Using this data, we intend to create a model that classifies gambling sites and other sites. Through this, it is expected that it will be possible to detect gambling addiction risk factors by using all online information as analysis targets, not just limited to gambling sites. In addition, it is expected to evaluate the risk level of addiction recurrence in real time and provide links to immediate warnings and treatment programs accordingly.

Table 2. Interview data.

	Response
Age	19
Start time	2023.03
Access Path	Start with an ad on the Internet
Duration	1 year
Gambling Types	Casino (Baccarat)
Family Relationship	My father (born in 71, at first, I cheered for him when he became aware of his gambling addiction, but the relationship deteriorated very much as the gambling addiction continued to recur, and there has been no exchange so far) Mother (born 75 years old, consistently supported quitting gambling from start to finish and was the greatest help in mental terms) Sister (born in 2004, when she first reported her gambling addiction, she was treated like a person who didn't exist, but when she recently showed signs of quitting gambling, she recovered to her old relationship)
Addiction Process	I haven't been able to go to school for a while because I have a personal illness. I was so bored and bored during that time, so I found a gambling advertisement on the Internet and tried it as a pleasure. As I won a lot of money (30,000 won to 500,000 won) in a short time, I thought, "This can really be my future." I thought that I could make money easily without putting any effort into it, so I lost all the money I earned from continuing in an hour. After that, I didn't gamble for about three months, and suddenly remembered the safe in my parents' room, and I gambling again by taking money out of it little by little.
Recovery Process	At first, I went to a gambling center in Chungmuro, but honestly, it didn't help much. So, while searching here and there, I learned that it was a meeting for gambling (GA), and I participated in it. Although there were many recurrences during the meeting, there were many areas that helped me enough, and first of all, they were all gambling, so I was very willing. Also, there was sadness about the

	absence of my father, but the age group of people who were active in the meeting was the same as my father, so I got a lot of comfort. While working hard there, he achieved his achievements so far.

Model

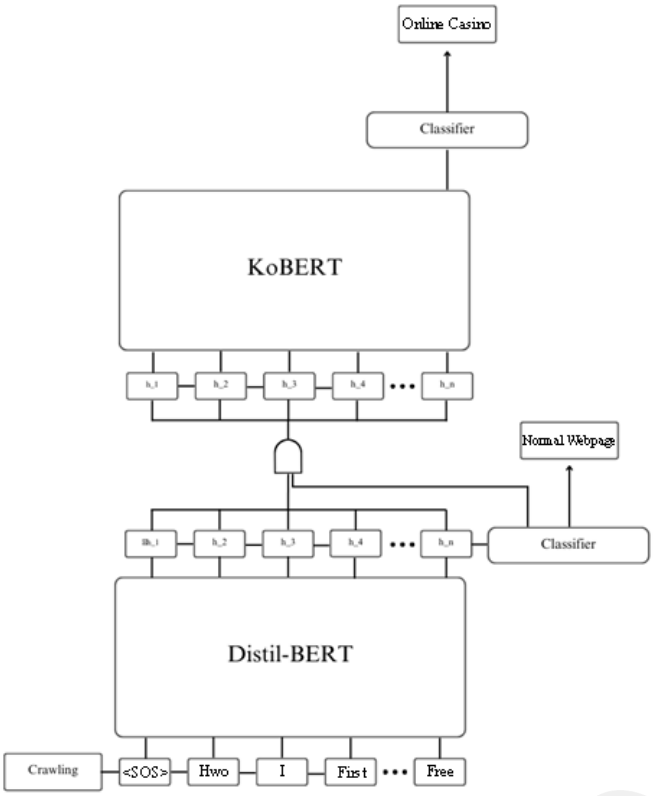
Large Language Model

Large Language Model (LLM) based on the Transformer structure is gradually replacing the existing classification models Random Forest, SVM, and XGBoost. Due to the vast number and complexity of these large language models, the process of training the entire model to specific tasks is very difficult. However, the introduction of parametric effective fine tuning (PEFT) techniques such as P-tuning [5], LoRA [6], and Adapter [7] has enabled fine-tuning even with relatively few computational resources. In addition, as large language models pre-trained through open-source platforms such as Hugging Face have become easily accessible, large language models can be used to better understand the context of text data and achieve superior performance even in simple classification tasks.

