Designing an Online Community Checklist Tool (OC2T) Based on Online Communities Implementation Framework Using Three-Tier-Architecture

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Abstract This research introduces an Implementation framework (IF) to evaluate the sustainability of online communities. The appropriateness and importance of the components in the IF are validated by four experts from the academia and industry. Based on these findings, a prototype called Online Communities Checklist Tool (OC2T) is developed and evaluated. A user acceptance test using the Perceived Usefulness and Ease of Use (PUEU) instrument conducted with fifteen developers’ demonstrated overall feasibility and acceptability of the prototype. Results further reveal that the OC2T is beneficial in evaluating the sustainability of online communities. Finally, to sustain a successful online community, the present study aids by assisting organizations in their policy making through positive engagement of users involving online communities and to embark into OC2T components to prevent online communities from failing.

Keywords System design · Online communities · Checklist tool · Three-tier-architecture · Implementation framework

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1 Introduction

The models that predict constructs of individuals’ acceptance are predominantly based on pre-adoption intention and behaviour rather than post-adoption. Although within the field of Information Systems (IS) a number of continuance models have been developed and tested for efficacy the capabilities of these models are limited because its underlying conceptualization of predicting acceptance behaviour underestimated social related influences [1]. The lack of social related influences in continuance participation models affects the sustainability of online communities. Moreover, many online communities that spring up fail due to the limitation and lack of attention given for social needs of individuals.

To overcome the mentioned limitations, a Continuance Participation Model (CPM) for online communities was presented and evaluated which is beyond the scope of this paper, but described elsewhere [2]. The model attempted to define the relationship between the Theories of Planned Behaviour (TPB) and Social Support (SST) alongside satisfaction and perceived value constructs towards the continuance participation intention and behaviour of online communities. By grounding the related constructs from the established models, the TPB model emerged to be the most appropriate model to explain on the continuance participation of online communities.

In IS, the TPB is heavily utilized and applied to study, explain and predict decisions of acceptance, adoption, and use of technology systems and other digital services [3456]. In addition, a related recent study integrating TPB and perceived value construct conducted by Al-Debei, Al-Lozi [5] on Facebook explained on the continuance use of online communities. Furthermore, the Satisfaction construct from the IS Success Model extends the TPB to explain continuance participation in online communities.

From the assimilation of observation, discussion and extensive literature review undertaken it is apparent that the inclusion of Social Support constructs contributes to the positive engagement of users in their online community which strengthens the reliability of the continuance participation model. Evidently, behavioral science and individual psychology also suggest that Social Influences and Personal Traits are potentially important determinants of adoption of a new system [7, 8]. For this study, the integration of the Social Support constructs from the Social Support Theory namely the Emotional and Informational constructs were considered for examining the Continuance Participation Intention and Behaviour constructs.

The addition of these two constructs with the integration of the Theory of Planned Behaviour, Perceived Value and Satisfaction construct were seen to be significant and has the potential to influence the continuance participation of online communities. The constructs contributing to the model is identified based on extensive literature review and Average Congruency Percentage (ACP) verified and validated by three panels of experts [2].

This study was established on a positivist approach in which a quantitative methodology was used to investigate the correlational paths [9]. Using a probability sampling
method, data was collected from 385 users of social networking sites (SNSs) with a minimum of two years of experience [10]. Hypothetical relationships were examined using Structural Equation Modeling (SEM) based on the Partial Least Squares (PLS) [11, 12]. The study findings indicate that the CPM achieved an acceptable fit with the data and specifically 9 out of 10 hypotheses were met [13].

The empirical evidence also reveals that social support constructs measured by informational and emotional support exert significant effects on the intention and behaviour as well as exerts positive effects on perceived value and the intention to continue participating in online communities.

Subsequently, this research introduces an Implementation framework (IF) to evaluate the sustainability of online communities. The appropriateness and importance of the components in the IF are validated by four experts from the academia and industry [13]. Based on these findings, a prototype called Online Communities Checklist Tool (OC2T) is developed and evaluated. A user acceptance test using the Perceived Usefulness and Ease of Use (PUEU) instrument conducted with fifteen developers’ demonstrated overall feasibility and acceptability of the prototype.

