A Conceptual Design for COMBI Dengue Prevention based on an Integrated Psychology and Persuasive Technology Models

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Abstract—**Dengue prevention is the best way to prevent dengue outbreaks, as the tagline goes, "prevention is better than cure". But the challenges lie in sustaining the preventive activity among the community, which commonly only takes place periodically, i.e. when they are dengue outbreaks, with the presence of health officers under the Communication for Behavioural Impact (COMBI) campaign. In this paper, a behaviour change model based on the Transtheoretical Model (TTM) and trigger elements derived from the Fogg Behaviour Model (FBM) is proposed to sustain a community in carrying out preventive activities to prevent dengue. Intervention strategies are added to connect the chosen TTM and FBM. A conceptual design is outlined to further exemplify the proposed model with the identified, which incorporate findings from the persona gathered from a selected community and a mock-up flow. An evaluation plan is described which will be carried out as part of the future work. The proposed model in this paper is hoped to pave the way for sustainable persuasive design.**

Keywords—**Behavioural change, community, dengue prevention, persuasive design, sustainable**

I. INTRODUCTION

The responsibility to eradicate dengue lies in everybody's hands to stop the disease from spreading. One of the efforts of the Ministry of Health in Malaysia is to work together with the community and other agencies to perform 'search and destroy' activities for Aedes Aegyptus breeding places which need to be carried out weekly, as they regard this would be the most important element in the success of controlling dengue [1].

There are many case studies in the tropical and subtropical countries around the globe which succeed in the prevention and control of dengue through community participation [2, 3, 4, 5]. The key to the success is the sustainability shown by the community in the activity, and for sustainability to happen, behavioural change has to take place, or it would become a periodic event. But behaviour change is not something that is easy to achieve. In the context of Malaysia, many awareness activities had been carried out by the *Pejabat Kesihatan Daerah* of every state through COMBI [6, 7], but the impact is still very small and unsustainable [1].

Technology that supports and promotes behavioural change is commonly known as persuasive technology, and most are applied to the health-promoting area, via the use of portable devices such as a smartphone, smartwatch, and smart fridge [8, 9, 10]. Getting the right information to be displayed on the devices is crucial as it could lead to an impactful result, i.e. change behaviour could change into a habit. Developing motivational technology to support long-term behaviour change is a challenge [14], especially to sustain behavioural change. To design effective persuasive technologies, many designs draw upon theories of behaviour change to understand what factors influence people's behaviour change decisions [15, 16, 17, 18].

In the context of dengue, some examples that already utilize mobile devices for dengue prevention include [11, 12]. But none of these adopts the behaviour change theory. In addition, there is no well-established method to translate theoretical constructs and insight to persuasive or motivational interaction designs to be used in practice [14] for dengue prevention.

Sustainable community participation is paramount to the surveillance system that is a part of the national health information system. By doing so, a harmonized effort across national dengue surveillance systems can inform the critical data of the disease's burden which is necessary to assess progress in reaching mortality and morbidity reduction goals [13].

In this study, we intend to address this by illustrating a model which will become a bridge for developers or researchers to study persuasive technology in dengue prevention. To change behaviour in terms of technology, it is called persuasive technology or interactive computing systems designed to change people's attitudes or behaviours [19]. By proposing this model, this study will figure out the way for people to sustain their behaviour such as what is the goals, the goals that the community needs is important for behaviour change.

The next section will provide some background on dengue scenarios in Malaysia. Related works on theories and models regarding behavioural change and persuasive technologies will be discussed next. A discussion on the proposed model will be presented next, followed by a concluding remark and future work.

II. DENGUE IN MALAYSIA

According to the Ministry of Health, the statistics of dengue cases before COVID-19 was 63,988 in August 2020, with 1,700 cases per week in 2020, and 2,500 per week in 2019 [20]. The number of cases reduced in 2021 to 16,565 with 534 cases a week, which is highly due to the lockdown where people stayed home most of the time.