Double Classification Structure

In previous studies, the gambling site discrimination performance of the single classification structure and the double classification structure was compared [1]. The single classification structure is a method of directly determining whether a gambling site is present in learning data, and the double classification structure is a method of first classifying whether a gambling site is present and then determining whether a gambling site is present again when it is classified as a harmful site. As a result of the study, it was found that the double classification structure classifies gambling sites more accurately. Based on the results of such existing studies, this study constructed an architecture with a structure of discriminating gambling sites using a double classification structure.

Figure 1. Architecture of gambling site classification model.



DistilBERT

The core function of digital therapeutics is to determine whether a user visits a gambling site in real time for all sites visited by the user. Since users often visit a specific site for a short time without staying for a long time, and then move to another site, the model must determine whether the user is a gambling site in real time. DistilBERT [8] is a model that maintains 97% of BERT while reducing the total number of parameters by using only 6 layers, half of the 12 layers of the BERT model, using a knowledge distilling technique that transfers knowledge of the teacher model to the student model. DistilBERT used DistilBERT because the inference time is reduced by about 40% compared to BERT due to a small number of parameters, it was judged to be suitable for the gambling site discrimination sustem of this study. which requires a short inference time.

Low-Rank Adaptation (LoRA)

It takes a lot of computational resources to learn LLM from scratch for a specific purpose. Due to the enormous number of variables in LLM in the fine-tuning stage of re-learning for a specific purpose, at least millions of variables must be learned, which requires long training time and computational resources.

To compensate for the shortcomings of this detailed learning, we use the parameter-efficient fine-tuning (PEFT) technique. PEFT includes Adapter [7] which fixes the variables of the pre-trained model and fine-tune them by inserting additional layers to be trained, Low-Rank Adaptation (LoRA) [6] which learns only that matrix by adding small low-dimensional matrices next to a specific layer of the pre-trained model, Prompt Tuning [5] which inputs appropriate prompts to model input to learn in detail based on the contents of the prompt, and Prefix Tuning [9], which places the token specialized for the purpose at the front of the input to learn in detail.

In this study, the LoRA technique was applied to the model. LoRA assumes that the process of adapting the pre-trained model to the problem takes place at the rank of the low-dimensional matrix [6]. LoRA is composed of the product of a weight matrix (A), which considers input data of a specific layer to be low-dimensional, and a weight matrix (B), which restores it to the existing dimension from the low-dimensional (Equation 1). This structure was selected as a PEFT technique suitable for this study that requires fast inference speed by minimizing additional inference delay.

Figure 2. Function of Low-Rank Adaptation.

$$W_x = W_0 x + ABx$$
$$A \in R^{h \times r}$$
$$B \in R^{r \times h}$$

Performance

The classification model of this study has little performance degradation compared to the existing model and is characterized by a fast inference speed. In the first classification, the learning results of three model structures were compared: using LoRA once, using it twice, or fine-tuning the entire model. Using LoRA twice in the first classification was the best, and it is estimated that the given performance can be improved by increasing the number of parameters themselves without reducing the inference speed.

In the second classification stage of the model, it was not just a double classification, but a more complex problem that distinguishes gambling sites, gambling sites excluded illegal sites, and general sites, so rather than fine-tuning using LoRA, the entire DistilBERT model could be fine-tuned to solve complex problems. The classification accuracy of this research model using a different model at each classification stage was evaluated as 0.9545 and the Fl-score was evaluated as 0.9439, and the inference speed was significantly improved compared to the existing model. When keyword text is input, the average inference time of this research model is 199.1ms, a decrease of 28.3% compared to the existing model.

Table 3. Comparison of model performance.

