

MEASURING PROCESS INNOVATION ON DOUBLE-FLANKED CONCEPTUAL MODEL FOR KNOWLEDGE SHARING ON ONLINE LEARNING ENVIRONMENT

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ABSTRACT

There are various innovation models that were discussed in the literature and the adoption is based on the organizational needs for their business contexts, vision and applications. These innovation models require effective innovation process framework to be followed. SECI Model has been chosen as knowledge creation model to facilitate innovation through knowledge sharing and creation. While literature has shown that SECI model has been applied in various fields such as management, manufacturing, education and business, very few has considered it as innovation tool for online learning environment. Knowledge creation requires community who has enculturated with knowledge sharing as part of the practices. For this purpose, Community of Practice (CoP) has been chosen as the essentialities for the prospective innovative community and consequently to make implementation of SECI model a success. Community with CoP values are postulated to provide the right organizational setting for innovation. It is suggested that both SECI Model and CoP are integrated as new a conceptual model being regarded as double flank strategy that synergizes to prepare the right community setting and to facilitate innovation through knowledge creation. Subsequently, this paper proposed the methods and approaches in measuring innovativeness in online learning environment based on the double flank conceptual model called DFCMI.

Keywords: *Knowledge Management, SECI Model, Community of Practice, Online Learning, Measuring Innovation*

1. INTRODUCTION

Innovation models are defined and practically used in various ways by the academics and industrialists. The variants are due to the numerous contexts of what innovations are needed for in order to bring values to the innovators, consumers and organizations. It varies at different business strategies ranging from process innovation, service innovation, product performance innovation, branding innovation, organization structure innovation, design innovation, consumer network innovations, profit model innovation and many more. To achieve the innovation, the fundamental elements should be in place. Some of these involve community engagement, sharing of vision, volunteerism, ad hoc idea generation and mutual interaction. These are essentials to form an innovative community prior to building a practical innovative community.

Innovation in the organization must be participated at community level rather than an individual effort. We believe Community of Practice (CoP) is a suitable platform for establishing a special group to instigate innovation and intellectual forum. CoP was [12] introduced by Etienne Wenger who had defined the CoP characteristics where the common interest group should fulfill. It is not merely a task-based committee that is formed merely to tackle certain issues and to make recommendations or produce solutions. Rather, the group must be formed and to be in practice for certain duration of time before certain level of engagement emerges within the CoP community. CoP needs to be in place as it overcomes the barrier in communication, aligns shared vision, steers volunteer participation and engagement and shares common knowledge resources in which these are the important foundation to stimulate group of innovators.

Many theoretical frameworks have been discussed in the literature, on various types of innovation process [3]. Innovation process is categorized by the factor driving the innovation such as technology [4], market [8], integration between market and R & D [1], interactive [7], network [11] and open [6], to name few. Rothwell [9] described the generation of innovation models based on the industrial technology evolution began from linear model in which the innovation is based on invention through R&D (Research and Development). The subsequent generation of innovation model is market driven that had caused innovation products to be developed as less sustainable due to strong influence of market trend. To overcome the problem, the later generation of innovation model balanced both the market demand and R&D as essential role in innovation, so-called coupled model. Interactive model has similar fashion with network model as described by Manley [7] in her illustration of several more innovation models with similar approaches. Open model is in contrary to the earlier version of innovation model where opportunity for participating innovativeness is non-exclusive and open to public as main character in participating the innovation process.

Innovation model that were described in the literature were adopted at the workplace and industrial environment. Our work is interested to look at implementation of the innovation in the online environment where members are not physically connected. The process of innovation involves on the knowledge creation, implementation, reuse and value creation. For this to happen, we adopted SECI model as the innovation model for knowledge creation and to be implemented in the online environment. Even though SECI model was originally developed for the manufacturing environment, the recent work had shown that it has encroached community learning in the web-based environment [2][5][13][10].

In our work, we postulate that it is required to establish the CoP environment as the pre-requisite to create a community that stimulates innovative environment, demonstrate how knowledge creation can be implemented in the digital environment and finally a proposed computational framework for measuring innovation. In the subsequent subsections, we do reflection on SECI model based on the previous effort of applying it in online environment, illustrate the innovation with respect to CoP and finally the measurement of innovation in the online environment.

