







# Exploration of Design Intervention in Eliminating Bias: A Persuasive System Design Approach of Introducing Intermediate Scenarios

Xingyu Tu<sup>(✉)</sup> , Hao Chen , Jiatao Wang , and Xiangyang Xin 

Shanghai International College of Design and Innovation, Tongji University, Shanghai, China  
2333779@tongji.edu.cn

**Abstract.** While the undeniable health risks of tobacco warrant attention, the substantial existing smoker base and potential challenges associated with mandatory cessation suggest that mitigating its impact is best approached through gradual reductions and awareness campaigns. In the Chinese context, e-cigarettes, as a harm-reduction alternative to traditional smoking, have stirred controversy. This study aims to uncover the reasons behind negative public perceptions of e-cigarettes in China and identify effective strategies for promoting local tobacco harm reduction by facilitating smoker transition. We employed qualitative and quantitative methods to collect and analyze public opinions on e-cigarettes and their users.

The study identified two primary reasons contributing to the negative public perception of e-cigarettes: online information with subjective guidance and the unfavorable impression of the e-cigarette subculture. Utilizing the Behavior Change Techniques (BCTs) and the Persuasive Systems Design (PSDs) framework, we identified design features aimed at shifting the social perception of e-cigarettes from being seen as ‘another kind of cigarette’ to serving as a medium for promoting healthy behaviors. Subsequently, a product solution was devised based on these findings.

**Keywords:** e-cigarettes · PSD · BCT · intermediate scenarios

## 1 Introduction

E-cigarettes, at equivalent nicotine levels, generate fewer cardiovascular and cancer-related toxins compared to traditional combustible tobacco [1]. Furthermore, their nicotine content can be adjusted through oil modulation.

Although theoretically posing considerably less harm than traditional tobacco, e-cigarettes have only achieved a 4.2% penetration rate among the smoking population in China as of 2021. Besides restrictive sales policies, the assertive design and suggestive promotional strategies employed by related companies frequently lead to public discontent. Research also suggests a concern that the entry of tobacco companies into the e-cigarette market may exploit mental illness for increased sales [2].

Our survey results among the general public indicate that 69.8% of randomly selected respondents neither use nor recommend e-cigarettes to other smokers, primarily due to their skepticism regarding the harm reduction potential of e-cigarettes. This substantial disparity between subjective bias and actual demand underscores an urgent challenge in advancing the overall population's health.

## 2 Related Works

The Persuasive Systems Design Model (PSDM) has garnered increasing recognition in both design and business domains, playing a pivotal role in shaping behavioral patterns and lifestyles within numerous public health initiatives.

In theoretical realms, B.J. Fogg introduced the Fogg Behavior Model, which outlines three key elements of human behavior: motivation, ability, and triggers [3]. Cialdini synthesized extensive research into six principles of influence: reciprocity, commitment and consistency, social proof (consensus), liking, authority, and scarcity [4], Kirsi et al. contend that these six elements are not mutually exclusive but rather context-sensitive [5], aligning with the findings of this study. Oinas-Kukkonen consolidated research findings and proposed the Generic Steps in Persuasive System Development along with corresponding principles of persuasion, offering a workflow framework for persuasive system design [6]. Michie reorganized the methodology of behavior change techniques (BCTs) [7], furnishing a toolkit for the subsequent application of behavior change techniques.

In the specific application domain, Rikke et al. highlighted users' value claims as the primary driver of their behavior and needs. Through interviews, they identified the needs and value claims of end users, which served as the foundation for designing the eCHANGE APP. This design process integrated Persuasive System Design Principles and Behavior Change Techniques (BCTs) [8, 9], showcasing a successful case of promoting a healthy lifestyle through thoughtful design.

While persuasive design inherently relies on meeting user value needs, addressing controversial products such as e-cigarettes requires caution. Simply reinforcing the connection between e-cigarettes and health values often results in negative impacts on the Social Acceptance/Rejection element of behavioral motivation [3]. Therefore, meticulous decisions regarding design elements are essential.

## 3 Methods and Process

### 3.1 Causes of Prejudice

This study employed a qualitative approach by combining online questionnaires and offline interviews to discern the primary causes of prejudice. Initially, we randomly selected 210 participants as Public Group, of which 68 had prior smoking experience, offering a sample reflective of the average public awareness level of e-cigarette products. Subsequently, we recruited 33 traditional cigarette users with previous e-cigarette experience, along with 3 core users who regularly use e-cigarettes, to be our User Group. These participants were all from China.