Results further reveal that the OC2T is beneficial in evaluating the sustainability of online communities. The structure of this study is presented as follows: section two discusses related literature review leading to the development of OC2T. Section three discusses the design principles required to develop the OC2T system. Section four explains the methodology adopted in the study. Section five provides research findings and analyses. Finally section six presents discussion of research limitation and conclusion of study.

2 Literature Review

2.1 Continuance Participation Model (CPM)

The extensive literature and analysis conducted in [2] contributed to the development of CPM. The CPM consists of the constructs from the Theory of Planned Behaviour (Attitude, Perceived Behavioural Control and Subjective Norms), Social Support (Emotional and Informational), Satisfaction and Perceived Value as the independent variables and Continuance Participation Intention and Continuance Participation Behaviour as the dependent variables [5, 141516].

Each of the independent variable has been tested and reported to influence the continuance participation intention and behaviour and therefore is crucial for ensuring the sustainability of online communities [2, 17]. Figure 1 depicts the CPM with supporting constructs and relationships.
2.2 Implementation Framework (IF)

The Implementation Framework (IF) provides an abstract view on the pertinent components required for ensuring the sustainability of online community sites. This framework collaborates with the findings which contributed to the development of CPM, as shown in Fig. 1. The purpose of this framework is to enable online community developers to evaluate the sustainability of online community sites as well as be informed on the components required for successful online community sites.

The IF is as depicted in Fig. 2. This framework is an integration of the constructs influencing the Continuance Participation Intention and Behaviour of the CPM (refer to Fig. 1) and Continuance Participation Analysis Process which consists of the measures, weighted checklist [18] as well as assessment of results [17].
2.3 **Online Community Checklist Tool**

The Online Community Checklist Tool (OC2T) is a prototype developed based on IF. Since the IF is developed based on validated CPM and literature review with the appropriateness and importance of its components verified by social commerce experts (partly the users) hence it is considered that the prototype is developed after performing initial analysis where user requirements are gathered [13, 17]. The prototype is developed in accordance with the processes proposed by Sommerville [19]. The section to follow discusses the initial analysis process, functional specifications, system architecture and software design of the prototype.

3 **Design Principles**

3.1 **System Architecture**

The system architecture of OC2T is based on three tier architecture. Three-tier is a client-server architecture in which the Presentation Layer, Application Layer and the Data Layer are maintained independently. In a web based application, the presentation layer is content rendered by the browser. For OC2T, the content is generated both statically and dynamically depending on the functions. Figure 3 illustrates the three tier architecture of OC2T.

The presentation layer is the user interface of the application. Users of the OC2T can access the application through the web browser on their computer. The web browser supports Hyper Text Markup Language (HTML).

3.2 **Software Design**

The use case diagram represents the specific flow of events in the prototype. For OC2T, the main actor is the web developer. Figure 4 shows the use case diagram for OC2T. Users of OC2T are able to login, update password, take checklist as well as view present and past results.

The overall content and navigation structure of OC2T is as depicted in Fig. 5. Referring to Fig. 5, users of the prototype in this case the web developers will first have to login into OC2T. They will then proceed to take the checklist or update their login password details. Following that, results are displayed for present and future viewing so appropriate decisions can be taken.
Fig. 3  System Architecture for OC2T

Fig. 4  Use case diagram
3.3 Technology Platform

As per the requirements of OC2T, it requires a web server which accepts the HTTP requests from the web browser. For that purpose, the Apache web server was used. The XAMPP tool was used to setup a web server locally. XAMPP is a free and open source cross-platform web server solution stack package consisting mainly of the Apache HTTP Server, MySQL database and interpreters for scripts written in the PHP and PERL programming languages. A database engine is required to store the information related to OC2T. The MySQL database engine was used for the development of OC2T because it is highly compatible with Apache server. Moreover, the fact that MySQL is free and reliable makes it an appropriate choice. The programming language used for the development of web pages of OC2T is PHP. As PHP is open source, easy to use, fast and customizable, it is a good choice for developing web pages. In addition, HTML5, CSS and JavaScript were used for developing the graphical user interface while Ajax and jQuery were used for the purpose of results simulation in OC2T.

