

A Collective Intelligence Framework for Lifestyle and Mental Health Management Systems (FLiMMS)

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Abstract— Mental health information systems are becoming a central fixture in healthcare settings, but only a few frameworks exist to provide innovative and sustainable management system. This study corroborates the knowledge, skills and collaboration of diverse stakeholders to develop a collective intelligence-based framework, (FLiMMS) for the implementation of mental health management system. Composite methods comprising of qualitative and quantitative techniques were adopted at development and evaluations stages. The framework design was covered in two main phases namely; document analysis (analysis of facts existing in the body of knowledge) and empirical analysis (experts' validation using four key parameters; efficacy, effectiveness, simplicity and flexibility). FLiMMS' components are apportioned into three core layers namely; Research- Design-Evaluation (RDE wrapper), Guides and Requirements (G&R), and Diagnosis-Prevention-Alleviation (DPA). Components are flexibly designed with seamless integration possibilities during system development. A face validity index of 0.61 indicates good acceptance by experts, thereby denoting FLiMMS' suitability for mental-health management system, irrespective of development expertise. Although the framework has been successfully evaluated by expert judges to evidence its suitability for system development, it is limited to lifestyle management for mental health. Also, the framework is currently a conceptual representation thus, a further deployment and usability parameters may be implemented at future stage. This work utilised a collective intelligence approach to develop a Framework for Lifestyle Management pro Mental health Systems. It provides developers with a platform for the implementation of mental health systems based on the premise of lifestyle management as a potent approach for managing mental health.

Keywords-component; formatting; style; styling; insert (key words).

I. INTRODUCTION

Subsequent failing of aspects of human health such as intelligence, imagination and thought is considered a mental health disorder [1]. Over the years, mental health disorders

are increasingly becoming popular to be a global phenomenon which humankind must deal with. About 26.2% of the adult population in the US suffers a 'serious' mental illness while 27% in the EU have mental issues[2]. Recent records show the gap between mental health treatment and its accessibility is increasingly becoming wider, currently estimated between 35% and 50% [3]. This gap is often widened by the stigma associated with mental health candidates, ineffective therapies, lack of adequate mental health resources and awareness among other factors. Therefore, a significant proportion of mental disorder candidates are left undiagnosed or those diagnosed receive no attention or treatments.

More significantly, the standard approach of dealing with these disorders include the process of *Diagnosis, Prevention and Alleviation* (DPA), which also has contributed to the shortcomings leading to this exponential gap increase. Currently, common DPA practice involves consultation with healthcare professionals, such as a GP or psychiatrist, who will examine a candidate's situation using the standard tools, for example, the Hospital Anxiety and Depression Scale (HADS) [4], the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) [5] and ICD criteria [6], GAD-7 [7] among other appropriate tools. However, most countries are unable to provide optimal access to these practitioners as almost half of the world's population lives in countries with fewer than 2 psychiatrists per 100,000 people [8].

The work extends existing work, which contends that lifestyle management approach can be an effectual DPA method for mental health disorders. Arguably, often is the occurrence of prominent mental health disorders such as depression, bipolar affective disorder, anxiety, schizophrenia and dementia are rather progressive in human health and not instantaneous. Therefore, in many cases, appropriate lifestyle management will better avert the occurrence, or positively contribute to the management of these disorders. Relatedly, lifestyle management could only be effectively managed by the respective candidate.

As earlier mentioned, appropriate diagnosis and subsequent alleviation of mental disorder requires the participation of skilled medical practitioners whom often are not readily available. However, advances in technology can support in filling the gap. Not only are technology advances necessitating its prominences in various aspects of human

lives including education, business and health, but sensors and hardware components are becoming smaller and more powerful. Furthermore, the existence of artificial intelligence, machine learning and analytics in combination with the power of internet support the importance and effectiveness of technology in all areas of life, particularly its application in health. For example, the smartphone technology combines mobile communication and computation in a handheld device, facilitating mobile computing at the point of care [9]. With the aid of the internet, mobile devices support different communication and online activities such as computer-based cognitive behavioural therapy (CBT), which has proven to be clinically effective as face-to-face treatment of a variety of mental disorder [3].

