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Evaluating Digital Applications on Smoking Cessation: A Theory-Driven Scoring System

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ABSTRACT

Indonesia has one of the highest number of smokers globally and strengthening smoking cessation services one of the key strategies for an effective tobacco control efforts. The rise of digital health has led to an increase in online applications dedicated for smoking cessation. While these online apps offer users valuable opportunities to improve their health decisions, the sheer number of options can make it difficult to find the most suitable app. There is a lack of scientific or theory driven approaches in conducting a systematic evaluation of the available apps. One way to evaluate the effectiveness of existing these apps is looking at them through the lens of behavioral science. Our study aims to assess app effectiveness using dimensions from the transtheoretical model (TTM), a well-known consumer behavioral model. We examined 122 apps from Android and iOS and found that while most incorporate some consumer-behavior insights, they often neglect other key stages of the behavior change journey. While apps support users ready to quit or maintain their commitment, they lack sufficient resources for those contemplating change. Additionally, many miss key features, such as user forums for social support and professional healthcare interactions, that could enhance the apps' efficacy.

INTRODUCTION

Smoking is a major preventable cause for Non-Communicable Diseases (NCDs) and a main contributor to death worldwide (WHO, 2015). Indonesia has one of the highest number of smokers globally. In 2016, more than 40 percent of its population aged 15 years and above are active smokers, translating to over 7 percent higher than the global average (Holipah et al., 2020). Majority of smokers in Indonesia smoke cigarettes, but there is a growing trend of electronic smoking, particularly across the young population (Hartono et al., 2024). With robust evidence pointing to e-cigarettes leading to equally harmful health outcomes to traditional smoking (Marques et al., 2021), this trend adds to worsening of tobacco control and indicate a dire need to strengthen interventions.

Smoking cessation is a key mechanism in improving the likelihood of people quitting smoking and is therefore an important part of tobacco control efforts (Pipe et al., 2022; Vallata et al., 2021). The method of delivering cessation interventions, however, play a significant role in determining their success (Barroso-Hurtado et al., 2021). For instance, traditional and in-person delivery cessation programs such as

perceived costs (commuting to the centres, fees), lack of motivation and psychological factors (poor stress management) can all hamper the program's potential.

Over the years, mobile health (mHealth) in the form of online applications have been utilized to address some of these challenges. These platforms leverage mobile technology to help people monitor, improve and manage their health, which offer a significant supporting function to existing conventional health services. They come in the form of digital applications that can be attained in two of the world's biggest operating systems; iOS and Android that are offered as free, semi-paid or fully paid services. mHealth are often designed by third-party developers. They can be classified based on their functionalities such as preventative behavior change, management of diseases and diagnostics and fitness.

M-Health has become a key part in the global digital health transformation. In Indonesia, growing the mHealth market has become one of Indonesia's key strategies to expand Indonesia's digital health (Ministry of Health, 2024). According to Indonesia's Social Security Agency for Health (BPJS Kesehatan) 32% of Indonesians, or around 92 million people in 2017 uses at least one form of mobile health applications or m-Health (Handayani et al., 2021). The growth of the internet and smartphones are some of the key factors to Indonesia's growing trend of online-based health services (Handayani et al., 2021). Indonesia has a large online consumer base. In 2023, almost 80 percent of Indonesia's population of over 250 million people are connected to the internet (Indonesia, 2024). A market study in 2022 revealed that Indonesia is within the top 10 countries with highest smartphone users globally.

There are currently hundreds of thousands of mHealth apps, including those designed for smoking cessation. Although the surge in mHealth apps presents valuable opportunities for users to make better health decisions, the overwhelming number of options can make it challenging to choose the most suitable app. Other than consumer rating, there is limited regulation, accreditation system, or standards to inform consumers of the apps' reliability. While consumer rating can be an important reference as found across existing studies, these ratings often reflect user satisfaction rather than the app's effectiveness or evidence-based practices. Consequently, users may struggle to identify apps that genuinely support their smoking cessation efforts. To address these challenges, it is essential to combine existing quality evaluation frameworks with scientific approaches.