	Accuracy	F1-score	Inference-time
Binary Model	0.9576	0.9421	-
Multiclass Model	0.9422	0.9666	-
Hybrid Model	0.9786	0.9864	277.5ms
DistilBERT-based 2 LoRA (Ours)	0.9545	0.9439	199.1ms
DistilBERT-based 2 LoRA	0.9408	0.9439	191.2ms
DistilBERT-based Full Fine-Tunning	0.9391	0.9591	183.7ms

Results

Create alert phrases and images

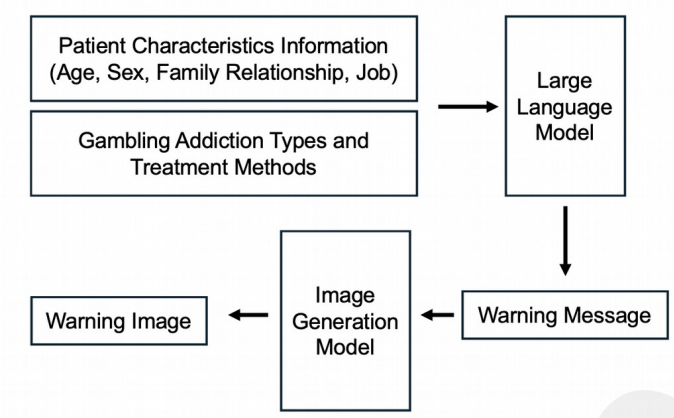
Based on the user's access record, the model implements a treatment system that provides visual feedback along with a warning message when a person to be treated accesses an online gambling site. This treatment system provides warning phrases and warning images using a generative

artificial intelligence model tailored to each characteristic.

Create alert phrases and images

In order to generate customized warning messages, the user's gambling causes are identified through Gambling Pathways Questionnaire (GPQ), and the patient's characteristic information (age, gender, family relationship, occupation, etc.) is also identified through a survey. A prompt is devised by adding a paper [10] that presents this information and treatment methods for each gambling type as an external document so that LLM can generate customized warning phrases for users.

Figure 3. Warning message generation pipeline.



The pipeline for generating warning phrases is designed in the Langflow environment. The patient's information and survey results are input, and the warning phrase is output through the three prompt chains. To solve the problem, we use Chain of Thought prompting, a prompting technique that helps the model obtain the final answer through intermediate thinking steps [11]. The first chain is responsible for classifying the patient's gambling addiction types by allowing duplication into three types (behavioral conditioning, emotional vulnerability, impulsive/anti-social type) [10] using patient information and survey results as inputs. The second chain is responsible for presenting appropriate gambling addiction treatment methods to patients according to the type of gambling addiction and patient information. The third chain serves to present appropriate gambling addiction warning phrases to patients according to the treatment method and patient information. In addition, Few-Shot prompting is applied to each prompt chain to show the desired answer format to the model. In order to create a Few-Shot example, the cases from previous studies are expanded to a format that can be used using the LLM Few-Shot model [12] based on and based on the examples from previous studies.

As an LLM model for generating customized warning phrases, OpenAI's latest generative artificial intelligence model, GPT-4o, is used. GPT-4o has a structure optimized for the next token prediction (causal language modeling) task of the language model and is characterized by predicting the next token based on the input text sequence to generate continuous text. This method contributes to increasing the consistency and contextuality of phrases provided by language models and is suitable for securing reliability in delivering important information due to the nature of warning messages.

In addition, GPT-4o contributes to improving the quality of the user experience as it has a high performance that can support the rapid generation of warning phrases. This study is designed to deliver addiction-related risk warnings to users at the same time as accessing the website by generating warning phrases in real-time using this speed and performance. In the process of

generating warning phrases, the language learning data of the model and the user's risk assessment data are combined to provide customized phrases to each user, which allows the results of reflecting the individual addiction risk level to be immediately reflected.

Table 4. Example of pipeline.