While technological approaches in the health sector are becoming increasingly popular for their effectiveness, associated low-cost and the ability to reach a larger audience, the lack of development standards has put many of the existing tools into question regarding their efficacy, effectiveness and acceptability. For instance, a simple online or mobile application diagnosis of a mental disorder is prone to challenges such as inaccuracy, exaggeration or misrepresentation that can sway diagnosis thus, constituting tremendous negative effects. To curtail such problems, this work presents a research-oriented Framework for Lifestyle Management pro Mental-health Systems, FLiMMS. The framework adopted a collective intelligence approach by utilising knowledge of various stakeholders, existing systems and other components. The following section explores some existing mental health systems and the importance of a standard framework for developing an effective mental health system for lifestyle management.

II. CURRENT MENTAL HEALTH SYSTEMS AND FRAMEWORK IMPORTANCE

Health information systems are becoming a central fixture in the healthcare setting, but only a few frameworks currently exist to help with their implementation and adaptation to innovative solutions. Integrating mental health information systems into primary care has shown growing evidence, which is now becoming an important way of treating mental health conditions such as depression [10]. Nevertheless, lower healthcare costs in addition to other benefits such as; improved adherence to medications, early-diagnosis, and better patients/treatment follow-ups. While mental health systems and their development require suitable infrastructures, effective policies and perhaps cutting-edge technologies, the acceptance of new technologies for diagnosis, prevention and alleviation of the condition by the stakeholders is still very low for several reasons.

With technological advancement such as the development of fast internet and 5G network, patients are now able to receive remote support/treatments in real-time for

conditions that do not require the physical presence of physicians from anywhere. For example, in recent times, the delivery of Cognitive Behavioural Therapies (CBT) over the internet has been proven effective [11] and internet-based CBT protocols have been widely adopted to date [12]. In additions, numerous Behavioural Intervention Technologies (BITs) - a technological application of behavioural and psychological intervention to address behavioural, cognitive and affective targets - are currently being adopted to treat or support physical, behavioural and mental health disorder situations [13]. Not only do these recorded advancements in ehealth related to internet infrastructures, further significant progress is being recorded in the areas of mobile, hardware and sensor devices. For instances, the traditional method of examining blood alcohol, nicotine and vitamin D levels are gradually being substituted using more technological means. Recently, Samsung released its smartwatch for measuring blood pressure [14]. In additions, devices such as [15] [16] [17] can carry out activities including the measurement of vitamin D level and other physiological activities.

Nowadays, smartphones have become readily available devices for ehealth, particularly the management of mental health disorders. Such platforms provide management opportunities similar to a face-to-face therapy in diagnosis, prevention and alleviation of mental health disorder [3]. They are also configurable with regards to triggering momentary interventions to assist mental health candidates in difficult and stressful situations. Accomplishing urgent treatments evidently justifies the importance of technology in the management mental disorder. Though numerous mobile applications have been created for mental health management (diagnosis, prevention and alleviation) in recent times, many of these applications potentially risk mismanaging its users' mental state perhaps, through misdiagnosis or unsuitable alleviation techniques. Such mismanagement could worsen the situation of these vulnerable users thus, leading to a potential health relapse through mismanagement.

The Google Play and the Apple Store represent hosting platforms for numerous Android and Apple health apps respectively. Jessica Shelton of Psycom analysed the top 25 mental health apps in 2018 [18] and classified these apps into categories including general mental health, addiction, anxiety, suicide prevention, depression, bipolar disorder and obsessive-compulsive disorder apps among other categories. In these categories are apps such as Self-help for Anxiety Management (SAM), CBT Thought Record Diary, MoodKit, IMoodJournal and Talkspace Online Therapy among others [18]. Although some of these apps are accessible to users at a cost, others may available to public mobile users for free in order to improve life-quality of users and their mood in general. For example, "*Depression CBT Self Guide*" is a pocket guide to help users learn about CBT and how to cope with depression. It also allows people to measure the severity of their depression and helps them to develop positive thoughts and encourages them to practice

meditations. Other apps such as “*Positive Thinking*” or “*Operation Reach Out*” have been highly rated on the Google store [19]. While the latter provides support to veterans and military personnel who suffer depression via different resources such as hotlines, videos, “*Moodkit*” in Apple Store provides more than 200 mood improvement activities to modify distressing thoughts.