A Communication for Behavioural Impact (COMBI) is a toolkit by the World Health Organization (WHO) which contains a seven-step approach for effective behavioural and communication interventions in support of outbreak prevention and control objectives to limit the loss of life and minimise disruption to families, communities, and societies [21]. There are three main objectives of having COMBI, first is to motivate the community sector to deal with the dengue issues among the community; second is to create shared responsibility in the community and third is to give influence and strengthen the social behaviour in the community.

In Malaysia, under the Ministry of Health, COMBI is adopted as the national approach to social mobilization and communication for dengue fever prevention and control. At every local government clinic, COMBI is executed by performing activities with the local community to create awareness and educate the people about taking care of their surroundings. By doing so, the community would then be able to set up their own COMBI and be responsible for their own community. In order to execute COMBI, there are five important elements to propose integrated communication actions, which are mobilized administration and advocacy, social mobilization, advertising, personal delivery and promotion in the service centre. All these elements shall use the approach of massive, repetitive, intensive, and persistent. Nonetheless, the biggest challenge of COMBI in Malaysia is not in the execution of COMBI, instead, the biggest challenge is to sustain the preventive activity among the community. In order to do this,

behavioural change is deemed to be the most suitable approach to overcome this challenge.

III. PERSUASIVE TECHNOLOGY AND BEHAVIOUR CHANGE MODELS

Persuasive technology has been defined as interactive systems designed for attitude and/or behaviour change [22]. In this era of technology, the mobile phone becomes one of the devices that support people in changing their habits. They can direct users towards specific behavioural options in a variety of application areas: sustainable choices and pro-environmental awareness [23, 24], health and wellness [25, 26], safety [27, 28]. In recent years, technology has been increasingly harnessed in pursuit of persuading people and motivating them toward various individually and collectively beneficial behaviours. There are two dominant conceptual approaches: the longer-established persuasive technology and the more recent but increasingly popular gamification [22]. As this study focuses on behavioural change which requires changing habits over time, the former concept is chosen.

In persuasive technology on the design of system qualities, there are four things to consider. First is primary task support, second is computer-human dialogue support, third is perceived system credibility and fourth is social influence [22]. To have a better understanding of persuasive technology, conceptual framing was created. To connect the conceptualizations of persuasive technologies to a wider framework, the definition of persuasive technologies should be integrated with the concept of motivational affordances and its relationship to psychological and behavioural outcomes [29, 30, 31].

Behaviour change is often a goal for staff working directly with constituents, organizations, governments, or communities. To design effective persuasive technologies, many designs draw upon theories of behaviour change to understand what factors influence people's behaviour change decisions [16, 17, 18, 32]. However, there is a challenge when using theory or models to design a motivational technology for behaviour change. This is due to the process of translation or mapping from theoretical hypotheses and insights to persuasive or motivational interaction designs to be used in practice requires detailed and careful analysis [33].

Based on the earlier findings in [33], the focus is given to the Transtheoretical model (TTM) as it asserts strong psychological elements in behavioural change [34], and on the technological, the focus is given to the Fogg model, as it is the most common and applied model in the domain of persuasive technology [37].

The Transtheoretical Model (TTM) uses a sequential element, the stages of change, to participate in progressions and change from a different theory of intervention hence the name transtheoretical [34]. There are five states of change that are proposed in this behaviour change model. They are pre-contemplation, contemplation, planning, action, and maintenance (Table 1) [35]. These stages are the level of the targeted user that involve in behaviour change. In order for the user to move to the next level, they need to be guided. The guide provided in the TTM is called the process of change, which involves 10 processes. The processes are consciousness-raising,

dramatic relief, self-re-evaluation, environmental re-evaluation, self-liberation, social liberation, counterconditioning, stimulus control, contingency management and helping relationships [35]. While doing the changes, the pros and cons of the changing are taken count into which lead to the decision balance that proposed by [36].

