A Review of Persuasive Technology and Design to Healthy Lifestyle

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ABSTRACT

Maintaining a healthy lifestyle plays a vital role in personal health and social development. However, many individuals encounter challenges in adhering to healthy behaviours, often struggling to sustain a healthy way of life. A significant portion of the available products related to healthy lifestyles on the market are designed with the intent of persuasion. They utilise various strategies of persuasion to influence behaviours, ultimately aiming to bring about behaviour change. To provide designers and researchers with more effective design solutions in future product design, this study conducted a study on the application of persuasion technology and persuasion strategies in healthy life and the Fogg Behavioural Model (FBM) by using ATLASti and PRISMA software. The analytical approach of a systematic literature review (SLR) provides a systematic analysis and objective assessment of the persuasive principles and strategies used in the persuasive design of products. The study underscored the significance of persuasive technology and design healthy lifestyle interventions. In this regard, the study highlighted the benefits of persuasive design across four dimensions: orientation, friendliness, interaction, and ethics. These insights collectively show the effectiveness of persuasive design approaches within the framework of promoting healthier lifestyles.

INTRODUCTION

The term "persuasive technology", which is coined at the intersection of psychology and computer science, denotes persuasive techniques or techniques for changing attitudes or behaviours through persuasion and social influence, rather than coercive means (Fogg, 2002). Fogg (2002) defined persuasive technology as interactive computing products used to form, change, or enhance individual attitudes and behaviours. Fogg (2002) later proposed and defined the term "computers as persuasive technology" or "Captology" (Figure 1) with emphasis on the influence of computers as a persuasive medium on one's attitudes and behaviours. Current persuasive technique studies primarily revolve around the domains of computer technology, internet products and services, wearable devices and applications, video games, virtual reality (Orji, 2016), and related products to study a combination of multiple subjects, such as psychology, computer science, and interaction design.

The emergence of persuasive technology in the early 1980s led to the mitigation of adolescent health issues, such as smoking, drinking and exercise. This technology has been widely used in various fields, such as e-commerce, social networking, and online games with the advent of the Internet (Nurul Ulfa et al., 2017). As persuasion aims to alter individual behaviour, a significant number of relevant cases can be examined in public affairs management and self-management, such as improving public awareness of energy conservation and environmental protection, the self-health management of chronic diseases, and optimal work efficiency.
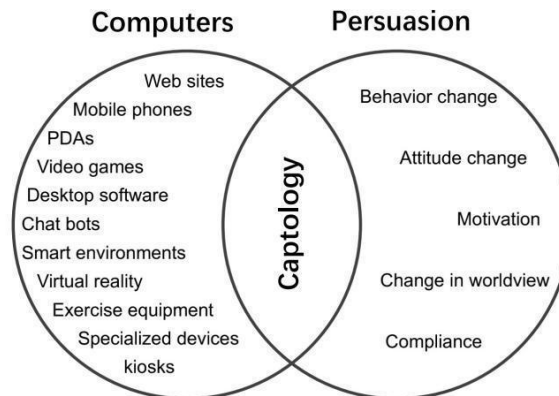

Figure 1. Captology Definition
(Source：Fogg & Hreha, 2010)

Persuasive design, which implies using persuasive technology to alter user attitudes or behaviour in design, employs current psychological theories and research methods to analyse users' intentions with suitable guidelines and change their attitudes and behaviours (Hamari, 2014). According to Buchanan (2008), a professor at the Business School of Case Western Reserve University, characterises products as arguments about how one should lead one's life, in this vein, persuasive design extensively discusses how designers can facilitate people to develop and maintain a healthy lifestyle with optimal persuasive techniques and products or services.

The persuasive means in persuasive design considers user emotions and acceptance more than mandatory design means (Thomson et al., 2016). The ideal output of the persuasive design should be the "desirable" level of "useful, usable, desirable". In his book entitled "Design and the new rhetoric", Buchanan (2008) mentioned that a product that successfully leads us to a certain lifestyle reflects that the product designer has struck a good balance between usefulness, usability, and desirability. It focuses on the situation in which the behaviour occurs, specifically the motivation and ability required for its occurrence.