Apart from the aforementioned mobile applications, other highly rated and readily available mental health mobile apps include depression test, which present users with diagnosis and progress tracking functionalities; *Moodtrack diary* [20] and depression screening test [21], that track progression of activities and diagnosis respectively. *Pacifica* [22] and *Relieve depression PRO* [23] provide prevention and alleviation functionalities, however without diagnosis or personalisation functionalities. While many of these apps support users following their different techniques, there is no known standards or framework typical to these systems. Moreover, profounder information of their implementation or policies adopted for deployment are not generally publicised. This work presents a collective intelligence based framework, which aims to provide development standards for mental health management system using lifestyle management approach. The following section illustrates the methodology adopted for this work including collective intelligence approach and its role in the framework development.

III. METHODOLOGY

Different study methods can be utilised at various phases of a research life cycle. For this work, a multifaceted mixed methods approach was adopted, although, classified into two main phases namely; 1) documentary analysis and 2) empirical analysis. While the documentary study phase involved the analysis of existing facts in the body of knowledge, empirical analysis involved qualitative and quantitative evaluation of knowledge derived from documentary analysis and the developed framework. Following the concept of collective intelligence i.e., knowledge, skills and collaboration outputs of diverse individuals, a framework for lifestyle management pro mental health has been developed.

A. Document Analysis

Methodical approach for literature analysis such as PRISMA [24] aids the narrowing down of intended research contents to most relevant fields. Although the concept of PRISMA was adopted in terms of the four cardinal stages (identification, screening, eligibility and included), multiple varying keywords were employed at different stages to improve the robustness of document inclusion. Reputable repositories and documentary platforms (including British Library [25], German National Library of Science and Technology [26], Google scholar [27] among others) for white papers, journal and conference articles on mental

health efforts in the body of literature were researched and analysed to identify key mental health concepts. In addition to general mental health effort analysis, specifics of mental health disorders including depression, bipolar disorder, sleeping disorder, and schizophrenia, among other conditions were evaluated. Key concepts including definitions, symptoms, appropriate methods of diagnosis, prevention and alleviation were also investigated. Health and system development policies, standards, system design methods, guidelines and system requirements were thoroughly evaluated to derive the components comprised in the framework for lifestyle management pro mental-health systems. In addition to the effort of the framework development, a further scientific evaluation was carried out to appraise the framework’s reliability as explained in the following empirical analysis.

B. Empirical Analysis

In order to rigorously validate the efficacy and effectiveness of the framework, multiple empirical validation methods were adopted, including; survey, discussion group and data triangulation. In addition, other qualitative and quantitative validity models were adopted including face and content validity index. A thematic survey was designed and utilised to gather general users’ perspectives and understanding of technology adoption for managing mental health and its disorders. While there isn’t a general exclusion criterion for the survey participants, a limitation of conducting the survey online limits the respondents to technology informed candidates with minimum knowhow of operating a basic application (mobile or web application). The survey outputs and documentary analysis aided the framework development, which was further validated using empirical methods including secondary survey, discussion group and data analysis. A user validation survey was completed by twenty-six expert judges (software engineers and developers of varying level of expertise) followed by three discussion groups of expert judges with varying expertise. Although the outputs of the survey and discussion groups were later triangulated to justify the validity of the instrument, the questions’ reliability were further measured using Cronbach’s alpha. The following section considers the output of the document analysis as a significant component of a collective intelligence approach in the framework development.

IV. COLLECTIVE INTELLIGENCE

The concept of *Collective Intelligence* is the use of skills, knowledge and collaboration of several people to solve a problem. Although the concept has existed for decades, its recent combination with machine learning intelligence has been catalyst for generating new and more interesting facts. Nowadays, advances recorded in technological visions, computing powers and machine learning abilities

(collecting/analysing data from millions of records over the cloud) has opened up new possibilities of finding solutions to modern-day problems [28]. For instance, the health sector has been one of the various industries that has benefited from the concept of collective intelligence for system improvement, where collaborations between individuals and companies have led to the development of numerous smart algorithms in health care. For example, machine learning techniques are today utilised to predict and prevent the worsening of disease's symptoms, and to reduce rate of hospitalisation and mortality.