	Text
Input 1 (Client Info)	Age: 25 When to start gambling: 2018 Gambling Access Paths: Start Voluntarily Gambling duration: 2 years Gambling Type: Online Illegal Sports Toto Family relationship: Father (55, small business employee who lacked communication with his children due to his busy work, but tried to support him emotionally after being aware of his gambling problems), Mother (53, elementary school teacher who noticed his child's gambling addiction problems early on and encouraged him to participate in psychological counseling and gambling programs), Sister (27, office worker who nagged him after learning about his brother's problems, but offered advice and encouragement to help him recover) Gambling Addiction and Healing Course: I loved sports enough to target a soccer player since elementary school, but I gave up my dream due to injuries. After going to college, while watching soccer games and continuing my passion for sports, I participated in illegal sports Toto at the recommendation of a friend. Winning a large amount of money in my first bet, I fell into gambling with the idea of "proof that I know Potts well." Afterwards, on the day I won the gamble, I felt confident and happy, but I experienced guilt and frustration when the loss occurred. I bet in pursuit with the idea that if I win money, everything will be solved," and my debt increases. In 2019, he realized his reality after suffering a large amount of money from illegal gambling sites and decided to stop gambling. For the next three years, he did not gamble, stayed in recovery, and focused on his studies. Whenever I have a gambling urge, I overcome it through conversations with my family and friends.
Input 2 (GPQ)	- General Questions about Gambling: 1. I usually gamble to relax and relieve my stress. * Answer: 5 2. I often do crazy or crazy things to surprise others. * Answer: 4 3. Gambling gives me a purpose in my life. * Answer: 6 4. I often say offensive and hurtful things when I'm angry. * Answer: 5 5. Gambling allows you to escape responsibility for a while. * Answer: 5 6. When you want sex, you don't mind paying for it. * Answer: 2 7. Winning big money in gambling will make sense in my life. * Answer: 6 8. I often accept challenges, even if they are dangerous. * Answer: 4 9. I often buy things on a whim. Even if I can't afford it. * Answer: 5 10. When you're angry, hitting or throwing something always makes you feel better. * Answer: 3 11. If you win the gamble, you'll feel less like I'm a failure. * Answer: 6 12. I often lose patience when I'm in line or waiting for someone else. * Answer: 4 13. I follow the rules only when I feel like I'm getting caught * Answer: 3 14. I usually gamble to relieve stress and life pressures. * Answer: 5 - Emotions and Actions prior to Gambling Issues: 1. I often felt panic. * Answer: 4 2. I was often nervous and nervous. * Answer: 5 3. I was very worried. * Answer: 5 4. I often fell into a sad, depressed mood (if it lasted at least two weeks). * Answer: 4 - Emotions and Actions after Gambling Problems: 1. I often feel panic. * Answer: 6

	2. I am often nervous and nervous. * Answer: 6 3. I worry a lot. * Answer: 6 4. I often get sad and depressed (if it lasted at least two weeks). * Answer: 5 - Childhood or Teenage Experience: 1. Hit, punched, or kicked at home. * Answer: 3 2. I was often teased or bullied at school. * Answer: 3 3. I have often heard hurtful words like "worthless," "useless". * Answer: 4 4. You have experienced unwanted or inappropriate sexual contact. * Answer: 2 5. Emotionally neglected or ignored by carers. * Answer: 4 6. Often left home alone or without proper clothing, food, heating or other necessities. * Answer: 3 7. I witnessed physical violence inflicted on someone else. * Answer: 3 - Thoughts on Gambling, Myself, and Life: 1. I only feel important when gambling. * Answer: 6 2. I sometimes meet people just for sex. * Answer: 2 3. I have tended to cause problems since I was young. * Answer: 5 4. I'll gamble on anything just for fun. * Answer: 6 5. I gamble to get out of trouble. * Answer: 6 6. If necessary, I do something illegal that is not related to gambling. * Answer: 3 7. People who know me will tell me my behavior is unpredictable and inconsistent. * Answer: 6 8. As long as I win the gamble, it wouldn't seem like my life is out of control. * Answer: 5 9. I often have a physical fight with someone else. * Answer: 4 10. If you feel good, you will do so regardless of the outcome. * Answer: 5 11. Gambling allows me to forget the bad memories of my life. * Answer: 6 12. I often get angry for no apparent reason. * Answer: 5 13. I have had unprotected sex with someone I don't know very well. * Answer: 3 14. Gambling helps me avoid difficult situations or people in my life. * Answer: 6 15. It's okay to lie to gain the benefits. * Answer: 5 16. Gambling paralyzes me so I don't feel bad. * Answer: 4 17. I often manipulate others to get what I want. * Answer: 6 18. I often say or do things without stopping and thinking. * Answer: 6 19. When someone tells me not to, I often want to do more. * Answer: 6
Chain 1 Output	Emotional Vulnerability, Behavioral Conditioning
Chain 2 Output	As this patient is experiencing gambling problems based on emotional vulnerability and behavioral conditioning, the following treatment options are appropriate. First, it helps to identify emotional triggers associated with gambling and explore healthy stress relief methods (exercise, meditation, artistic activities, etc.) that can replace them. It analyzes the negative consequences of gambling behavior and guides the patient to look at their gambling behavior objectively. For emotional vulnerability, it maintains a record of emotions in order to learn the skills to recognize and express emotions, and utilizes relaxation techniques or psychological tools to relieve tension and control emotions. In order to correct gambling habits caused by behavioral conditioning, the patient is encouraged to receive positive rewards through alternative behavior by using progressive exposure methods. Through family-based treatment, the family members are educated on gambling addiction and recovery processes, and positive communication is promoted through emotional support with the patient. In particular, it provides appropriate counseling to help parents and sisters play supportive roles in the patient's recovery process. In addition, it helps the patient set new goals and restore self-esteem through realistic achievements such as study or employment. As psychotherapy, cognitive behavioral therapy (CBT) helps to correct distorted beliefs ("If you earn money, everything will be solved") and develop a realistic mindset. In addition, we encourage participation in community activities or meetings for quitting gambling, and continue to seek ways to improve social relationships and strengthen motivation for recovery. We