Another way to evaluate the effectiveness of existing online health products is looking at them through the lens of behavioral science. Behavioural insights can help us better understand how and why consumers behave in ways that affect their health. These models help explain the barriers that consumers face in adopting favourable health behaviors and potential solutions. Another distinction offered through this angle of analysis is that this approach reflects the insights of health communicators, academics and other experts working in related fields as opposed to the views of consumers. This adds a layer to what is known about developing effective digital-based interventions for smoking cessation.

By integrating behavioural insights, such as nudges, habit formation techniques, and cognitive biases, into the evaluation process, we can gain a deeper understanding of how these apps influence user behavior and improve long-term outcomes. Currently, much of the literature primarily focuses on the technical quality and usability aspects of mHealth apps (Bold et al., 2023), overlooking how behavioral strategies can enhance user engagement and adherence. Our review on the literature found that studies have looked into apps' states of technological usability across its various typologies (Bold et al., 2023), views of consumer experience as well as their preferences (Xie & Or, 2023). This is also the case with smoking cessation apps (Bold et al., 2023; Hartono et al., 2024), with key findings revealing that majority of apps focus on features that accommodate target setting and self-monitoring. Literature also note that there is high variability in usability and available features across the apps. Most of the apps also have in-app purchases to access important features, which affects usability, experience and potentially, effectiveness of outcomes.

Incorporating behavioral approaches can offer a more comprehensive perspective, identifying psychological triggers and motivations that contribute to the effectiveness of smoking cessation interventions. The transtheoretical model (TTM) is one of the widely used consumer behavioral models aimed to explain the different stages of people's knowledge and attitude of a certain health behavior. Within this model, people move across different stages of readiness. This model consists of the unaware (precontemplation), people with intention to change (contemplation), people who are preparing themselves for change (preparation), people acting on their intention (action), people maintaining their behavior (maintenance) and finally people who have succeeded to adopt the behavior (termination).

This model has been widely applied in explaining the behavior of smokers. For active smokers, quitting smoking is often a long and non-linear process. Risks of relapses is often reported (Lee et al., 2022). There are barriers unique upon the different stages of the journey, and therefore the interventions that develop from it. The model emphasizes ways to help move people along different stages of change to reach the final stage of termination. This model also suggests that a single intervention may combine the different stages of change for optimum outcome.

Considering the above, our study is designed to assess the quality of available smoking cessation apps in Indonesia using a behavioural analysis approach. We will conduct this assessment by observing (1) how far the apps apply behavioral consumer approaches and (2) at which stage within the consumer behavior change journey are the majority of efforts concentrated in. We will produce a set of dimensions guided by the TTM to serve as key elements in performing the assessments. Findings from this study will offer recommendations to smokers and healthcare practitioners in identifying reliable applications on smoking cessation. This study will also add to existing literature in assessing the reliability of mHealth apps and in particular, within the field of smoking cessation. When examining m-Health as a tool for tobacco control, the body of literature is notably limited. This gap is even more pronounced in the Indonesian context, despite

the country's vast potential for the m-Health industry and its large population of active smokers. Therefore, there is great room to produce further knowledge in this topic.

METHOD

Sampling techniques

The sampling technique in this study follows the PRISMA framework [table xx] which is proven to be the most exhaustive approach for reviews. We also conducted the search process through all available operating systems, IOS and Android to optimize result. From 1 -17 October 2024, we conducted a search in IOS's Apple Store and Android's Google Play using the keywords "smoke" and the Indonesian translation, "rokok". We also tried a third keyword, "quit" which altogether resulted in 295 apps in Google Play Store and 181 in Apple Store. We sorted the apps based on relevance and popularity for both IOS and Android.