TABLE I. TTM STAGES AND BEHAVIORAL FEATURES [35]

State of Change	Behavioural Features
Precontemplation	No intention of the need to change (within six months)
Contemplation	Intend to change using available information (within six months)
Planning	Intend to change within 30 days
Action	Engaging in active behaviours to change
Maintenance	Sustaining change that was made

Meanwhile, in the Fogg Behaviour Model (FBM), there are three factors that promote the behaviour; motivation, ability, and trigger [37]. If the behaviour does not occur, it means that one of the factors is missing. There are three core motivators in FBM, which are sensation, anticipation, and belonging. All of these motivators have two elements within them. The elements in the three core motivators are pleasure/pain, hope/fear, and acceptable/rejection, respectively [37]. The horizontal axis is ability. In order for people to have an ability, they must train themselves to gain the ability. But for some people, the training is way too hard for them which leads to low ability. Another is the element of simplicity. The elements of simplicity are time, money, physical effort, brain cycles, social deviance, non-routine, and key point about simplicity. People get to choose the element that suits them. The diagonal arrow across the plane is the increasing likeliness to perform target behaviour. The third factor that exists is triggers which are a vital aspect of designing persuasive products. There are three types of triggers, which are sparks, facilitators, and signals [37]. Sparks work when a person has low motivation but high in ability. While facilitators work when a person has high motivation and low ability. Lastly, a signal works when a person has both high ability and motivation.

The strengths of TTM and FBM models are combined by connecting both models together using the intervention strategy for the proposed COMBI behaviour model. These intervention strategies also follow the design of system qualities in the Persuasive System Design (PSD) model.

IV. PROPOSED COMBI BEHAVIOURAL CHANGE MODEL

The proposed COMBI behavioural change model for sustainability dengue prevention activity has structured its model according to the TTM, which consists of strong and effective ways to sustain the consistent behavioural change of dengue prevention activities. However, in TTM, the trigger element is not inclusive. A trigger is very important to push people to do something. In this study, the trigger elements from FBM are incorporated together into the proposed model. Even though in the FBM there are two other factors that contribute to behaviour, which are motivation and ability, we did not incorporate these elements into the proposed model, due to the fact that these are already being considered extensively by using the TTM.

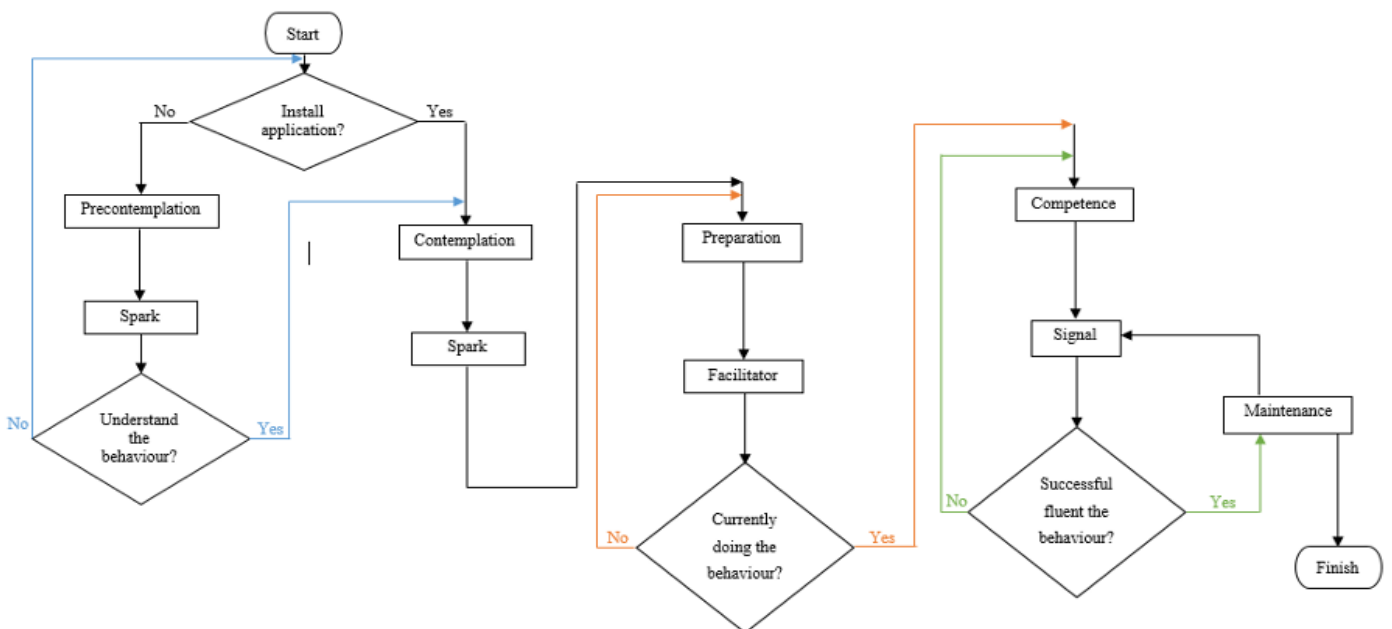There are five stages in the proposed model, as shown in Fig. 1.