	conduct medication to alleviate emotional instability when necessary, and monitor the recovery process through regular consultations with the treatment team.
Chain 3 Output	["Gambling can destroy your sports passion. Stopping now is the way to continue your bigger passion.", "The excitement of the first victory is not your talent, but your luck. Face it.", "Winning money won't solve all the problems. Choose academics and new goals instead of gambling.", "To regain the trust of your parents and sisters, stop gambling and make a new beginning.", "Gambling does not boost your confidence. True confidence comes from achievements other than gambling.", "Don't forget the experience of eating and running. Gambling is an unreliable choice.", "Your value comes not from money from gambling, but from your relationships and achievements with your family.", "Gambling does not heal past wounds. Take care of your feelings and find new paths.", "Sport shines with passion and hard work, not gambling. Bring back your true sportsmanship.", "Look for a sense of accomplishment in academics and social activities instead of gambling. Your future may be brighter."]

Create a customized alert image

Then, in the customized warning image generation step, OpenAl's DALL-E 3 model is used. DALL-E 3 is an image generation model that converts text to image, and has the function of generating various visual contents based on text description through artificial neural network [13]. Unlike earlier image generation techniques, DALL-E 3 is capable of capturing nuanced textual details- such as specific themes, moods, or stylistic requests— and translating them into coherent, contextually relevant images. This high-fidelity image generation capability allows researchers to create warning images that are both persuasive and directly aligned with the intended messaging. As of the end of 2024, it was not possible to specify the model directly, so the method chosen involved calling and outputting the model using a function capable of making image requests through the ChatComplete API. This approach ensures that even when direct model access is limited, the system can programmatically send prompts and receive generated images, thereby preserving a fully automated workflow.

In this study, the generation process for warning images mirrors the example used to create warning phrases. A prompt was constructed by combining the previously generated warning phrase and Input 1. Through this prompt, DALL-E 3 was instructed to generate a customized image that visually represented the same ideas conveyed by the warning phrase. By designing the image prompt to reflect both the user's risk level and unique contextual factors, each output image was more likely to "speak" to the individual's situation.

Warning images utilize visual elements to immediately deliver warnings to users, and can be expected to have a greater effect than simply presenting phrases. In particular, visual warnings contribute to making users aware of risks faster and increasing the intensity of warnings. In the process of generating warning images, DALL-E 3 uses artificial intelligence-based text-image mapping techniques to express the core content of the phrase as visual content, and each image is optimized to reflect the user's risk and the content of customized warning phrases. This customized approach contributes to improving the user experience and maximizing the effectiveness of warnings.

The design of this system is focused on increasing the effectiveness of providing customized warnings by combining both the performance of the generative artificial intelligence model and the advantages of image generation technology, and expanding the possibility of providing customized warnings for each user. Through this strategy, the system aims to contribute significantly to addiction prevention and risk reduction measures, offering prompt visual reminders at critical decision points.

Figure 4. Sample of alerting image.

