A SOCIAL BOOKMARKING MODEL BASED ON DESIGN PATTERN LANGUAGE USING A HYBRID TAXONOMY-FOLKSONOMY APPROACH

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MODEL PENANDA SOSIAL BERDASARKAN REKA BENTUK BAHASA POLA MENGGUNAKAN PENDEKATAN TAKSONOMI-FOLKSONOMI HIBRID

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DECLARATION

I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged.

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ABSTRACT

The Social Bookmarking System (SBS) has become the most popular approach for knowledge sharing over internet especially with the launch of Web 2.0. It has shifted from traditional to conversational approaches where SBS provides users with necessary tools to manage information that can later be used or shared and where the information is evaluated either by expert or other users to obtain quality information. For example, in academic world, SBS really helps a scientific community of experts and professionals to manage and share resources among researchers. This approach give benefits, especially for new students (i.e. graduates) who are having difficulty in finding information to start their research in a particular domain. Therefore, a quality SBS is needed, especially on how to optimize the user's collaborating and share in an effective and usable way. A basic unit of SBS is representing bookmarks of web resources and tags that are used to organize these bookmarks. The current SBS either uses taxonomy or folksonomy schema to create and organize the bookmark. Applying taxonomy is expensive, time-consuming, and does not reflect the user's vocabulary, while applying folksonomy has limited regard to retrieval capability from the lack of vocabulary control. The previous studies had shown that applying a hybrid taxonomy-folksonomy approach for social bookmarking system has become prominent. However, applying this approach still has limitation regarding representing and organizing web resources during bookmarking, as well as bookmarking interface design to build common language between users. On the other hand, Pattern Language (PL) has offered a method to prove a quality solution in a context. PL has been used in many areas such as interaction design in ethnographic studies, in ubiquitous computing, and user interface interaction designs. Therefore, this research aims to propose a social bookmarking model based on design pattern language using a hybrid taxonomy-folksonomy approach that supports better representation and organization of bookmarks in SBS. In this research, the Design Science Research Methodology (DSRM) has been adopted. DSRM mainly consists of identifying the problem, defining the objectives of a solution, designing and developing the artefact, demonstration, evaluation, and communication phases. The proposed social bookmarking (ISBookmark) model is validated by expert review. A social graduate bookmarking prototype (GISBookmark) is developed to prove the proposed model is workable. After defining the GISBookmark model, a panel of Web 2.0 experts were consulted to validate the model. The qualities of the social bookmarking are evaluated in two stages. In the first, qualitative study was used to test the usability and effectiveness of the proposed system, while the second used quantitative study to confirm the effectiveness, efficiency and user satisfaction. The evaluation results showed that the proposed social bookmarking model help graduates to represent, organize, and share the quality of information among them in an effective and usable way.

ABSTRAK

Sistem Penanda Sosial (SBS) telah menjadi pendekatan yang paling popular bagi perkongsian ilmu melalui internet terutamanya dengan pelancaran web 2.0. Ia telah beralih dari pendekatan tradisional kepada pendekatan perbualan di mana SBS menyediakan alat yang diperlukan oleh pengguna untuk menguruskan maklumat yang kemudiannya boleh digunakan atau dikongsi, dan maklumat tersebut dinilai sama ada oleh pakar atau pengguna lain bagi mendapatkan maklumat yang berkualiti. Contohnya, dalam dunia akademik, SBS benar-benar membantu komuniti pakar sains dan profesional untuk mengurus dan berkongsi sumber di kalangan para penyelidik. Pendekatan ini memberikan faedah, terutama bagi pelajar baru (iaitu graduan) yang mengalami kesukaran mencari maklumat untuk memulakan penyelidikan mereka dalam domain tertentu. Oleh itu, SBS yang berkualiti diperlukan, terutama dalam mengoptimumkan kerjasama pengguna dan cara perkongsian yang berkesan dan berguna. Unit asas SBS mewakili penanda halaman bagi sumber web dan tag yang digunakan untuk menyusun penanda halaman ini. SBS terkini menggunakan sama ada skema taksonomi atau folksonomi untuk mancipta dan menyusun penanda halaman. Penggunaan taksonomi memerlukan modal yang besar, memakan masa, dan tidak mencerminkan perbendaharaan kata pengguna, manakala penggunaan folksonomi pula mempunyai keupayaan yang terhad untuk mendapatkan kemampuan semula dari kekurangan kawalan perbendaharaan kata. Kajian sebelumnya menunjukkan bahawa penerapan pendekatan taksonomi-folksonomi hibrid bagi sistem penanda sosial telah menjadi terkenal. Bagaimanapun, penerapan pendekatan ini masih mempunyai batasan mengenai perwakilan dan penyusunan sumber web semasa menanda halaman, serta reka bentuk antara muka penanda halaman untuk membina bahasa umum antara pengguna. Sebaliknya, Bahasa Pola (PL) telah menawarkan kaedah bagi membuktikan penyelesaian yang berkualiti dalam konteks yang dinyatakan sebelum ini. PL telah digunakan dalam pelbagai bidang seperti reka bentuk interaksi dalam kajian etnografi, pengkomputeran di mana-mana, dan reka bentuk interaksi antara muka pengguna. Oleh itu, kajian ini bertujuan untuk mencadangkan model penanda sosial berdasarkan reka bentuk bahasa pola menggunakan pendekatan taksonomi-folksonomi hibrid yang menyokong perwakilan dan penyusunan penanda halaman yang lebih baik dalam SBS. Dalam kajian ini, Kaedah Penyelidikan Sains Reka Bentuk (DSRM) telah diterima pakai. DSRM sebahagian besarnya terdiri daripada mengenalpasti masalah, menentukan objektif penyelesaian, mereka bentuk dan membangunkan fasa artifak, demonstrasi, penilaian, dan komunikasi. Model penanda sosial yang dicadangkan (ISBookmark) disahkan oleh kajian pakar. Prototaip penanda sosial graduan (GISBookmark) dibangunkan untuk membuktikan model yang dicadangkan dapat dilaksanakan. Setelah mendefinisikan model GISBookmark, model telah dirujuk kepada panel pakar Web 2.0 untuk tujuan pengesahan. Kualiti penanda sosial dinilai dalam dua tahap. Pada permulaan, kajian kualitatif digunakan untuk menguji kegunaan dan keberkesanan sistem yang dicadangkan, kemudian kajian kuantitatif digunakan untuk mengesahkan keberkesanan, kecekapan dan kepuasan pengguna. Keputusan penilaian menunjukkan bahawa model penanda sosial yang dicadangkan telah membantu graduan bagi perwakilan, penyusunan, dan perkongsian kualiti maklumat di antara mereka dengan cara yang lebih berkesan dan berguna.

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CHAPTER I

INTRODUCTION

1.1 BACKGROUND

Knowledge management is considered one of the most significant techniques that can be used for improving the performance of the organization through empowering individuals to capture, organize, share and apply their collective knowledge in solving problems and making decisions at the right time (Lee & Lan 2007; Giampaoli et al. 2017). The method of organizing the repositories of centralized data in an organization for collecting organizational knowledge is regarded as traditional knowledge management (Hong et al. 2011). Due to technological change, traditional approaches to knowledge management have been shifted to what are known as conversational approaches that pay more attention to the collaboration and integration of creating knowledge among knowledge workers (Lee & Lan 2007; Hong et al. 2011). A study by Clarke and Cooper (2000) showed that knowledge management is an integrative activity that depends on the creation of "shared context" among participants. Hence, it could be stated that information technology, which generates opportunities for collaboration, has a robust impact on empowering knowledge management with a significant increase of capabilities (Maharana et al. 2010; Ali et al. 2014).

New technological capabilities obtained by the Web 2.0 convey novel perceptions in addition to new tools for knowledge management (Amin et al. 2018; Di Iorio & Rossi 2018). Web 2.0 is a social web which facilitates extensive user participation in the creation, sharing and use of web resources (Kwanya 2018). Moreover, Web 2.0 tools reinforce the simultaneous individual management and the processes of collective knowledge accompanied with social processes (Razmerita et al.

2009; Di Iorio & Rossi 2018). Therefore, Web 2.0 is a knowledge-oriented environment where humans create content which can be managed, published, and used via the applications of a network in a service-oriented architecture (Wu & Hua 2008). An example of an online encyclopedia is Wikipedia (Yun et al. 2016; Pentzold et al. 2017). Through Web 2.0, several social bookmark tools can be established, and knowledge can also be shared among individuals (Murphy 2010; Amin et al. 2016). Moreover, individuals can exchange views and personal experiences using blogs or wikis on either internet or intranet (Sigala & Chalkiti 2015; Kaur 2016). Hence, such processes are significant for individuals as they can play a vital role in contributing to collective knowledge (Razmerita et al. 2009; Di Iorio & Rossi 2018).

Through Web 2.0, individuals can organize and manage bookmarks of web resources using social bookmarking tools and share these bookmarks with others (Hwang & Ronchetti 2016; Namdev 2012). The shared bookmarks can be viewed using the internet or other social software such as wikis, social networking, blogs and other tools to facilitate knowledge sharing between individuals (Usman & Oyefolahan 2014; Zhao et al. 2015). Social software provides the necessary tools that support knowledge creation for collaboration and sharing to identify and follow professional experts as well as to obtain access to their opinions worldwide or even in a closed community (Behringer & Sassenberg 2015). Social software gives individuals space to keep and control knowledge-learned, where its original resources and individuals can maintain the space for which he/she has complete control over the knowledge for sharing (Behringer & Sassenberg 2015). This builds a bottom-up style of collaboration and knowledge sharing, instead of imposed or top-down corporate strategy (Eid & Al-Jabri 2016). The simplest and most popular Web 2.0 tool that is proving to be a powerful knowledge sharing tool is a social bookmarking system (Al Rasheed & Berri 2014).

Social bookmarking is a way that allows internet users to manage and save their bookmarks of web resources, allowing users to keep it private or share with other users online for retrieval at a later time (Manca et al. 2014; Namdev 2012; Wise & Shorter 2014; Kaur 2016). Social bookmarking is different than folders or file sharing; the resources themselves are not shared; only bookmarks can be shared (Al Rasheed &

Berri 2014). In the social bookmarking tools, internet users save the Uniform Resource Locators (URL) of the web resources that they want to share or retrieve for personal use at a later time. Therefore, the saved URLs of the web resource are called “bookmarks” (Estellés et al. 2010; Kaur 2016). These bookmarks are usually shared publicly, to which internet users can retrieve and re-find these bookmarks at a later time for personal use (Al Rasheed & Berri 2014). In addition, users can share only with a specified community and private domains such as learning communities (Barnes 2011).

In learning and research context, social bookmarking tools help learners and researchers to add value to learning resources that are important for collaborative learning (Chua & Goh 2010; Kalyanaraman 2018; Barnes 2011; Castillo & Haddud 2018). Social bookmarking, which primarily discusses learning topics, constitutes a significant part of the public medium of learning environment due to the large audience of professors, graduates and undergraduates to share learning resources (Estellés et al. 2010; Barnes 2011). Thus, these bookmarking tools provide new channels for sharing and disseminating learning resources among professors and researchers as well as for university students (Abbitt 2009; Estellés et al. 2010; Colwell & Gregory 2016). Learning professionals, researchers and university students use social bookmarking tools to manage and save bookmarks of web resources for retrieval and reuse at a later time (Estellés et al. 2010; Malik 2013).

Researchers and learners acquire knowledge from various web resources in order to solve their study problems (Wong & Kong 2016). Learners and researchers collect, manage, save significant web resources through social bookmarking tools for sharing and retrieval at a later time (Malik 2013; Wong & Kong 2016). However, current social bookmarking tools have drawbacks; the major drawback is the lack of standardization in tagging, including representing and organizing bookmarks of web resources. Specifically, sharing, re-finding and retrieving the bookmarks of social bookmarking are challenging, given the lack of systematic approach to represent and organize bookmarks of web resources in appropriate and meaningful way (Hwang & Ronchetti 2016). As a result, these social bookmarking tools still do not meet the expectations of their users (Al Rasheed & Berri 2014).

1.2 PROBLEM STATEMENT

There are two critical aspects that define effective knowledge sharing tool (Hughes 2006). The first, "how knowledge is stated", implies that knowledge is information that requires context for its application. The second, "how knowledge is retrieved", implies that stated knowledge requires metadata to help users to re-find and retrieve at a later time. Metadata is search criteria that help users re-find and retrieve the knowledge need (Hughes 2006; Rowley & Hartley 2017). In Web 2.0 era, users not only create and share web resources, but they also organize these web resources via metadata that helps them to re-find and retrieve web resources efficiently (Sommaruga et al. 2011; Batch et al. 2014). The most productive tool for knowledge sharing in Web 2.0 era is social bookmarking (Estellés et al. 2010; Manca et al. 2014). Therefore, knowledge organization is a crucial aspect of a social bookmarking tool for sharing and retrieval at a later time (Peters 2009; Brusilovsky & He 2018).

The most important characteristics of social bookmarking tools are a bookmark of web resources and the use of tags to organize bookmark (Estellés et al. 2010; Hwang & Ronchetti 2016). A bookmark is referenced information including URL of the web page for web resource and metadata “tags” about web resources (Estellés et al. 2010; Manca et al. 2014; Hwang & Ronchetti 2016). The use of tags to organize bookmark of web resources help users to re-find and retrieve the information at a later time (Brusilovsky & He 2018). The result of the collection of these tags is known as folksonomy (Estellés et al. 2010; Abel et al. 2013; Zubiaga et al. 2013; Hwang & Ronchetti 2016). Therefore, folksonomies are generated from tags assigned by users to web resources (Abel et al. 2013). Thanks to ease-of-use, low-cost and the high degree of personalisation that allow users to assign tags based on their vocabulary, folksonomy relies on user vocabulary for organizing bookmarks of web resources for sharing and retrieval at a later time (García-Peñalvo et al. 2010; Uddin et al. 2013).