Healthy lifestyle stemmed from the development of lifestyle, a term coined by a famous German sociologist, political scientist, and philosopher called Max Weber. This term was initially proposed by psychologist Adler in 1927. Lifestyle is the external form manifested by individual cognition in a certain society, culture, and space. Most health-oriented studies consider lifestyle as a personal or collective behaviour. Arden denotes lifestyle as "an individual as a member of society, a fundamental characteristic of all daily life formed by behaviours, choices and experiences, including those that affect the individual health behaviours". Similarly, Wiley asserted that "lifestyle is any behaviour that has an impact on health" (Meng Jiao, 2015). In this vein, a healthy lifestyle includes a range of behaviours with health implications (Disque & Bitter, 2011).

The World Health Organization (2004) defined health in its charter as "a state of physical, mental and social well-being, not merely the absence of disease or infirmity" in 1946. Thus, health involves assessing the human body and holistically evaluating mental psychology, social relations, moral ethics, and other aspects.

In defining "healthy" and "lifestyle", a healthy lifestyle characterises an individual under good social, cultural, physical, and mental conditions. The healthy lifestyle concept in this study involves people who choose and engage in complex multi-dimensional behaviour patterns, including the organic unity of physical, mental, and social health (Figure 2), specifically embodied in spiritual growth, health responsibility, nutrition, physical activity, interpersonal relations, and stress management. Concurrently, a healthy lifestyle constitutes sustainability and stability to a certain extent for effective disease prevention and the sustenance or improvement of individual health levels (Mozaffarian et al., 2018).
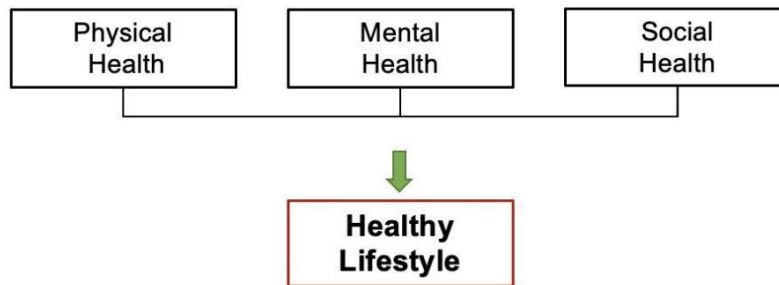

Figure 2. The content of Healthy Lifestyle
(Source: World Health Organization, 2004)

LITERATURE REVIEW

Fogg Behaviour Model

In addition to pertinent strategies, Fogg Behaviour Model (FBM) is widely used in persuasive design (Agha et al., 2019). Perceivably, a behaviour contains three factors (motivation, ability, and trigger). An individual must demonstrate sufficient motivation, the ability to perform the behaviour, and the influencing factors to implement a specific behaviour. In expressing this model as an equation, B=MAT, B denotes behaviour, M implies motivation, A reflects ability, and T demonstrates triggers (the factors promoting the behaviours). Fogg draws the relationship between the three factors, as illustrated in (Figure 3) below.
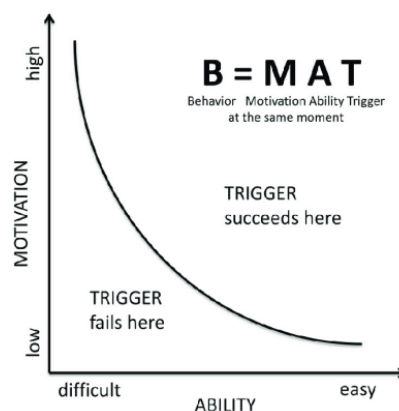(11 pt)

Figure 3. Fogg Behaviour Model (FBM)
(Source: Fogg, 2009)

Motivation is the reason underpinning a behaviour. Fogg (2009) divides the motivation for behaviour into three core motivators (sensation, anticipation and belonging), each of which has two sides: pleasure and pain, hope and fear, and acceptance and rejection. Pleasure and pain characterise an instinctive and

primitive bodily response, such as hunger and sexual desire (Agha et al, 2019). Furthermore, hope and fear are an expectation of the behavioural outcome. Hope stems from the anticipation of positive results. Meanwhile, fear originates from the expectation of negative behaviour results to prompt users towards action and conscious avoidance. Notably, hope is the most inspiring motivation for target users. In psychology, motivation denotes a key research concept with a broad spectrum. The three aforementioned categories are correlated, with persuasive design being the most closely related.