Discussion

The significance of this study is as follows. First, the method's practical effectiveness was explored through actual interview data collection and prototype production. Rather than relying solely on theoretical models or hypothetical user profiles, real feedback was gathered from individuals who have experienced or are experiencing online gambling addiction. These interviews, conducted in a non-face-to-face manner, allowed for candor and privacy, enabling participants to provide honest insights into how certain warning phrases and images might resonate with or fail to deter-them. As a result, the user-centered design process became more refined: iterative prototypes were tested and improved based on real-world experiences, ensuring that the final system is more aligned with actual user needs and psychological triggers.

Second, there was thorough analysis of previous studies to inform the development of the digital therapeutic tool. By examining research on the psychological mechanisms of gambling addiction and exploring various addiction stages, the study was able to identify and target gambling addicts in the maintenance stage as the optimal demographic. Drawing from the literature, including work on behavioral addiction and its neurological parallels with substance addiction, the system design and warning content were meticulously aligned with evidence-based treatment strategies. This approach not only gave credence to the choice of methods (e.g., personalized warnings, image-based alerts) but also ensured that the classification model, built and validated through in-depth literature review, achieved high accuracy in matching users with relevant warnings. As a result, it grounds the study in proven psychological theories and sets a strong foundation for future interventions.

Finally, although the study has not yet collected extensive experimental data on the impact of these warning phrases and images in real-world gambling scenarios, it represents an important stepping stone. By being "the first study to systematically analyze the subject and present an original approach," it pioneers the application of advanced generative Al in creating both text-based and image-based warnings customized to an individual's gambling risk profile. Future research can build upon these findings by conducting controlled trials, user experience tests, and longitudinal studies to measure the long-term efficacy of these interventions. Additional data will also allow researchers to refine how and when warnings are delivered, potentially integrating metrics such as gambling

frequency, user engagement, and relapse rates into a continuous improvement cycle.

Conclusion

In this study, actual online gambling addicts were interviewed to gather appropriate data for warning phrase and image generation prototypes. The interviews served as a crucial data collection method, yielding a rich source of personal experiences, triggers, and emotional responses that informed both the content and style of the warnings. Conducting these interviews in a text-based, non- face-to-face format provided participants with a level of privacy that may encourage more candid feedback, which in turn enriched the depth and quality of the data collected.

Additionally, building on psychological studies that emphasize the behavioral patterns of gambling addicts, the research deliberately focused on individuals in the maintenance stage. As literature suggests, maintenance-stage addicts have unique needs— they are simultaneously committed to refraining from gambling and prone to relapse due to overconfidence or lack of continuous reminders. By honing in on this specific demographic, the project sought to develop targeted interventions- namely personalized warning phrases and images precisely for a population that stands to benefit most from timely and salient reminders.

The results of this study lay the groundwork for further exploration into comprehensive online gambling addiction treatment systems. In particular, the creation of prototype warning messages and images demonstrates how Al-generated content can serve as a dynamic intervention tool, offering immediate, personalized risk alerts at critical decision-making junctures. With more extensive testing, refinement, and the eventual integration of real-time user data, future versions of this system could evolve into a robust digital therapeutic solution, contributing to broader harm-reduction strategies and supporting long-term recovery outcomes for those at risk of gambling relapse.

Acknowledgements

This research was supported by the MSIT (Ministry of Science and ICT), Korea, under the Graduate School of Metaverse Convergence support program (IIITP-2025- RS-2023-00254129) supervised by the IITP (Institute for Information & Communications Technology Planning & Evaluation and Culture, Sports and Tourism R&D Program through the Korea Creative Content Agency grant funded by the Ministry of Culture, Sports and Tourism in 2025.+ Project Name: Development of game-based digital Therapeutics technology for adolescent mental health(psychological and behavioral control) management, Project Number: RS-2025-00344893 and the MSIT (Ministry of Science, ICT), Korea, under the Global Scholars Invitation Program (RS-2025- 00459638) supervised by the IITP(Institute for Information & Communications Technology Planning & Evaluation).