Although it is widely accepted, folksonomy is not without drawbacks. The major drawback is the lack of standardization as “there is no controlled vocabulary” (Kiu & Tsui 2011; Al Rasheed & Berri 2014); the high degree of personalization

(Hwang & Ronchetti 2016), and the use of subjective keywords gives a lack of semantic precision (Kim et al. 2010). Therefore, folksonomy is insufficient for information retrieval (Kim et al. 2010; Hwang & Ronchetti 2016). Furthermore, the lack of consistency and way of representing tags leads to ambiguities and inconsistencies of tags (Kiu & Tsui 2011). In order to solve these problems, there has been an agreement by many researchers on taxonomy (Hayman 2007; Kiu & Tsui 2011; Batch et al. 2013).

Taxonomy is essential and critically important in the development of successful tools in domains such as organization, classification, navigation, searching and retrieval (Kiu & Tsui 2011; Kang et al. 2016). Taxonomy is a set of predefined terms that are controlled by a list of standard keywords that have been defined and identified explicitly to organize and classify web resources (Souza et al. 2012; Zhou et al. 2012). All terms in a controlled vocabulary must have an unambiguous and non-redundant definition (Bleik et al. 2013). Although taxonomy is very important for knowledge classification and sharing as well as web application development and exploitation in different domains (Kang et al. 2016), taxonomy still has limitations because controlled vocabulary is a limited structure (Kiu & Tsui 2011) that represents a classification system of meaningful terms to organize a given domain (Tuarob et al. 2013). In addition, controlled vocabulary is usually identified by taxonomist or professional experts who have different behaviours in finding information (Kiu & Tsui 2011), and do not reflect users' words (Batch et al. 2013; Batch et al. 2014). Moreover, the maintenance of the taxonomy is exhausting and time-consuming (Kiu & Tsui 2011). Therefore, the re-finding and retrieving of web resources has become a challenge.

Despite the drawbacks mentioned above, social bookmarking systems are useful for social interaction, collaboration and sharing (Liu & Chang 2008; Hamid et al. 2015). Few previous studies have attempted to solve the problems mentioned by exploring a hybrid taxonomy-folksonomy approach by providing a feasible way to integrate taxonomy with folksonomy (Hayman 2007; Kiu & Tsui 2011; Sommaruga et al. 2011; Batch et al. 2013; Batch et al. 2014). The hybrid approach exploits the advantages of each approach to improve the organization of web resources for retrieval at a later time. Although these approaches enhanced retrievability and re-finding of web resources with

minimal costs (Kiu & Tsui 2011; Batch et al. 2013; Batch et al. 2014), they still have drawbacks because the taxonomy of these approaches does not come from explicit tagging activities that are based on users' behaviour in finding information. In addition, hybrid approaches did not take into consideration of the importance of appropriate context in sharing and finding information. User behaviour in finding information and appropriate context plays an important role in re-finding and retrieval at a later time (Maslinda et al. 2013; Hwang & Ronchetti 2016; Xie et al. 2016).

If neither taxonomy and folksonomy nor hybrid approach solves the problem of organizing bookmarks for later retrieval, what could be done to help users effectively re-find and retrieve saved bookmarks? A study by Boardman and Sasse (2004) revealed that users have a strong preference for browsing than searching to retrieve what they need. Browsing requires users to select a particular action (i.e. problem) that has happened before, and then scan available contents to recognise, while search method requires users to remember the exact research words. Therefore, recognition is much less labour-intensive process than recall in memory. Hence, once the user interface provides rich context that allows user to "see and choose is easier than recall and type", the search and retrieve is less likely to be a problem (Hwang & Ronchetti 2016).

Context has been shown to play a significant role in the re-find and retrieval bookmarks of web resources and has been successfully used in several existing tools (Hailpern et al. 2011; Deng et al. 2013; Hwang & Ronchetti 2016). According to Hwang & Ronchetti (2016), context does not replace current classification approaches, it can aid in re-find and retrieval when there are gaps in these approaches. As mentioned, both current classification approaches have advantages and disadvantages. However, both approaches can be combined under an umbrella of appropriate context to acquire the benefits of each in a new scenario.

A pattern language is considered as a rich context to its applications and helps in building a common language among individuals for representing and organizing knowledge (Pan & Stolterman 2013; JI 2015). Besides, pattern language is great for improving communication, capturing and representing knowledge, and creating forms

of communication between individuals (Pan & Stolterman 2013). In addition, pattern language was used to usability knowledge management and sharing (Hughes 2006). Thus, this study exploits advantages of taxonomy and folksonomy approaches in the context of a pattern language for representing and organizing bookmarks of web resources more efficiently and effectively.

In knowledge management context, applying such a hybrid approach is promising for improving the representation and organization of bookmarks of web resources. Consequently, better representation and organization of bookmarks should improve information retrieval and the sharing of useful bookmarks of web resources from these bookmarks. Moreover, by applying this approach, it is possible to share context which helps in building like-minded communities.

1.3 RESEARCH QUESTIONS

This research aims to answer the main question: Could a conceptual model that exploits advantages of hybrid taxonomy-folksonomy in design pattern language context be offered to represent and organise bookmarks of web resources more efficiently and effectively in a learning environment? There are four sub-questions for this research:

RQ1. How can a hybrid taxonomy-folksonomy approach which is based on design pattern language context and user behaviour be applied to represent and organise bookmarks of web resources?

RQ2. How can a new social bookmarking model that exploits such hybrid approach be defined to represent and organize web resources in learning environment?

RQ3. How can a new model that employs a hybrid taxonomy-folksonomy approach to represent and organize graduates' bookmarks of web resources be introduced?

RQ4. How can the efficiency, effectiveness and satisfaction from user's perspective of such a model be demonstrated?

1.4 RESEARCH OBJECTIVES

The main objective of this research is to identify social bookmarking model that serves as a template to develop a Web-based system that improves the representation and organization bookmarks of web resources in social bookmarking. In particular, the main objectives of the research are to:

RO1. Propose a hybrid taxonomy-folksonomy approach based on design pattern using user behaviour in social bookmarking for better represent and organise bookmarks.

RO2. Propose a social bookmarking model based on a hybrid taxonomy-folksonomy approach that is identified in RO1 to improve the representation and organization of bookmarks of web resources in learning environment.

RO3. Propose a graduate social bookmarking model as a proof-of-concept based on the proposed model in objective RO2 to represent and organize graduates' bookmarks.

RO4. Develop a graduates' social bookmarking prototype and evaluate the proposed models.

Figure 1.1 shows the directions for each objective, that is, which objective will answer which research question.

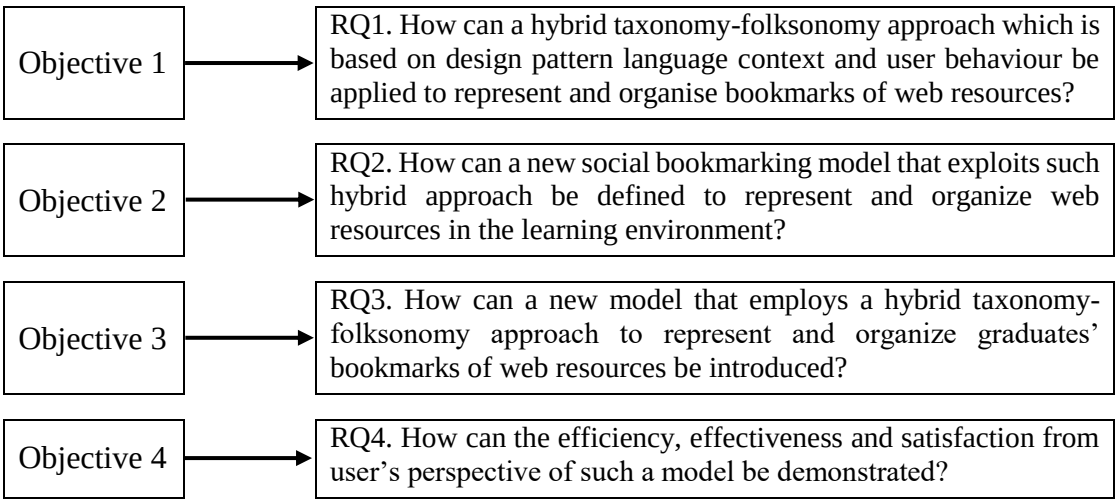

Figure 1.1 The research objectives answering the research questions

1.5 RESEARCH SCOPE

In this study, a model is proposed to make social bookmarks more standard and contextual that supports sharing bookmarks using a hybrid taxonomy-folksonomy approach based on design pattern language context. The proposed model provides meaningful way based on design pattern language context for representing bookmarks. Also, the proposed model provides a dual classification schemes for organizing bookmarks based on user behaviour in finding and using information. As discussed in Section 1.1, in learning and research context, bookmarks can be categorised according to their creator into professors, researchers and university students. The proposed model is generally intended for learners that create, organize web resources written in English, and intended particularly for graduates in the workability and applicability of proposed model phase. Graduates were selected to prove the workability and applicability of the proposed model because they are a group of active knowledge seekers and they prefer to surf the web and online database to find information need in order to solve their research problems (Nadzir et al. 2013; Nadzir & Salim 2015). This study focuses on bookmarks of web resources that discuss learning and research issues only and does not involve social interests of learners.

1.6 THESIS STRUCTURE

Chapter II: Literature Review

Chapter two reviews state of the art in research field to effectively manage and share web resources in social bookmarking. This chapter continues by investigating and analysing existing classification approaches of Web 2.0 applications. This chapter examines the definition of effective knowledge sharing tool aligned to social bookmarking as a popular knowledge sharing tool and explores the critical aspects that define any effective knowledge sharing tool. This chapter also discusses the pattern and pattern language concept as an approach to usability knowledge management and sharing tool. The reviews on user information seeking behaviour in higher education are carried out. The discussion of the importance of Web 2.0 tools for knowledge

sharing and management are also highlighted in this chapter. After that, the classification methods of Web 2.0 applications are highlighted. This chapter continues by investigating the definition of bookmarking and social bookmarking in Web 2.0 era by discussing the characteristics, structure, usage of social bookmarking in general and in a learning context. This chapter also analyses a variety of current classification methods in social bookmarking. The use and the importance of context in information systems and bookmarking tools are discussed in this chapter. Finally, Section 10 investigates and elaborates the problem of existing social bookmarking classification methods from two critical aspects of any knowledge sharing and management tool including organization and representation methods.

Chapter III: Research Methodology

Chapter three defines the research methodology followed in this study to address the major stated objectives. The chapter begins by providing background on design science in information system research. A design science research (DSR) methodology review and a discussion of background are also carried out in this chapter. Finally, this chapter discusses the implementation of DSR methodology that was selected and its criteria for this research context. Detail explanations on how phases of DSR methodology were performed are also done in this chapter.

Chapter IV: The Proposed ISBookmark Model

Chapter four presents a new hybrid taxonomy-folksonomy approach as a solution to the identified problem. this chapter shows how we exploit the advantages of taxonomy and folksonomy under the umbrella of design pattern language to build a hybrid approach in a new scenario. This chapter continues by explaining how we utilized the proposed hybrid approach in order to build a new social bookmarking model. Also, this chapter discusses the adoption of knowledge creation model (SECI) in building the new social bookmarking model.

Chapter V: Graduates Social Bookmarking Model

Chapter five demonstrates the application of the proposed approach on a case study to prove its applicability and validity by proposing a new social bookmarking model called "GISBookmark" model especially for graduates to represent and organize their bookmarks of web resources. The rest of the chapter proceeds to present the architecture and the design specifications of the GISBookmark model. The chapter also explains how design specifications of the GISBookmark model are constructed by following a proper development methodology.

Chapter VI: Development of GISBookmark Prototype

In this chapter, GISBookmark prototype for a graduate social bookmarking system is developed based on the proposed hybrid taxonomy-folksonomy approach of the ISBookmark model. This chapter describes the features that are included in GISBookmark and show some examples of the prototype interfaces that are made based on the design specifications obtained from Chapter V.

Chapter VII: Evaluation

Chapter VII presents the theoretical and practical evaluation of the proposed models, namely the ISBookmark model, GISBookmark model and the GISBookmark prototype which are evaluated as a research outcome. This chapter discusses the effectiveness of the proposed models in solving the research problems. This chapter also presents the evaluation methods and the results.

Chapter VIII: Conclusion and Future Work

Chapter VIII summarizes the results and finding of the research and contribution of the research work. Following that, this chapter presents several research recommendations for further research.

Figure 1.2 provides an overview of the structure of the thesis as well as the interrelations among the chapters and research objectives.