We initiated the data collection process by distributing a questionnaire to the Public Group. This questionnaire asks participants to share their perceptions regarding the harm reduction potential of e-cigarettes and the reason. Subsequently, we collated and categorized the reasons contributing to negative evaluations, yielding a total of 184 valid questionnaires. The detailed breakdown of reasons for negative evaluations is presented in Table 1.

**Table 1.** Public group results for Reasons of negative comments: keywords, example post and value.

Reason Label	Keywords	Example Post	Value
User Impression	Smoky, Hooligans, Look, Atmosphere, Face, Tattoo	People who smoke e-cigarettes look like hooligans	43
Actual Experience	Helpless, Addictive, Physical examination, Dizziness, cough, not used to, feeling	I can't get used to it, and sometimes it can cause dizziness	3
Media News	Media, Internet, News, TV, report, paper, magazines	I often hear negative reports	107
Subjective Guess	Guess, Suppose, Never heard of, Unfamiliar	I don't know much about it, but hearing the name is unhealthy	6
Heard from acquaintance	Friend, Relatives, Neighbors, Colleagues	I heard from my colleagues that it has no effect on smoking cessation	21

We then distilled the reasons into a new set of questions and presented them to the User Group, instructing them to rate their level of agreement on a five-point scale (-2 = strongly disagree to 2 = strongly agree).

Interviews conducted by three designers with 36 members from User Group, the average scores for each reason were determined as follows: User Impression = 1.28, Actual Experience = -1.42, Media News = 1.72, Subjective Guess = 1.86, and Heard from acquaintance = 0.67. It was observed that the User Group strongly concurred with the categorization of Media News, User Impression, and Subjective Guess as significant factors contributing to negative ratings.

Combining feedback from both the Public and the User Group, along with additional desktop research, we propose two potential causes of bias:

1. Negative Impression from the E-cigarette Subculture:
2. Subjective information on the Internet.

Young promoters introducing new trends make the e-cigarette subculture appear immature to the public in China. Additionally, one-sided reports on the Internet have increased people's distrust.

### 3.2 Identification of Intermediate Scenario

After analyzing the system, we believe that we need to find a more motivating sub-theme under the parent theme of health as an intermediate scenario that can improve the negative social image of e-cigarettes and their users and thus reduce public prejudice.

First, we needed to identify the values and needs of individuals interested in vaping. After interviewing 36 User Group, we obtained three major value claims: “health”, “differentiation”, (result also included the claims of “relaxation” and “inspiring”, but they are not typical from traditional cigarettes, so they are not regarded as the value claims of e-cigarettes users). With the sale of multiple flavors of e-cigarettes being restricted, our focus will be on developing persuasive strategies for the values of ‘different’ and ‘healthy,’ as illustrated in Fig. 1.



**Fig. 1.** Values and Needs of People using e-cigarettes instead of traditional cigarettes.

To address the identified needs and values, designers conducted brainstorming sessions and evaluated potential behaviors in four scenarios: technological aesthetics, sports and fitness, fashion trends, and daily wellness. We screened 10 e-cigarette users and 6 designers from User Group and scored them based on their degree of agreement with the four criteria (ranging from 1 to 5). The scenario with the highest average score was then selected as the intermediate scenario, as detailed in Table 2.

The result showed Sports fitness had the highest score. We further subdivided Sports and continued the scoring process with the same criteria, the 16 participants in this phase indicated that daily fitness should be introduced into the system as the mediating element.

To ensure that the scenario derived from this methodology do meet the participation needs of both cigarette and e-cigarette users, the results were validated by questionnaire. we distributed questionnaires to participants with smoking experience among Public Group and all User Group (104 in total), and the results showed that 72.1% of users maintained a frequency of exercise more than 2 times per week, while 81.7% of users expressed their recognition of promoting smoking cessation through exercise, which supported the results in terms of both the user base and user recognition.

