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Critical Approaches in the Design of a Mobile Phone Diet Application For Prolong Use

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***Abstract*—Many mobile phone diet applications are available today, most of which are free for the user to download on their mobile phone. However, findings have reported that, the existing applications for diet management are not very effective for prolonged use. The statistics have also shown that the rate of obesity in Malaysia is increasing over time. Thus, strategies to design and develop a new mobile phone diet application must be developed. This paper reviews previous research to observe the implementation of diet management elements in existing mobile phone applications. The aim of this review is to improve current mobile phone diet application development efforts towards effective diet management in terms of prolonged usage by identifying the effective approaches from previous research. This paper not only includes a review of relevant journal papers but also a review of the various available online diet management systems. This approach is used to identify the current trends in the implementation of mobile phone diet applications. The main finding of this review is a conceptual model that consists of an important approach to the design of mobile applications for diet management developed so that users will use the application long-term. Additionally it is hoped that the conceptual model will prove helpful for health practitioners or mobile application developers in the development of an effective mobile diet application for successful long-term diet maintenance. Ideally, our approach will aid in overcoming obesity, which is a well-known disease in many countries today.**

Keywords — Weight loss Management ,Diet Management, Online Weight Loss Applications, Mobile Weight Loss Application, Weight Loss Monitoring.

I. INTRODUCTION

Obesity is classified as one of the most dangerous illnesses in the world, in part because the number of obese persons continues to increase. According to a report by the World Health Organization (WHO) in February 2010, at least 2.-6 billion people die each year from obesity or being overweight. Eating a healthy diet that consists of balanced nutrition can prevent obesity. The implementation of eating a healthy diet requires high discipline and proper guidelines for selecting the right food and controlling the amount of food intake. Individuals must manage their daily food intake accordingly and must follow the correct amount of food intake, which is highly dependent on the seriousness of a given individuals with respect to overcoming obesity. Thus, individuals with serious obesity problems require significant discipline for food intake to achieve successful weight loss. Previous research reported that self-monitoring practices are the most effective way to manage dietary intake. [1], [2], [3]. Burke gives the definition of self-monitoring from diet perspective as, "Self-monitoring is consists of dietary intake and physical activity so that individuals are aware of their current behaviour." [2]. Self-monitoring has also been described as an important practice in developing a behavioural treatment for weight loss that acts like a measurement or cornerstone when adapting the new diet style for diet management. This approach enables the practitioner to review their performance when adapting a

new diet style. Despite the effectiveness of self-monitoring in diet management, practice still requires high motivation when applied to long-term in diet management. Previous research on observing self-monitoring reported that the adherence of a user is declines over time. [2], [4], [5]. The situation occurs as a result of stress, discomfort while recording the information and a lack of social support. [6] To overcome this problem, researchers have conducted several studies on obesity interventions using internet-based tools, which normally includes three main components which combine dietary restriction, physical activity and behaviour [7]. Advances in internet-based infrastructure and accessibility have produce effective web-based health behaviour intervention approaches which help users to overcome previous difficulties. The next evolution of computerized health interventions incorporates mobile technology and health also known as mHealth. Recently, researchers have increasingly begun to use mobile phones as platforms for the delivery of health interventions. According to Riley and colleagues, "Compared to Internet interventions delivered to desktop and laptop computers, mobile interventions have the capacity to interact with the individual with much greater frequency and in the contact of the behaviour". [8]. The usage of mobile phones to assist in self-monitoring for diet management represents a new area of research. There are several reasons why mobile phones are suitable for use as a health monitoring platform. First, mobile phones with increasingly powerful technical capabilities are widely available. Other reasons are considered from the perspectives of individuals, such as people's tendency to carry their phones everywhere, in addition to their attachment to their phones. The context awareness feature that can be enabled through sensing and phone-based personal information also becomes a strong reason for mobile phone intervention in healthcare [9]. Additionally, following the enhancement of both data input and data transmissions, tailored health behaviour changes can be delivered more effectively. [10, 11]. As a result of all of these potential characteristics, many diet applications or self-help and commercial programs have been developed using mobile phones. [12] [13]. Today, many mobile phone diet applications are available in the market or on the internet. Users can download these applications free of charge on their mobile phones. These applications are capable of performing many tasks especially in assisting users in the self-monitoring of daily dietary consumption. However, despite the availability of many mobile diet applications in current market, difficulties remain in solving the obesity problem. This is particularly true in Malaysia where the amount of obese citizens continues to increase each year. Research on the design of an effective mobile phone diet application has started to solve this problem and with the capability of mobile phones to serve as the platform, a new design diet application would be a powerful tool to combat obesity. Before pursuing the main research objective, a review of the existing research conducted on mobile phone diet applications is performed to identify the important approaches that have been used. This review will be discussed at the end of this paper. The identified approaches will be used as the basis for the development of a new model for designing mobile phone diet applications.