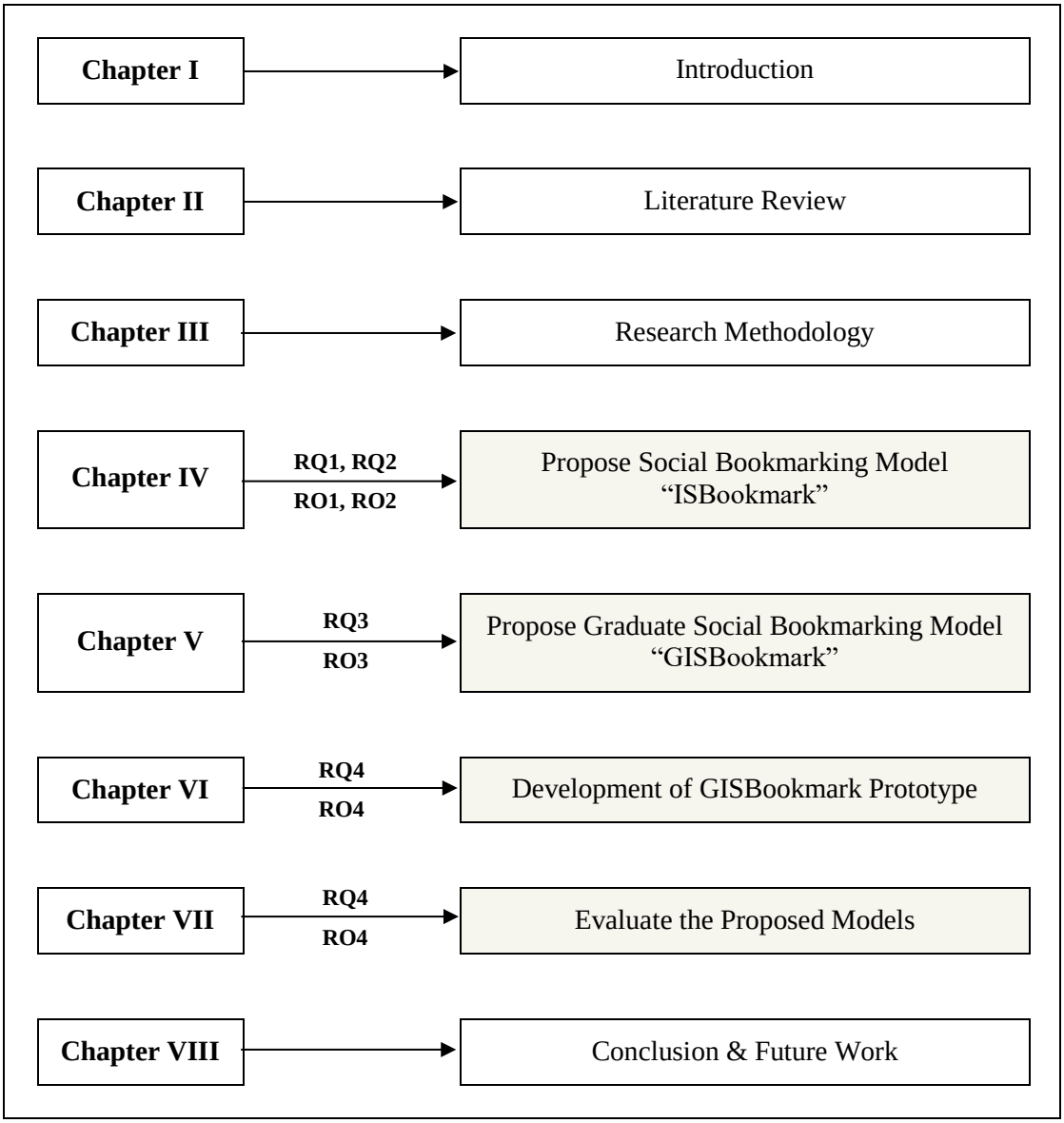

Figure 1.2 The structure of the thesis

CHAPTER II

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter reviews state of the art in research field to effectively manage and share bookmarks of web resources in social bookmarking. In order to explore ways to carry out effective social bookmarking, this chapter investigates and analyses existing classification methods of social bookmarking and Web 2.0 applications. This chapter is organized as follows; Section (2.2) examines the definition of effective knowledge sharing tool aligned to social bookmarking as a popular knowledge sharing tool and explores the critical aspects that define any effective knowledge sharing tool. Section (2.3) discusses the pattern and pattern language concept as an approach to usability knowledge sharing tool. Section (2.4) reviews the literature on information seeking behaviour in learning context. Section (2.5) discusses the importance of Web 2.0 tools for knowledge sharing. The classification methods of Web 2.0 applications are highlighted in Section (2.6). Section (2.7) investigates the definition of bookmarking and social bookmarking by discussing the characteristics, structure, and its usage in learning context. Section (2.8) analyses a variety of current classification methods in social bookmarking. The use and the importance of context in information systems and bookmarking tools are discussed in Section (2.9) and finally, Section (2.10) investigates and elaborates the problem of existing social bookmarking classification methods from two critical aspects of any knowledge sharing and management tool including organization and representation methods. The proposed social bookmarking model is described in Chapter IV, the applicability of proposed model is described in Chapter V while the demonstration of the proposed model is described in Chapter VI, and the evaluation of the proposed social bookmarking model is provided in Chapter VII.

2.2 EFFECTIVE KNOWLEDGE SHARING TOOL

Knowledge sharing is becoming more and more important (Usman & Oyefolahan 2014; Lee & Lim 2017). For years, many researchers have argued that the design of knowledge sharing tool is, at its heart, a communicative process for collaboration as well as sharing that relies on creating 'shared context' among the participants (Clarke & Cooper 2000; Ma & Chan 2014). A major view of knowledge sharing, accepted by many researchers in the knowledge management, is that of designing knowledge sharing tool as a way of controlling and carrying out the conversation between participants (Balubaid 2013). The knowledge sharing tool is an application and set of processes that allow individuals to organize, save, share and retrieve knowledge (Islam et al. 2011; Islam et al. 2013; Serrat 2017).

Two critical aspects that define any knowledge sharing tool are how the knowledge is stated, it requires appropriate context, and how it is retrieved (Hughes 2006). Retrieving knowledge is largely a function of how the users re-find and retrieve the saved knowledge (Hughes 2006). In Web 2.0 era, a social bookmarking system is proving to be the most popular and simplest knowledge sharing tool (Razmerita et al. 2009; Al Rasheed & Berri 2014). Social bookmarking enables users to organize, manage and save bookmarks of web resources for sharing and retrieval (Razmerita et al. 2009; Hwang & Ronchetti 2016; Tella et al. 2018). Therefore, any effort to build effective social bookmarking tool for sharing knowledge should be taken into account the two critical aspects of knowledge sharing tools; how knowledge is stated, to which it requires context and how it is retrieved, to which it requires metadata (Hughes 2006).

The researcher in this study believes that effective social bookmarking tool should provide context for its application together with metadata that can help users to represent and retrieve web resources in an effective way. In social bookmarking, adapting the appropriate context (Hwang & Ronchetti 2016), and metadata based on users' behaviour in finding information (Xie et al. 2016) for representing and organizing bookmarks of web resources is critical in order to establish an effective knowledge sharing and conversation between users.

2.3 PATTERN LANGUAGE

This section is dedicated to provide a background on the concept of pattern and pattern language, benefits of pattern language, and the typical design pattern language.

2.3.1 Pattern and Pattern Language

Pattern language was initially introduced by Christopher Alexander in 1977 (Seffah & Taleb 2012; Nickerson et al. 2015). Pattern language has been defined by Alexander et al. (1977) as a common language which is employed to guide engineers and architects to design towns, buildings and other urban entities. That is to say, patterns provided resolutions to the current problems encountered by designers and provided a resolution within a particular context. Alexander et al. (1977) viewed that an individual pattern can already be very valuable for designers, however, when they are related to each other it is possible that they potentially become far more valuable. Such a set of connected patterns is known as a pattern language. Initially, Alexander's pattern language aimed to empower the non-architects' participation in the design that suited their environment. Therefore, the pattern language of Alexander obviously addressed this objective by supporting its users with a common language that qualified them to express their experience and the relationship between their experiences and their environment in accordance with the pattern language of architecture (Alexander et al. 1977).

Subsequently, the notion of patterns has been employed in object-oriented programming and motivated the thinking to capture and reuse the knowledge of design efficiently (Buschmann et al. 2007; Seffah & Taleb 2012). Borchers (2001) acknowledged that human-computer interaction (HCI) was able to modify the notion of original patterns from the architecture field. Pan and Stolterman (2013) pointed out that the adaptation of pattern language idea to human-computer interaction was proposed by Erickson (1998) concerning the use of pattern language in an interdisciplinary task. They find an even greater influence of views pattern language as a common language (lingua franca) among individuals having various expertise (Erickson 1998), and this has been subsequently repeated frequently (Bayle et al. 1998; Pan & Stolterman 2013).

Dearden and Finlay (2006) categorised the pattern language into types; patterns that dealt with the large-scale design issues, and patterns that illustrated the solution to a recurrent problem. According to Dearden and Finlay (2006), a pattern language can be viewed as a set of patterns which try to provide a solution for a recurring problem in context. In learning and research context, learners and researchers very often face problems in the field of their study. Therefore, applying such a concept of pattern to capture the proven solution to the recurring learning problem is possible.

Seffah and Taleb (2012) confirmed that there are several definitions of patterns to which there is even some sort of contradiction among such definitions. The pattern can be viewed as named, reusable and commonly repeatable resolution to a recurring problem (Monk & Dix 1987; Petrelli et al. 1999; Tidwell 2010). Pattern features comprise particular attributes and can combine with well-matched pattern languages. According to the view of Seffah and Taleb (2012), pattern features are aimed at providing actual solutions to the hitches since they are abstract and can be, thus, employed in different situations. Dearden and Finlay (2006) viewed pattern as a prearranged description of an invariant resolution to an occurring hitch in a specific context.

In addition, Norman (1988) asserted that the use of pattern language can affect and establish the behaviour and recognition of humans. Dearden and Finlay (2006) further divided patterns into design patterns as well as activity patterns. Activity patterns explain the patterns as they are without providing an opinion regarding whether it should be utilized again in emulated manner or should be retained. However, design patterns are concerned with explaining the hitches regarding the resolution which has been attested in practice (Bayle et al. 1998). Furthermore, a pattern can be used to create things or parts of a single thing (Dearden & Finlay 2006). Likewise, the context is "any information that can be used to characterize the situation of an entity" (Wu et al. 2006). In this study, the researcher aims at utilizing the design patterns as context and activity method of representing and organizing bookmarks of web resources and knowledge learned to build an effective social bookmarking as a knowledge sharing tool.

2.3.2 Benefits of Pattern Language

Seffah and Taleb (2012) stated that there are many advantages of using patterns in interface design including their ease of use even for inexperienced designers, being context and problem oriented and their reusability of known best practices. Patterns also provide an advantage as they can be utilized as a tool for communication and collaboration (Seffah & Taleb 2012; Athavankar et al. 2014; Ogo et al. 2016). Furthermore, patterns can be utilized as a tool for sharing solution to problem (McLean 2016; Neutszky-Wulff et al. 2016). This is because they are clear and readable for the designers, developers and stakeholders alike. In a similar vein, Borchers (2001) provided the same view claiming that the utilization of patterns in interaction design, software architecture, and the application domain of project at hand can enhance the interaction among interdisciplinary teams. In this regard, Bayle et al. (1998) investigated the patterns which act as a tool for communication and as lingua franca and contended that because they are derived from the situation for which the design is being made, this feature qualifies them to be good at doing such tasks. In addition, patterns can characterize knowledge from different perspectives (Seffah & Taleb 2012), for instance organizational and social aspects and comprise views from various levels of design like the information from detailed or conceptual level view.

Pan and Stolterman (2013) interviewed 14 pattern language experts whose research interest is in human-computer interaction field. When the researchers asked the experts about the benefits of the use of pattern language, they came up with a list of benefits related to the use of pattern language. In addition, they mentioned in their study the benefits of the use of pattern language on the basis of the interviews; the most important of which are representing knowledge, education, sharing concepts, and documenting conventions and innovations. Furthermore, they highlighted the benefits of the use of pattern language as a means of interaction identification in the interaction of human computer in comparison to other design methods. Based on the interviews, the authors proposed that pattern language offers advantages in the advancement and formation of design thinking. Also, they asserted that patterns can influence the thinking of the pattern's user in a particular direction so that the user will be diligent and careful

with the details as well as definitions. Finally, the authors applauded that pattern languages can be also viewed as a representation form that enhances creativity.

Pattern language provides a good way to represent knowledge for sharing solution to the learning problem (Iba & Sakamoto 2011). In learning and knowledge management context, the knowledge gained from various resources' observation of expert learners is often applied only to solve learning (i.e. research) problem and then forgotten or lost once the expert student moves on (Hughes 2006). For example, "in action research, a researcher works with a group to define a problem, collect data to determine whether or not this is indeed the problem and then experiments with potential solutions to the problem" (Hughes 2006). Once the problem is solved, there is no motivation or efficient way to capture knowledge-learned that can be codified, saved and shared with other learners who have difficulty in finding information to meet their knowledge needs (Nadzir et al. 2013; Nadzir & Salim 2015). In this study, the researcher utilizes the concept and principles of a pattern language to represent knowledge in order to share this knowledge among learners in the learning environment.

2.3.3 Typical Design Pattern Language

Van Welie and Van der Veer (2003) described each pattern as the following structure in Table 2.1:

Table 2.1 Typical design patterns language

Pattern	Description
Name	Brief description that used to refer to the pattern name.
Problem	Brief description of the problem from the user's point-of-view. This problem must be related to users need, goals and tasks.
Context	The characteristic of the context of the user that determined when the pattern can be applied.
Solution	A concrete and illustrated description of the core solution to the problem.
Value	Describing the value of the patterns

In knowledge management context, patterns have been adopted in usability knowledge management by Hughes (2006). Hughes (2006) proposed an approach based on the concept and principles of pattern language that offers a way to capture

knowledge-learned from usability testing to organizational knowledge that can be shared among other members. Hughes (2006) noted that a pattern language provides rich context to its applications by offering a good way for capturing and representing knowledge.

In order to build effective knowledge sharing tool, pattern language is required to provide rich context thus creating participation between the users, providing technical lexicon by building organizational memory, and constructing a "lingua franca" and common language between users for representing and sharing knowledge. A common language helps in building common ground between users and system, and let users understand each other (Wiemann 2016). Current popular knowledge sharing tools (i.e. social bookmarking) have an essential barrier to establishing effective interaction between users as it is still the basic unit of referenced information, and using tags gives a lack of common language between users. The powerful approach that proves to be the most productive for building a common language among users is pattern language to create participation between the user and the computer (Pan & Stolterman 2013).

Therefore, the researcher in study argues that by providing users with a common language and rich context using pattern language approach that is based on problem-oriented will help users in representing, organizing and creating a form of communication between users. Thus, the proposed model in this study uses a design pattern language approach to design new bookmarking approach to usability of social bookmarking tool.

2.4 INFORMATION SEEKING BEHAVIOUR

The research on students' behaviour in higher education has become the focus and interesting topic since the last few decades. Most user studies involved a more holistic approach (Pettigrew & Bruce, 2001). A study by Ellis (1989) identified patterns of information seeking behaviour among social scientists to identify key information sources that can help students to do their tasks (i.e. do a literature review), identify related information sources through citations and references, identifying relevant

journals in the field of study, compare, filter and evaluate the acquired information. In this context, the development of research in the field of study is being observed by monitoring information sources such as journals, newspapers, books and conference articles. Ellis's studies gave an impact as she showed the importance of identifying information seeking behaviour which has been influenced by recent developments in information technology and identifying the implications of the findings can help improve systems and services to support research processes.