Mulgan highlighted 5 factors of collective intelligence, which are crucial to solving problems [29]. These factors include (i) *Autonomous Commons*: elements of a collective intelligence platform should be given the chance to grow, become more refined and not subordinated by ego or hierarchy; (ii) *Balance*: a spread of data, judgement, analysis, creativity and memory; (iii) *Focus*: encouraging tasks priorities among different groups but also knowing what is relevant at different scales; (iv) *Reflexive*: the ability to question any patterns or abnormalities and changing the ways people think and finally; (v) *Integrate for action*: developing concepts through experiments rather than relying solely on logic [29]. On embracing the concept of collective intelligence, i.e. the knowledge, skills and collaboration outputs of diverse parties, the work contends that development and accesibility of effective mental health system should take these factors into consideration. Subsequently, a multifaceted data gathering method and analyses of existing mental health management approaches in the body of knowledge presents a rich background for developing an effective framework, upon which mental health management system can be based.

A review of mental health literature revealed the reluctance of mental disorder patients in seeking support when experiencing emotional or mental health difficulty. Stigma, negative perceptions, self-reliance, and lack of awareness are the foremost factors in the reluctance of adults in seeking help [30]. Embracing the concept of collective intelligence for the development of health systems englobes human resources, finance, medicines, technology, service infrastructure as well as the intangible assets of ideas and interests, relationships, policies, values and people centred norms as identified by Glenn [31]. Such encirclements does not only unveil the benefits and limitations of electronic health care systems, perhaps, barriers and facilitators between the users and the systems are recognised. This work adopts a concept from Glenn and Mulgan's five factors of collective intelligence to analyse past mental health care sytems and services, the current systems and the proposed future solutions of mental health and disorder management (**Error! Reference source not found.**). In the following section, barriers and facilitators of healthcare-system development are identified and highlighted



Figure 1:

V. BARRIER AND FACILITATORS

People's mental health has been considered a vital aspect of general health yet, current health care providers do not possess adequate measures to cope with the existing burden of mental disorders. Since mental health conditions range in a spectrum such as, mild depression to extremely severe states such as schizophrenia, different conditions require different management plans i.e., diagnosis and treatment plans. Therefore, a seamless integration of mental health services into primary care to bridge the management of treatment gaps is required [32]. For instance, the NHS in the UK provides mental health services (including dealing with problems such as drug, alcohol addiction and psychological therapies - IAPT) for patients but access to most of these services are through local GP referral [33]. However, to effectively manage the current mental health burdens, a seamless user-treatments interface is necessitated, and technology advancements have proven to be best suited for this situation. While technology can facilitate seamless management of mental health conditions, some barriers can also be identified as hinderance in diagnosing and treating of mental health situations. In order to identify the barriers and facilitators for mental health system development, the SURE (Supporting the Use of Research Evidence) framework is utilised to aid mental health system design through the involvement of a wide range of stakeholders [34]. The SURE framework was mainly developed for implementing health system changes and help in policy making in Africa [32]. Table 1 highlights various barriers and facilitators of mental health system implementation. Among these factors are segregated care, lack of finance and resources, policy makers, privacy and acceptance issues, among others are identified to be hindering factors (barriers) for mental health system and its development. However, factors including data access, end users' motivation, strong technological infrastructure and the collaboration of medical and IT professionals could accelerate successful implementation of a mental health management system. Collectively, knowledge accrue through document analysis and the evaluation of barriers

and facilitators are considered for the development of Framework for Lifestyle Management pro Mental-health Systems (FLiMMS) as described in the result section.