Fig. 1. Proposed Model of COMBI Behavioural Change [38]

The proposed model was first briefly appeared in [38]. Pre-contemplation is a phase in the earliest stage where the person is not yet engaging in prevention activity and has no intention to do so. While contemplation is a phase where one

is not engaging in prevention activity but has the intention to do so. The following phase or stage is the preparation, in which one has started to get involved in prevention activity. Fourth is the competence phase, or stage, in which one has been consistently involved in prevention activity within six months, and, finally, the last stage or phase is maintenance, where one has been consistently involved in prevention activity for more than six months. Each stage has its own triggers. For pre-contemplation and contemplation, the trigger that was found suitable is a spark, where at this phase, the person has a low ability to do things. While for the preparation stage, a facilitator is found to be the suitable trigger, as it could consistently push and provide guidance to the person from time to time. During competence and maintenance stages or phases, the suitable trigger is a signal. This is because, at these phases, the person already has both high ability and motivation, which then only requires some sort of signal for one to execute or perform.

There are several interventions strategy that we proposed in the model. The interventions strategy is based on the triggers and the suitability of the person's stage. At the pre-contemplation stage, the interventions strategy are education, advice, and self-monitoring. Contemplation stage use education, advice, and comparison as interventions strategy. At the preparation stage, the interventions strategies are goal and comparison. While competence stage use engagement, communication, and reward as the intervention's strategy. The last stage is the maintenance stage which uses communication and reward as the intervention's strategy. Table 2 summarizes the model with its strategy. Below is the explanation for each intervention's strategy:

- Education is suitable to approach people and teach them why they should learn to do the behaviour. A simple explanation about the information in the applications will guide them through a process that can have a good impact on persuasion.
- Advice is something we always receive from time to time. In the proposed model, one will be given advice about what they can do to start the activity. The advice can come in the shape of a flashcard in applications.
- Self-monitoring is to let people observe their own behaviour. It allows people to find a way to improve themselves. The interaction will help motivate the user.
- The goal is an intervention strategy to challenge people to accomplish their aim. The technique to have people achieve their goal is by giving them a simple goal to achieve and it becomes harder from time to time.
- Comparison is one will be compared to others' performance. They will have healthy competition which effectively motivates themselves.
- Engagement is a strategy where a user's emotion and curiosity being controlled. For example, one will have his/her own virtual character to keep. In order to keep them alive, one has to perform a certain behaviour.

- Communication is to allow people to communicate with people of the same interest. For example, the application will link with one's social network.
- A reward is a prize for one who has completed their sustainable behaviour. There will be virtual rewards such as point, or star earned and emotional rewards.

For dengue-related prevention activities, there are several activities that can be done at home with family to eliminate breeding sites of Aedes aegypti mosquitoes.