Previous researchers have developed information search models which include information search phases. Information search models were developed in various fields such as medicine, education and business. Information Search Process (ISP) model based on learning theory has been used in various studies about learning processes and problem solving by students or library users (Ingwersen & Jarvelin 2005). Another model is known as Big 6 model which was developed by Eisenberg and Berkowitz in 1990. This model can be used in situations that require information in order to solve a decision-making problem. The model consists of six key skills, namely; the definition of task, strategies for seeking information, location and access, use of information, synthesis, and evaluation. These skills are aimed at enabling students to be used in their learning process, specifically in completing tasks and solving problems.

Although all the studies addressed the importance of the information search process specifically in identifying key information sources, there is a difference between all the previous models. Ellis (1989) emphasized patterns of information seeking behaviour incorporated in the research process that are intended to support an individual in the process of finding relevant research information. Information Search Process (ISP) model along with Big 6 models incorporate stages in information skills in their learning process and specifically in completing tasks or solving problems rather than behaviour in seeking information.

Having the knowledge on the behaviour of graduate students in seeking information is an advantage as the knowledge will guide the students in the process of finding information in support of their research processes. Fister (1992) found that those

students who do not have basic information skills tend to use trial and error in finding the information to carry out their research process. A study conducted by Ajiboye and Tella (2007) showed that students who have less knowledge about the source of information face some difficulties in using these resources. Wright et al. (2005) pointed out that research on students' information seeking behaviour need to be undertaken in order to understand how students acquire, manage and use information. Given the lack of students' knowledge about the behaviour needed in finding information such as in the Ellis, Big 6 and Information Search Process models, a study by Nadzir et al. (2013) focused on graduates' information seeking behaviour by proposed Graduate Information Seeking Behaviour (GISB) conceptual framework.

Information seeking behaviour among individuals occurred when there is the need to find information to overcome and solve research and learning problems. Information seeking behaviour covers individual information needs, information search, selection and use of information suitable with the needs of the individual (Williamson & Watson 2007). Graduates' information seeking behaviour framework identified the information needs of graduates and how graduates use the information (context). In this framework, information need of graduate students refers to the need to obtain the relevant information to support their studies specifically to support their research processes by solving problems. Thus, it is important to identify the information needs to solve these problems. Past research on seeking behaviour showed that graduates are not aware of what information is relevant and necessary for solving problems (Shanahan 2007).

There are a variety of information sources that have the potential to be used in helping to create a task, goal and solve problems. In addition, in order to retrieve information to meet information needs, it is important to know how it is organized in the fields being searched. Students should be aware of various sources of information available and the type or feature of its content. Nadzir et al. (2013) proposed a conceptual framework for Graduates Information Seeking Behaviour (GISB) as shown in Figure 2.1 to identify graduates' information seeking behaviour. The GISB conceptual framework is divided into three main sections and is explained in the

following sections. Information seeking behaviour comprises several aspects; information needs, selection of information sources, methods use to search for information and the use of information. All of these aspects were identified in order to determine graduates' information seeking behaviour.

Graduates Need Information (IN) • Related to past research in the field studied • About how to writing a thesis • About how to do literature review • About methods of data analysis • About data collection • About academic writing • About how to prepare research proposal • About the sampling method • About how to identify research problems • About how to determine the objectives of study • About how to define research topic • About the source of information in the field of study • About form research hypothesis
Graduates Using Information (UI) • Evaluated for use in research • Analyzed to identify areas related to the research conducted • Synthesized for research purposes • Used to produce new knowledge • Compiled accordingly • Used to solve problems • Used for decision making • Used in knowledge sharing

Figure 2.1 Graduates Information seeking behavior framework

Source: Nadzir et al. 2013

Information seeking behaviour comprises identifying information needs, determining the sources of information, finding the necessary information and using the information obtained from the search process. During the information search processes, some students have difficulty in acquiring information for their research. Based on the literature review, some of the main problems are the lack of students' knowledge on the information required for conducting research and selection of appropriate information sources in order to find information based on their research needs. Recognizing the importance to overcome the problems, the proposed GISB framework focused on graduates' information seeking behaviour.

The findings of the study by Nadzir et al. (2013) showed that the majority of graduate students prefer to use online databases and web resources as their main source of information. Coincidentally, most of the graduates prefer to search for information in the electronic environment by surfing the web, using electronic sources and searching for information through the web using search engines and subject directories. The information acquired by graduate students during the search processes mostly will be evaluated for research. The results from their study can also be used by system analysts to develop a system which can help students find information for learning activities and research process. It also can be used by graduates in the process of seeking information whether for learning or research. An identification of the graduates' information seeking behaviour can improve the information skills program offered by the library to facilitate graduates' information seeking process to enable them in seeking research information more effectively.

In knowledge management context, the knowledge gained are usually applied merely to the immediate situation under test and then forgotten (Hughes 2006). Likewise in learning and research context, the knowledge gained is often applied only to solve study or research problem in a certain context, soon afterword the knowledge gained and the resources (i.e. the URL of the web page) are forgotten or lost once the graduates move on. In the context of social bookmarking, graduates prefer to use bookmarking tools for sharing and retrieval at a later time (Estellés et al. 2010). In existing social bookmarking tools, there is no motivation or meaningful way to capture this valuable knowledge learned and URLs that can be captured (i.e. bookmark), saved and shared with other learners who have difficulty in finding information and knowledge need to solve their research problems. Existing research in information seeking behaviour of graduates' lack of identifying graduates' information needs that can help them in finding the information they need (Nadzir et al. 2013; Nadzir & Salim 2015). Because information seeking behaviour framework discusses information needed by the graduates, it can also help graduates to find and retrieve information needs (Nadzir et al. 2013). Hence this study adopts the graduates' information seeking behaviour framework during design in order to develop a new social bookmarking approach. Furthermore, this study's approach is a problem-oriented approach that

focuses on the problem to find information need. This study intends to utilize their framework for building graduates social bookmarking model that can help graduates to organise and find information need.

2.5 WEB 2.0 AND KNOWLEDGE SHARING

Knowledge management is considered as one of the most significant techniques that can be used for developing the performance of the organization through empowering the participants to capture, manage, share, imitate and apply their knowledge in solving problems and making decisions at the right time (Lee & Lan 2007; Islam et al. 2011; Kaur & Misra 2018). Through Web 2.0 applications, individuals can capture, organize and manage web resources and online contents (Razmerita et al. 2009; Al Rasheed & Berri 2014; Kaur & Misra 2018). For example, social bookmarking tools enable individuals to create, organize, and manage bookmarks of web resources for sharing and retrieval at a later time (Orehovački et al. 2012; Bamansoor & Shanmugam 2015; Serrat 2017). The shared bookmarks can be viewed using internet or other social software such as wikis, social networking, blogs and other tools to facilitate knowledge sharing between individuals (Malik 2013; Usman & Oyefolahan 2014; Zhao et al. 2015). In addition, social software provides the necessary tools that support knowledge creation for collaboration and sharing to identify and follow professional experts and gain access to their opinions worldwide or even in a closed community (Behringer & Sassenberg 2015; Amin et al. 2016; Eid & Al-Jabri 2016). The simplest and most popular Web 2.0 tool that proves to be a powerful knowledge sharing tool is a social bookmarking system (Orehovački et al. 2012; Al Rasheed & Berri 2014; Hwang & Ronchetti 2016).

Knowledge sharing implementations require diverse tools that come into play throughout the knowledge management cycle. Nonaka and Takeuchi (1995) took up a dynamic model of knowledge management as a knowledge management cycle that shows knowledge as an activity and process for creation of knowledge. Such a model concerning the creation of knowledge is known as the knowledge creation theory (also called SECI model). Chatti et al. (2008) presented Web 2.0 Driven SECI Model-Based

Learning Process which examined the importance of collaboration and discussed the knowledge creation theory of the learning process. Their study aimed at achieving a vision of blended learning which can be defined by the knowledge management convergence and Web 2.0 notions so that it will be an incorporated resolution towards a fresh model of network learning through dynamic participation in several societies.

Figure 2.1 shows the modelled spiraling which is composed of four processes of knowledge creation and its conversion. The four processes of the SECI model include; Socialisation, Externalisation, Combination, and Internalisation. A detailed discussion concerning these modes is shown below within the context of learning, corresponding to the real instances on the different way of how Web 2.0 notions and promising technologies are utilized and applied in relation to one another so as to support all modes of learning process. Knowledge creation can be defined as the process of developing new knowledge from various information resources and experience (Sabherwal & Sabherwal 2005; Islam et al. 2011). The following points discuss the SECI model and how Web 2.0 supports this model (see Figure 2.2):

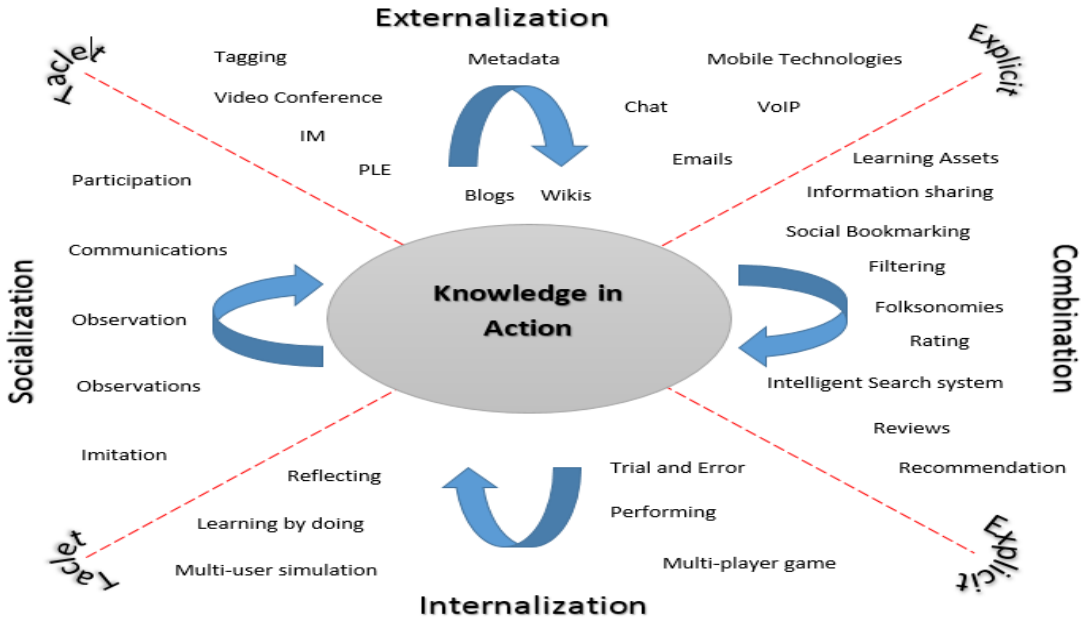

Figure 2.2 SECI model based learning process

Source: Chatti et al. 2008

- **Socialisation**: socialization is the process of sharing acquired and created knowledge from various online resources such as electronic publications on the internet and online (Nonaka & Takeuchi 1995; Islam et al. 2011). It is pointed out that the socialization mode begins with constructing a social interaction "field" or "space". Web 2.0 applications and social software (i.e. wikis and blogs) offer great chances to construct such spaces and transfer knowledge from one person to another (Chatti et al. 2007). Therefore, similar to other Web 2.0 tools, social bookmarking tools build social space for sharing bookmarks of web resources and knowledge learned from these resources among individuals.

- **Externalisation**: externalisation is the process of knowledge articulation into explicit concepts (Nonaka & Takeuchi 1995). Nonaka and Takeuchi (1995) pointed out that externalisation is the key to capturing and creating knowledge because it produces new knowledge. Web 2.0 application provides distinctive means for effective capturing of rich context and quality knowledge having been created, with the least effort (Snowden 2002). The organization of captured knowledge for retrieval at a later time is a challenge, and so is the entire knowledge management life-cycle (i.e. create, organize, save, retrieve and share) (Sharma et al. 2008; Islam et al. 2011). Web 2.0 tools organize knowledge and resources in a suitable deliverable format so that users (i.e. learners) can retrieve and re-use the resources very easily (Chatti et al. 2008). The retrieval process highly depends on the appropriate storage of knowledge. Hence, systematic and well represented and organized knowledge is very significant for Web 2.0 applications in both of the knowledge management. Social bookmarking build social space for capturing knowledge learned from web resources with its metadata (Snowden 2002).

- **Combination**: combination is the process of organizing concepts into the system of knowledge which incorporates various bodies of knowledge (Chatti et al. 2008; Islam et al. 2011). Once the knowledge is confined, it changes into explicit knowledge like accessing and storing information. The construct of Web 2.0 applications and social software (i.e. wikis) provided the community stores of information with recent searchable and context-rich learning assets as opposed to

traditional centralised learning object repositories. The information captured can be then transferred through a social context. Blogs and wikis offer fast and widespread information dissemination in classroom and institutions. Social bookmarking systems facilitate sharing resources across networks by bringing content from different sources (Al Rasheed & Berri 2014). In addition, such captured information can be managed individually or collectively (Peffers et al. 2007). Folksonomies are highly effective types of collaborative information management. Adding, reorganizing and combining reconfiguration of the existing explicit knowledge can lead to discoveries of new knowledge during the process of combination.

- **Internalisation**: internalisation is regarded as the process of transferring the explicit knowledge into tacit knowledge (Nonaka & Takeuchi 1995). The explicit knowledge is internalised into tacit knowledge bases of the individual in the form of mental models or know-how technique, imitation and learning by doing any internalisation activity (Jenkins 2006; Chatti et al. 2008).

Based on above, knowledge sharing can be supplemented by the concepts and technologies of Web 2.0. Therefore, this study adopts SECI model in order to construct social bookmarking model with focus on externalization process because externalisation is the key to capturing and creating knowledge (Nonaka & Takeuchi 1995; Islam et al. 2011; Al Rasheed & Berri 2014). Externalization process builds space for capturing knowledge learned from web resources with its metadata.