2. COMMUNITY OF PRACTICE (COP)

Community of Practice can be described as a natural formation of group members who have common interest, free-will membership in a malleable organizational structure, non-task-based but have shared set of problems to deal with and mutually involved and participated [23]. It was believed that the structure is socially created rather than formally set up like task force or task-oriented committee [24]. Somewhat in a later development, some practitioners have argued that CoP can be cultivated and designed for a specific group which was not initially established as CoP group, to enhance the performance [25][26]. For example, an organized group of specialists who are not acquainted well with each other assigned to solve a complex unprecedented problem could be designed to be in a CoP-based group in order to obtain promising CoP values. Another important development which is related to our work is the emergence of CoP in the virtual environment such as in online learning [28][29].

There are three crucial characteristics of CoP which are domain, community and practice [30]. Domain is referred to the topics and subjects of interest that are shared. For example, a group of students who face similar problems with new regulations introduced by the authority, gather to share similar topic to discuss why the needs of such rule, how to counter propose and what are the implications of non-compliance. The domain may not necessarily require the members to be the technical experts or specialized topics that are not comprehended by others rather the members are composite of various level of expertise for that particular topics. The community involves mutual engagement and participation such that they learn from each other, contribute to each other's affair, share related resources and knowledge and have frequent interactions. Group of boys playing cricket daily may not be a community of practice unless, they share cricket techniques and helping to develop skills and knowledge. The practice is the practical aspects of community where they share repertoire such as stories, experiences, information and other resources. The sharing must lead towards generating new artefacts for the benefit of the community. For example, a group of marketing and sales executives from various organizations who shared their problems and know-how may not necessary become the community of practice unless those shared items are further developed into useful items such as "manual guide for strategic marketing".

Table 1 CoP Essentials, Values and Supporting Technology

CoP Essentials (described in [31] as CoP Characteristics)	Supporting Technology	CoP values
Community Structure	e-forum, discussion thread, bulletin board	Volatile structure, free-will membership
Learning through Participation and Reification	CSCW (Computer Support Collaborative Work), Web-based Collaborative Software	Generating new artefacts from the group participations and engagement; new ideas and solutions
Negotiation of Learning	Project Management Software, Collaborative Virtual Environment	Traceable evolutionary of idea generation and new knowledge as a result of repetitive discussion
Learning as Temporal	Project Management Software, Collaborative Virtual Environment	Incremental development of knowledge resources
Boundary Objects	Internet forum, threaded discussion	Multiple membership to different group discussion and resource sharing across different group
Boundary Encounters	Internet forum and multiple channel threaded discussion	Multiple membership and sharing similar thought across different group
Mutual Engagement	Social Network Analysis	In-out relationship demonstrate the level of participation and involvement; analysed the relationship as cordial, animus or collaborative
Joint Enterprise	Social Network Analysis	Frequent exchange of ideas between individual, balanced participation on selected issue and playing leading role.
Share Repertoire	Multimedia objects	Individual sharing resources created or modified from others
Identity	Social Network Analysis	Recognizing individual's character or role in the online group, such as leadership role, knowledge expert

Community of Practice has recently been implemented in the online and virtual environment. This is made possible as the virtual community has been in existence since the internet revolution and it has benefitting in many sectors mainly in

education, manufacturing, financial services and other knowledge-intensive industries. With the modern supporting technology, the essential elements that are required to be in place to fulfil the criteria for CoPs are now feasible if virtual CoP is to be implemented. The essentials of CoP that we believe can be implemented with the supporting technologies to extract some CoP values, as shown in Table 1. We do not deny that there are other CoP values that are not discernible in computational form.

The presence of the CoP in the online environment is to be detected in digital form. Given the list mentioned in Table 1, while the computer technologies are currently available to capture most of the CoP characteristics, but not all CoP values can be sensed in a straightforward manner. For example, in boundary encounters, the membership of individual learner can be detected through its registration, but to monitor who share the knowledge earned from one CoP group across another CoP group can be a challenging task in computational context. Another example is on mutual engagement where relationship between members need to be traced. Relationship of two individuals can be defined objectively through the summation of response value for each interaction that occur, by assigning some values such as +1 for cordial, - 1 for animus and 0 for collaborative. The relationship is labelled based on the highest value of the response. However, the relationship which is based on emotion and subtle relation will be difficult to extract merely from text processing. In the following section, we describe SECI model and its implementation in online learning environment.