From this result, we removed duplicates, excluded the apps that were not within our inclusion criteria. We eliminated game apps, apps that were not accessible in Indonesia, apps that do not feature language settings, and all the other apps that do not serve health support functions. We included apps that were free upon downloads as costs can often be a barrier to adoption for mHealth consumers (Xie & Or, 2023). We also eliminated cessation programs that are targeted for general addictions – including illicit drugs or alcohol, but included apps that are designed specifically to quit vaping. From this process we arrived at a total of 46 apps.

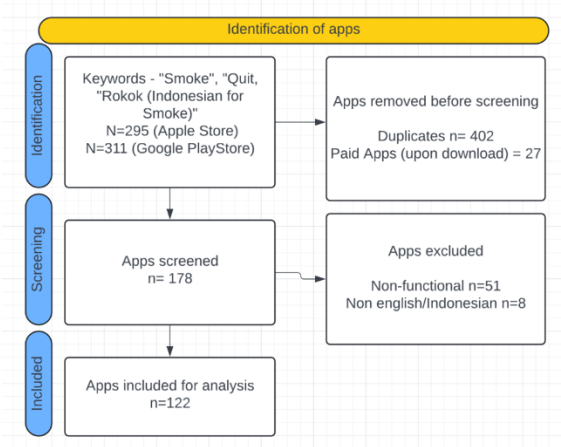

Figure 1. Process of identification and screening applications

Evaluation Framework

Our study aims to evaluate the quality of the apps using a consumer behavioral approach, TTM. We develop the evaluation framework by operationalizing TTM principles, to produce key measurable dimensions (table 1). As this model is fairly universal and has a high compatibility in explaining various health behavior, we will use the dimensions as one of the basis in formulating the evaluation framework.

The dimensions are grouped according to the different stages of the model (table 1). For instance, perceived benefits, barriers, risks or social norms are dimensions that

help explain smokers who are likely in the pre and contemplation stages as they still grapple with weighing the pros and cons of switching their behavior.

Using our understanding of the model and modification of the theory from current literature (Evers & Balestrieri, 2024; Imeri et al., 2022; Lee et al., 2022), we produced a set of relevant dimensions and mapped them along the stages of change. We will also assess the relevance of dimensions across the different stages of change. While each of the dimension can be applied across all stages, some are more relevant to support specific stage of the journey. For instance, apps that contain information on the benefits and risks would best target those who are still unsure, but people who have already started (action) and working to prevent relapse (maintenance), they would be aware about the dangers of smoking and require more intervention on building their abilities to cope against cravings or stress management.

Table 1. Mapping dimensions across the stages of TTM

	Pre-contemplation	Contemplation	Preparation	Action	Maintenance
Understanding Benefits *how quitting smoking can benefit user*	High relevance	High relevance	Relevant	Low relevance	Low relevance
Understanding Risks *Implications of smoking on health, social, personal outcomes*	High relevance	High relevance	Relevant	Low relevance	Low relevance
Self-Efficacy *Perceived ability to accomplish goals*	High relevance	High relevance	High relevance	High relevance	High relevance
Self-assessment and tracking *Assessing and tracking progress in the journey*	Relevant	Relevant	High relevance	High relevance	High relevance
Motivation *Encouragement that relates to user foreseen benefits*	Relevant	High relevance	High relevance	High relevance	High relevance
Professional advice *Availability of trained coach*	Low relevance	Low relevance	High relevance	High relevance	High relevance
Social Support *Interaction across users*	Relevant	Relevant	High relevance	High relevance	High relevance
Readiness *resources to get started*	Relevant	Relevant	High relevance	Low relevance	Low relevance
Target setting *Personalized, self-developed goals and timeline*	Low relevance	Low relevance	High relevance	High relevance	High relevance
Award and recognition *Appreciation for achieving goals*	Low relevance	Low relevance	High relevance	High relevance	High relevance
Emotional regulation *Stress management*	Low relevance	Relevant	High relevance	High relevance	High relevance
Capacity building *Relapse mitigation, craving management,*	Low relevance	Low relevance	High relevance	High relevance	High relevance

identifying challenging situations and triggers, actions to address setbacks					
Total	**3**	**5**	**7**	**9**	**9**

Understanding Benefits

At the very early stage (precontemplation and contemplation), people weigh the pros and cons of quitting. People may be looking through cessation programs to finalize their thoughts and collect motivation before making commitments. Information on future benefits may include better health, relationships, work performance, life goal achievements. Apps that include evidence-based information and are continuously updated will score higher.