2.6 CLASSIFICATION METHODS OF WEB 2.0 APPLICATIONS

Existing studies on classification methods of web resources mainly focused on the difference between tagging and other indexing methods. For example, organizing web resources by using metadata that describes what these resources are about (Mathes 2004). Mathes (2004) differentiates three different types of knowledge organization system users; intermediaries, creators, and users. In the field of information science and libraries, intermediary indexing by experts and professionals in the domain has been an essential method (Mathes 2004). This method is aimed at indexing and organizing resources by using such controlled vocabularies (Søbak & Pharo 2017). The aim of

using controlled vocabularies is to improve the consistency and control of the ambiguity by choosing which terms are appropriate to index and organize the resources (Søbak & Pharo 2017). Creators also can use the controlled vocabularies by choosing which terms are appropriate to index and organize the resources (Mathes 2004). However, controlled vocabularies have not received much attention because there is lack of useful metadata on indexing and organizing resources that are essential for effective retrieval (Kipp 2006; Søbak & Pharo 2017).

On the other hand, tagging is an act of describing and organizing web resources through tags, where the responsibility of describing and organizing web resources by tags is placed on the users (Søbak & Pharo 2017). Although it is widely accepted, tagging is not necessarily the most appropriate classification method for organizing web resources in every situation. (Shirky 2007) argued that indexing by intermediator is still a more appropriate approach than tagging. In addition, he argued that in case of the small and stable collection of objects with clear formal predefined terms, the indexing by categories is better and appropriate. The problem with this method is not only that the indexers have to be professional experts in the domain and have different behaviour from the users, but users should also have experience on how to use the classification systems. In contrast, social tagging does better for big, dynamic and heterogeneous corpora in which the users might not get expertise in a coordinated scheme of classification (Shirky 2007). An example of such a scenario is Web 2.0 era which has billions of web resources that wildly differ in quality and topic.

Therefore, there are two main different classification methods that are used in knowledge organization systems for organizing resources. Essentially the approaches can be grouped into two categories; indexing and tagging. Indexing means organizing web resources using controlled vocabularies that belong to taxonomy, while tagging means organizing web resources using personalized classification that belongs to folksonomy. In this study, the terms taxonomy and folksonomy are used because they are common in the literature. The next subsections discuss the taxonomy and folksonomy sequentially with different aspects of their indexing and tagging activities.

2.6.1 Taxonomies and Controlled Vocabulary

Taxonomy, by definition, is a set of predefined terms and controlled vocabulary for knowledge and web resource organization (Nickerson et al. 2009; Kiu & Tsui 2011). Taxonomies are crucial for any knowledge-based system (Cimiano et al. 2005), and it is essential to develop successful tools in a domain such as organization, classification, navigation, searching and retrieval (Kang et al. 2016). In addition, taxonomy is very important for knowledge sharing and exploitation in different domains (Kang et al. 2016) where the term is originally known as organism classification and was subsequently extended to take into account classifications in any area (Sommaruga et al. 2011). In the context of social bookmarking, taxonomies and controlled vocabulary are employed in descriptive metadata to sustain consistent precise indexing bookmarks of web resources and retrieval at a later time (Hedden 2010). Controlled vocabularies or taxonomies provide consistent, precise, and quick retrieval as well as indexing of bookmarks (Hedden 2010; Kiu & Tsui 2011). As opposed to personalized classification, "folksonomy tags" use user-defined keywords for indexing and retrieval (Sommaruga et al. 2011). A controlled vocabulary is a limited list of terms generally employed for descriptive indexing. It is regarded to be controlled due to the fact that users might solely apply particular terms of the list for its scoped domain (Hedden 2010; Kiu & Tsui 2011; Tuarob et al. 2013). Moreover, the taxonomist is the one who is responsible for that, not the users.

In learning and research context, the taxonomy is a framework that provides terms denoting academic or learning concepts as well as their relations which can be used to describe learning and teaching contents or resources in a structured and standardized way (Krathwohl 2002; Kang et al. 2016). Some examples of learning controlled Subject Headings, Classification Systems and classification standards through the web are Bloom’s, ERIC, and Library of Congress Subject Headings (LCSH). Bloom's taxonomy is viewed as a group of three models which cover the objectives of learning in sensory, affective and cognitive fields which is utilized to systematize the objectives of learning into levels of specificity and complexity (Bloom et al. 1956; Krathwohl 2002). According to Forehand (2010), Bloom's taxonomy is a

scheme of classification that is used for identifying different levels of human cognition such as thinking, learning and comprehension. Many studies have been conducted by specifically applying terminology taken from Bloom's categorization so that attributes of learning can be described while searching for information (Jansen et al. 2009).

The Education Resources Information Center (ERIC) is "an online database and digital library of education and research-related information" (ERIC 2014). ERIC was launched by the Institute of Education Sciences of the United States Department of Education. ERIC produces taxonomy, controlled vocabulary, and Thesaurus of ERIC descriptors in order to help learners seek and find information they need (ERIC 2014). The Library of Congress Subject Headings (LCSH), which was founded by the United States Library of Congress, is composed of a controlled vocabulary of subject headings used in bibliographic collections (Lu et al. 2010). Library of Congress Subject Headings (LCSH), where librarians are allowed to collect, classify and share documents, is an important part of controlling references. LCSH conforms to every item within the collection of library that allows the users to access subjects in the catalog with similar subject matter.

There are many kind of taxonomies in the learning context, nevertheless, all the taxonomies and controlled vocabularies identified by taxonomist or professional experts who have different behaviour in finding information. In addition, there have been no taxonomies or terminologies that discussed user behaviour in finding information need to solve a specific problem (i.e. goal, task, need) in a certain context. According to Hwang and Ronchetti (2016), user context has been shown to play a significant role in the re-find and retrieval of web resources and has been successfully used in several existing tools. This has led the researcher in this study to find suitable taxonomies for the purpose of the study regarding organizing web resources for retrieval at a later time. In addition, to effectively help users to find their resources and information need, it is critical to understand users' behaviour and preferences (Xie et al. 2016). Likewise, to effectively help users to find their resources and information needed to solve a specific problem in certain context, it is critical to understand users' behaviour in finding information and preferences.

However, this study intends to adopt the users' behaviour in finding information categories as a taxonomy, users' behaviour categories should identified based on user context and behaviour in finding information. Adopting such taxonomy as a predefined classification (taxonomies) is promising for assisting learners in organising their bookmarks of web resources. In demonstration phase of this study, Graduates Information Seeking Behaviour (GISB) framework is suitable for this study because GISB framework is built based on graduates' behaviour in finding and using information. Application of such a framework as taxonomy in this study is promising to assist graduates in organising their bookmarks of web resources.

2.6.2 Tagging and Social Tagging

The previous section introduced definitions and characteristics of taxonomies which align to learning context. This section presents definitions and characteristics of tagging as well as social tagging.

a. Tagging

According to Golder and Huberman (2006), tagging is a process where web resources can be marked with descriptive keywords by internet users even from non-experts in the domain. In other words, tags are essentially free-words that users assign to web resources to describe, organize, and manage shared web resources for retrieval at a later time (Krestel & Fankhauser 2009; Krestel et al. 2009; Cao et al. 2015). The tags have been widely utilized and applied in various web-based systems with various purposes and goals (Cao et al. 2015). Tags are not imposed to users in a top-down way by forcing them to solely select from a predefined classification (taxonomies); instead, users are free to type any keywords or phrases to describe web resources during tagging, resulting in true bottom-up classification. In social bookmarking, tags organize and manage bookmarks of web resources for re-find and retrieve in the future (Hayman 2007; Eijlander & Bogers 2009; Luo 2010; Niebler et al. 2017). According to Cao et al. (2015), tagging is a set of three elements; user, resource, and tags in which these elements are known as 'triple' (see Figure 2.3).

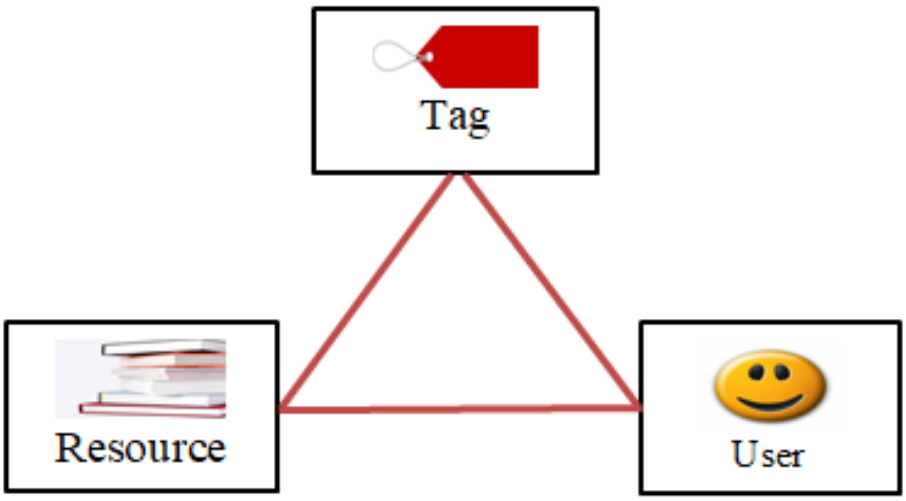

Figure 2.3 Tagging system model

Source: Cao et al. 2015

As the core of social tagging and bookmarking systems, tagging is broken down into three elements; user, resource, and tags (Estellés et al. 2010; Luo 2010; Cao et al. 2015). This means social bookmarking allows users to assign tags to bookmarks of web resources (Luo 2010). Once the tags are assigned, the bookmarks are tagged and can be shared among others and retrieved at a later time. According to Marlow et al. (2006), tags offer effective, easy ways and also as successful directories for organizing and managing of web resources.

The idea of tagging for organizing web resources is widely accepted in which several web applications have adopted this idea for managing the resources. For example, tagging for online photos-sharing (i.e. Flicker photos sharing tool), tagging for online video-sharing (i.e. YouTube), and tagging for online bookmarks-sharing (i.e. Delicious social bookmarking tool) (H. Wordofa 2014). In the learning and research context, tags are also prevalent such as in CiteUlike, Connotea, LibraryThing and Diigo where social bookmarking tools support tags for managing and sharing learning web resources (H. Wordofa 2014). As one of the example of these tools, Figure 2.4 presents bookmarking activity in Diigo social bookmarking system. Diigo is a common social bookmarking tool for learning research (Al Rasheed & Berri 2014).

Figure 2.4 Diigo bookmarking activity interface

Source: Diigo Social Bookmarking

Helic et al. (2012) distinguished between two types of tagging; broad and narrow tagging (Helic et al. 2012). Broad tagging are the ones in which tags are employed for collaborative and social purposes while narrow tagging are the ones in which tags are utilized for individual purposes. Several users who tag the same object employ the broad tagging and each user is able to tag the object employing her/his own vocabulary (Helic et al. 2012). Sequentially, Figure 2.5 illustrates the broad tagging, and Figure 2.5 illustrates the narrow tagging.

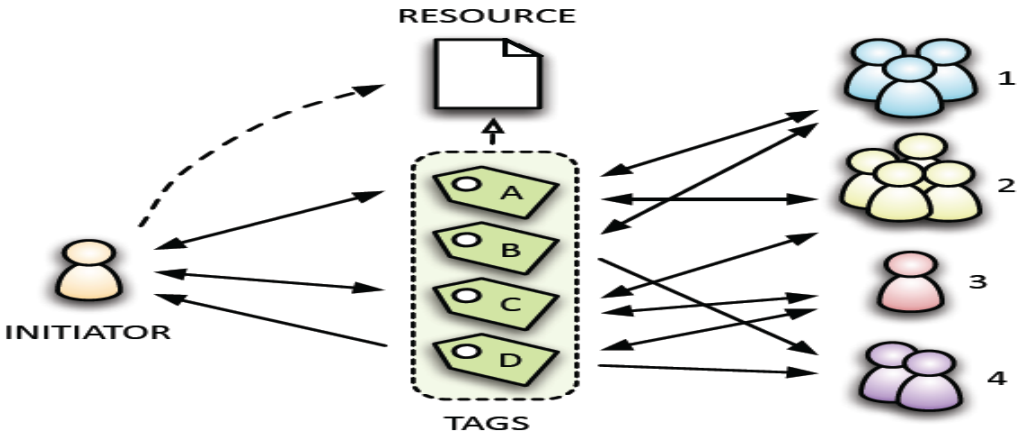

Figure 2.5 Broad tagging

Source: Eijlander and Bogers 2009

The aim of broad tagging is to have a stable pattern in distributing tags for web resources (Helic et al. 2012). In other words, the tags used to describe web resources remain the same after a period of time. Consequently, a number of popular tags are produced and aggregated that could be used at a later time for a further organization or for retrieving web resources tagged. Helic et al. (2012) concluded that broad tagging in online systems offer a more efficient navigational method for users to find resources. Figure 2.4 illustrates an example where the ‘initiator’ adds the new resource to the system for sharing or retrieval at a later time, and the initiator user has also tagged the added resource with tags "a" and “c". Other users in group "1" and group 2 added tags "a" and "b" to the available tagged resources and users in group 3 added tags "c" and "d". Notice that the users in group 4 added no tags. Notice that there are also three types of users, the original creator " initiator " added "a" and "c" tags, other users in groups 1, 2, 3 who added the tags "b" and "d" are called taggers, while the users in group 4 added no tags, and are hence called "viewer". Although the initiator did not add the tag "d", he/she can use it to later retrieve the resource. Also, the users in group 4, who added no resource or tags, can use tags "b" and "d" at a later time.

This means the tagging in this scenario is collaborative and social tagging in nature, in which that tags can be assigned many times to the same web resource. This nature of social tagging is called folksonomies (Helic et al. 2012), which is a term used in this study because it is common in literature. In addition, this study involves the three types of users (creator, tagger and viewer) in the design of the proposed model.