3. SECI MODEL

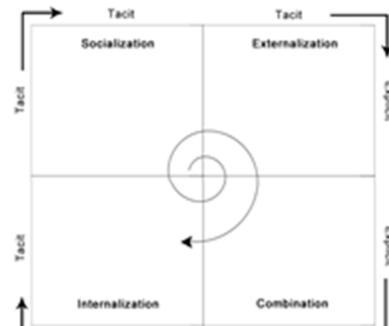


Figure 1 Classical View of SECI Model (By Ibmgroup - Using a image editor, CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=18653983>)

SECI model is a popularly known model for researchers in various disciplines mainly for those looking at implementing knowledge innovation for their organizations. The model describes the

knowledge creation to take place through the conversion of two types of knowledge – tacit knowledge and explicit knowledge. There are four types of conversion so-called socialization, combination, externalization and internalization as shown in Figure 1.

In the first quadrant, Socialization is the process where tacit knowledge is transformed within itself where new tacit knowledge is generated. This occurs during conversations, discussions and meetings [19] where one's tacit knowledge is shared with another person and probably it is received and perceived in the same substance or biased due to "stickiness" [20]. The second quadrant, Externalization is the process where tacit knowledge is transformed into explicit knowledge through actions such as minutes writing, note taking, diagram drawing and reflection writing [17]. Since the source of the knowledge is in a tacit form, some researchers may pose a challenging question on how one would be able to determine whether the explicit knowledge is derived entirely from tacit knowledge or a mixture of another explicit knowledge. In SECI model, tacit knowledge and explicit knowledge is treated as discrete form and hence the shift movement of the knowledge type is assumed to be in a single-type form. The third quadrant is Combination process where new form of explicit knowledge is produced as the result of reorganization, reclassification, compilation or other means of demonstrating of knowledge regeneration explicitly. This may require combination between tacit knowledge and explicit knowledge. For example, in building a prototype requires one's tacit knowledge for his design skills and explicit knowledge in a form of reference manual for rules and guidelines. These two forms of knowledge that could be earned from previous transitions (socialization and externalization). The final quadrant is Internalization where knowledge is converted into one's tacit knowledge from the explicit knowledge regenerated from the combination process. At this stage, the learner established a kind of ownership to the knowledge earned and the degree of control towards the knowledge determined by his effort towards it ([21], pp 8). In the context of a learner, one achieves a high level of internalization once he has mastered a specific knowledge and skills. SECI model suggests the knowledge conversion moves in a spiral manner to induce knowledge creation and knowledge sharing.

3.1. Applying Seci Model In Online Learning Environment

Application of SECI model in the online learning environment had been investigated to gauge relationship between e-learning and SECI model; and LMS (Learning Management System) and SECI Model [32]. The outcome of the experiment indicated that knowledge creation occurred and the knowledge creation process prescribed in SECI model took place in the e-learning environment. SECI model had also been applied as a framework in virtual learning environment [33]. While the attempt was to implement in virtual environment, Hosseini admitted that not all processes in SECI model can be implemented in the virtual environment. For example, in the socialization, the actual meeting where face to face interactions were done instead of using face to face online meeting. Not least to mention, Chatti [34] was among the earliest to describe the possibilities of implementing SECI model in web-based environment and he highlighted few possible technologies that could support such SECI model activities. However, the paper did not mention specifically how it can be done. The recent work illustrated the effort to build an integrated platform for facilitating some selected SECI model activities [10] which specifically mention which activities for each quadrant of SECI model and which technology that would support them. Our emphasis in this paper is that CoP is the precondition to SECI model as knowledge creation will not take place without the effective knowledge sharing process. We believe that CoP prepares a solid platform for knowledge and integration between CoP and SECI model as a double-flanked framework for facilitating and measuring innovation in the online learning environment. The framework will be discussed in the subsequent section.