**Table 2.** Results of criteria-based scoring of four scenarios: modes, means and SDs.

Intermediate Scenarios	Criteria Means (SDs)	Final Value
Technology esthetics	C <sub>1</sub> = 3.19 (0.66) C <sub>2</sub> = 3.56 (0.89) C <sub>3</sub> = 1.44 (0.63) C <sub>4</sub> = 4.06 (0.57)	3.06
Sports and Fitness	C <sub>1</sub> = 4.75 (0.45) C <sub>2</sub> = 4.00 (0.73) C <sub>3</sub> = 4.50 (0.63) C <sub>4</sub> = 4.81 (0.40)	4.52
Fashion	C <sub>1</sub> = 3.25 (1.61) C <sub>2</sub> = 3.31 (1.66) C <sub>3</sub> = 1.75 (0.86) C <sub>4</sub> = 1.63 (0.89)	2.48
Diet	C <sub>1</sub> = 3.06 (1.29) C <sub>2</sub> = 3.56 (1.21) C <sub>3</sub> = 3.88 (1.26) C <sub>4</sub> = 4.69 (0.48)	3.80

C<sub>1</sub>: Audience Size

C<sub>2</sub>: Topicality

C<sub>3</sub>: Difficulty

C<sub>4</sub>: Persistence

### 3.3 Identification of User Requirements and Design Features

In the process of identifying the intermediate scenario, we gathered user values and needs. These were then linked to the Persuasive Systems Design (PSD) and Behavior Change Techniques (BCT) methodologies. Subsequently, focus group interviews were conducted to translate specific user needs into design elements, as outlined in detail in Table 3.

**Table 3.** User group results with design elements to support smokers change to use e-cigarettes.

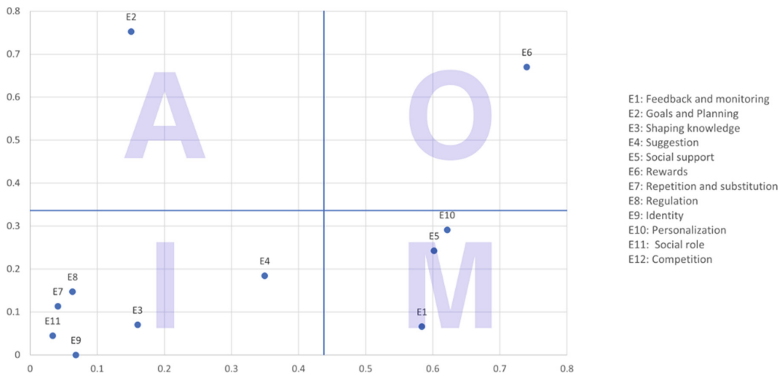
User Values	User Needs	Design element (PSDs and/or BCT)
Health	I. Improve long-term health	1. Feedback and monitoring (BCTs) 2. Goals and Planning (BCTs) 3. Shaping knowledge (BCTs) 4. Suggestion (PSDs)
	II. Reduce impact on others	1. Social support (BCTs) 2. Rewards (PSDs)

(continued)

**Table 3.** (continued)

User Values	User Needs	Design element (PSDs and/or BCT)
	III. Help to quit smoking	1. Repetition and substitution (BCTs) 2. Regulation (BCTs) 3. Suggestion (PSDs)
Distinctive	I. Look cool II. Feel different III. Be a minority IV. Be stylish	1. Identity (BCTs) 2. Personalization (PSDs) 3. Social role (PSDs) 4. Competition (PSDs)

A KANO questionnaire, designed to determine which elements should be included in the design, was assessed by members of the Public Group who smoke and by the entire User Group (104 in total). The results are as follows: Feedback and Monitoring (Must have), Social Support (Must have), Personalization (Must have), Goals and Planning (Nice to have), Rewards (Nice to have), and Rewards (Must have). The detailed results can be found in Fig. 2.

