A Framework for Social BPM based on Social Tagging

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PhD Thesis

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May 2016

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Declaration

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Abstract

Traditional Business Process Management (BPM) has a number of limitations. The first one is the typical separation between process design and execution, which often causes discrepancies between the processes as they are designed and the way in which they are actually executed. Additionally, because of this separation, valuable first-hand knowledge generated during process execution may remain unused during process design and also prevented to be shared within the organisation. Social BPM, which predicates to integrate social software into the BPM lifecycle, has emerged as an answer to such limitations. Although there have been a number of approaches to Social BPM, they have not been able to address all the issues of traditional BPM. This thesis proposes a novel Social BPM framework in which social tagging is used to capture process knowledge emerging during the enactment and design of the processes. Process knowledge concerns both the type of activities chosen to fulfil a certain goal (i.e. what needs doing), and the skills and experience of users in executing specific tasks (i.e. skills which are needed to do it). Such knowledge is exploited by recommendation tools to support the design and enactment of future process instances. This framework overcomes the limitations of traditional BPM systems as it removes the barrier between the design and execution of the processes and also enables all users to be part of the different phases of the BPM lifecycle. We first provide an analysis of the literature to position our research area, and then we provide an overview of our framework discussing its specification and introducing a static conceptual model of its main entities. This framework is then elaborated further with a more dynamic model of the behaviour and, in particular, of the role and task recommendations, which are supported by social tagging. These mechanisms are then applied in a running example. Finally the framework is evaluated through the implementation of a prototype and its application in a case study. The thesis ends with a discussion about the different evaluation approaches of the proposed framework, limitations of our framework and future research.

CHAPTER 1: INTRODUCTION

1.1 Introduction

This chapter presents an overview of what this thesis contains and what motivated investigation in the chosen research area (Section 1.2). After briefly identifying the gaps in the current literature, Section 1.3 lists the aims and objectives set for this research and also the research questions which need to be answered in order to fulfil the set objectives. Section 1.4 presents the scope of the thesis. The methodology devised to fulfil the objectives of the research is presented in Section 1.5. Finally Section 1.6 presents a summary of what has been discussed in this chapter and also sets the overall outline for the remainder of the thesis.

1.2 Background & Motivation

With the advancement of technology over the past decade and increase of competition in the industry, the need for effective management of organisation's business processes has become more important than ever before (Ryan et al., 2009). Furthermore, the changes in industry such as the rise in frequency of goods ordered, the need for quick decision making and speedy transfer of information, the need to adapt to change in demand, the presence of more international competitors and demands for shorter cycle times (Simchi-Levi, 2000) are amongst the factors which have made the need for efficient and effective management of business processes essential. Gradually over the past two decades, the manual completed forms started to be replaced by electronic applications. This trend eventually evolved into a new phenomenon, today known as Business Process Management (BPM) (Ryan et al., 2009).

BPM includes concepts, methods, and techniques to support the design, administration, configuration, enactment, and analysis of business processes (Weske, 2007). The evolution of BPM over the years suggests that there are still limitations within the different stages of BPM. One of the main limitations of traditional BPM is the separation between the process design and execution, which causes a discrepancy between the designed and executed processes (Filipowska et al., 2011; Schmidt & Nurcan, 2009a; Palmer, 2011). For instance, because the users have not been involved in the design of the processes, they may often find shortcuts to execute specific activities, which better reflects their understanding of the process. Additionally, because of this separation, valuable first-hand knowledge from executing the processes may remain unused during process design and also prevented to be shared within the organisation. For instance, if a user has found a new and innovative approach to execute a process, this knowledge should ideally be used during the process design. However because of the separation which exists between the process design and execution phases, this knowledge would not be utilised or shared with others in the organisation.

Limitations in the traditional BPM approach have triggered research that is inspired by other emerging trends. Social BPM is one of these trends that attempts to overcome the existing limitations and it is the focus of this thesis.

Social BPM is generally concerned with the integration of social software and platforms into the design and execution of business processes. According to one industry report in 2015 (Terpening et al., 2015) who surveyed 113 strategists (social, digital and/or heads of social) at companies with more than 250 employees, 68% of them strongly agree that the use of social media is growing in their organisation. According to this recent report, 82% of businesses report they are either fully integrated, in the process of, or planning the integration of social with digital in 2015. This indicates that there is a general trend towards the “social enterprise” in businesses and companies are investing massively to integrate social software in their processes. Social

BPM can be seen as part of this trend, as it aims at actively involving all relevant stakeholders into BPM through the use of social software (Pflanzl & Vossen, 2013).

The start of research in Social BPM can be dated back to 2008 (Nurcan & Schmidt, 2009) with a workshop on Social BPM and it has evolved ever since. Although there have been a number of definitions suggested for the concept of Social BPM, there is not a unique understanding of how Social BPM operates.