4. DOUBLE-FLANKED CONCEPTUAL MODEL FOR MEASURING INNOVATION (DFCMI)

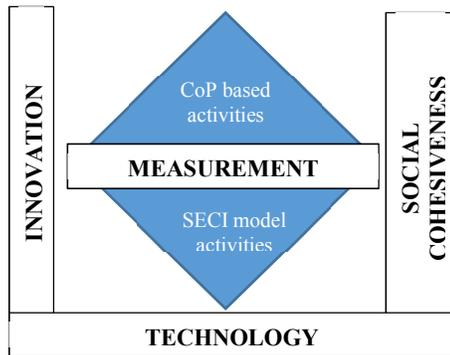


Figure 2 Double-Flank Conceptual Measuring Innovation (DFCMI)

The problems with knowledge sharing had been discussed elsewhere and the reasons are many. Vajjhala and Hassan [35] reported that in a small and well-structured organization such as small enterprise where employee numbers are rather small, there still exist a resistance for knowledge exchange and the reasons are mainly on cultural and motivational issue. It is not about cultural differences since the workers are locals but rather the intrinsic cultural values that occur within its own culture and this requires changes. Bureš [36] had elaborated well on the factors contributing to cultural issues at both individual and social levels. The factors stated by Bureš in his paper (page 58), were “loss of power”, “fear from revelation”, “uncertainty”, “illusion of reward deprivation”, “single culture elements”, “difference between awareness and knowledge”, “conflict of motives”, “language”, “conflict avoidance”, “bureaucracy and hierarchy”, “incoherent paradigms” and “underestimating of lower levels”. Ahrend et al [37] identified reasons for barriers in knowledge sharing as “trust among colleagues”, “decision structures where lack of autonomy and flexibility”, “poor incentives for sharing” and “improper ICT infrastructure to support knowledge reposition and sharing”. There are many more literature reporting barriers in knowledge sharing [38][39][40]. In our view, the essence of the barriers to knowledge sharing is on the social factors more than technology, while the latter is crucial for facilitating the knowledge sharing process.

Our proposed innovation measuring model (DFCMI) was based on the two important theories which are CoPs and SECI model where technology is the backbone to support the activities and processes in knowledge sharing since it occurs in the online environment as shown in Figure 2.

DFCMI has placed CoP on top of SECI model as prerequisite for establishing social cohesiveness. Social cohesiveness encompasses the values that are prescribed under CoP discussed (refer to Table 1). It is shown that CoP and SECI are an attached entity which signifies that the community who are participating in the SECI model activities are CoP compliances and group members uphold CoP values. Social cohesiveness overcome the issues raised in the earlier literature describing the barriers for knowledge sharing. CoP value emphasizes on shared repertoire which includes the communication language, common jokes, problems, vision, strategy, solution and even knowledge artefacts. Depending on the organizational setting on CoP, the “wall” between the management and workers maybe permeable if both are involved in the CoP. In many cases, management fails to communicate their vision and goals effectively as that information are presented in a formal presentation through verbal or strategic plan manual and this syndrome is called “single culture elements”. In addition, this overcomes the problems in “underestimating lower levels” and “bad appraisal of co-workers” since the management team members are also part of the CoP teams. CoP requires mutual engagement where every member participates in one way or the other and establish him/herself in a notable manner and not merely as listener or viewer. The common perception of “knowledge is power” is the cause for fear of “loss power” as members deemed each other as “contender”. Joint enterprise counter the “fear from revelation” and “uncertainty” as members who reveal the knowledge will have some useful feedbacks as they are acquainted to each other such that the feeling of embarrassment for not getting appropriate feedback will not occur. “illusion of reward deprivation” can be addressed by recognizing one’s identity in the community as identity is an essential characteristic in CoP. One’s continuous contribution to the success of the organizational performance will be noticed and reward is redeemed from this recognition. Resistance to take risk and to avoid “rocking the boat” is common fear among workers who are fear for being blame. CoP encourages mutual development of new ideas rather than individual effort, as such, the risk is taken in collective manner. Boundary encounters breaks the “wall” that prevents transparency in the inter-departmental communication. Other aspects that cause the knowledge sharing barriers such as “trust between colleagues or management”, “ill feelings bad emotions among members” and “pseudo innovators” will diminish gradually as CoP values

built up within the CoP members. Traditionally, CoP values are monitored and observed through subjective approach by the consulting companies who are presence physically at the premise of the organization. In the online environment, detecting the presence of CoP activities in the online environment would be different from the physical environment and hence, some methods are needed to be considered as alternative to be able to capture activities that are compliances to the CoP characteristics.