II. PROBLEM BACKGROUND

The existence of mobile diet applications for the mobile phone is expected to assist self-monitoring practices to achieve successful weight loss. According to the recent Malaysian obesity statistics, the role of mobile diet applications is insignificant with respect to Malaysian citizens. Research from previous studies has reported that it is difficult for a user to use mobile phone diet applications for prolonged amounts of time. According to Dr. Sherry Pagoto a licensed clinical psychologist and an Associate Professor of Medicine at the University of Massachusetts Medical School, [49] current mobile diet applications possess several weaknesses consequently, mobile diet applications have contributed little to obesity outcomes. One reason is that current diet mobile applications mostly requires high levels of motivation, while the social network is an afterthought. Additionally, individuals may doubt the information provided because too many free diet management applications are available in the market. This statement also supported by Breton, a colleague in their research, who identified that the research has not kept pace with technological innovation, further, Breton has indicated that the efficacy of such approaches has not yet been determined [14, 15]. Lieffers and colleague reported that, "Although new nutrition applications in app stores offer potential benefits, their quality remains largely unknown and caution needed when they are used."[16]. Another researcher mentioned that clinical and commercial weight loss were mostly effective for short-term weight loss, while most individuals regained 40% of their lost weight in the first year and the amount increased in later years. [17, 18]. This finding is also supported by the research performed by Aphramor and Linda, which demonstrates the unreliability of the conventional claims of sustained weight loss. [19-21]. As a result the problems raised, mobile phone diet applications have not lead to success in supporting diet management because the functionality is doubted and unable to maintain the prolonged usage of the application due to decreasing user motivation over time. A lack of research has discussed this scenario. Thus, in reference to the problem, correct approaches must be applied in mobile phone diet applications to ensure that users remain motivated in the management of their diets in addition to obtaining user trust with respect to use of the application. This paper identifies the approaches that were implemented in the previous research regarding the usage of mobile phone diet applications.

III. METHODOLOGY

According to figure 1, several steps were carried out in the production of this paper. The related journal articles by previous researchers were downloaded from various

databases including IEEE, Science Direct, SpringerLink, Nutrition Journal, and SCOPUS. Most of the journals referred that we reviewed was published between 2005 and 2012. Key words such as "Weight Loss Management", 'Online Weight Loss Monitoring", "Mobile Application" and "Mobile Health Applications" (i.e., "mHealth") were used for selecting the journal papers. The themes that we were looking for are "Strategies in implementing mobile phone diet application", "Diet management using mobile phone" and "mHealth in diet management". The important information that was searched in the papers included strategies for using mobile phones to support diet management for prolonged use. Additionally, the information regarding the capabilities and the potential of mobile phones to support diet management were also studied. Overall approximately 150 papers were identified. After reading, the papers were shortlisted according to themes. Unfortunately, very few papers have studied mobile phone diet applications because this research is new within the field. Consequently, only 8 papers were selected, believed to be strongly related to the themes.