Ability denotes another FBM element. According to Fogg (2009), simplicity is an important principle in persuasive design. On another note, Albert Einstein stated that "Everything should be made as simple as possible, but no simpler" (Fogg, 2009). The fundamentals of this principle lie in the lazy nature of human beings. Regardless, designers must emphasise this phenomenon as simple behaviours for some people may prove intricate for others in certain situations. The ability summarised by Fogg (2009) includes five aspects: time, money, physical effect, mental effect, and routine.

Trigger is the third FBM element. The target behaviour would not occur without a trigger, categorizable into three types: facilitator, signal, and spark. Individuals designing to influence behaviour should utilise the trigger type that matches their target users' context, which integrates motivation and ability. Owing to the emergence of the Internet and interactive technology, the role of persuasive technology is demonstrating more and more benefits (Prengel, 2013).

Under the FBM model, three elements must exist to describe the conditions under which a behaviour occurs. This model could serve as a powerful tool in behaviour change-related design for designers to effectively identify issues and corresponding problems to propose solutions. Nur Zarna Elya & Marshima, 2021) propose a conceptual framework consisting of a combination of personal fitness data, The Transtheoretical Model (TTM), and FBM to predict appropriate physical activity based on personal context, this research will provide new insights into the development of software for healthcare technologies to support individuals' personalisation in managing their own health. Agha et al. (2019), who evaluated the impact of social marketing campaigns on condom usage in Pakistan with FBM, effectively increased condom use among men engaging in high-risk sex. The research further complemented the FBM validity in designing behaviour change interventions. Alsaqer (2021) developed a medication adherence system following FBM to address medication adherence issues among the elderly. The empirical work highlighted the significance of considering user needs and preferences when designing technology-based interventions for high medication adherence among older adults with persuasive technological features to facilitate behavioural change.

Conclusively, FBM is a useful framework to comprehend the occurrence of behaviour change in designing interventions that promote such shifts. Interventions could be designed to increase the likelihood of a behaviour occurring through motivation, ability, and triggers. Regardless, the model encounters several limitations. This model disregards the behavioural intervention time, which is a key determinant affecting behaviour. For example, some behavioural changes require long-term intervention. The model also lacks the consideration of external environmental factors for different behaviours, which would be emphasised in the subsequent stage of the research.

METHODOLOGY

The Systematic Literature Review (SLR) was used to explore the application of persuasive technology and design in healthy lifestyle. PRISMA or Preferred Reporting Items for Systematic Reviews and Meta-Analyse process was clarified by explaining the sources, identifying, screening, and checking the eligibility process of articles. According to Sierra-Correa & Cantera Kintz (2015), PRISMA guides the SLR study by defining an exact research question, identifying inclusion and exclusion criteria, and assessing relevant scientific articles in a large amount. The PRISMA flowchart provides information on articles screened, assessed for eligibility, and included or excluded for the reviews (Pati & Lorusso, 2018). Thus, this provides a transparent and credibility process of methods.

Resources

The review was based on two journal databases – Scopus and Connected Papers. Scopus is an abstract and citation database of about 5,000 publishers and around 22,800 journals. Meanwhile, Connected Papers uses graph visualisation technology to create links between research papers, making it easy to understand the interrelationships between papers, saving researchers time and effort, and understanding the latest research in their field. Both databases consist of a wide range of topics. As both databases are peer-reviewed, the content is trustworthy. Figure 4 shows the processes involved in retrieving the articles, specifically using 1) identification, 2) screening, and 3) article eligibility verification techniques. The search was completed on the 20th of January 2023 with retrieved 139 articles from both databases.
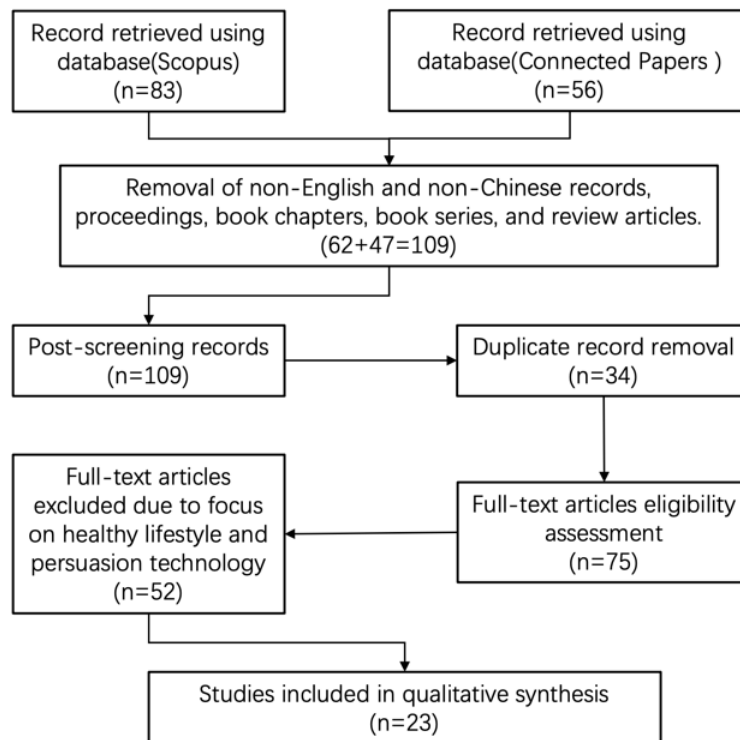