4 Methodology

A total of 15 respondents participated in the online survey developed using google forms. According to Faulkner [20], studies to evaluate a prototype of a novel user-interface design reveals severe errors quickly and therefore often require fewer participants. Literature suggests that three to twenty participants provide valid results [21] hence the 15 respondents. The respondents come from two IT companies dealing with web development of which two of them are also the expert reviewers involved.
Table 1 Demographics of respondents

| Demographic | Group       | Frequency | Percentage (%) |
|-------------|-------------|-----------|----------------|
| Gender      | Male        | 14        | 93.3           |
|             | Female      | 1         | 6.7            |
| Age         | 18–24       | 0         | 0              |
|             | 25–34       | 6         | 40             |
|             | 35–44       | 9         | 60             |
|             | 45 or above | 0         | 0              |
| Designation | Junior developer | 1     | 6.7            |
|             | Senior developer | 12    | 80             |
|             | Webmaster   | 2         | 13.3           |
|             | Other       | 0         | 0              |

in the expert review process. The participating companies are VICT Systems and DXC Technology. Seven developers from VICT Systems and 8 developers from DXC Technology participated in the user acceptance test, conducted via an online survey. The system is first downloaded and installed on individual machines. This requires the installation of XAMPP, php files as well as sql. Then, they were required to explore and use the OC²T. When this task is completed, they were requested to answer the online survey based on their usage experience of OC²T.

Additionally, four experts from the industry and academia also participated in the expert review. The experts from the industry come from IT background and are involved in software development projects and the managing of web. In addition, they have experiences developing and managing social commerce sites where requirements come from the clients themselves. As for the academics, they are actively involved in social commerce domain of research, evaluation of usability and interface design as well as evaluation of usability and user experience study.

The questions in the expert review form are first pilot tested by two academics and were found to be well-structured and understandable. Next, all the four expert reviewers were met for their valuable input. The reviewers were first briefed on the content of the expert review form as well as the flow of the research. Following that, they are required to complete the questionnaire. Both these processes were diligently done and took slightly more than an hour per reviewer. The basic demographic of these respondents are as listed in Table 1 with a response rate of 100%.

5 Results

5.1 Results of Implementation Framework (IF)

Reviewer 1 who is a senior web developer found the CPM, IF, its components and subcomponents to be systematic clear and comprehensive. The summary feedback of
the first reviewer with regards to all three sections of the expert review questionnaire were (i) the Continuance Participation Model carries a set of constructs which are significant pointers for continuance participation of online communities therefore the components of the construct known as measures should carry equal weight, (ii) the subcomponents of constructs referred to as checklist items are able to guide web developers on the vital features required when developing online community sites and (iii) the simulations provided for processing the end results to identify the sustainability of developed online community sites are commendable. The feedback obtained from reviewer 1, particularly on (i) is noted and considered during the prototype development.

Reviewer 2 who is a system testing manager respondent alike to that of reviewer 1 but had the following feedback to add, (i) the IF is significant in improving the quality and sustainability of online community sites, (ii) fresh and novice web developers will benefit from the proposed framework through the prototype implementation and (iii) experienced designers can also benefit from the proposed framework by suggesting the vital pointers required to their clients for ensuring continued usage of online communities. The feedbacks obtained from reviewer 2 were positive and no major improvement on the framework was required.

Reviewer 3 who is a senior lecturer from Universiti Teknologi Malaysia gave comprehensive feedback and the overall feedback was (i) the category weight assigned to the constructs during the simulation process has to be justified, fixed and must come from the researcher, (ii) the Importance-Performance Map Analysis (IPMA) [12] should be considered for deriving the category weight at the same time extending the results of PLS-SEM and (iii) the prototype development which is a follow up from the implementation framework is vital provided it has a strong justification with regards to the category weight assignment. From the feedback obtained from reviewer 3 on (ii) and (iii), the IPMA was used for the assignment of category weight.

Reviewer 4 who is an associate professor from the International Islamic University Malaysia found the proposed framework useful for web developers particularly those involved in developing social commerce sites such as Facebook that requires social involvement from users. However, the reviewer also provided the following feedback for improving the research model, (i) before adopting the proposed model, developers should have basic knowledge on the social perspective factors that are crucial when developing online community sites. It is only then, they will be able to perceive the model as well as utilize the tool at optimum level and (ii) the proposed model is an excellent guidance for novice developers and should be made mandatory when user requirements for clients are gathered.