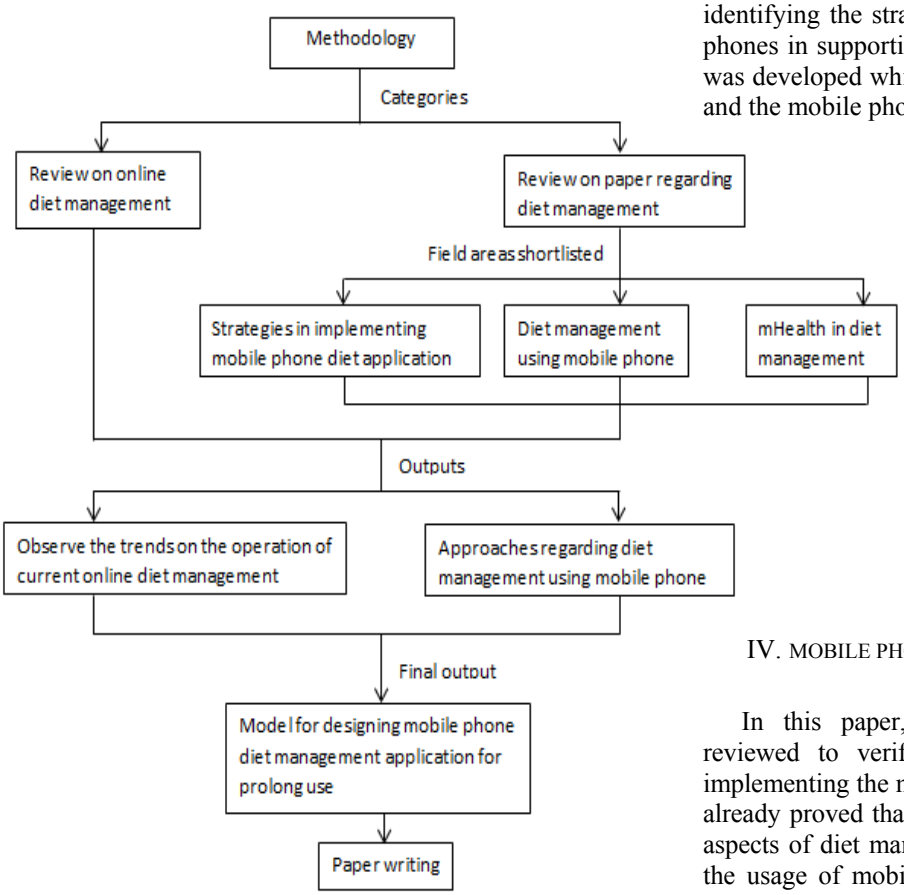

Fig. 1. Research Methodology Diagram

The types of papers involved include articles, experimental research, methodological research, and also research reviews. Approximately 2 papers fell into the "diet management using mobile phone" theme, and 3 papers fall into the "Strategies in implementing mobile phone diet application" theme. Finally, for the "mHealth in diet management" theme, 3 papers were identified. Other than journal papers, few online diet management systems exist, e.g. MyFitnessPal, SparkPeople, Atkins, and Weight Watcher. Mobile diet applications can also be accessed and downloaded in Google play [50] and Android-Get Apps [51] for viewing the operational processes. Although a significant number of online weight loss management applications are available, this research focused only on SparkPeople and MyFitnessPal, because these two online weight loss management applications have been frequently referred to in previous works and also contains many dietary tasks and applications for observation. [22], [23]. The objectives of accessing these two online and mobile phone applications is to observe the functions and task that are available in these systems to support diet management. An Additional goal was to observe the trends and capabilities of mobile phones in supporting diet management. Then, after identifying the strategies and the potential usage of mobile phones in supporting diet management, a conceptual model was developed which contains the mapping of the strategies and the mobile phone technologies.