Table 1: Barriers and Facilitators in implementing Mental Health Systems

| Barriers | Evaluation from Research Work |
|--------------------------------------|--|
| Segregated Healthcare | The perception that mental health is separate from mental health systems informs the lack of integration of both concepts [10], [35] |
| Financial Resources | The limitation in budget leads to the lack of developing integrated mental health care systems. [10] |
| Bureaucracy (Policy makers/planners) | High cost of medical care attributed some policies procedures and decision making makes the implementation of mental health systems harder [38] |
| Norms and Standards (HL7) | There are certain norms and standards that need to be followed when implementing mental health system for system interoperability which can be implemented with the right experts' skills. [32] [40] (World Health Organization., 2012) |
| Privacy and Security | There are concerns about the privacy and the security of the systems that deal with confidential and personal information. [41] |
| Technology Acceptance/ Change | There are usually mixed views about the use of new information systems i.e., organisation staff very often show unwillingness to adapt to changes or lack of time/interests.[41] |
| Credibility/Appro priateness | The appropriateness of technology needs to be assessed in order to solve particular problems faced by mental health professionals. There is little evidence that supports the efficiency of tools used to support patients suffering from mental health issues.[41] [44] |
| Facilitators | Evaluation from Research Work |
| Technological Infrastructure | Mental health systems can be integrated with other sub-systems through the exploitation of technology such as IoT, cloud and 4G. [36] |
| Knowledge/ Skills | The knowledge and skills of different experts such as Psychologists, Physiotherapist, GPs, Nurses, Patients and Software Companies can help to design mental health system to suit the needs of patients. (World Health Organization, 2012) |
| Motivation | Current healthcare professionals should be able to understand the benefits of using such a system to be motivated to use it. [39] |
| Data Access | Integrated mental health care systems may facilitate access of patients' data [36] at any time and from anywhere as far as there is an internet connection. |
| Training | Training can facilitate the knowledge exchange and helps motivate staff to use the new system. [42] |
| Collaboration | The collaboration of different stakeholders such as pharmacists, psychologist, nutritionists, GPs, designers, programmers, can facilitate the implementation of a mental care system. [42] [43] [36] |
| Resources/ Government Strategies | With a time frame and appropriate resource allocation, strategic plan with clear objectives can facilitate the implementation of mental health system. [45] |

VI. RESULTS

The outcome of the research work is divided into two, namely; framework and its evaluation. The framework section explains the core components of FLiMMS including the Research Design Evaluation (RDE) wrapper, Guidelines and Requirement (G&R), and the Diagnosis Prevention Alleviation (DPA) layers. The evaluation section covers analysis of the framework using expert judges. Subsequently, the derived results from expert judges are subjected to further analysis to improve confidences of framework effectiveness.

A. Framework for Lifestyle Management pro Mental Health System (FLiMMS)

Iterative document analysis of mental health literature, system development concepts and the derivation of facilitators and barriers in conjunctions with the findings of the user survey aided the development of a Framework for Lifestyle Management pro Mental-health System (FLiMMS). Not only do these factors guided the identification of the framework's composition, but they also aid the classification of its components into layers that improves the implementation of a robust mental health management system. Although FLiMMS's components are apportioned into three layers namely; RDE wrapper, Guides and Requirements (G&R), and DPA layers, each layer is flexibly represented to allow seamless integration when it comes to system development. The following sections describes FLiMMS's components in their corresponding layers as depicted in Figure 2.

Figure 1: Framework for Lifestyle Management pro Mental-health Systems

- RDE Wrapper
The RDE wrapper is the outermost layer shielding all components of the framework. The wrapper is consisted of three basic features namely; **R**esearch, **D**esign and **E**valuation. Fundamentally, developers

are expected to consider the wrapper layer as a pilot to the development of lifestyle management systems, irrespective of the types of mental health or systems. The **Research** component considers the aspect of mental health (states, disorders and types etc), Users (candidates, practitioners and other stakeholders) and systems. Considering the dissimilarity in the types of mental-health and the diversity of the stakeholders (candidates, users, medical practitioners etc.), developers are required to conduct intense research about specifics of mental health focus, system to be deployed and the needs of the potential system users. Whereas the **Design** component expects that the process of the development of any mental-health supporting system should be less demanding and moderately automated, aspects involving user interaction such as, the GUI (Graphical User Interface) has to be simple and intuitive. Considering the users' state, it is expected that interfaces should be undoubtedly simple and usable in order to avoid any aggravation of the stakeholders' states. Concepts such as colour impacts, fonts, navigation, interface-perception and overall comprehension of the system are expectedly to be thoroughly thought through, i.e. significant research will be considered in the process of design. Finally, the **Evaluation** components permits the researched and designed elements of the proposed system to be comprehensively appraised in order to ensure its suitability for the intended users. The RDE wrapper is considered a core for developer of mental health system to consider, irrespective of the disorder type.