The feedback obtained from reviewer four was only minor and therefore no major improvement was needed on the proposed model. The expert review process was ended with the fourth respondent since it has reached the saturation point. In summary, the findings of expert reviews on all the four reviewers show that they are agreeable to the sequence and content of the entire proposed model together with its components and subcomponents.
5.2 Results of Prototype

There were two main steps involved in this phase; (i) all the targeted respondents were asked to perform testing on the prototype and (ii) to complete the online survey form based on their experience of usage on the prototype.

This research implemented the user acceptance test based on the Perceived Usefulness and Ease of Use (PUEU) instrument by [22] which has been based on the Technology Acceptance Model (TAM) [23, 24]. Perceived usefulness and perceived ease of use are hypothesized to be fundamental determinants of user acceptance and system use [22, 25]. To analyze the PUEU test, descriptive analysis (mean, standard error) using SPSS was carried out. For the discussion of descriptive analysis in this research, item rated with scale 6 which denotes ‘Agree’ and scale 7 which denotes ‘Strongly agree’ show that the item measured is highly useful as ratings of 6 and 7 in Likert scale has synchronous meaning of high usability [26]. The questions of the survey are divided into two parts. The first part is on demographics while the second on prototype perceived usefulness and ease of use.

To measure OC²T, the perceived usefulness and ease of use of each item in the survey are determined based on the agreeable level of the respondents using the Likert scale from (1) Strongly disagree to (7) Strongly agree. The seven-point Likert scale was used for the usability study as it appears to be more suited to electronic distribution of usability survey [26]. The Likert scale score reflects the level of agreement on agree-disagree scale. Many types of benchmarks are used to judge the level of agreement obtained for Likert scale scores however literature suggest that an average score of 75% is rated as high usability [27, 28]. For the purpose of this research, a threshold value of 75% is therefore used as a benchmark.

5.3 Usability Test Survey

Participants rated the usability of the system positively. PUEU scores obtained from all the 15 participants’ responses for all the twelve evaluation questions surpassed the average score of 75% indicating a high overall usability. Figure 6 depicts the mean scores obtained by all twelve items. The average mean scores are all above 5

Fig. 6 Mean scores for PUEU
(somewhat agree) indicating that the overall respondents agree with the perceived usefulness and ease of use of the system.

Figure 7 reports on the standard deviation where the scores are closely clustered around the mean value indicating data is well dispersed and reliable.

Distributions of data are considered to be of low-variance if the coefficient of variation, CV calculated by dividing the scores of standard deviation and mean (CV = standard deviation/mean) is lesser than 1 (CV < 1). Table 2 lists down the CV on all twelve items evaluated. As the CV score for all the twelve items are below 1, it can be concluded that the data are well distributed. The agreement level for each of the item tested are also summarized in Table 2. In general, the level of agreement for the usability test conducted with 15 respondents is more than 75% and therefore demonstrates a high level of agreement. This shows that the IF is perceived useful and easy to use. Additionally, some positive remarks were given by the respondents on the practicality of the prototype. These include the ability to view past reports as well as obtain results on the significance level of sites to.

![Fig. 7 Standard deviation for PUEU](image)

| Table 2 | Coefficient of variation and agreement level for PUEU |
|---------|-----------------------------------------------------|
| PUEU1   | 0.09 | 100     |
| PUEU2   | 0.12 | 93      |
| PUEU3   | 0.12 | 93      |
| PUEU4   | 0.12 | 93      |
| PUEU5   | 0.11 | 93      |
| PUEU6   | 0.13 | 100     |
| PUEU7   | 0.13 | 100     |
| PUEU8   | 0.14 | 100     |
| PUEU9   | 0.12 | 100     |
| PUEU10  | 0.12 | 100     |
| PUEU11  | 0.13 | 100     |
| PUEU12  | 0.13 | 100     |
6 Conclusions and Discussions

Drawing on the theories of planned behavior and social support as well as satisfaction and perceived value constructs, this study introduces an Implementation framework (IF) to evaluate the sustainability of online communities. The IF provides an abstract view that emphasizes the pertinent components required for ensuring the sustainability of online community sites. The IF consists of the continuance participation analysis process (measures, weighted checklist, results) applied on the validated CPM.