IV. MOBILE PHONE CAPABILITIES IN SUPPORTING DIET MANAGEMENT

In this paper, several previous publications were reviewed to verify the strategies that were utilised in implementing the mobile diet applications. Previous research already proved that the ICT intervention can improve many aspects of diet management. As technology has progressed, the usage of mobile phones also increased at all levels of age, including among children. Because of mobile phone usage and technology, these devices are becoming increasingly important to healthcare and are now being used to deliver health behaviour intervention. According to Riley et al., "Compared to the internet interventions delivered to

desktop, laptop and computers mobile intervention have the capacity to interact with the individual with much great frequency and in the contact of the behaviour." [8]. With the usage of mobile phones, health behaviours such as self-reporting, psychophysiological state, social context and activity level and behavioural pattern can be delivered more effectively [10]. There are several reasons why mobile phone have very high potential to deliver health behaviour intervention. According to Klasnja and colleagues in their review paper, first the widespread adoption of phones equipped with many features including technical capabilities. Second, people usually carry their phones with them everywhere. Third, people are highly attached to their phones, and the fourth context describes the awareness of the features enabled through sensing and phone-based personal information [9]. After the review of several research papers, the trends and usage of mobile phone were identified and mapped in the diagram below. From the figure above, it can be seen that several aspects of mobile device usage can be applied for weight loss management. For example, SMS and MMS applications were used in the experimental research by [17] which the candidates received messages or pictures related to the topics on weight loss management that they had learned during the activity. The messages serve as reminders and guidelines for the user when practicing their lesson. Calculations can also be performed using mobile applications. For example various applications are available in the android market [51],

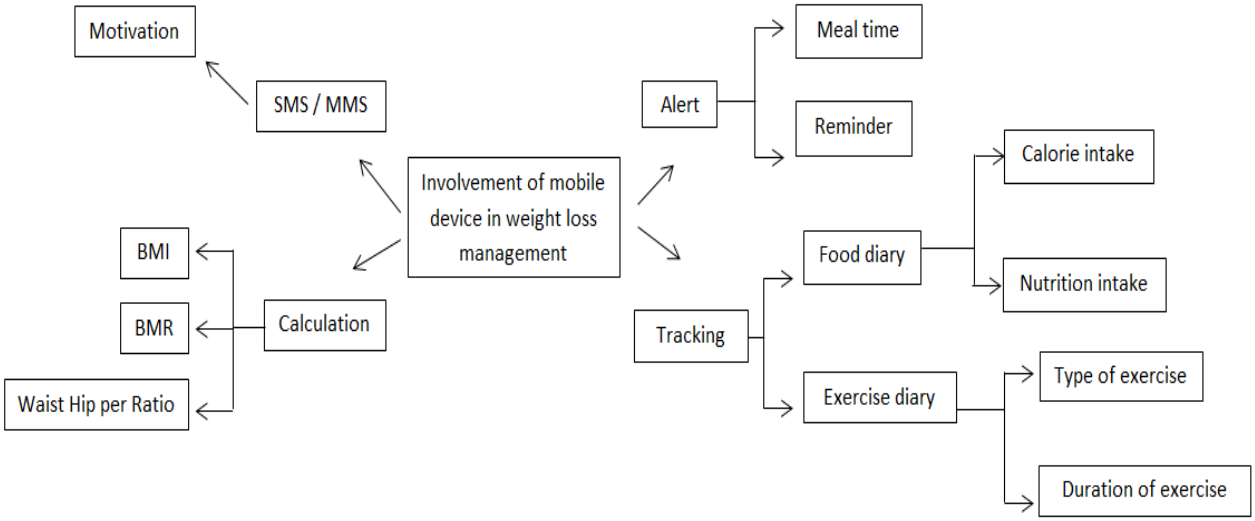

Fig. 2. Trends in Mobile Weight Loss Applications [24]