Figure 4. Operationalisation of the study
(Source: Ji Kang 2023)

The review methods of the present study were conducted using two primary databases, namely Scopus and Connected Papers, with the keywords used as in Table 1. In the identification stage, the keywords chosen were based on the subject topic and several search attempts. The attempts found that synonym search covered a wide range of study that was out of the scope. Thus, the keywords derived from exact terms and Boolean search limit the search results. The search was done on 20th of January 2023 and successfully retrieved 139 articles from both databases.

Table 1. Search strings

Database search string (Keywords)	
Scopus	"Persuasive Design" AND "Persuasion Technology" AND "Persuasion Strategy" AND "Healthy Lifestyle"

Connected Papers	"Persuasive Design" AND "Persuasion Technology" AND "Persuasion Strategy" AND "Persuasion and Healthy Lifestyle "

A total of 109 articles were selected according to the criteria in Table 2. The first criteria are the publication timeline. The deadline for sample article selection is in 2005. Then, the documents from the conference proceeding, a chapter from a book and books were excluded. In terms of language, non-English and non-Chinese were also excluded. Eventually, the studies that are not discuss persuasive design were excluded. Finally, the selected articles quality assessment was done by checking whether the articles main aims and objectives are related to methodology, healthy lifestyle and persuasion technology. Then, the 34 duplicates of articles were removed due to duplication.

Table 2. Inclusion and exclusion criteria

Criteria	Inclusion	Exclusion
Recency	Publication recency was not considered	
Document types	Peer-reviewed articles	Conference proceedings, book chapters, book series, and books
Language	English and Chinese	Non-English and on-Chinese
Content	Relevant to healthy lifestyle and persuasion technology	Irrelevant to healthy lifestyle and persuasion technology

In the eligibility stage, 75 articles title, abstract and content were carefully reviewed to ensure that the inclusion requirements are followed and achieved the study's objective. A total of 52 articles were excluded due to the lack of focus on the non-methodological aspect. Finally, a total of 23 qualified articles were left for analysing.

ATLAS.ti software was employed to analyse the related articles. Two steps were used in the analysis: First, a vocabulary cloud or list was generated to compare and finalise the most frequently used words in each article. The most frequent vocabulary items determined the core content. Second, the articles were imported into ATLAS.ti and the goals were set to reflect the primary and secondary article coding that emphasised a "more comprehensive understanding of the application of persuasive technology in healthy lifestyle". A cross-comparative analysis of the content focused on the two-level coding and high-frequency vocabulary. Finally, the remaining finalised publications 1) application of persuasive principles and strategies 2) application of Fogg model 3) advantages of persuasive

FINDINGS

Principles of Persuasion

Cialdini (2007), a research expert in the field of persuasion and influence, indicated the role of persuasion in predicting and fulfilling people's psychological needs. Explicit and engaging cases dissect the psychological factors underlying behavioural change, which reveals six weapons of influence: reciprocation, consistency, social proof, authority, liking, and scarcity (Figure 5).
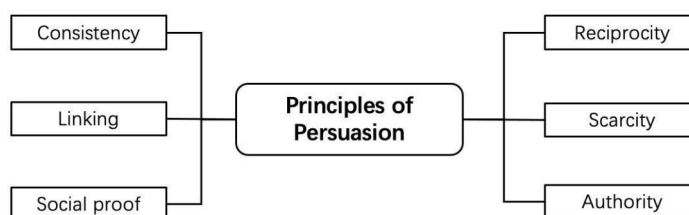
Figure 5. The six principles of persuasion
(Source: Cialdini, 2007)