Understanding Risks

Understanding of the risks is another key information before making decisions to quit. Many smokers underestimate their risks due to many factors, including optimism bias, or thinking that any of the dangers from smoking will not happen to them. Apps that can offer a complete information of all possible risks will score higher. Raising awareness about the risks of smoking often happens at the earlier stage of the journey as people are still deciding to commit. There are various ways to frame these risks. For instance, studies show that smokers are not only motivated to quit due to their own health, but also the health of their loved ones (Sharma et al., 2022).

Social Support

Social support refers to features that help connect users. Examples would be a forum and live chat or any other mechanisms that allow users to interact. Social support is one of the key ingredients in ensuring successful cessation programs, particularly in preventing relapses (Arabshahi et al., 2023). We therefore mapped social support in the preparation stage and beyond within the journey.

Capacity Building

Cessation services are also provided to help people build the right set of skills understanding their triggers, developing effective coping strategies, managing stress and tracking progress. These services may offer information, and through interactive activities such as games, filling in diaries, etc. For instance, apps may get users to reflect on any potential triggers when faced with setbacks, or inform about ways to cope with cravings. Interventions to support skills development are most relevant to prevent people from relapsing. Information on potential barriers in apps may ask users to reflect on their peers, stressors, interact with challenging environment, any history of failed quitting attempts and are currently using other substances (Olando et al., 2020).

Emotional Regulation

Addiction can be emotionally difficult. Apps should offer support for people to better regulate their emotions. Some of the services might be in the form of a mood tracker, a daily journal, and information. Apps that offer support for people to manage stress is also key to prevent relapses.

Target Setting

Target setting is an important component of a smoking cessation. Like any anti-addiction interventions, goal-setting encourages patients to aim towards achieving several short-term goals to prevent relapse and gradually move towards long-term success. In smoking cessation, target setting provides structure, motivation, and a clear sense of progress. Target setting is particularly important to support people within the preparation stage and beyond.

Readiness

Readiness in smoking cessation intervention refers to all resources to get started. Readiness involves assessing both the mental and physical preparedness of the individual to undertake smoking cessation. This can involve evaluating personal motivation, understanding the individual's reasons for quitting, and identifying potential challenges they may face during the process. Apps should accommodate assessment of readiness through screening tools. Mechanisms to accelerate people's readiness can be done through providing motivational messages, guidance and information.

Self-Efficacy

Self-efficacy is the degree to which a person believes in their ability to perform the action. Smoking cessation interventions should aim to improve confidence and self-trust (efficacy). This may include efforts to foster ownership of their own progress (self-monitoring, self-reporting and using information to make own decisions) and stay committed in challenging situations. Self-efficacy is required across all stages of a smoking cessation journey.

Self assessment and tracking

Self-assessment and tracking refers to the ability of users to assess and update information related to their journey progress. Apps often require users to fill in important information on key baseline personal and health information or their current smoking habits (ie quantity, triggers), carbon-monoxide levels, and financial spending. This information allow the apps form tailored plans for users. Apps send notifications to remind users to input new information at daily basis to facilitate better tracking system.

Awards and Recognition

Smokers who successfully quit or achieve their pre-determined goals in their cessation journey should be given recognition. These may look like digital badges, certificates, words of appreciation and many more. These awards may serve as additional

Motivation

Motivation can be in the form of encouraging words and illustration of future benefits. Motivation is a key component across all stages of change in a smoking cessation, but is particularly the case during contemplation and maintenance.