many of which are capable of calculating the Body Mass Index (BMI), Basal Metabolic Rate (BMR) and Waist Hip Ratio for the user, helping the individual to track their body measurements. Alert applications are usually used to issue reminders to the user, e.g. meal times, medication intake, etc. Other research has used the mobile phone's alert system to inform the hospital about a patient's cardiac status. In this case, the mobile device acquires the ECG signal from the patient and then alerts the system with a direct connection to the hospital [25]. For tracking usage, i.e., a food or exercise diary, the mobile device can attend to the difficulties associated with using the traditional methods which require pen and paper to track food intake and exercise activity. The mobile device should be more convenient for the user because users can track their food intake and activity directly after eating or performing the exercise. Thus, the tracking activity should be more accurate, allowing the user to revise and analyse the records. Several well-known websites that provide mobile applications for the user to track progress, e.g., SparkPeople which has over 15 million registered members [52] and MyFitnessPal which already achieved more than 30 million user [53]. According to Klasnja and Pratt, mobile phones have many capabilities to support health intervention [9]. The potential technologies or capabilities that can be applied using mobile phones for diet management are SMS, cameras, native applications, automated sensing, and internet access. SMS can be used to deliver tips and educational content for diet management.[26] [27] [28] [29]. Camera technologies that are embedded in mobile phones also have significant functionality with respect to diet management. The technologies can be used to journal health-related behaviours, e.g., food consumption. [30] [31]. Additionally, mobile phones can be used to provide health care providers with additional information about a patient's condition. [32]. Finally, the technology can be used to document circumstances that are relevant to the self-management process. [33]. Today, mobile phones can also support sophisticated application because they possess powerful operating systems. Example Apple IOS, Android, Windows Mobile, Blackberry and many more. Accordingly, many applications have been developed according to operating system compatibility. These applications possess a variety of functions that are capable of supporting diet management.

According to Klasnja, four types of relevant applications exist. One is the journaling applications. This type of application enables the user to log and chart data and other health related behaviours and measurements. [34] [35]. Another applications type is the patients terminal for condition telemonitoring, e.g. hypertension, or heart failure [36]. The third type includes applications that receive data from pedometers, blood pressure monitors, and other devices [37]. The last type is games, which are developed to teach health related skills [38]. Other than applications, mobile phones can also act as automated sensors in supporting diet management. Mobile devices can connects with other devices, as receivers and store data for the collection of a variety of health intervention approaches. The functions also be enabled by the detection of user behaviour, even without the use of an external device. Finally, mobile phones can increase user acceptance of health intervention by freeing the user from the need to keep track of, charge, and wear an additional device [39]. Mobile phones also have the ability to establish internet access, the cellular network can be used to connect to the Internet from nearly anywhere. By using an internet connection, the data can also be uploaded to websites where users can easily view, chart, and edit their information. From the review, of the mobile phone diet application, we can see the potential of mobile phone technologies to support diet management. Every technology embedded in the mobile phone is useful in the support of diet management including the simplest application, SMS. With the large demographic using mobile phones, the technology is high potential to be the platform to solve diet management problems at every age including children. The current applications that can be downloaded from the internet tend to perform one task, e.g., counting BMI, tracking food diary, tracking exercise diary and more. Consequently this requires the user to use and download multiple or different applications to monitor the overall diet management tasks. This becomes inconvenient, requiring users to open multiple applications each time to monitor their activities. This might be one of the reasons for the discontinued usage of many applications. To overcome this problem, mobile phone diet applications should be designed with complete tasks and correct the approach to motivate users to manage their diets properly.

V. DIET MANAGEMENT APPROACHES IN MOBILE PHONE

The current trends surfacing from the previous review shows that many activities associated with diet management can be performed using mobile phone. The sources were compiled not only from previous research papers, but also from the applications downloaded from the internet. These activities require a high degree of user motivation for every day performance. Based on the previous research, it has been shown that user motivation tends to decrease over time, tending to stop using their diet applications. In reference to these issues, researchers conducted various investigations to improve mobile phone diet applications in addition to optimising the usage of mobile phones to support diet management. The important approaches used in the implementation of mobile phone diet applications were observed in these work. In other research, the articles have discussed and reviewed the usage of mobile phones in supporting diet management. The table below shows the approaches identified from the previous research in using mobile phone diet applications. Approximately eight papers describe the usage of mobile phones both to support diet management and to verify the approaches used to implement mobile phone diet applications. These approaches are identified in table 1 and are evaluated below