Reciprocation: The psychological basis constitutes a sense of debt and gratitude for the principle of reciprocation to work, where people return a favour they have received. Although the payment and return are not necessarily equal, no detrimental consequences result from such reciprocation. Consumers who receive free product samples from a store clerk in a mall would reciprocate by purchasing the products. This situation aptly characterises the use of the principle of reciprocation in marketing methods.

Consistency: Consistency relies on a fore mentioned psychological basis, where people are in alignment with past words and deeds. Internal and external pressures would compel an individual to fulfil his promise upon making a choice. Such fulfilment and matching one's words with actions denote one of the basic principles of human behaviour. People can persist in completing certain tasks or healthy habits through fitness applications and social media platforms following promises to constrain their behaviour. Regarding the persistence of healthy behaviours, some people post their exercise tasks or results on social media platforms (Facebook and Twitter) to motivate themselves towards task completion.

Social Proof: Social attributes explain the workings of the principle of consensus on individual attitudes and behaviours. In many cases, other people's behaviours serve as one's criteria for judging affairs and performing behaviours. The "signature dishes" often launched in restaurants and "best sellers" recommended by online shopping malls typically reflect good sales under this principle. These examples demonstrate why Amazon and Lazada have large user review groups in their mobile apps.

Authority: Authority, which can relatively influence people's behavioural decisions, explains why sick people heed a doctor's advice and refrain from unhealthy behaviours when seeking medical help. In applying this principle, some weight-loss information or fitness guidance providers openly declare their adherence to the principle of scientific weight loss to users. Some fitness software publicises their information source for users to perceive the authority and scientific nature of the products and gain their trust.

Liking: The psychological bases used in the principle of liking are presented as follows: (i) people are willing to accept the requirements of significant others; (ii) the primary reasons for liking entail appearance, charm, similarity, compliment, and contact and cooperation. This principle is extensively employed in sales, with many product sales using the promoter's acquaintance network to attain sales benefits. For example, gamification methods are widely adopted on the mobile internet. Regarding the persuasive principle, developers use "compliments" in one of the psychological foundations of "liking" for users to reflect a stronger sense of accomplishment regarding the completed tasks.

Scarcity: People compete for scarce resources following the psychological basis of the principle of scarcity. Based on psychology, fewer opportunities induce higher values. Further analysis depicts the contradiction of resource depletion to individual free will, which compels people to obtain limited resources. Hence, this principle is highly applicable to persuasion. Despite the exorbitant prices of luxury goods, such products continue to attract many followers and pursuers. Marketing methods involving "last chance" and "limited time offer" in physical and digital shopping malls contribute to product appeal. All these aspects influence people's psychological sustenance of scarce resources and consumption decisions.

Summarily, the six principles of persuasion offer a useful framework to influence and convince people to persist in completing anticipated actions. Researchers and designers with a sound understanding of these principles could optimally promote their ideas and products.

Strategies of Persuasion

The persuasion strategy is proposed following the principle of persuasion. Notably, the recommended methods differ as multiple fields reflect distinctive issues to be addressed. Scholars would propose different empirical strategies that apply to multiple scenarios.

Marketing: Emotional appeal, social proof, scarcity, and humour are common strategies used in advertising to attract consumers' attention and sell their products. Essentially, emotional appeal is the most extensively used persuasive strategy in advertising. Advertisers employ emotions involving fear, happiness, sadness, and anger to connect with viewers and persuade them to take specific actions. In terms of social proof, advertisers utilise recommendations, endorsements, and statistics to show that other people have tried and benefited from the product.

This strategy generates a sense of trust and believability that motivates viewers to try the product. Scarcity is frequently used in festivals or promotions through phrases resembling "limited time offer" or "buy one free one" to change consumers' psychology and create a sense of urgency. This strategy, which induces a fear of loss, could convince the audience to purchase the product. Finally, advertisers employ humour to render commercials more memorable, appealing, and shareable and create a positive product association.