This activity can be done once a week. There are many common places and locations at home areas that potential be breeding sites, for instance, flowerpots, open buckets, and toilets. Besides that, installing mosquito nets on the windows of the house is proven helpful. This is crucial for every house.

V. CONCEPTUAL DESIGN

A. Persona

Adhering to good practice of the interaction design process, we began our design phase by first developing personas which we gathered based on the surveys and interviews from the selected community; Desa Bakti, Skudai. There were three personas created to illustrate and exemplify the types of users or residents in the Desa Bakti. The first persona is Mr Hadi. Mr Hadi is in his late twenty and lives with his wife at Desa Bakti – a residential area provided by the workplace. His working hours are from 8 am to 5 pm. He loves gardening. He usually spends about an hour in his garden after work.

Sometimes, he spends too much time in the garden, he often missed spending time taking care of his house. To Mr Hadi, nothing is more important than keeping his family close to him and being able to keep his family safe and sound. He always wants to have a healthy family. So, he needs to expose positive behaviour to his family.

The second persona is Mrs Ani. Mrs Ani is in her early thirties and lives with her husband and has two children. Their kids are between 7-10 years old and already attend primary school. Mrs Ani is a housewife. Every day she does the housework chores and prepares the kids for school. Her husband has a side business which is selling satay. The stall is nearby at Taman Pulai. After lunch, she will start to prepare ingredients to cook satays such as the seasoning and preparing the meat. They start their business from 8.30 pm until 11 pm. Because of the time constraint, she sometimes does not have enough time to check around the house. Mrs Ani is very concerned with cleanliness. She wants her family to value cleanliness and learn how to maintain it.

The third persona is Mr Aziz who works at the OSHA department. Mr Aziz is in his late thirties and lives with his wife in Desa Bakti. They have four children. Mr Aziz was appointed as head of the community in Desa Bakti. It is his responsibility to keep track of the prevention activity among the community. But it is difficult to monitor the community whether they do their responsibility or not. It is also of utmost

importance to Mr Aziz to keep the surrounding area of his home clean to ensure the family live healthily and peacefully.

B. Mock-up Flow

To further illustrate the proposed model, InVision is used as a tool to visualise the flow of mock-ups which represents the phases identified in the model. This is illustrated in Fig. 2, where the pre-contemplation, contemplation, preparation, competence, and maintenance are highlighted with the suggested interface mock-ups that would fulfil the needs of the phases. The phases which are labelled in the pink boxes mapped to the TTM Stage in Table II.
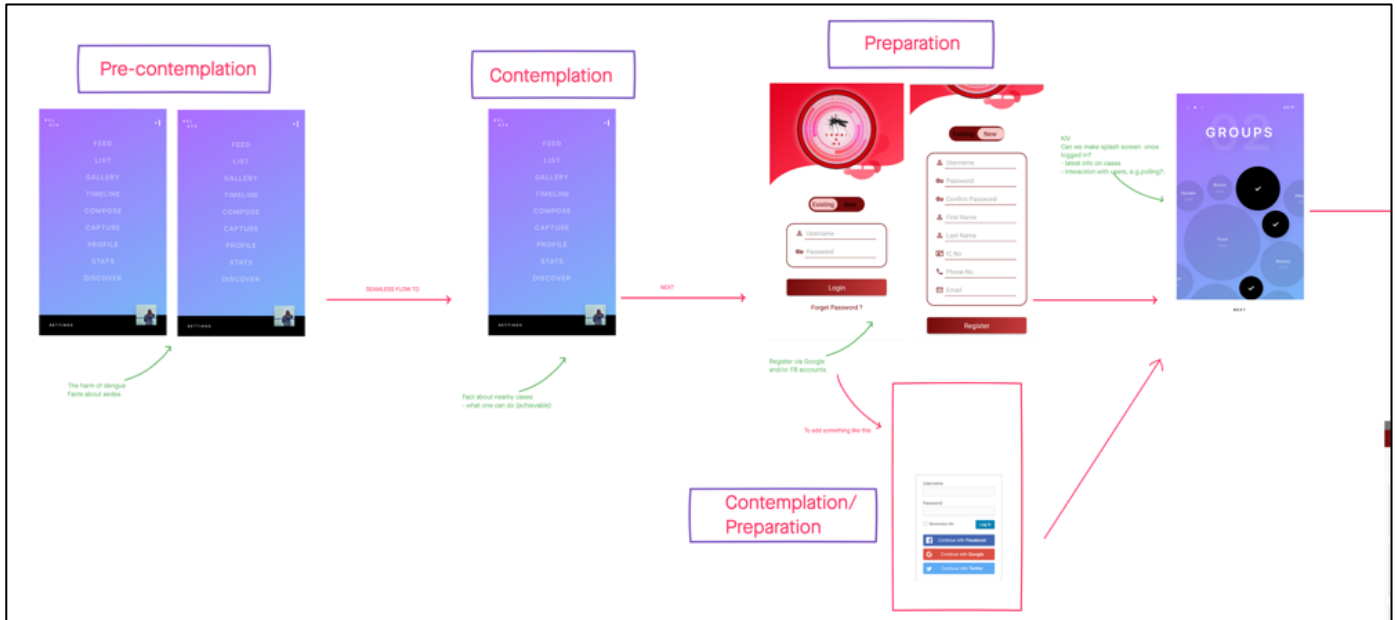