TABLE I. *IMPORTANT APPROACHES USED IN MOBILE PHONE DIET APPS* ABLE TYPE STYLES

Author	Approaches
[9]	i. Tracking health information ii. Involving a healthcare team iii. Leveraging social influence iv. Increasing the accessibility of health information v. Utilising entertainment
[40]	i. Educating people ii. Notifying people iii. Reminding people iv. Collecting data from people v. Journaling by the user vi. Getting answers from a database vii. Getting answers from a person viii. Connecting individuals ix. Connecting groups x. Getting things done
[41]	i. Increasing the awareness of dieting aims ii. Fostering motivation and self-efficacy iii. Impact on a dieters' attitude
[16]	i. training requirement, ease of update, cost application/device quality and capability ii. Proper training and on-going feedback and encouragement iii. Social support mechanisms and personalised feedback iv. Collaboration with nutrition application developer
[42]	The result demonstrates that a daily feedback message delivered remotely can enhance adherence and improve weight loss
[43]	Interactive training to provide extra practice in taking images
[44]	i. Continued contact with the group, therapist, or the programme leader has been shown to be a major predictor of success in weight loss ii. Successful long-term weight loss maintenance has been related to frequent self-monitoring.
[45]	i. Tailored communication is more effective than generic messages in promoting health behaviour change ii. Health communication is effective when it reaches people on an emotional and rational level iii. Interactivity is the most important trait for an effective health behaviour intervention iv. Involvement of the user in the design and engagement with the intervention is important to them to adopt the proposed behaviour

From the table, we can conclude that few important approaches that can be considered in a new mobile phone diet application. According to the work by Klasnja, it is important to track activities for the delivery of health intervention in mobile phones. That is, tracking can also be performed by self-monitoring from the users themselves. By including tracking elements, tracking can provide better understanding and awareness about a user's behaviour. [2] [46]. This elements also appears as an important component of Haapala's research. Furthermore, the leveraging social influence is another of the important approaches to mobile phone diet management applications. Leveraging was applied in the program by having the participants use social interaction with friends outside of the program or with family members. The justification for embedding the strategy is to let the participant change ideas, tips and experience with their friends who already may have achieved weight loss. By incorporating social influence into the application, the user will be exposed to many styles of diet and motivation from peers. Social influence is also implemented in Lieffer's research in which it is believed that it is an important elements in mobile phone weight-loss intervention. Another elements that was identified in the research by Klasnja, was the ability to access health information. This means people will receive informational messages when using mobile phone diet applications via multiple platform e.g., reminders, glanceable displays, SMS and many more. It is believed that, by receiving continuous health information, mobile phone can increase awareness and commitment to health goals [47], which are two

significant elements. These elements mentioned are in three different works, written by Mansar, Lieffers, and Burke, intended for effectiveness in using mobile phone diet applications. The use of entertainment also appeared to be one of the important approaches identified from the review. According to the previous research, the use of entertainment e.g., sending jokes, sport scores and interesting news is believed bring user closer and increased interest in the use of the application. [48] Involving the health care team is another of the elements identified in previous research on mobile phone use for weight loss, as conveyed by Klasnja and Lieffers. Expert user involvement include dieticians, doctors or consultants. Having the healthcare team informed of the user's status, allows effective and rapid care to be provided. [9]. This approach also builds user trust with respect to the use of mobile applications. Continued group contact is another important approach that must be considered because the continuous interaction between others with the same goal is important to maintain the user progress. The interactivity of a mobile application was another element identified in the reviews of two different researches,