The attempted approaches towards a Social BPM framework (Brambilla & Fraternali, 2012; Brambilla et al., 2011; Brambilla et al., 2011a; Silva et al., 2010) are limited to the inclusion of social extensions such as polls, dynamic enrolment, social sourcing, voting and ranking/commenting (Brambilla & Fraternali, 2012; Brambilla et al., 2011l; Brambilla et al., 2011a) in the process design stage. As an example, polling tools such as doodle can be used during the design stage of BPM to seek the opinion of analysts regarding the design of the processes or setting a brainstorming session date. In doing so, the separation between the process executors and designers, that is, one of the limitations of the traditional BPM, still exists. Furthermore, the authorisation boundaries which are typical of traditional BPM models still exist in these approaches. This is the main reason why useful information is not shared and passed throughout the organisation and to different users and designers. Additionally, none of these approaches focus on capturing process knowledge during execution in order to be used during process design or even future executions. If, for example, a user involved in the execution of a process finds a different and better way of doing something, this process knowledge cannot easily be reused during the process design or future executions.

Amongst social software technologies, social tagging is a growing trend and it has emerged as one of the best ways to make associations between data, pictures or web objects (Gupta et al., 2010). According to Trant (2009), social tagging refers to the practice of publicly labelling or categorizing resources in a shared and on-line environment. Social tagging is currently used in different contexts, such as libraries, museums, online archives, education and social entertainment or networking. The tags are used to capture knowledge about specific content from users and communities in terms of their preference, interests or chosen categories. For example in the website LibraryThing[1], people share and tag their personal book collections and currently members have added nearly 20 million tags to 15 million books, making it the second largest library in North America (Smith, 2008). In this example, knowledge about the books is being captured by the tags, such as categorising the books as romance, fiction or science for instance. Flicker[2] is another example of a social tagging platform which is a popular photo sharing website mainly for entertainment that allows users to tag their photos. In this example, information about pictures such as the location or the occasion they were taken is captured by tags. Given the popularity of social tagging and the benefit it brings about by capturing various resources, we use this technology in the context of Social BPM.

This research builds on previous works in the area of Social BPM and exploits the benefits of social tagging to capture process knowledge from users during the enactment and design of the processes. Such knowledge may refer to either design-time concerns, such as the type of tasks successfully considered in the past to fulfil a certain goal, or run-time concerns, such as choosing users to execute tasks based on their the experience and skills demonstrated in previous execution of the processes. Process knowledge is exploited to drive and support the *role* and *task* recommender tools. On the one hand, the role recommender tool helps the users to choose people to execute tasks based on

[1] www.librarything.com
[2] www.flicker.com

their expertise and past experience. The task recommender, on the other hand, helps to design processes, by suggesting what has been done in the past to fulfil a certain goal. In other words, in our Social BPM framework the task fit for purpose in the context of a specific process and users' experience and skills as emerged during the design and execution of processes are captured via social tagging to be reused in current or future enactments of processes.

1.3 Research Questions and Objectives

This research aims to answer the following questions:

1. What are the key concepts that can drive the design of a Social BPM framework exploiting social tagging as a tool to capture and re-use process knowledge?
2. Does the Social BPM framework improve the collaborativeness and reuse of process knowledge during the design and enactment of business processes?

In order to answer the above questions, a number of research objectives need to be fulfilled:

1. Perform a literature review of BPM and Social BPM to identify the key characteristics of a Social BPM framework.
2. Design the key capabilities of a Social BPM framework that exploits social tagging.
3. Build a prototype based on the proposed design for the purpose of evaluating the designed Social BPM framework
4. Evaluate the Social BPM framework through the implemented prototype in real world settings.

The first question addresses the fundamental concern of what constitutes a Social BPM system. This question is answered by fulfilling the first and second objectives, which is done through the literature review in Chapter 2 and the design of the Social BPM framework in Chapter 3.

The second question focuses on the value of our Social BPM framework for the users and is answered by evaluating its functionalities. This is done by achieving the third and fourth objectives through the prototype implementation and case study evaluation, which are both presented in Chapter 4. The reason why we evaluate the improvement of collaboration and the reuse of process knowledge is that these are the two main areas affected by the limitations of traditional BPM discussed before. If collaboration is improved, it would reduce the gap between the process executors and process designers, which in effect would reduce the discrepancy between the designed and executed processes. Additionally, the reuse of process knowledge is enhanced with collaboration between users and allows for the knowledge gained from the execution to be used during the design of the processes. This would eventually lead to the improvement of business processes.

1.4 Thesis Scope

As presented in Fig. 1.1 there are 3 different types of business processes defined in the literature, namely *ad-hoc*, s*tructured/predefined* and s*emi-structured* (Huth et al., 2001). This thesis addresses ad-hoc business processes. In ad-hoc processes the execution paths are completely defined at runtime. This is opposed to structured and semi-structured processes. Structured processes are fully defined and remain unchanged during process execution. In semi-structured processes there is a structure, but part of it is left undefined and specified or completed only during process execution.