At this stage of discussion, based on the literature and the DFCMI illustration, the following assumptions are made:

- a. Online-based for CoP activities – it is possible to perform online activities that leave digital traces as evidences as proof to some selected characteristics of CoP [31].
- b. Online-based activities on SECI model – it is possible to monitor the online activities that are supporting the evidences of the online activities based on SECI model for an individual.

Based on the above assumptions, the measurement of innovativeness is proposed in the following section.

5. MEASUREMENT OF INNOVATION BASED ON DFCMI

Literature has shown that innovation in online learning subscribes to three categories: innovation in technology, innovation in the pedagogy and academic administration and innovation in the learner's learning strategy. In the technological perspective, adaptive learning covers aspects on the knowledge representation techniques, strategies for presenting knowledge based on learner's preferences, evaluation mechanism and automated feedbacks to the learners (refer to [41], page 4 – 5). Another example is using technology to analyse the learner's learning behaviour and learning pattern, so-called learner's analytics for the consumption of the students and faculty members [42]. In the second category, Twigg has provided few case studies and reviews on various aspects in the online learning innovation with regard pedagogy and academic administration [43]. Some aspects encompass increasing the accessibility to higher education, managing cost in higher learning, developing new strategies to increase interest in learning, improve success rate in degree completion, understanding learning styles and

improving learning experiences. Learning strategy had been a field of study by itself independent from the technology for decades. Traditionally, learning strategy focus on the classroom learning, teaching practices, teaching professionalism and cognitive psychology, constructivism and learner's learning behaviour [44]. With the emerging internet technology, collaborative learning software applications and social media, the learning strategy must embrace to these developments.

In our proposal for DFCMI, activities of the learner in the online activities to stimulate innovation is given the primary focus alongside with the technology, learning strategy and pedagogy. Online learning is a broad area and the scope of defining innovation can be indefinite. DFCMI narrow the innovation process to four dimensions: formation of innovative community, evolution of special interest topics, learner's participation in knowledge development and social recognition. For each of the dimension, there is an element of innovation which should be measurable. Firstly, formation of innovative community is on voluntarily basis such that the members are passionate about the group's interest such that the interest, vision, objection, mission of the group must be clear, free-flow registration and de-registration on the group to focus on genuinely and potential members, building profile of him/herself with live video (self-introduction) and background information for each member to expedite process of acquaintance and socialization. The profile of the members must be kept active and up-to-date to ensure reliability and validity of the members. The profile may include member's personal collections (includes articles, images, videos and links) which are relevant to the subjects of group as indication one one's commitment to the group. Member earns score that contributes to the building the profile of him/herself from each of these activities. We regard this as innovation process which is significant towards attaining than innovation product. The activity is captured using keystroke loggers to capture user's activity.

The second dimension is special interest topic which is usually a temporal affair for the group member and usually disperse after resolution is achieved or loss of interest. It evolves because of the demand from the current problem that require immediate attention. The discussion in the online discussion platform focusses on issues relevant to the topic. Hence, there are three major measurable parameters which are the life-span of the topic (when it is activated or become inactive) which can be traced from the log file, the continues growth of

the knowledge sources through knowledge sharing (uploading and downloading of multimedia files), participation on crowd-sourcing and collaborative application software (wiki, blogs, forum etc). While these activities need to be translated into some measurable items, some of them pose some challenges to determine the relevancies of the knowledge sources to the special interest topics. This is due to complexity in analysing the content of the multimedia format such as video, audio, images and so forth. For this purpose, collaborative filtering [45] or crowdsourcing would be the appropriate solution towards using group members to assess and evaluate the relevancy of the content posted by other member. The mechanism to collect input from the members and to sum up the total score based on the crowd input need to be established to compute the relevancy of the content. The overall score for the level of process innovation in establishing special interest group will consider the temporal information, knowledge growth [47] and contributing factors of the member based on the relevancy of the posted content.