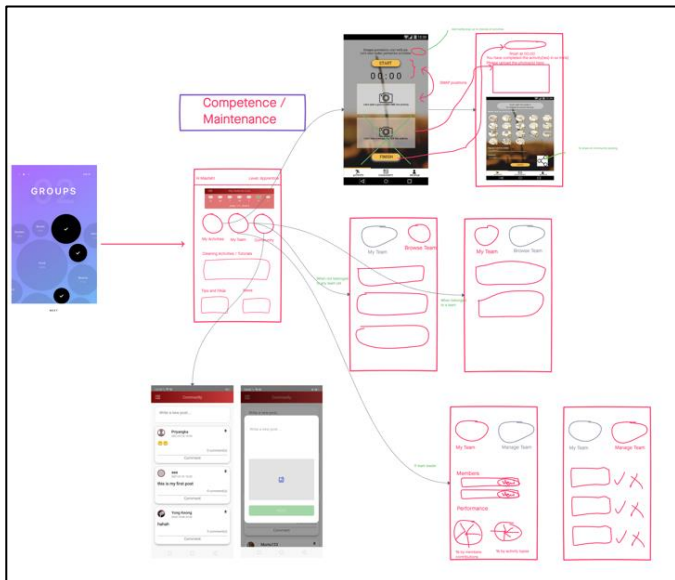Fig. 2a. Flow of sketches to illustrate the phases identified

Fig. 2b. Flow of sketches to illustrate the phases identified (continued)

TABLE II. TTM STAGES, BEHAVIORAL FEATURES, INTERVENTIONS AND TRIGGERS

TTM Stage	Behavioural Feature	Intervention Strategy	Trigger
Pre-contemplation	Not yet engaged in prevention activity and no intention to do so	Education Advice Self-monitoring	Spark
Contemplation	Not yet engaged in prevention activity but have the intention to do so	Education Advice Comparison	Spark
Preparation	Has started involved in prevention activity	Goal Comparison	Facilitator
Competence	Has been consistently involved in prevention activity within six months	Engagement Communication Reward	Signal
Maintenance	Has been consistently involved in prevention activity for more than six months	Communication Reward	Signal

103

Together from Table II and the flow identified in Fig. 2, we suggested the design interfaces of the medium-fidelity prototype to closely reflect the stages and intervention strategy of the proposed model. Fig. 3 are the examples of interfaces for *education and advice* from the intervention strategy. This interface is based on the contemplation stage which uses education and advice as to the strategy.