Conflicts of Interest

none declared

Abbreviations

DTx: Digital Therapeutics
URL: Uniform Resource Locator
LLM: Large Language Model
OCR: Optical Character Recognition
XAI: Explainable Al

HTML: Hyper Text Markup Language
SVM: Support Vector Machine
PEFT: Parametric Effective Fine Tuning
BERT: Bidirectional Encoder Representations from Transformers
GPQ: Gambling Pathways Questionnaire
Al: Artificial Intelligence
API: Application Programming Interface

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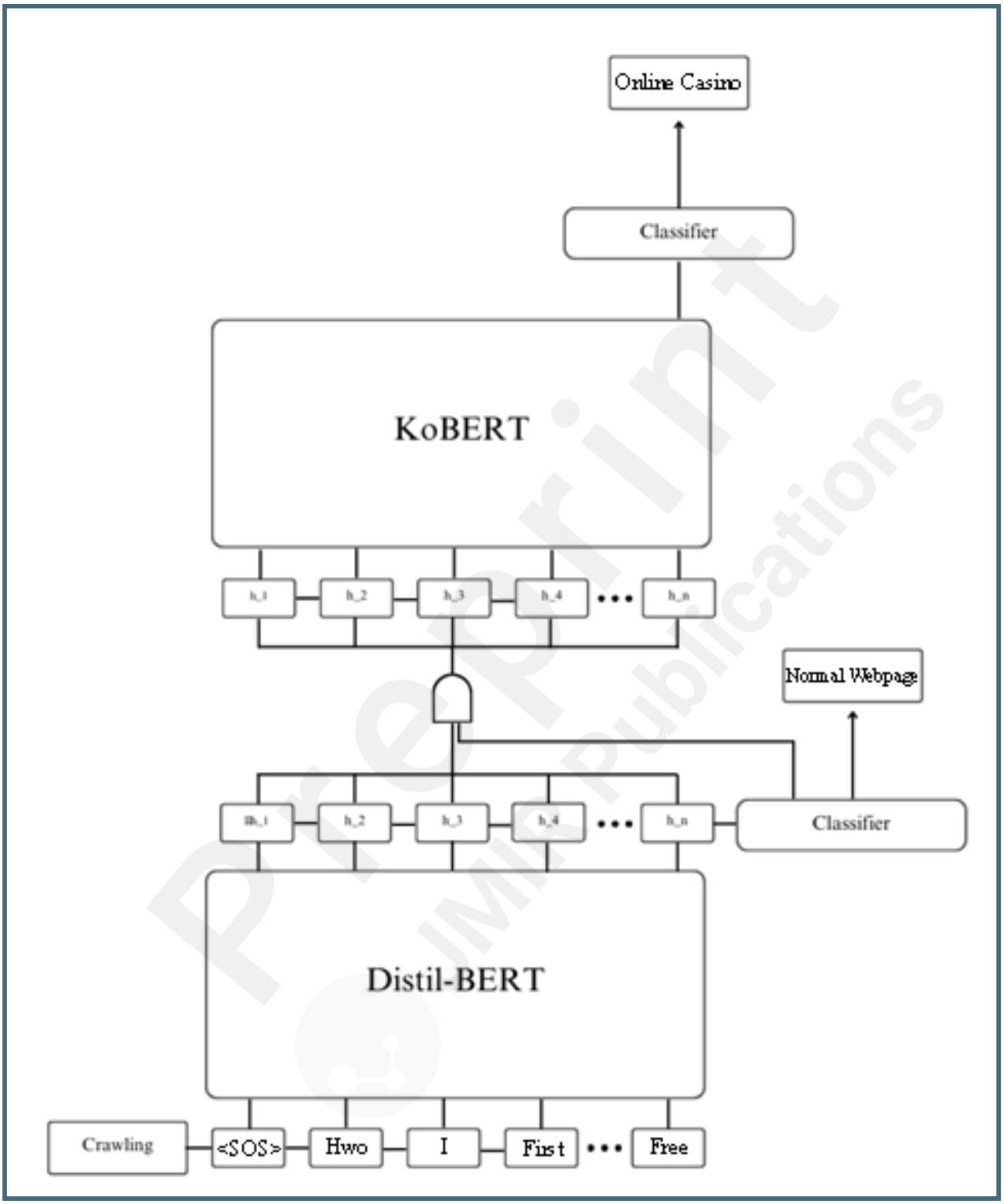
Supplementary Files

Figures

Architecture of gambling site classification model.