Thirdly, the learner's participation in knowledge development is an inducement to the innovation process for knowledge creation. Online communities are built in different model and among those are for information dissemination such as Twitter, LinkedIn; work-related collaboration such as in e-forum, Blackboard or social purposes such as Facebook, FishBrain etc. Two important aspects for the tools for the software is the facilities for knowledge sharing and tools for assessing and analysing each movement and action of the members in the online environment. The computed values for the member activities are used to indicate the process innovation in knowledge development. For example, the number of articles shared with the group, forum participation in terms of quality and involvement across various discussion channels and enriching the knowledge repository for the group are activities that can be traced, translated to numerical values and calculated some values to assign some scoring to them.

Fourthly, the members participating on online activities have rewards in terms of social recognition. Despite in the online environment, one may dispose oneself as the leader among the members from its dominance over the group discussion and possession of knowledge [48]; or as a follower [49]; as well as domain expert [50][51]. The challenges to deal with the online communities in identifying expert would be the dynamic change of the community structure in terms of membership

enrolment, topic of discussions, participatory behaviour of the members such that the roles of the members may change over in temporal manner. The mechanism for measuring the participation of the member and assigning scores to rate the level of expertise and leadership is suggested in [52]. Based on the scores, the innovation process of identifying the social status of the members in the online environment and recognizing them are possible.

The four dimensions recommended for measuring innovation process are based on some of the CoP essentials (ref Table 1). Another aspect of DFCMI is on innovation product which should occur as the consequences to the successful innovation process. SECI model is a conceptual framework for knowledge creation which includes forming new ideas, generation of new artefacts, improvement to policies, services and procedures, design and modelling and others which lead towards innovation. SECI model has been considered as tightly linked to innovation [53] while others regard it as knowledge creation model. In the perspective of online learning, the knowledge creation through online activities are the innovation products. For example, summarization of read articles, solutions to complex problems, critical review of the scientific literature, arguments in intellectual forums are generated from the cycles of knowledge creation.

DFCMI stipulates that the innovative community has to experience the four quadrants of the SECI model in a repetitive manner. Some selected SECI model activities that are implementable in online environment that leave traces as evidences of a member who had involved in the four types of knowledge transformation are described in [10]. In order to ensure the group discussion to stay focus on the specialized topic, the relevancy checking and monitoring are performed as background engine [47]. The checking of the relevancy is however, only on the text-based discussion. There is need to explore further on other types of knowledge media such as video, audio, images without going through complex image processing techniques to determine the content and its relevancy to the topic of discussion.

In our view, measuring innovation may receive many criticism as innovation can be defined broadly and it appears in many situations as tangible product which is not presentable in digital format. However, the process innovation is possibly monitored in the online environment albeit with some limitations which will pave way for us to explore more for further research.

6. CONCLUSION AND FUTURE WORK

In this paper, we present the idea of measuring innovation process based on the proposed double-flank model which integrates CoP and SECI Model. The innovation process is a medium platform for a community to embark to innovative community prior to be able to produce various innovative products such as service innovation, technology innovation, marketing innovation and including process innovation (which is not to be mistaken with innovation process). In the context of online learning, measuring the innovation process emphasizes on knowledge sharing and knowledge creation where knowledge is represented in the form of text such as articles and other multimedia format. The innovation process activities performed in online environment are traceable as they are captured in digital format. Hence, measuring the innovation process based to determine the compliance to CoP values and to monitor the knowledge transformation to the four quadrants of SECI model is feasible. The doubly flank model is introduced here to emphasize the importance of establishing the innovative community as many failures to knowledge creation is due to lacking knowledge sharing within community even in a small enterprise due various factors such as culture, communication skills and job related issues.

The future work for this research is on two aspects: technology and empirical experimentation. The previous work has shown where knowledge flow can be traced computationally for SECI Model [10] but on text-based format. There is also a need to investigate how knowledge that is from other format can also be analyzed to determine its relevancy to the topic of discussion. Another aspect of the technology is on determining the COP values in which some of these values are subtle and hardly to captured merely based on text processing. On the empirical experimentation, SECI model itself is lacking empirical evidences and hence DFCMI ought to be fully experimented in real world situation. It requires some proof that CoP is able to be inculcated in the online environment and hence measuring its presence without using the traditional method of *in situ* observation. In similar fashion, computational platform based SECI model that has been built ought to be experimented to examine the actual output of knowledge creation.

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