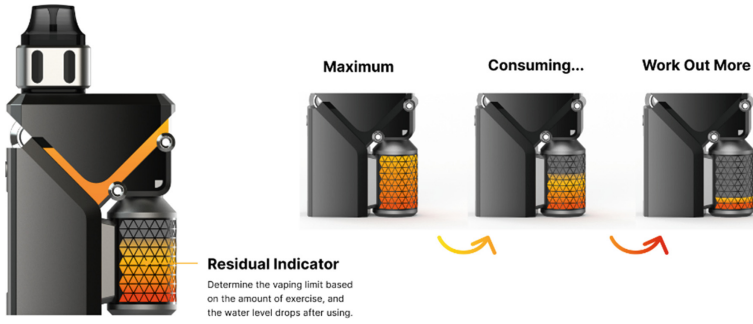


**Fig. 2.** Distribution of design elements based on Kano model.

## 4 Result

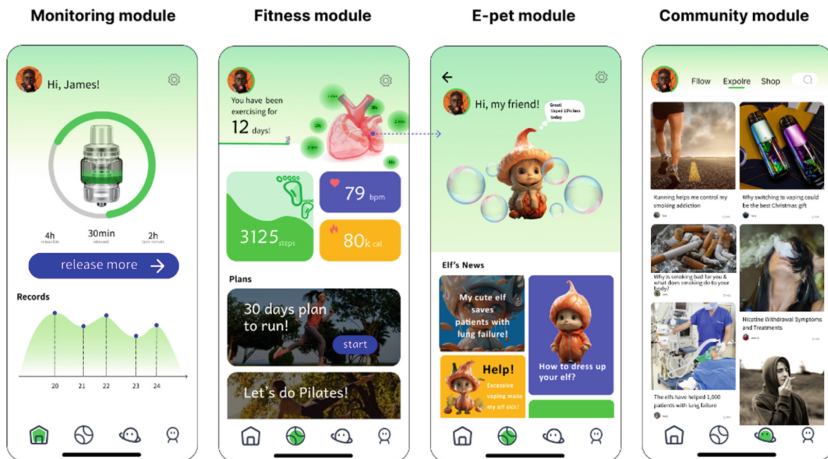
The sQuit design solution integrates the five design elements mentioned above, drawing inspiration from sports cars, sports equipment, and other products to shape its styling. This ensures that the product aligns with the conversational needs of users in sports and fitness scenarios.

For the Feedback and Monitoring element, we devised an e-cigarette usage mode that links the allowed usage to the day’s exercise. The current remaining amount of usage is then communicated through a light indicator (refer to Fig. 3 for details). This design encourages users to engage in fitness as a substitute for smoking behavior.



**Fig. 3.** Light indicator to give feedback on the current remaining capacity.

For the elements of Social Support, Goals and Planning, and Rewards, we integrated them into the product’s APP (refer to Fig. 4 for details). The Community module allows users to share their fitness and smoking cessation experiences. The Monitoring Module displays e-cigarette usage, enabling users to set or adjust the capacity. In the Fitness module, users can create fitness plans, and the app provides customized planning suggestions with schedule reminders. The e-pet module gamifies the Rewards element, featuring a customizable pet image and various boosts based on the user’s exercise and smoking reduction progress.



**Fig. 4.** The interface of each functional module of sQuit’s mobile APP.

The elements of Personalization, which are reflected in the customization of personal plans and e-pets, the product’s V-shaped light is designed to generate light effects with varying colors and intensities based on the user’s recent exercise and the type of fitness program. Some examples of which are shown in Fig. 5.

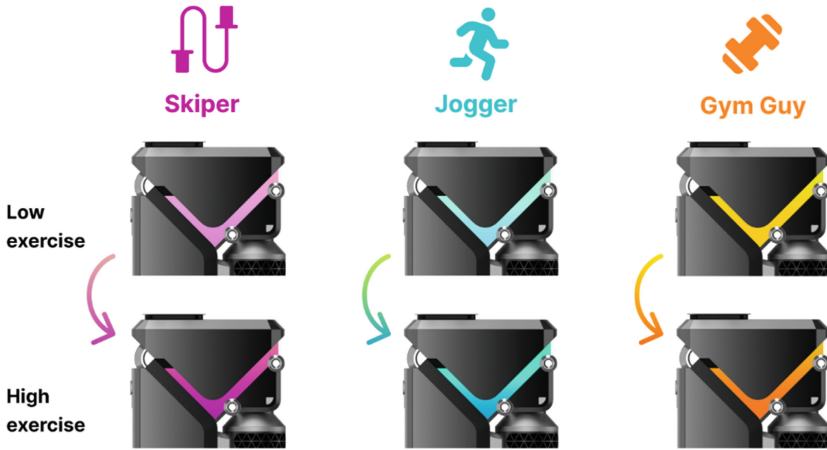


Fig. 5. Produces different lighting effects depending on the fitness of the user.