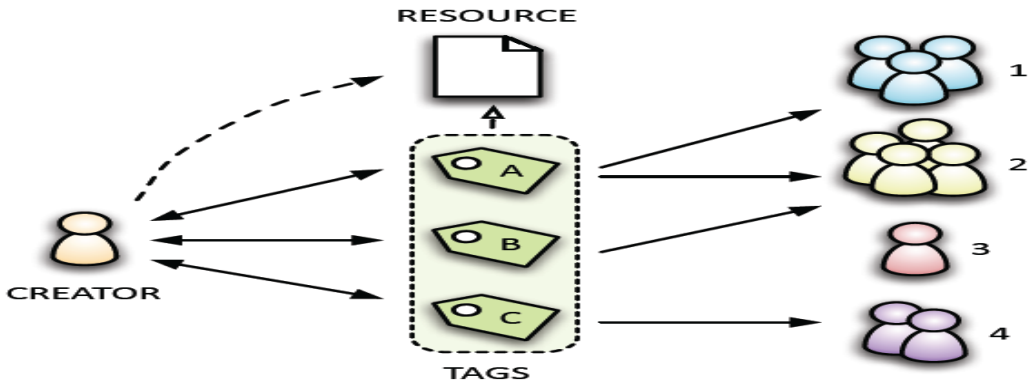

Figure 2.5 Narrow tagging

Source: Eijlander and Bogers 2009

In narrow tagging, the navigational structure is less effective than broad tagging because narrow tagging only focuses on the one user, and does not allow social interaction and discussion (Peters 2009; Helic et al. 2012). For example, YouTube is a common tool that uses narrow tagging around videos; YouTube is an online tool for sharing videos that allows users to upload videos and tag them for sharing and to re-find them at a later time (Eijlander & Bogers 2009). In narrow tagging, only the creator of web resources can tag them (Figure 2.5 illustrates narrow tagging). In YouTube, as an example, a user can upload a video to the website, only the user, as creator can add tags "a", "b", and "c" to the uploaded video to annotate and describe it. As a result, each tag is used only once for a specific item (i.e. web resource) in a narrow tagging. Therefore, narrow tagging is considered as individual tagging. Moreover, in narrow tagging, other users try to find the uploaded item (i.e. videos) based on the creator's words and vocabulary; users in group 1, 2, 3 can use tag a, b, or c to find the tagged resources, users in group 2 may use tags "a" and "b", and group 4 users may use tag "c". However, users in group 3 cannot find the target resources because the resources are tagged based on creator's vocabularies and words.

In order to build effective social bookmarking for discussion and social interaction, users should apply among them broad folksonomies that allow all users to tag available bookmarks of web resources for further classification. Therefore, this study adopted broad tagging by allowing users to create bookmarks of web resources and allowing other users to tag available bookmarks for further classification. In other words, this study focuses on social tagging (broad tagging), not on individual tagging (narrow tagging).

b. Purpose of tagging

The use of tags differs based on the context (i.e. social or personal) as well as the kind of the resources tagged (i.e. bookmarks, photo, video, etc.). Marlow et al. (2006) demonstrated the complementary picture of the aim of tagging in organizational and social needs. They are created as the principal goals of tagging and the incentives which make such motives comprise opinion expression, self-presentation, play and

competition, attracting attention, contribution and sharing, and retrieval (Marlow et al. 2006). This study mainly focuses on the contribution, sharing and retrieval of bookmarks that discussed learning-related web resources which could be leveraged for the aim of learning. According to Tang et al. (2008), tagging offers ease-of-use, ability to assign tags to web resources with minor cognitive cost and effort, and efficient visualization and representation of tagged resources through tag cloud (Tang et al. 2008; Hwang & Ronchetti 2016). The utility of tags has led to tags being applied and adapted in many different domains. Smith (2007) grouped the use of tags in five different categories as shown in Table 2.2.

Table 2.2 Tags categories (Source: Smith 2007)

Category	Application	Type	Purpose
Personal Information Management (PIM)	Yahoo mail	Email	Tag Email.
E-commerce experience	Amazon	Online Store	Tag items for navigation later
Sharing digital objects	Flickr	Photos	Tag photos for sharing.
	YouTube	Videos	Tag videos for sharing.
	LibraryThing	Books	Tag books for sharing.
Blogs	WordPress	Blogs	Tag blogs.
Social bookmarking	Delicious	Social	Tag bookmarks of web resources for sharing and retrieval at a later time.
	CiteUlike	Academic	Tag learning and research bookmarks for sharing and retrieval at a later time.

Moreover, tags can also be considered as effective information retrieval technique when tags are visualized through tag cloud (Hassan-Montero & Herrero-Solana 2006). Visualized tags through tag cloud based on the frequency of use tags are a powerful way to help users recognize what are popular web resources (Hassan-Montero & Herrero-Solana 2006). Also, such an effective design interaction can also help users effectively and quickly discover the important and popular resources (Kaser & Lemire 2007). Furthermore, meaningful representation of tags also helps and facilitates navigation and browsing (Kaser & Lemire 2007). More clearly, through the representation of tags in a structured and meaningful way in the systems, the users can access and re-find the web resources easily and effectively.

Tagging purposes are useful since different reasons for tagging are described based on various areas. Specifically, the users' experience improvement is considered as the essential reason for using tags. The notion of interactions through tags and indexing is still to be investigated as a reason of tagging, especially in social bookmarking for learning environment. This study tries to improve the user experience by providing rich context to the application. Also, similar to CiteUlike goal (see Others in Table 2.2), an important purpose of tagging in research and learning context is to tag learning and research bookmarks of web resources for sharing with others who have difficulty in finding information needs or for personal re-find at a later time.

c. Social tagging

Social tagging is an application of tags in Web 2.0 and social software, where the tags created by users are available to other users (Golder & Huberman 2006; Feng & Wang 2012; Tennis 2017). Social tagging is regarded as a process where several users add tags in the form of keywords to shared content (Zubiaga 2012; Font et al. 2013; Parra-Arnau et al. 2014). Recently, social tagging has increased in popularity on the web due to the fact that they enable users to tag bookmarks of web resources (i.e. CiteUlike), photographs (i.e. Flicker) and other resources. In this study, the term social tagging is used during the design of the proposed model because it is common in Web 2.0 and social software literature.

In social bookmarking, social tagging allows users to tag bookmarks for sharing and retrieval at a later time (Luo 2010). After bookmarks are tagged and saved, other users can view available bookmarks and use these tags to retrieve the saved bookmarks and to tag them (Eijlander & Bogers 2009; Hwang & Ronchetti 2016). The most common social bookmarking tools that use social tagging systems are Delicious and Diigo (Luo 2010; Al Rasheed & Berri 2014).

Additionally, several other Web 2.0 tools use the social tagging system to establish their resources (i.e. Flicker). A particular environment of users adopts each of these services (Marchetti et al. 2007). Consequently, each service compromises social

tagging, so that its users can be supported to organize their resources that are needed for future retrieval (Macgregor & McCulloch 2006; Marchetti et al. 2007).

Hence, the tags collected from social tagging establish a system of social classification that can be used as shared resources. This system is known as a folksonomy (Macgregor & McCulloch 2006; Marchetti et al. 2007; Eijlander & Bogers 2009; Hwang & Ronchetti 2016).

d. Social tagging systems challenges

The major drawback of the social tagging systems is the standardization in tagging (Al Rasheed & Berri 2014). In other words, there exists no controlled vocabulary that represents a number of standard keywords (Noruzi 2006; Spiteri 2007; Al Rasheed & Berri 2014). Therefore, many mistakes might take place because of synonym confusion, misspelling, tags that are too personalized or tags which have different meanings (Marchetti et al. 2007; Cairns 2013). There exist several obstacles concerning the usage of tag which seem to obstruct its effectiveness, the major one of which is relatively associated with the numerous methods of the use of keywords (Marchetti et al. 2007). These comprise synonyms (referring to words with similar meaning); polysemy (referring to a word with different meanings), different forms of lexis (like plurality) (Marchetti et al. 2007), name-adjective and acronym, conjugation, spelling including alternate and incorrect spelling and different levels of accuracy as well as association (Marchetti et al. 2007). Such deficiency in the keywords use is relatively linked to the semantics or meaningfulness of tags. However, this problem can be dealt with by consulting the semantic database (Marchetti et al. 2007; Suchanek et al. 2008).

Moreover, the keywords employed by the users are probably unclear in several situations leading to another challenge - the ambiguity of tag, where a group of keywords employed as tags could be in the wrong context. The tag ambiguity has been studied by Weinberger et al. (2008) which proposed a probabilistic model as a mean to recognize ambiguous tags and provide a tag proposition as a method to clarify tags. Furthermore, Au Yeung et al. (2009) investigated the same issue by initially defining

20 unclear tags from Delicious (tags having many contexts like soap, opera and so forth) and subsequently conducting a graph-based analysis of clustering. This study proposes a tag context similarity network as the most convenient method to disclose the context of the applied tag to attain tags disambiguation. Another solution for such a challenge is provided by the analysis of taxonomy relations (ontology) as carried out by Ulicny et al. (2010). In this taxonomy, tags dynamic relations identified through the triples semantic processing are suggested to be a good alternative to clustering. This study tries to deal with these problems by offering predefined categorization based on users' behaviour in finding information and collection of most common tags.

Another challenge of social tagging systems is the relationship between tags (Uddin et al. 2013). In order to solve this problem, many studies investigated the lack of relationship among the tags. For instance, Cattuto et al. (2008) suggested grounding the tag relatedness measures semantically and characterizing various kinds of measures of similarity based on the type of semantic relationships that they correspond with. Consequently, their approach was applied to get related tags that have a relationship in common with a certain tag. Mika (2005) conducted an analysis of social network on a group of communities with a similar interest. Moreover, Hotho et al. (2006) used PageRank algorithm into folksonomies tags to examine the relationships among the tags, the resources as well as users.

Begelman et al. (2006) investigated the co-occurring tags distribution for a certain tag and calculated the threshold above which recurring tags are closely linked to each other. Many other methods also employ distributional measures with various contexts of the folksonomy tags data aggregation. In particular, Heymann et al. (2008) employed the tag-resource contexts; Heymann et al. (2008) applied the tag-tag context, while Schwarzkopf et al. (2007) applied multiple measures combining the tag-user context with the tag-tag context. Besides, Cattuto et al. (2008) suggested an analysis of the different context of distributional aggregation. However, Markines et al. (2009) suggested a fresh type of measure that depends on mutual information calculus apart from a framework for the analysis of various kinds of measures on similarity between tags and resources.

Another study by Liu and Chang (2008) stated that the used tag is ranked by algorithms to identify tags that are more relevant. The other approach solved this problem by linking folksonomy tags with formal ontology in order to enrich folksonomies (Van Damme et al. 2007). Hayman and Lothian (2007) introduced taxonomy-directed folksonomy approach that combines both folksonomy tags and predefined categories “taxonomy” to overcome the lack of relationship between tags.

In order to design taxonomy-folksonomy approach of the proposed model, this study adopted the approach proposed by Hayman and Lothian (2007) that exploits advantages from personalized classification "folksonomy tags" and predefined classification "taxonomy" approaches to organize bookmarks of web resources in social bookmarking. By applying this approach, the relationship between folksonomies tags in social tagging systems is less likely to be a problem through grouping folksonomy tags under users' problem category based on user’s behaviour in finding information. Moreover, applying this approach represents semantic entities in a knowledge base (García-Silva et al. 2012).

e. Social tagging systems design

According to Doerfel et al. (2016), the social interaction between users in social tagging systems is critical (Doerfel et al. 2016). Moreover, Marlow et al. (2006) argued that the social relations between users are critical element and they pointed out that social interaction connects bookmarking activities of individuals with a rich network of tags, resources, and users (Doerfel et al. 2016). In addition, they presented a model for design social tagging systems. This model presented some critical key features to design tagging systems. The features for designing social tagging system are as follows:

- ***Tagging rights:*** An important characteristic which can possibly be considered as the most significant one of the tagging system is its ability to be restricted on group tagging. In that, it can be restricted to self–tagging, in which users can only tag the resources they generated (e.g., Technorati) or it can allow users to tag any resource free-for-all-tagging. However, this is not the only possible dichotomy as systems

can allow different levels of compromise. In order to build broad tagging around bookmarks of web resources, this study follows free-for-all tagging approach that allows users who are viewing web bookmarks to tag them.

- ***Tagging support:*** The tagging system behaviour is very affected by the mechanism of tag entry. Accordingly, the detected systems encompass three different categories; blind tagging, viewable tagging and suggestive tagging. In blind tagging, user is unable to see what other users tagged to the same resource, while viewable tagging allows user to view the tags assigned by others, while the last category is suggestive tagging, where the system suggests tags to the users. In this study, the proposed approach offers a list of problems and list of tags assigned by others, so the user can view and choose from both lists to assign resources.

- ***Aggregation*****:** One of the much related features of group dynamics arises from the aggregation of tags around a given resource. The system can allow a large number of tags for the same resource which may cause duplication of tags from a number of different users. This approach is called the bag-model for tag entry. In contrast, there are many systems that may ask the users to tag an individual resource in a group, and hence no repetition is allowed. This interface is termed as set-model approach for tag input. This study follows bag-model approach where the same tag can be added by the users for the same bookmark of web resource more than once.

- ***Type of object:*** The type of resource being tag is of importance. The most prominent in sample objects types include (but not limited to); web pages, bibliographic material, blog posts, images, users, video, audio, and songs. The tagged object in this study is the URL of the web page that discusses and provides solution to recurrent learning and research problem in certain context.

- ***Source of material:*** The tagging resources can be provided by the users, by the system, or a system can be open for tagging of any web resource. In this study, the URL of web pages for web resources to be organized and tagged comes from learners (i.e. graduates).

- ***Resource connectivity:*** The system resources can be connected to each other separate from the user tag. Resource connectivity may fall into three categories; linked, grouped, or none. For example, web pages are associated to directed links; Flickr photos can be allotted to groups, events in Upcoming are connected depending on time, city and venue linked with the event. The resultant tags have useful implications such as merging with similar tags for connected resources, particularly in suggested and viewable tagging support scenarios. In this study, bookmarks of web resources connectivity are grouped under user problem-based category that is part of information seeking behaviour categories.