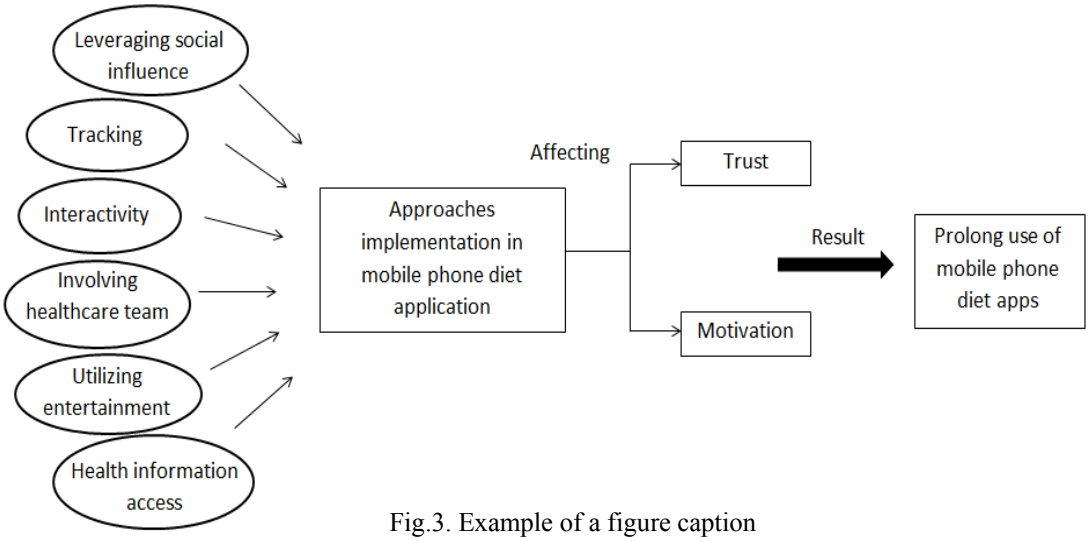

Fig.3. Example of a figure caption

Daugherty and Tufano. According to social influence theory, there is evidence that interactivity may be the most important traits, allowing the user to adopt the desired behaviours. Interactivity is also important in terms of assisting the user faster adaption to the application environment addition to the routine that is recommended or suggested by the application. The identified approaches should enable users to continue the use of mobile phone diet applications over time. All of the approaches identified from the review are discussed in the next section below.

VI. DISCUSSIONS

From the review, most of the current mobile phone diet application are believed to be lacking in these approaches and strategies and can lead users into failure when the application is applied only for short term usage. The current diet applications typically focus on the user's routine because this aspects emphasizes self-monitoring. Ultimately, self-monitoring activities decline overtime. Instead of focusing on the application, the correct approach to deliver the diet application must also be considered. As discussed before, mobile phones have strong capabilities that can assist most diet application routines and, most importantly the self-monitoring practice. The input from the review also shows that most of the implemented approaches do not cover the whole diet management perspective, i.e., they are not holistic. Consequently, this approach often leads to failure, where the user does not use the application continuously. With the information identified from the review, hopefully developers can begin to identify other important approaches that must be considered when developing mobile phone diet applications.

By implementing all of the approaches in one mobile phone diet applications, it is believed that the usage of mobile phone to support diet management will lead to success. Users will enjoy managing their diets daily because entertainment will be included in their daily diet monitoring in addition to the involvement of the healthcare team. The developed application should be able to keep users motivated in the management of their diet while also developing user trust in the use of mobile phone diet applications. With the capability to access health information, the mobile applications must also play a role in educating users and providing users with knowledge regarding healthy diet practices. Mobile phone diet applications can also help in

other ways by applying self-monitoring practices, which are the key to achieving a healthy diet. Thus, by managing their diets every day, users should be able to avoid over-eating situations and the problems associated with obesity should be diminished.

VII. Conclusions

After the review was carried out, several approaches for developing mobile phone diet applications were identified. These approaches hopefully can be implemented within any diet management application. The justification for this is that the developed application will be wasted if the users fail to reach their goals by using it, and who may not receive the important benefits from the application. Hopefully the identified approach can lead to producing effective diet applications that provide many benefits and can be applied for prolonged use.

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