This framework serves as the implementation of the proposed model and is an integration of the constructs influencing the Continuance Participation Intention and Behaviour of the CPM, and Continuance Participation Analysis Process. The purpose of this IF is to guide web developers’ in online community web developments, measure the sustainability level online community sites as well as assist web managers in organizing and handling their online community sites. The weighted checklist method is applied on the continuance participation analysis process to generate results. The framework was reviewed by four expert reviewers from the social commerce domain. The framework serves as a guideline for both researchers and practitioners on the vital components required for ensuring continuance participation in online communities.

Subsequently, a prototype named OC²T is developed to validate and to test the efficacy of the IF. The system architecture of OC²T is based on a three tier architecture comprising of presentation layer, application layer and data layer maintained independently. The data layer is implemented using database and database server, the application layer is implemented using PHP script and Apache Web Server while the presentation layer is implemented using browsers such as Internet Explorer or Google Chrome.

Findings from the deployment of OC²T to 15 respondents are positively inclined to IF and was reported perceived useful. The OC²T was tested using the PUEU test and resulted in positive engagement. The PUEU usability test was conducted on fifteen respondents who are web developers. The results of the study indicate that social support theory alongside with its constructs, informational and emotional, theory of planned behaviour alongside with its constructs, attitude, perceived behavioural control and subjective norms, satisfaction and perceived value constructs are key determinants in driving continuance participation intention and behaviour in an online community in the context of Web 2.0 technologies. The results also show that the measures associated to these constructs contribute to the continuance participation of online communities in ensuring the sustainability of online community sites.

The lack of guidelines in the development of online community sites in ensuring continuance participation and the sustainability of online communities are vital issues to online community developers [5, 16]. This is evident because documents reporting on the development or the design of popular social networks are yet to be published [29].
With thousands of social networks springing up it is crucial to establish a guideline for ensuring the sustainability of online communities [5]. The present study therefore aids organisations in their policy making through positive engagement of users involving online communities. To guarantee post-continuance participation of users, organisations must look to the constructs specified in the model to satisfy online communities’ continuance usage. This is because users are concerned about the value and benefits they perceive from within the online community and these values indicate their willingness to continue participating in online communities. It is vital for web development companies to be aware of the components required for ensuring the sustainability of online communities. This is evident as consumers are more inclined to perform transactions online especially considering the current pandemic, such as the Covid-19. The authors believe that the OC²T will act as a significant checklist tool for studying the status of the developed online community site.

6.1 Theoretical Implications

In terms of theory building, this study aims to develop a new theory through the integration of a social psychology theory, mainly social support constructs, by extending the standard Theory of Planned Behaviour to study the constructs that influence continuance participation in online communities. To be specific, this study addresses the post-adoptive intentions and behaviour of online communities mediated by the Web 2.0 technologies. Online communities hosted by the Web 2.0 platform, such as the Facebook, LinkedIn and TripAdvisor, though are swiftly expanding, yet still lack theory-driven empirical research in information systems domain investigating the post-adoption issues from a behavioural and social perspective.

This study is significant as the decision to continue or discontinue participating in online community is heavily dependent on the post continuance intention and behaviour of the users. This study, through its hypothesized model also known as CPM, combines the TPB and social support theory through its two dominant constructs; informational construct and emotional construct and adds the perceived value and satisfaction constructs. The results show that nine out of then tested hypotheses are supported and thus mean that the model makes a significant contribution to the online community literature as a theory model. The addition of the social support constructs contributes by improving the standard Theory of Planned Behaviour constructs in driving continuance participation in online communities.
6.2 Practical Implications

From a practical perspective, to sustain a successful online community, the present study aids by assisting organisations in their policy making through positive engagement of users involving online communities. To guarantee post-continuance participation of users, organisations must look to the constructs specified in the model to satisfy online communities’ continuance usage. This is because users are concerned about the value and benefits they perceive from within the online community and these values indicate their willingness to continue participating in online communities.

7 Limitation and Future Work

Although the findings provide significant insights, a number of limitations should be acknowledged. The OC²T was developed based on the findings from experts involved in web development but not necessarily related to the development of online communities. Future research should involve testing of the OC²T with respondents that have vast experience in developing online community platforms such as Facebook, Twitter, Instagram and other online community sites. Additionally, prior to the development of the OC²T, requirements gathering was skewed towards popular social networking sites and only involved respondents who were based in Malaysia. Finally, this study model should further be tested with other behavioural constructs that can potentially influence the continuance participation of online communities.

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