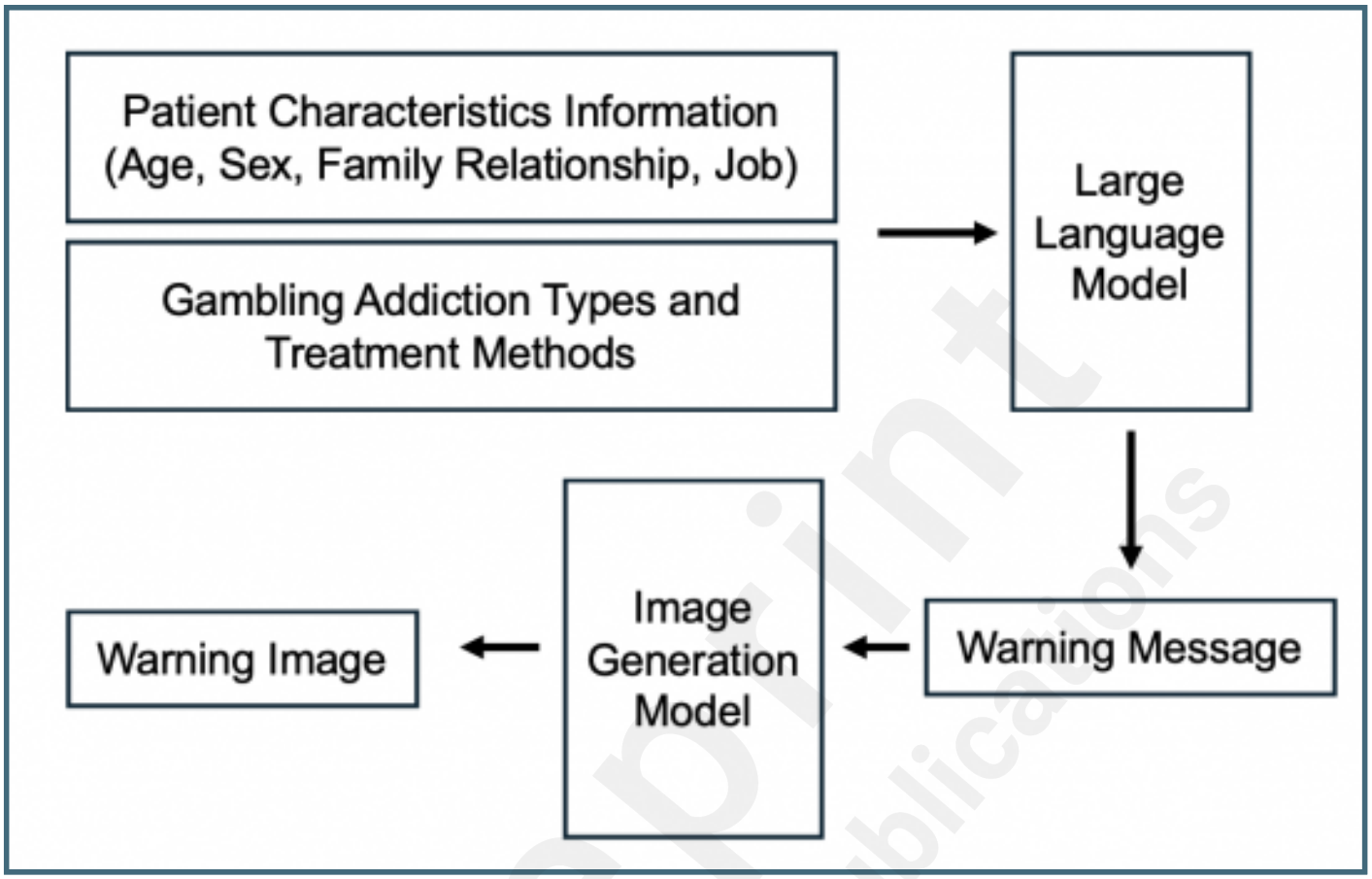
Function of Low-Rank Adaptation.

$$W_x = W_0 x + ABx$$

$$A \in R^{h \times r}$$

$$B \in R^{r \times h}$$

Warning message generation pipeline.



Sample of alerting image.