Overall, emotional appeal, social proof, scarcity, and humour only reflect some of the frequently used advertising techniques. Advertisers can holistically comprehend persuasive principles to design different persuasive methods, sell their products and services, and facilitate organisations to design more effective advertising campaigns.

Environmental protection: Environmental protection has garnered much scholarly attention in recent years. In this field, persuasion techniques are frequently used to persuade individuals to conserve the environment and energy usage.

Reward, the most effective persuasion strategy in environmental protection, encourages individuals and businesses to engage in eco-friendly behaviour. Following Chiu et al. (2020) offering feedback and incentives on electricity use could significantly reduce energy use. Feedback serves to encourage personal environmental protection behaviours and lower energy consumption by adequately understanding and comparing energy usage. Emeakarohae et al. (2014) disclosed that a real-time feedback system of electricity consumption between student dormitories and appropriate incentives significantly reduce students' electricity usage. Furthermore, social influence functions to affect individuals through social norms and pressure and alter individual behaviour. explored the theoretical-practical gap in encouraging individuals' adoption of climate-resilient water use behaviours at home and how social influence is applicable to bridge this gap and promote sustainable water practices, thus highlighting the possibility of social impact for positive change (Lede & Meleady, 2019).

The information communication strategy serves to catalyse environmental protection behaviour. The government or schools and other departments convey the current environmental damage and implications in multiple ways to subconsciously instil the environmental protection concept and encourage people to take conscious actions to conserve the environment (Aydin et al., 2018).

Summarily, several persuasive techniques have been employed to stimulate individuals to protect the environment. Companies and individuals with a holistic comprehension of these methods could develop successful environmental protection strategies.

Health management: Advanced technologies involving mobile applications and wearable devices are prevalent in supporting health management and disease prevention. Various studies have also verified the effectiveness of these persuasive techniques. In promoting disease prevention and health management, some applications use strategies entailing health monitoring, personalised information delivery, and plan formulation to promptly evaluate users' health status and persuade them to prioritise health issues.

Coughlin et al. (2016) revealed that mobile applications that provide personalised feedback and educational content optimally facilitate disease screening. Likewise, a study by Wang et al. (2019) identified a mobile application that offers personalised dietary advice and guidance to improve patients' eating behaviour. With regards to promoting healthy behaviours, competition, rewards, and gamification could alter individual behaviours and promote their engagement in more physical activities (Kwan et al., 2020). Chow et.al. (2017) addresses poor health, lack of companionship, disinterest, and low mobility.

Persuasive technology also plays a pivotal role in other fields, including learning and interpersonal relationships (Williamson, 2017). Nevertheless, the essence of the persuasive strategy lies in its embodiment of the principle of persuasion, regardless of the circumstances (Chao, 2020). Usually, multiple strategies would be intensively incorporated into the strategy application for optimal persuasive effects. The contextual information on the study of persuasion's principles and strategies is shown in Table 3:

Table 3. Contextual information on the study of Persuasion's Principles and Strategies

Authors	Principle						Strategies		
	Reciprocation	Consistency	Social Proof	Authority	Linking	Scarcity	Marketing	Environmental protection	Health management
Cialdini (2006)			✓						✓
Cialdini (2007)	✓	✓	✓	✓	✓	✓			
Chiu et.al. (2020)			✓		✓			✓	
Emeakaroha et.al. (2014)			✓	✓				✓	
Lede and Meleady (2019)	✓			✓	✓		✓	✓	
Aydin et al. (2018)				✓				✓	
Coughlin (2017)			✓	✓	✓		✓		✓
Wang et al.(2019)		✓	✓	✓			✓		✓
Kwan et.al (2020)			✓	✓					✓
Chow et.al.(2017)			✓	✓				✓	✓
Moschny et.al. (2011)			✓	✓					✓
Williamson (2017)			✓	✓					✓
Rapp (2018)			✓	✓				✓	✓

Chao. (2020)	✓	✓	✓	✓	✓	✓			✓

CONCLUSION

According to the definition of persuasive design and the related persuasive theory of Professor Fogg, it is concluded that persuasive design has the following major advantages: orientation, friendliness, and interactivity and.

Orientation: Product services and functional details should reflect a strong target orientation by promoting green and environmental protection, healthy lifestyles, and the relationship between people to change their attitudes and behaviours through persuasive design., The design concept and method apply to the management of public affairs and personal behaviour.