- ***Social connectivity****:* Some systems provide the users, within the system, with the possibility to be connected. Similar to resource connectivity, such social connectivity can be categorized as linked, grouped, or none. In this study, the aggregated bookmarks consist of the name of bookmark creator and still have the chance to follow certain users so that their bookmarks can be viewed.

The customization of tagging attributes and features has been applied for designing the proposed approach of the social bookmarking model in this study.

2.7 BOOKMARKING AND SOCIAL BOOKMARKING

Hwang and Ronchetti (2016) defined bookmarks as "Uniform Resource Identifiers (URI) of the web resources saved for sharing and later retrieval". Social bookmarking is an online service that allows internet users to create, organize, manage and save bookmarks for sharing and retrieval at a later time (Estellés et al. 2010; Luo 2010; Redden 2010; H. Wordofa 2014). Usually, these bookmarks are set as public for sharing among others, or users can also save privately to re-find them later (Al Rasheed & Berri 2014). Bookmarks can be shared either within specified groups or within another combination of both public and private domains (Al Rasheed & Berri 2014). Internet users are sharing their bookmarks of web resources, and by saving them on social bookmarks aggregator website, users can retrieve them anytime, anywhere they need (Estellés et al. 2010).

Moreover, users can usually retrieve and view these saved bookmarks either via the search engine, or tags or by categories (Dalkir & Liebowitz 2011). Usually, social bookmarking services use personalized classification (tags and annotation) instead of formal taxonomy or categorizing methods for the purpose of retrieval at a later time (Hammond et al. 2005; Marlow et al. 2006; Hayman 2007; Neelakrishnan et al. 2013). The using of annotation can be provided to such bookmarks in the shape of metadata with the intention that it becomes easy for users to understand the resource content and no need for downloading it. For instance, free text annotation, comments or tags are all easy descriptions and add value to resources.

Social bookmarking is helpful that it enables the users to easily share resources with others in a way that the original resources, as well as the knowledge-learned about it, can be shared (Redden 2010). Therefore, social bookmarking play superior role in future communities because it helps in building like-minded communities, individuals who share similar resources can find other individuals who tag or annotate the same resources (Estellés et al. 2010; Shih 2011). In a closed community, since the individuals share the same context, goal, task and share the same terminology, tagging as the core of social bookmarking is less likely to be a problem and more effective (Estellés et al. 2010; Redden 2010; Al Rasheed & Berri 2014). Social bookmarking and tagging can be beneficial in building understandable profiles for retrieving information at a later time using knowledge management tools. Hence, these social bookmarking tools may help knowledge capture and can help in building social interactions among individuals (Chua 2007). It is also a great knowledge and resource discovery tool (Barsky & Purdon 2006).

2.7.1 Characteristics of Social Bookmarking

According to Estellés et al. (2010), the social bookmarking systems have some well-known characteristics. The most popular characteristics of current social bookmarking are the basic unit of referenced information and the use of tags. The basic unit of referenced information is common for any social bookmarking system (Estellés et al. 2010). The referenced information of bookmark is a set of three elements; user,

resource, tags whereby these elements are known as 'triple' (Estellés et al. 2010). This unit defines the way the social bookmarking system works and it reflects that a certain user has assigned a concrete tag to a particular URL of the web page for a web resource. According to Zubiaga et al. (2009), the social bookmarking system normally contains the following elements:

- Tags or terms that describe the resources, which can be numbers, names, acronyms, or any free text or phrases with no meaning restriction.
- Notes or comments are considered as a short free text describing and explaining the resource content.
- Highlights are known as parts of the resource marked as relevant.
- Reviews, which deal with free text assessing the resource content.
- Ratings, which indicates that users liked or disliked specific resource content.

Based on above, there are two main users of social bookmarking systems; creators and taggers. Creators organize and save bookmarks of web resources, whilst the taggers use the tags to organize saved bookmarks. In this study, the creators and taggers still have to sign up and sign in to access social bookmarks to use its features including bookmarking, browsing and tagging available bookmarks. Liu and Chang (2008) confirmed that occupational differences and gender do not affect the bookmarking perspectives. In this regard, the interaction requires a greater contact with individuals. Therefore, individuals do not need to live in one place and they are not restricted to age, occupation and gender. They only need to share the bookmarks of web resources and comment on their knowledge. The creators and taggers in this study are male and female, who are familiar with bookmarking tools including creating, tagging and annotating bookmarks of web resources in English in different understanding level, age and cultural background.

2.7.2 Social Bookmarking in Learning Context

Bookmarking also has rapidly become common in learning community (Estellés et al. 2010; Colwell & Gregory 2016). Social bookmarking system allows learners to manage

and save their web bookmarks as well as share bookmarks with other learners online (Abbitt 2009). It also allows them to share their knowledge learned and insights concerning the resources of web with others, and collaboratively proposes interesting web resources to others (Liu & Chang 2008; Maharana et al. 2010; Cao et al. 2015). A social bookmarking for learning and research primarily discusses web resources that contain learning resources such as methodologies or learning concepts and topics (Colwell & Gregory 2016).

Social bookmarking for learning and research environment provides new channels for communicating learning resources and information to a wider range of professors, researchers and university students (Laird 2014). Most social bookmarking systems allow students to classify and organize their bookmarks with personalized classification (tag and annotation) instead of traditional file folders (Laird 2014). Therefore, social bookmarking can be successfully used as a knowledge sharing tool to encourage students to use collaborative learning by providing social space and interaction between them. Social interaction in learning and research community seems to be complicated that it depends on technology rather than social aspects (Gunawardena 1995). Therefore, great attention should be paid to the instructional methods as well as designs to assist in and simplify the interaction of the students with one another. Although the purpose of learning is to improve the cognition of learners, the communications established by affection can promote their collaboration (Kreijns et al. 2003).

Study by Nadzir et al. (2013) showed that graduates are an active group seeking knowledge from online databases and web resources. Their study showed that some graduates have difficulty in finding information. This means they need a knowledge sharing tool that allows users to collect, organize and share web resources with others who have difficulty in finding what they need. Therefore, this study addresses social bookmarking as a knowledge sharing tool among learners in learning and research environment because they are found to be better suited to collect web resources.

2.7.3 Usage of Social Bookmarking

Social bookmarking tools are useful for learning and collaboration because bookmarks of web resources are shared and users generate the metadata that describes these bookmarks collaboratively. According to Estellés et al. (2010), social bookmarking is a useful tool in learning and research environment for the following reasons:

- Managing and organizing web resources for professors and researchers and also for university students using folksonomies. Therefore, social bookmarking is a powerful tool for creating and generating knowledge.
- Organizing and sharing reference lists by adding value to the shared web resources.
- Managing the web resources and knowledge-learned gained and collected in any research stage or process (i.e. Mindly).
- Managing research groups that are interested in a particular project or specific field. Researchers or learners who have difficulty in finding information or resources can follow and navigate the bookmarks of web resources that have been created by professional and tagged by collective intelligence.
- Searching for resources or knowledge that users need to solve a specific problem of interest directly where users can access and view the original knowledge.

According to Kolay and Dasdan (2009), when user search for knowledge or resources through bookmarks of web resources in social bookmarking tools (i.e. Delicious), the quality of available resources is higher than the resources found via other research engines (i.e. Yahoo or Google). In spite of this, Heymann et al. (2008) noted that 25% of the resources available on Delicious social bookmarking website was not indexed by other search engines such as Yahoo.

In another interesting aspect of the usage of social bookmarking tools, each member of the community (i.e. learning) can contribute in enhancing the quality of resources by folksonomies (Estellés et al. 2010). Folksonomies allow users to collaboratively organize these resources for more quality. Collective intelligence refers

to the development of more quality of knowledge by allowing each user to contribute and organize (Bebensee et al. 2012).

In social bookmarking and learning context, the collective intelligence decides what bookmark of web resources is valuable to solve a problem in context through filtering bookmarks using tags (Lau 2011). Therefore, the value and quality of information or web resources increases, as a result, the users can get the information needed and can learn from other members simply by following specific other users who have the same interests.

2.8 CLASSIFICATION METHODS OF BOOKMARKING SYSTEMS

There are two different classification methods that are used in social bookmarking systems for organizing bookmarks of web resources in social bookmarking. Essentially the approaches can be grouped into two main categories; taxonomy-based approach and folksonomy-based approach. These classification approaches focus on different aspects of bookmarking activities. The next subsections highlight the current classification methods and the combination between the social bookmarking systems.

2.8.1 Taxonomy-Based Approach

The first classification approach is taxonomy-based, which is essential in developing a social bookmarking tool for organizing bookmarks of web resources and knowledge for searching and retrieval at a later time (Kang et al. 2016). The term taxonomy has also become popular as the term for any kind of controlled vocabulary (Hedden 2008; Hedden 2010). Furthermore, taxonomy is very important for knowledge sharing and its exploitation in different domains (Kang et al. 2016). Thanks to its precise and consistent indexing of web resources (Kiu & Tsui 2011), the implementation of taxonomies is found in various means of bookmarking. For example, TechnologyForTeaching social bookmarking tool offers the taxonomy-based indexing system for pre-service teachers to organize and share bookmarks of web resources in the educational environment (Abbitt 2007; Abbitt 2009).

Taxonomy is categorized hierarchically; which means its establishment of relations among terms is found and possible. Similarly, Tagsonomy is easy to access to websites, offering taxonomy-based approach with top-down classification "controlled vocabulary" defined by the content manager of the website (Sommaruga et al. 2011). Although taxonomies are widely accepted, they do not come without drawbacks. The search and retrieval of resources has become a challenge because controlled vocabulary is a limited structure (Kiu & Tsui 2011) that represents a classification system of meaningful terms to organize a given domain (Tuarob et al. 2013). In addition, controlled vocabulary is usually identified by taxonomist or professional experts who have a different behaviour in finding information (Kiu & Tsui 2011), and do not reflect users words (Batch et al. 2013). Moreover, the maintenance of the taxonomy is exhausting and time-consuming (Kiu & Tsui 2011). Therefore, the re-finding and retrieving of web resources has become a challenge.

A study carried out by Xie et al. (2016) showed that to effectively help users to find their resources and information need, it is critical to understand users' behaviour and preferences. In fact, current taxonomy-based approaches provide users with constraint terms that are not based on their behaviour in finding and seeking information to organize their information and resources for retrieval at a later time.

2.8.2 Folksonomy-Based Approach

The concept of folksonomy was introduced and coined in 2005 by Vander Wal (2007). Folksonomy is composed of the terms "folk" and "taxonomy" and is a "kind of many users generated tags to organize web resources for retrieval at a later time" (Vander Wal 2007; Hwang & Ronchetti 2016; Klašnja-Milićević et al. 2017). Folksonomy gives users a high degree of personalization in organizing web resources with minimum cost (Hwang & Ronchetti 2016).

A folksonomy is defined by Vander Wal (2007) as the results, which are a personalized classification "tag" of resources for re-finding and retrieval at a later time (Søbak & Pharo 2017). In contrast to classical taxonomy for resource organization,

folksonomy employs user-defined keywords, “tags”, for retrieval as well as indexing (Hwang & Ronchetti 2016). Tags do not only provide users with great freedom in selecting the most significant keywords in their views but also reduce the “cost of participation”(Kiu & Tsui 2011), usually encountered with formal ontology due to the fact that users do not require detailed knowledge of the current taxonomy or ontology to significantly systematize resources. This is due to its ease-of-use and high degree of personalization that reflect the vocabulary of users (García-Peñalvo et al. 2010; Kim et al. 2010; Hwang & Ronchetti 2016).

Although it is widely accepted, the folksonomies nature tags do not come without a price and drawbacks. Due to the high degree of arbitrary personalization, the retrieval and search of web resources have become a challenging task (Hwang & Ronchetti 2016). Besides, the use of subjective keywords gives a lack of semantic precision (Kim et al. 2010). Therefore, folksonomy is insufficient for information retrieval (Kim et al. 2010; Hwang & Ronchetti 2016). Furthermore, the lack of consistency and way of representing tags leads to ambiguities and inconsistencies of tags (Kiu & Tsui 2011; Al Rasheed & Berri 2014).

In social bookmarking tools, folksonomies-based systems make it possible to share bookmarks of web resources with others in a way by sharing not only the URL of the web resources but also its metadata “tags”(Al Rasheed & Berri 2014). Al Rasheed and Berri (2014) noted that one of the benefits of folksonomy-based social bookmarking to help in building like-minded community. In order to build like-minded community, folksonomy tagging should be approximated for peers, whether unanticipated or unknown users (Dalkir & Liebowitz 2011; Al Rasheed & Berri 2014). Moreover, folksonomy-based social bookmarking can aid in building an implicit and explicit search using data captured in informal knowledge management tools. In addition, Bergman et al. (2008) demonstrated that users are in favor of navigation rather than search. It is worth mentioning that folksonomy-based systems offer folder-like functions for users so as to systematize their tagged bookmarks of web resources (Hwang & Ronchetti 2016).

After viewing and investigating what taxonomies and folksonomies are and how users organize bookmarks of web resources by using these different classification methods, the following subsection discusses how existing studies tried to overcome taxonomy and folksonomy problems.

2.8.3 Taxonomy-Folksonomy Approach

As mentioned in subsections 2.8.1 and 2.8.2, taxonomy and folksonomy approaches have drawbacks. In order to overcome problems of taxonomy and folksonomy, a few studies have combined taxonomy and folksonomy for better organization of web resources. Lemieux (2009) argued that combining taxonomy and folksonomy in hybrid structure provide an important basis for organizing web resources, improved content retrieval and searching, an enhanced process of taxonomy management, and a new navigational facet that facilitates the creation and representation of resources, and resources classification with negligible costs (Kiu & Tsui 2011).