- Guidelines and Requirements (G&R)

The G&R is an intermediate layer that integrates the RDE and DPA layers of the framework. It considers technical and medical requirements for a mental health management system through major components namely; Policies & Standards, Experts Advice, Ethics, and Security & Privacy. The layer permits seamless integration of supports, medical and technical requirements as a single system for effective management of mental state.

Since standards and medical guidelines vary by country [46], medical prerequisites from a given country or a region's perspective is imperative. For example, while NICE [47] in the UK recommended that healthcare professionals provide information, advice, diagnosis and treatment for patients, Mental Health in America (MHA) develops guidelines to identify mental health measures [48]. Also, the APA provided evidence-based recommendations regarding psychiatric disorders assessments [49] and the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) to diagnose or classify mental disorders. Therefore, medical tools and contents need to be stringently evaluated and validated.

Similarly, the system's technical requirements are considered in terms of generic and specific

standards. International standards in terms of software and hardware's requirements, system accessibility, scalability, interoperability and technology acceptance are rigorously considered. Further to technical reequipments, the Security & Privacy of the users is considered paramount. The sensitivity of mental health conditions demands a robust Ethics and Security architecture. Therefore, the data handling process of the system should consider user's data privacy, encryption algorithms and access level amongst other factors.

Finally, developers need to understand that lifestyle management for mental health issues are not to displace practitioners but to enhance their roles in dealing with mental health situations. Therefore, FLiMMS requires that systems based on the framework facilitates easier communication process between stakeholders, i.e., practitioner (GP, psychiatrist, career) and patients. Other support features including automatic management of sleep rate, diet, exercise and other lifestyle factors. The DPA layer expands on some support components of the framework, particularly, the lifestyle factors that correlate with mental health situations.

- Diagnosis Prevention Alleviation (DPA) Layer

Lastly, FLiMMS consists of an additional layer, DPA Layer, which is comprised of three major components namely; **Diagnosis**, **Prevention** and **Alleviation**. These components consist of other sub-components including tools for determining a mental health disorder's presence and severity, its symptoms, prevention and progress managements. The subcomponents assist DPA activities which is similar to the traditional approach i.e., examination of mental health symptoms and its severity. Therefore, mental systems considering diagnosis should have a means of examining mental health symptoms and their severity. Furthermore, the framework embraces flexible techniques to allow developers adopt a preferred standard diagnostic tools/questionnaire such as DSM-5 [5], ICD-10 [50], the Beck Depression Inventory, BDI [51], PHQ-9 [52] and GAD-7 [7], among other tools. In order to maintain robustness, the flexibility of the framework transients the prevention and alleviation components. Since the framework focuses on mental health through lifestyle management approach, it is expected that emphasis is laid on preventions and alleviation methods through lifestyle management. Indicated lifestyle factors to be considered include nutrition, exercise and sleep rate among other factors. For example, the study conducted by Jacka et al, reflected significant association between diets and mental health management [53]. Similarly, Tanaka and Freeman [54] [55], found correlations between sleep rate and mental health management. Taking a cue from these studies, the framework considers fundamental lifestyle factors such as sleep

rate, activities/exercises and stress management as core, although it flexibly allows the inclusion of further activities. Finally, personalisation and progress tracking are considered for all DPA components i.e., the process of *Diagnosis*, *Prevention* and *Alleviation* are personified, and FLiMMS-based system should provide progress-track functionality to manage lifestyle activities, perhaps, in correlation with the user's mental health state. The following section discusses FLiMMS' evaluation to ensure its robustness for mental health system development.