Professional advice

Professional advice in smoking cessation refers to guidance provided by healthcare professionals (such as doctors, nurses, pharmacists, or smoking cessation

counsellors) to help individuals quit smoking. This advice typically includes a combination of information, motivation, and structured strategies to increase the likelihood of successfully quitting. Apps may involve professional coaches or healthcare practitioners as partners through live chats.

Scoring and Reliability testing

This study uses a categorical scoring system ranging from 0 to 1, where a score of 0 indicates the absence of a dimension, and a score of 1 indicates its presence. To enhance our understanding of how these dimensions relate to the various stages of change in the Transtheoretical Model (TTM), we employed a crosstab format of 12 dimensions by 5 TTM stages. This approach allows us to present the frequency of each dimension across the different TTM stages. To ensure reliability, two coders—a social marketing academic and a high performing student—were involved, with a briefing session to align their understanding of the dimensions. Intercoder agreement was measured using Cohen alpha. A score close to +1 indicates a perfect reliability.

Limitation of Study

Findings of this study relies on expert's knowledge and skills to test the presence and frequency of dimensions and how they fit into the TTM key stages of change.
One of the limitations to this study design is that we do not consider consumer's rating. While this information is equally important, this topic is not the primary focus of our research. By concentrating on expert assessments, we aimed to ensure a high level of accuracy and reliability in determining the presence and frequency of dimensions within the TTM stages. However, future studies could benefit from incorporating consumer ratings to provide a more comprehensive perspective on how these dimensions are perceived in real-world contexts. This could lead to a deeper understanding of the factors influencing behavior change and enrich the overall findings of TTM-related research.

RESULT AND DISCUSSION

Data Analysis

Cohen's Kappa is a measurement for inter-rater reliability across coders and like most coefficients, has a range between 0-1. The result of the Cohen's Kappa in this study indicates varying levels with scores ranging from a fair level of 0,445 0 to a perfect score of 1, as illustrated in table xx.

Some dimensions are much more straightforward to code such as the presence of a trained healthcare interaction (professional advice) or features of community forum which is indicative of a social support feature are easier to spot than the more latent content such as motivation or self-efficacy. The lowest score which is 0,4 is still within the fair range.

Table 2. Inter-rater score (out of 1)

	Pre-contemplation	Contemplation	Preparation	Action	Maintenance
Understanding Benefits	0,918	0,89	0,931	1	0,974
Understanding Risks	0,951	0,972	0,965	1	0,877
Self-Efficacy	0,777	0,601	0,787	0,5	0,763
Self-assessment and tracking	0,922	0,963	0,766	0,987	1
Motivation	0,47	0652	0,555	0,677	0,819
Professional advice	1	1	0,912	1	1
Social Support	0,937	1	0,975	1	1
Readiness	0,445	0,777	0,51	0,655	0,543
Target setting	0,951	0,934	0,67	1	1
Award and recognition	0,937	0,8	0,911	1	1
Emotional regulation	0,765	0,661	0,7	0,68	0,919
Capacity building	0,688	0,786	0,519	0,712	0,923
Total	**3**	**5**	**7**	**9**	**9**

From 122 number of online applications, 63 have features that are in-paid. Some of the apps offer packages for a tailored program that are marketed for higher efficacy, ranging from IDR 300,000 (USD 20) up to IDR 2,000,000 (USD 130). Some of the in-app purchase is also applied to access certain features, such as community forums (social support), or interacting with a health coach (professional advice).

Out of a total of 122 apps, very few are verified. For instance, Kwit that has received verification from the World Health Organization (WHO) and quitSTART from the Center for Disease Control (CDC). This highlights that very few apps have undergone a rigorous verification process. This aligns with the findings from prior work about the very little method for quality standardization (Llorens-Vernet & Miró, 2020).