We provide facts about dengue to instil fear in users, which fear is one of the approaches in *spark*. The facts are about danger signs and symptoms that lead to dengue and statistic of dengue cases in the world.

The mock-up interface in Fig. 4 is illustrated to display the list of prevention activities. Users can choose any activity they want. As outlined by COMBI, the ideal goal is to accomplish one activity per week. If they accomplish one activity per week within one month they will be upgraded to the next level.

The activity level is acting like motivation for them to keep doing the activity so that they can upgrade to a higher level. The levels indicate the stages in the proposed model, which are based on the frequency and sustainability of executing the activity.

All performed levels and achieved rewards can be shared on social media. In the Summary Page (Fig. 5), will be shown the activity level, reward, and summary activity of the month.

Fig. 6 is the mock-up interface to show how *communication* in the intervention strategy takes place. The newsfeed page is for a user to communicate with their friends and colleagues who are situated within a 20km distance. Communication with their friends and colleagues is one of the motivations for a user to keep doing an activity every week. The newsfeed can also help the head of the community to monitor the community activities within his or her vicinity.

Fig. 3. A group of the screen displays meaningful messages and advice which exemplify pre-contemplation and contemplation

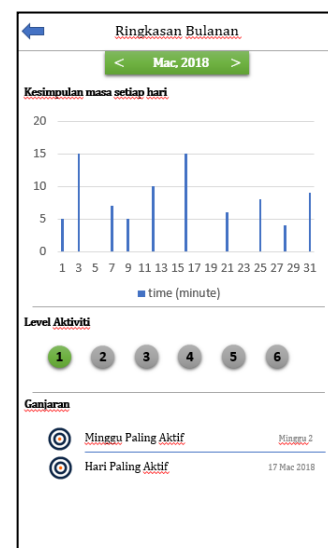Fig. 4. List of prevention activities

Fig. 5. Summary Page

Fig. 6. Newsfeed page

VI. EVALUATION PLAN

There are two phases of evaluation that will be performed for the proposed model. The first evaluation will be focusing on obtaining initial feedback particularly on the flow of the process, and the general understanding of the design from the same group of participants from the selected community.

The second evaluation will focus on evaluating the proposed model via the use of the developed application. Over a period of three months, a group of users will be assessed and monitored based on three checklists; behaviour checklist, motivation checklist and focus-time checklist. A behaviour checklist is to observe user behaviour during the time process. A motivation checklist is to show the importance of motivation for a user and to show how the user is able to move to the next stage of the behaviour model. The focus-time checklist is to trace user time with the application. Participants will be evaluated every week for three months. The improvement of user behaviour can be seen from the consistency of the level upgrade.

VII. CONCLUSION AND FUTURE WORK

The most challenging condition for persuasive technology is to change the behaviour of the users for the better. The technology itself needs to be powerful enough to persuade people to change the behaviour and sustain it for a very long time. This challenge must be overcome in order to change the behaviour. All aspects need to be studied, for example, the environment of the people, the community, demographic of the surroundings and others. In this case, we need to learn the dengue preventive activity, which requires the community to work as a team to overcome or to lower the possibility of people having dengue. The style of living now, however, shows that the most responsive action from the community is only when the dengue cases started to rise, and unfortunately, in some areas, the community from the affected area only finally do something when there are officers visited their place to perform the activities. Furthermore, even though some

people will work on their own to prevent dengue, such as clean up their own area, but it is still dangerous if the neighbours do nothing to prevent this thing from happening. That is why we need the community to gather to create awareness and prevention from the dengue cases.

In this paper, we proposed the COMBI behavioural change model, which we foresee could be the solution to this challenge. The model is proposed based on two solid foundations, psychology, and persuasive technology. The sketches of mock-ups flow and initial design ideas are built based on the phases identified in the model. The next phase of the study is to conduct the evaluation as described previously. The findings will hopefully facilitate the improvement of the proposed model.

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