Friendliness: As persuasive technology denotes the use of non-mandatory technical means, associated products place much emphasis on user experience. Users' acceptance would be duly regarded in selecting persuasive methods and specific design details for a more optimised solution.

Interactivity: Persuasive design, which relies on an interactive computing system as a medium, requires interaction and feedback between products and users. In this vein, persuasive design is a type of interaction design. Relevant interaction design theories and methods are also applicable to persuasive design.

Overall, persuasive design proves beneficial in terms of orientation, friendliness, and interactivity following past literature. Designers could use persuasive design principles and techniques for more effective and impactful user experiences in different domains.

Persuasion design methods strive to influence individual attitudes, behaviour, and decision-making with psychological and behavioural principles. In promoting healthy lifestyles, persuasive design could optimally promote individuals' adoption of healthy behaviours. The persuasive design application and effectiveness in promoting healthy lifestyles have been validated by numerous empirical works. Given the prevalence of chronic ailments caused by unhealthy lifestyles, this study aimed to identify design use methods to change such detrimental lifestyles. Persuasive design promotes healthy behaviours through the following techniques for user motivation and engagement: competition, social influence, feedback, rewards, and gamification.

Essentially, the persuasive design must adopt different persuasion techniques following the actual situation to increase the design enthusiasm and ability in users' interaction process. In this vein, the persuasive design must focus on users' behaviour process and employ corresponding persuasion skills for goal attainment purposes. Wang et al. (2019) used a framework containing persuasive system design principles to examine persuasion technique use and effectiveness in intervention studies to reduce sedentary behaviour at work. In analysing the reminders, hourly personal computer (PC) reminders alone demonstrate no significant effect on reducing sedentary behaviour at work.

It is deemed pivotal to synchronise the intervention with other persuasion strategies for optimal persuasion efficiency. In line with Orji, the development of a mobile application that combines game-like elements with rewards, challenges, and social support strategies to promote physical activity among the elderly revealed that gamification could increase physical activity levels and reduce sedentary behaviour. Mohamad Hidir et al. (2017) designed a mobile application with persuasive design principles to encourage users' adoption and sustenance of healthy eating habits using feedback and rewards.

The study outcomes disclosed the application's effectiveness in improving user knowledge and attitudes regarding healthy eating and increasing their fruit and vegetable intake. Furthermore, Sittig et al. (2020) holistic review of different persuasive design categories and principles for behavioural obesity interventions revealed that successful interventions integrate multiple categories and persuasive design principles. A sound understanding of different persuasive design categories and principles could facilitate designers to create more effective interventions and address obesity and other health behaviours. Matthews et al. (2016) systematic review of persuasive design studies in mobile applications that promote physical activity discovered that strategies of goal setting, self-monitoring, social support, feedback, rewards, and reminders in mobile applications can increase physical activity levels and improve health outcomes.

Regardless, the long-term effectiveness of these interventions remains unexplored. Bascur et al. (2018), who evaluated a persuasion application for improved physical activity and reduced smoking through persuasive design, disclosed that monitoring, feedback, and social support in applications encouraged users' adoption of healthier behaviours, increased users' physical activity levels, and reduced cigarette consumption. Miller et al (2016). underscored the essentiality of gamification in chronic disease management by adding elements of scoring, competition, and rewards to the design for high user engagement and motivation. Although relevant studies also discussed design challenges in sustaining long-term engagement and avoiding over-reliance on rewards, persuasive designs that incorporate gamification potentially improve effectiveness and engagement in managing chronic diseases.

In general, from the above research on persuasive design in healthy lifestyle, it is found that persuasion design has penetrated into all aspects of healthy lifestyle, helping people change bad habits, such as sedentary, obesity, chronic disease management, promotion of physical activity, etc. , persuasive design is an effective method for promoting a healthy lifestyle because it uses psychological and behavioural principles to influence people's attitudes, behaviours, and decisions. gamification, social influence, feedback, and rewards are effective ways to promote healthy behaviours, and they can be integrated into various environments, such as mobile applications, websites, and wearable devices. The above research also shows that in persuasive design, a single persuasive technology cannot have an effective impact on behaviour, and the combination of persuasive technology is more conducive to the change of behaviour.

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