Table 3. Findings

		Total (out of 122 apps)
Operating system	**Android only**	**26 (21.3%)**
	IoS only	**45 (36,9%)**
	Available in both	**51 (41,8%)**
In-App purchase	**In-App purchase**	**63 (51.6%)**
	No in-app purchase	**59 (48.4%)**
Verified Status	**Verified**	**2 (2%)**
	Not verified	**120 (98%)**
Language	**English**	**117 (96%)**
	Language switch to Bahasa	**5 (4%)**

English language is often the default language of the apps included in this study. Only five of the apps in the study has a language switch with Bahasa as one of the options. This result may indicate that there may be a potential language barrier for Indonesian users. While it may be strategic to have this affect scoring, we decided to not factor in this aspect to isolate only the factors related to behavioural insights which is the main objective of this study.

Tabel 4. Findings: scores of apps

Scores (out of 60)	Total number of apps (from 122 apps)
0-20 ; Lack of features	**54**
21-40 ; Comprehensive	**61**
41-60 ; Highly comprehensive	**7**
Mean	**22,5**
Standard Deviation	**9,7**
Minimum score	**7**
Maximum score	**55**

We first conducted the scoring per application. Per application, a perfect score would be 60 which derives from the presence of all dimensions within each five stages across TTM. From a total of 122 apps, 54 apps showed lower score, 60 scored in the mid range and only very few of 7 apps scored highest.

As we map the results of dimensions per stage of change of TTM, we found that apps on smoking cessation in this study are much more accommodating for people within the maintenance and action stage.

Table 5. Findings: scores of apps x stages of change

	Pre-contemplation	Contemplation	Preparation	Action	Maintenance	Total
Understanding Benefits	46	57	7	7	0	117
Understanding Risks	58	71	9	4	0	142
Self-Efficacy	13	21	119	118	117	388
Self-assessment and tracking	3	9	122	122	122	378
Motivation	4	19	100	109	113	345
Professional advice	0	5	27	34	34	100
Social Support	3	9	15	42	42	111
Readiness	23	29	39	45	4	140
Target setting	0	4	121	121	121	367
Award and recognition	0	9	11	121	121	262
Emotional regulation	0	0	32	59	63	154

Capacity building	0	0	32	98	111	241
	150 (5%)	233 (8%)	634 (23%)	880 (32%)	848 (39%)	2745

From a total score of 2,745 across various dimensions, we found that 32 percent of apps include features supporting interventions in the action stage, while another 39 percent focus on the maintenance category. Together, these two stages account for more than half of the total score when evaluated by dimension. The preparation stage follows, representing 23 percent of the overall findings. Notably, there is a significant gap between preparation and the earlier stages, with contemplation at 8 percent and precontemplation at just 5 percent.

In the maintenance stage, we observed the presence of several dimensions, with one notable exception: information on benefits and risks. The most prominent features include self-assessment tools that prompt users to evaluate their current habits (122 instances), target-setting options that allow individuals to establish personalized goals (121 instances), and awards and recognition systems that celebrate achievements (121 instances).

Under the action stage, all dimensions were present, with a strong emphasis on self-assessment (122), target-setting (121), and awards and recognition (121). A similar trend emerged in the preparation stage, suggesting that these elements of self-assessment, goal-setting, and recognition are common themes across the more advanced stages of preparation, action, and maintenance.

In the precontemplation category, the focus was primarily on information-based approaches, highlighting the importance of understanding risks (49 instances) and benefits (57 instances). This pattern continued in the contemplation stage, where the respective numbers were 58 and 71.

DISCUSSION

The findings of this study indicate that most smoking cessation apps do not adequately support individuals across the various stages of their journey. Smoking cessation services should be designed to address the diverse needs of users at different stages. Previous studies have highlighted that many services aimed at helping individuals quit smoking primarily focus on those who are already aware of their need for change, often targeting individuals in the later stages of the Transtheoretical Model (TTM). This may exclude people who are still deciding whether or not to commit or those in the precontemplation and contemplation stage. They are potential users of the apps, as they might seek recommendations and resources during their decision-making process.