B. FLiMMS Evaluation

In order to determine the usefulness of FLiMMS for system development, holistically, a face validity evaluation was conducted using expert judges to ensure robustness. Mixed-methods comprising qualitative and quantitative techniques were adopted for evaluation using four key parameters namely; efficacy, effectiveness, simplicity and flexibility. Quantitative and qualitative instruments explicitly; survey, and focus group were independently utilised respectively; and outcome of both methods were triangulated to improve the results confidence level. The survey procedure and results were discussed in the survey section as follows.

- Survey

Twenty-two expert-judges (software developers with varying level of expertise) participated in a validation survey comprising of a 22 item-question. A significant proportion of the questions are multidimensional that transcend multiple evaluating parameters, a few were of unidimensional. **Error! Reference source not found.** illustrates the item-questions and corresponding parameters intended for evaluation. For example, the 'knowledge and expertise' dimension aims to identify the level of expertise and knowledge of participants through questions 1, 2, 3 and 5, while question 4 primarily focused on measuring participants' perception of the framework and its suitability. Twenty-one participants completed their evaluation by providing answers to all item-questions, though one participant's uncompleted item-questions were excluded from the data analysis. Although some questions are multidimensional, the questions are validated to be internally consistent and reliable with a Cronbach's alpha score of 0.95. Figure 3a and 3b depict the overall perception's rating (Question 4 only) and evaluation of parameter rating respectively. Twenty-one participants completed their evaluation by providing answers to all item-questions, though one participant's uncompleted item-questions were excluded from the data analysis. Although some questions are

multidimensional, the questions are validated to be internally consistent and reliable with a Cronbach's alpha score of 0.95. Figure 3a and 3b depict the overall perception's rating (Question 4 only) and evaluation of parameter rating respectively.

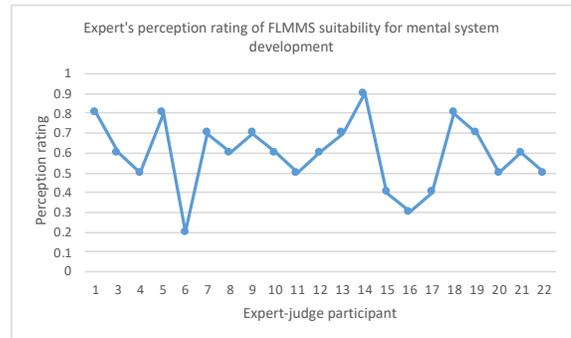


Figure 3a: Experts' perception of FLiMMS

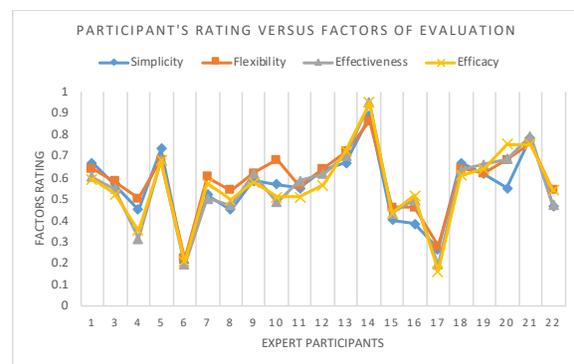


Figure 3b: Rating of Evaluation factors

The Pearson correlation co-efficient of the overall perceptions and combination of evaluating parameters (i.e., rating in flexibility, simplicity, effectiveness and efficacy) is 0.79, indicating a high positive correlation [56]. Not only does the recorded high correlation indicate a true suitability of the framework but also strengthens the success of the evaluating parameters. Figure 3c represents the correlation between the perceptions and evaluating factors while figure 3d represents the correlation between participant's knowledge & expertise and their perceptions.



Figure 5:

Finally, a matrix representation of the coded data as shown in Table 4., indicated high relationship between effectiveness and efficacy, simplicity, expertise and level of perception. There is quite low association between expertise and mental health knowledge, which further justifies easier deployment of the framework irrespective of mental health practicing knowledge.

Overall, results from both qualitative and quantitative evaluation indicate the suitability of the framework for mental health system deployment pro lifestyle management. The framework's robustness is further evidenced through expert judges review with no preference to the level of expertise.