## 5 Discussion

This study introduces fitness as an intermediate scenario based on the persuasive design workflow and uses e-cigarettes to promote fitness behavior. We believe that encouraging long-term fitness among e-cigarette users can improve their public image and help reduce negative perceptions. Additionally, exercise can aid e-cigarette smokers in quitting, CLD diagram is shown in Fig. 6. It’s crucial to highlight that our focus in selecting intermediate scenario is to promote a healthy lifestyle and sustain motivation. We excluded options with health hazards and prioritized sustainability during the screening process.

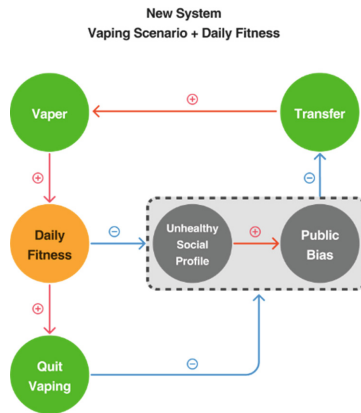


Fig. 6. Analysis of CLD, a new system for introducing fitness as intermediate scenario.

In addition, KANO’s findings show that feedback and monitoring, social support, and personalization are essential for users, which may be due to the difficulty of obtaining



guidance on smoking cessation in China, or the reluctance of users to seek help due to attitudinal reasons. E-cigarettes, as an emerging product, are more appealing to young people, so the importance of personalization has been increased accordingly.

Considering the widespread and long-term nature of social perception formation, more in-depth and sustained validation is needed to ascertain whether the system is resilient to external risks to demonstrate that the methodological model can have a sustainable impact on public prejudice.

## 6 Conclusion

In this study, we delved into the obstacles hindering smoker conversion in the Chinese region, particularly in the design and development of controversial products like e-cigarettes. Employing persuasive design and system design methods, we proposed a workflow introducing intermediate scenario to establish a novel smoker conversion system, linking two behaviors: e-cigarette use and daily fitness.

During the design phase, PSD principles and BCT methodology were applied to derive elements transforming e-cigarettes into a medium that stimulates fitness behaviors. The resulting design solution activates the fitness behavior of e-cigarette users through customized lights, electronic pets, and community support. The enhanced user image resulting from fitness engagement aims to diminish public prejudice and counter one-sided reports, thereby overcoming barriers to smoker conversion. Concurrently, it aids light users in achieving smoking cessation.

The introduction of intermediate scenarios offers a fresh perspective on how persuasive design methods can be more effective in contexts marked by subjective bias, improving the existing workflow.

## References

1. Jackson, S., Bullen, C.: UK report underscores potential of e-cigarettes to reduce smoking harms. *The Lancet* **400**(10365), 1747–1750 (2022)
2. Ebrahimi Kalan, M., Brewer, N.T.: Longitudinal transitions in e-cigarette and cigarette use among US adults: prospective cohort study. *Lancet Reg. Health - Am.* **22**, 100508 (2023)
3. Fogg, B.: A behavior model for persuasive design. In: *Proceedings of the 4th International Conference on Persuasive Technology*, pp. 1–7. ACM, Claremont (2009)
4. Brown, S.L., Asher, T., Cialdini, R.B.: Evidence of a positive relationship between age and preference for consistency. *J. Res. Personal.* **39**(5), 517–533 (2005)
5. Halttu, K., Oinas-Kukkonen, H.: Susceptibility to social influence strategies and persuasive system design: exploring the relationship. *Behav. Inf. Technol.* **41**(12), 2705–2726 (2022)
6. Oinas-Kukkonen, H., Harjumaa, M.: Persuasive systems design: key issues, process model, and system features. *Commun. Assoc. Inf. Syst.* **24** (2009)
7. Michie, S., et al.: The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: building an international consensus for the reporting of behavior change interventions. *Ann. Behav. Med.* **46**(1), 81–95 (2013)

8. Asbjørnsen, R.A., et al.: Combining persuasive system design principles and behavior change techniques in digital interventions supporting long-term weight loss maintenance: design and development of eCHANGE. *JMIR Hum. Factors* **9**(2), e37372 (2022)
9. Asbjørnsen, R.A., et al.: Identifying persuasive design principles and behavior change techniques supporting end user values and needs in eHealth interventions for long-term weight loss maintenance: qualitative study. *J. Med. Internet Res.* **22**(11), e22598 (2020)