We identified several dimensions that were present across all stages and are most frequently found, which includes self-efficacy, self-assessment and awards/recognition and tracking. The more high quality apps offer highly interactive features to enhance these components. Apps will ask users to fill in important information upon the first sign-up, such as the number of cigarettes per day, money spent on cigarettes, motivation

to quit, and the goals. This also reflects a component of trusting users in contributing to develop their own plan, which shows that the apps enhance user's self-efficacy. Self-efficacy is a highly important ingredient in achieving a successful smoking cessation services. Higher self-efficacy often correlates with greater persistence in the face of challenges and setbacks.

Understanding benefits and risks are informational interventions, which may be more relevant for people planning to quit or within the earlier stage of the model. Findings in this study were indicative of this, where messages reflecting these two dimensions are mostly targeted for people who are still yet convinced to quit, such as health benefits for user and loved ones, financial benefits, environmental benefits. Information on risks may include.

Self-assessment and tracking play a vital role in the cessation process by encouraging individuals to monitor their progress, identify triggers, and understand patterns in their smoking behavior. The apps would ask users to complete daily journals and offer reflection questions about their progress in achieving key goals. All apps also come with features to nudge users when they fall short of completing their daily journals. Emotional regulation refers to features that help people reflect on their mood and emotional wellbeing. These can include a mood diary and tracker, and information on techniques to overcome stress.

Motivation is the driving force that propels individuals through each stage of the quitting journey. We found the use of encouraging words as possible mechanism to increase user's motivation. Examples of these statements may include "you have the power", "Take the first step towards a healthier you!", "Every journey begins with a single step—start yours today!", "Break free from smoking—your future self will thank you!, "Join the millions who have taken back their lives!" among others. Some of the encouraging statements centre on the benefits of user's action on their loved ones, the environment and other external parties.

Another impactful component is capacity building, which focuses on helping smokers manage cravings, prevent relapse, and navigate setbacks. This is achieved through regular notifications that serve as check-ins, along with resources that empower individuals to identify triggers and develop effective techniques for combating cravings. Additionally, it provides actionable steps to take when faced with setbacks, reinforcing a proactive approach to the quitting process.

CONCLUSION

Our study highlights the pressing need for a systematic evaluation of smoking cessation apps in Indonesia, particularly given the country's high smoking prevalence. While the rise of digital health presents promising avenues for supporting individuals in their journey to quit smoking, the overwhelming number of available applications can hinder users from making informed choices. Our analysis of 122 apps through the lens of the transtheoretical model reveals that many of these tools, although incorporating some aspects of consumer behavior, fall short in addressing the diverse

needs of users at different stages of their behavioral change journey. By acknowledging these distinct stages and providing appropriate interventions, smoking cessation services can be more effective in supporting individuals throughout their quitting journey, ultimately leading to higher success rates in achieving long-term abstinence.

The findings underscore a critical gap in the resources offered by these apps, particularly for those in the contemplation phase of quitting smoking. While several applications effectively support users who are ready to quit or those who are maintaining their commitment, they often overlook the vital pre-contemplation and contemplation stages. This oversight suggests a missed opportunity to engage and motivate potential quitters who may need more tailored support and resources to consider making a change in their smoking behavior.

Moreover, our evaluation reveals that many apps lack essential features that could enhance user experience and efficacy, such as user forums for social support and direct interactions with healthcare professionals. These elements are crucial in fostering a sense of community and providing users with the encouragement and guidance needed to navigate the challenging process of quitting smoking. The absence of such features may limit the potential impact of these apps and prevent them from fully realizing their role in tobacco control efforts.

Ultimately, the integration of behavioral science principles into the design and evaluation of smoking cessation apps is essential for maximizing their effectiveness. By aligning app features with the various stages of the behavior change process, developers can create more comprehensive support systems that address the needs of all users. Strengthening these digital health resources can play a significant role in enhancing smoking cessation efforts in Indonesia, contributing to better public health outcomes and reducing the overall burden of tobacco use.

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