VII. CONCLUSION AND FUTURE WORK

Over the years, the advancements in technology have led to its substantial deployment of clinical and health management systems. Technology adoption for managing lifestyle in line with human mental well-being is increasingly becoming popular in modern society. However, several existing mental health systems were developed without a known development reference. This work classifies lifestyle management as a potential approach for mental health management and presents a Framework for Lifestyle Management pro Mental health by applying a collective intelligence approach. The framework was evaluated using parameters including holistic perception, flexibilities, simplicity, efficacy and effectiveness. The face validity indicated a good acceptance index by expert judges, indicating the suitability of the framework. Also, there is negligible correlation between judges' level of expertise and their perception of the framework's efficacy, therefore, mental health management systems' development is made easy with FLiMMS, irrespective of development expert or mental-health knowledge. Although the framework has been successfully evaluated by experts, usability represents an important parameter that was not adequately examined. Therefore, the technical implementation of the framework for system development is imminent in future work.

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Table 3: Survey questions recapitulated with dimensions of evaluation for FLIMMS

| No | Expert-judge questions | Experts' knowledge & expertise | Evaluation parameters pro questions correspondence | | | |
|----|--|--------------------------------|--|---------------|-------------|------------|
| | | | Efficacy | Effectiveness | Flexibility | Simplicity |
| 1 | Expert's level of expertise of Web/Software/System development | √ | | | | |
| 2 | Expert's experience of clinical & MH system development | √ | | | | |
| 3 | Expert's knowledge of MH disorders, characteristics & symptoms | √ | | | | |
| 4 | Expert's perception of utilising the framework for developing MH management system | - | - | - | - | - |

| | | | | | | |
|----|---|---|---|---|---|---|
| 5 | Expert's knowledge of MH Standards and its availability | √ | | | | |
| 6 | Technology acceptance & change within the framework | | √ | √ | | |
| 7 | Acceptability of the framework by system developers for MH system development | | √ | √ | | |
| 8 | Credibility of Framework for MH system development | | √ | √ | | |
| 9 | Framework acceptability (Question 'g' repeated) | | √ | √ | | |
| 10 | User's privacy consideration for MH system development | | √ | | | |
| 11 | Provisions of guidelines for developers of MH system | | √ | | | |
| 12 | Skill & knowledge enhancement for developers of MH system | | √ | √ | √ | √ |
| 13 | Motivation and support for developer in developing MH management system | | | √ | √ | |
| 14 | Resources consideration for development of MH system | | √ | | | |
| 15 | Guide to MH Policies & Strategies for developing MH system | | √ | √ | √ | √ |
| 16 | Easy of comprehending framework for MH system development | | | | | √ |
| 17 | Expert's perceived usefulness of the framework for MH system development | | √ | | | |
| 18 | Effectiveness/efficacy of the framework for developing MH Diagnosis | | √ | √ | | |
| 19 | Effectiveness/efficacy of the framework for developing MH Prevention | | √ | √ | | |
| 20 | Effectiveness/efficacy of the framework for developing MH Alleviation | | √ | √ | | |
| 21 | Effectiveness of the framework for developing MH system holistically | | | √ | | |
| 22 | Expert's ideal characteristics of framework for MH system development | | √ | √ | √ | √ |

Table 4: Matrix representation of themes' association via coded data

| | Expertise | MH knowledge | Expert perception | Flexibility | Simplicity | Efficacy | Effectiveness | Other factors |
|-------------------|-----------|--------------|-------------------|-------------|------------|----------|---------------|---------------|
| Expertise | - | - | - | - | - | - | - | - |
| MH knowledge | 2 | - | - | - | - | - | - | - |
| Expert perception | 16 | 5 | - | - | - | - | - | - |
| Flexibility | 4 | 0 | 10 | - | - | - | - | - |
| Simplicity | 4 | 0 | 11 | 10 | - | - | - | - |
| Efficacy | 7 | 3 | 8 | 5 | 6 | - | - | - |
| Effectiveness | 20 | 4 | 17 | 7 | 12 | 18 | - | - |
| Other factors | 6 | 0 | 6 | 5 | 10 | 8 | 15 | - |