The extent of suggested hybrid approach to taxonomy and folksonomy are divided into four approaches; taxonomy-directed folksonomy, folksonomy-directed taxonomy, folksonomy hierarchies, and co-existence of taxonomy and folksonomy (Lemieux 2009; Zorica et al. 2014). While taxonomy-directed folksonomy offers tags propositions that allow users to assign web resources with the appropriate term from predefined terms list in the form of drop-down menus, folksonomy-directed taxonomy can be used as a set of candidate tags that can symbolize fresh terminology to update and enrich the taxonomy and provides new taxonomy terms. The third approach is folksonomy hierarchies that provide two types of folksonomy hierarchies; automatic derivation and user powered. User-powered is considered a social approach where typically small population makes the contribution. On the other hand, a folksonomy hierarchy is done through statistical or clustering algorithms. The fourth approach is co-existence of taxonomy and folksonomy. In co-existence approach, both taxonomy and folksonomy work side by side. Each approach is preserved and each of their philosophy is kept in originality. Every classification is regarded as autonomous and there is no relationship between the folksonomy tags and the taxonomy terms (Beatch &

Wlodarczyk 2009). Although other hybrid taxonomy-folksonomy approaches show a degree of success in organizing web resources in different areas, co-existence played a major role in providing better organization of web resources. Therefore, the use of co-existence approach in social bookmarking and other Web 2.0 is not novel. However, a few researchers have applied co-existence approach to help users organize and re-find web resources in recent years. Table 2.3 presents the summary of existing hybrid approaches that combined taxonomy directed folksonomy.

Table 2.3 Summary of existing hybrid taxonomy-folksonomy approaches

Author	Approach	Results	Limitations
Hayman and Lothian (2007)	MyEdna, a taxonomy-directed folksonomy portal.	MyEdna able to produce a more consistent categorization of resources. MyEdna users able to make discussions and connections around tags and resources.	The portal was designed on a conceptual level only Without proper development or user evaluation.
Kiu and Tsui (2011)	The algorithm named TaxoFolk which is dedicated to the integration of folksonomy and taxonomy in order to improve the classification of web resources for navigation.	The resultant structure of taxonomy and folksonomy enhances taxonomy navigation with personalization for knowledge search and retrieval.	The data-mining algorithms that has been used by TaxoFolk are not accurate perfectly. Also, the proposed approach lack of users' evaluation studies.
Sommaruga et al. (2011)	Tagsonomy is "ease-of-access" of web resources through taxonomy and folksonomy.	Their users' evaluation study of Tagsonomy showed positive results, Which could be done by combining the users' search keywords and the predefined classification.	Tags do not reflect the vocabulary used by users rather, they are extracted from the keywords of the users.
Batch et al. (2013)	ICDTag, a user-driven taxonomy–folksonomy approach to organize medical posts in physician-written blogs in which tagging is explicit.	The results showed that ICDTag helped physician to retrieve blog posts by combining the users' generated-tags and the predefined classification of medical information.	It lacks user context by limiting it to explicit tagging that built by medical taxonomist who have different user behaviour in finding information.

MyEdna, a proposed taxonomy-directed folksonomy by Hayman and Lothian (2007), allows users to assign web resources using personalized classification (tags) with predefined classification by drop-down menus that are based on taxonomy. Taxonomies in MyEdna produce a more consistent and accurate organization, while folksonomies produce a high degree of personalization for other users to use their word

"tags" to organize web resources. MyEdna also provides social interaction that helps in building communication between users for discussions and connections around resources. Such study reveals that users strongly prefer to use improved performance and MyEdna in re-finding and organizing tagged web resources. Nevertheless, MyEdna hybrid approach is rather limited; it considers only taxonomy thesaurus that is based on thesaurus defined by taxonomist who have a different behaviour in finding information and folksonomies tags (i.e. Facebook). In addition, the effectiveness and efficiency of MyEdna in achieving its objectives could not be assessed.

Another approach, "TaxoFolk", was proposed by Kiu and Tsui (2011). TaxoFolk also integrates taxonomy and folksonomy in a new scenario to improve the organization of web resources. This approach was based on four phases; tag preprocessing, contextualization, contextual clustering, and concept-tag consolidation. As with MyEdna, user study showed positive results; users can organize web resources effectively and re-find web resources page quicker. Although TaxoFolk is a powerful tool that allows users to organize web resources for easy retrieval, it is not without drawbacks. TaxoFolk employed data-mining algorithms which are not totally precise and might result in the imprecise classification of taxonomy terms and tags (Sahu et al. 2011; Batch et al. 2013). Moreover, the tagging activity does not reflect users' behaviour in finding information.

The third hybrid taxonomy-folksonomy approach called "Tagsonomy" was proposed by Sommaruga et al. (2011). Tagsonomy is "ease-of-access" of web resources through taxonomy and folksonomy (Sommaruga et al. 2011). Tagsonomy users can re-find web resources of interest by using a taxonomy that is built based on the history of users' search keywords and personalized classification, or "folksonomy tags". Although Tagsonomy makes it easy to access web resources for easy retrieval at a later time, it is not without drawbacks. Tags are extracted from users' search words and do not come from explicit tagging that is based on user context and behaviour in finding information.

The last approach to combine taxonomy and folksonomy is called "ICDTag" proposed by Batch et al. (2013). ICDTag attempts to address the limitations of existing

approaches by introducing a user-driven taxonomy–folksonomy approach called "ICDTag" to organize medical posts in physician-written blogs in which tagging is explicit. The results showed that Tagsonomy helped users find posts of interest by combining the predefined classification "taxonomy" built by medical experts called "ICD content model" and predefined classification that other users generated. The disadvantage of this approach is that taxonomy of this approach is designed and defined by "taxonomist" who have a different behaviour in finding information and do not reflect users' preferences.

The literature review on existing hybrid approaches (MyEdna, TaxoFolk, Tagsonomy, and ICDTag) show that the existing hybrid approaches still has limitations; the portal of MyEdna designed on a conceptual level only without proper development or user evaluation. TaxoFolk has used the data-mining algorithms not perfectly accurate and the proposed approach lack of users' evaluation studies. Tagsonomy tags extracted from the keywords of the users and do not reflect users' words. While taxonomy of ICDTag built by medical taxonomist who has different user behaviour in finding information. Furthermore, none of the above approaches come with tagging activity that is based on users' behaviour in finding information. Moreover, none of the all above mentioned approaches takes into account the importance of user context in organizing bookmarks of web resources for sharing and better retrieval at a later time.

2.8.4 Formal Taxonomy and Folksonomy

As mentioned earlier, Taxonomy is a set of predefined terms and controlled vocabulary for knowledge and resources organization (Kiu & Tsui 2011). The emergence of social bookmarking systems has provided informal conceptual structures called folksonomies for organizing of web resources for retrieval at a later time (Kiu & Tsui 2011).

In order to define the informal conceptual structure, there should be a formal conceptual analysis. Ganter and Wille (2012) viewed Formal Concept Analysis (FCA) as a domain of applied mathematics that is based on the mathematization of conceptual hierarchy and concept. Thus, it sets off mathematical thinking for the analysis of

conceptual data as well as knowledge processing. It is completely workable to employ a Formal Concept Analysis to examine human conceptual thinking (Ganter & Wille 2012). Therefore, in order to formalize taxonomy and folksonomy approaches, Formal Concept Analysis was followed in this study.

The essential concepts of Formal Concept Analysis are those of a formal notion and a formal context. The word "formal" is aimed to assure that this study contends with mathematical concepts that solely reproduce some aspects of concept and context meaning in a standard language. A formal context is viewed by (Ganter & Wille 2012) as a triple $\mathbb{K} := (G, M, I)$ consisting of two sets G and M and a relation I between G and M. The *G* elements are the objects while the *M* elements are the context attributes.

In order to state that an object g is in a relation I with an attribute m, gIm must be written and it is then read as "the object g *has* the attribute". Paving the way to define *formal concept*, this study redefine $A' := \{m \in M | \ gIm \text{ for all } g \in A\}$. The set of attributes common to the objects in $A \subseteq G$.

Correspondingly, for a set B of attributes in this study defines $B' := \{g \in G | \ gIm \text{ for all } m \in B\}$ to be the set of objects which have all attributes in B.

Ganter and Wille (2012) defined a formal *concept* of the context (G, M, I) as a pair(A, B), with $A \subseteq G, B \subseteq M, A' = B$ and $B' = A$.

The definition of the formal concept (A, B) is written in general symbolical form, whereas this study is concerned with specific occasions. So for convenience, in order to relate the *concepts* of (A, B) to *context*, this study redefines (A, B) as follows:

1. The concept (N, B), where N and B denote name and bookmark of web resource, respectively.
2. The concept (P, B), where P and B denote problem and bookmark of web resource, respectively.

3. The concept (C, B), where C and B denote context and bookmark of web resource, respectively.
4. The concept (V, B), where V and B denote value and bookmark of web resource, respectively.

Henceforth, the notations (N, B), (P, B), (C, B) and (V, B) instead of (A, B) are used to formalized taxonomy and folksonomy in this study.

2.9 CONTEXT IN INFORMATION SYSTEM AND BOOKMARKING

Context is a very general concept and is defined differently by many scholars. This study adopts the definition by Hwang and Ronchetti (2016) that limits the definition of context to "any information that can be used to characterize the situation of an entity". Hwang and Ronchetti (2016) also noted that providing context for organizing bookmarks helps users in finding bookmarks of the web resource that are of interest to them (Hwang & Ronchetti 2016). Furthermore, they noted that the use of context in bookmarking systems is still in its infancy. On the other hand, Hughes (2006) noted that providing context is an essential and very important requirement for knowledge sharing tools (i.e. social bookmarking) because it provides a way for representing knowledge for sharing and retrieving at a later time. Goker et al. (2009) argued that the context “provides a significant basis for identifying and understanding” the resources and information needs of users. Therefore, the context performs a vital role in offering more relevant information to users. Nevertheless, a few studies have carried out some experiments with context-based approaches to assist the internet users to retrieve and re-find information and resources in current years. Table 2.4 presents the summary of studies that contextualize bookmarks.

Hailpern et al. (2011) proposed YouPivot for easier retrieval and re-find of bookmarks of web resources by adding user-specific context. YouPivot allows users to contextualize activity to pivot, and users can view the available and saved web resources that are visited in the specific and close time. YouPivot also allows users to mark their activities in close and specific time by providing a time-annotation approach called

"TimeMarks" that can help users to remember when they last visited the web resources. Although the users' evaluation study of "YouPivot" showed that users strongly agree to use "YouPivot" and "TimeMarks" that enhanced performance in remembering and re-finding visited web resources, YouPivot is very limited, and it considered only the time of activity and name. In other words, YouPivot looks like folksonomy used in many Web 2.0 application (i.e. Facebook).

Table 2.4 Summary of studies that contextualize bookmarks

Author	Approach	Results	Limitations
Hailpern et al. (2011)	YouPivot browser for easier retrieve and re-find bookmarks of web resources based on user-specific context that includes activity in specific time.	Their users' evaluation study showed that users strong agree to use "YouPivot" and "TimeMarks" that enhanced performance in remember and re-find visited web resources.	YouPivot considers only the name and time of activity. YouPivot looks like folksonomy used in many web 2.0 application (i.e. Facebook).
Deng et al. (2013)	ReFinder tool for search and query of web resources based on context memory snapshot that capture the time, activity and location.	Their users' evaluation study showed positive results; ReFinder help users' effectively and faster to re-find and retrieve web resources.	ReFinder lacks of the breadth and depth of user context by limiting it to time, location and activity, the activity does not reflect user activity but is an arbitrary list of to-do or taxonomy.
Hwang and Ronchetti (2016)	Contextualizing bookmarks approach based on folksonomy and ontology under user context to enhance the organization of bookmarks for retrieval at a later time.	Contextualizing bookmarks approach produce a consistent organization (tags. annotation and ontology) for better information retrieval of personal bookmarks.	The approach was designed on a conceptual level only without proper development or evaluation. Also this approaches lack of taxonomy or controlled vocabulary.

Deng et al. (2013) proposed ReFinder that allows users to search and query web resources by taking a "context memory snapshot of saved web resources". This snapshot includes activity, time and location. As with YouPivot, the users' evaluation study of "ReFinder" showed that users strongly agree to use "ReFinder" that help users to re-find web resources faster and more effectively. Even though ReFinder is a simple and powerful tool that allows users to add the context of web resources, however it is not without limitations; the user context is limited to location, activity, and time, apart from the lack of the depth and breadth of user context. In addition, the activity does not reflect the activity of user but represents an arbitrary to-do list or taxonomy.

Hwang and Ronchetti (2016) proposed an approach that takes benefits of both formal ontology and folksonomy to “contextualizing bookmarks” for better retrieval of bookmarks. However, this approach was designed on a conceptual level only without proper development or empirical experiment. So, the effectiveness of the proposed approach in achieving its goal could not be assessed. Furthermore, this approach lacks of explicit tagging activity based on users’ behaviour in finding information.

Although the context-based approach is very important to design effective social bookmarking tool (Hwang & Ronchetti 2016), the literature review on existing context approaches (YouPivot, ReFinder, Contextualizing bookmarks) show that the existing context-based approaches still has limitations: YouPivot considers only the name and time of activity which looks like folksonomy used in many Web 2.0 application (i.e. Facebook). ReFinder lacks the breadth and depth of user context by limiting it to time, location and activity, whereby the activity does not reflect user activity but is an arbitrary list of to-do or taxonomy categorization. While contextualizing bookmarks approach was designed on a conceptual level only without proper development or empirical experiments. Furthermore, all the context-based approaches mentioned above lack controlled vocabulary and taxonomy. According to Kiu and Tsui (2011), taxonomy and controlled vocabulary are one of the best classification schemes for organizing web resources.

2.10 PROBLEMS OF BOOKMARKING CLASSIFICATION METHODS

As mentioned earlier, the use of user context in bookmarking is still novel, and there is no previous studies on using the user context on social bookmarking systems. This section briefly discusses the problems of social bookmarking classification methods that have seen more attention.

One of the strengths of social bookmarking as a way of organizing web resources is that users are free to tag based on their personalized classification "folksonomy tags" without any considerations of relationships between tags (Hwang & Ronchetti 2016). However, many mistakes might take place because of synonym