An example of ad-hoc processes is organising a picnic, in which a group of friends just discuss and come up with an idea and a park and go with it. There is no predefined flow which is followed here. In an organizational context, e.g. higher education, an example of ad-hoc processes is the process of recruiting a Teaching Assistant (TA) to support the tutorials for a module. There is a general goal to be achieved (to recruit a TA), however, how this is achieved is not defined and is left to the relevant department to decide because there is no standard way of achieving this goal. This differs from the process of, for instance, recruiting a permanent member of academic staff, where there are usually clear protocols and procedures in place for the recruitment. Depending on how detailed the procedure of recruiting a permanent member of academic staff is, this would be a structured or semi-structured process.

In Social BPM, the processes do not necessarily have to be pre-defined. The activities related to each process can be designed and executed on the fly, therefore the scope of our research is to discuss and address ad-hoc processes, as presented in Fig. 1.1.

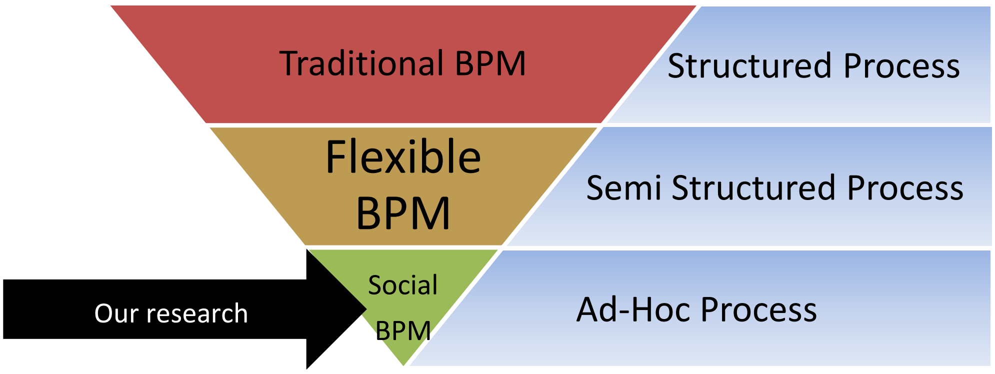


Fig.1.1 Research Area

As far as implementation is concerned, the development of a full BPM system which is deployed in the market is out of scope in this thesis. The prototype that is implemented in this thesis is only part of the evaluation to assess the "buildability/feasibility" of the framework. Additionally, the scope of our evaluation only covers the validation of "usefulness" (Laitenberger & Dreyer, 1998) of the proposed framework, that is, we evaluate whether the capabilities of a the Social BPM framework are useful and if they have improved the collaborativeness and reuse of process knowledge during the design and process execution. The evaluation of the usability of the prototype, e.g., user interface, or the performance of the prototype, e.g., scalability, is out of scope at this stage.

1.5 Research Methodology

In this section, the stages of this research and the methods adopted in each stage are discussed. Fig. 1.2 presents a summary of the key stages of this research:

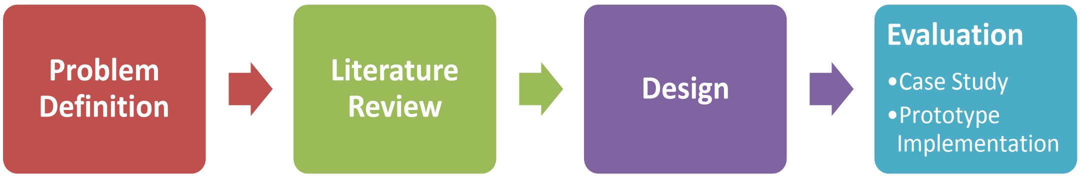


Fig.1.2 Social BPM Research Methodology

The *problem definition* discusses the overall motivation, background and scope of the research and defines the research objectives which the research aims to achieve. In the second stage of the research, which is the *literature review*, an investigation is carried out in the literature in order to find out the state of the art and identify the exact research gap which we are investigating. The approaches to fill in the identified gap are presented from the literature and we argue why these approaches have not fully addressed this gap and how our research relates to the work which has been carried out until today. To do this, we present an analysis of the background and concept of BPM, its phases and an overview of currently available BPM tools. A number of limitations are identified with regards to the traditional BPM systems and some of the attempts to overcome these limitations are presented. Flexible BPM is an approach which has been used over the past few years to address the downfalls of BPM systems and it mainly supports semi-structured processes. Social BPM is another approach which attempts to overcome the limitations of traditional BPM, which is the focus of our research. Furthermore the researches up to date in the Social BPM area are presented and analysed case by case to identify the gap in the literature which is related to Social BPM supporting ad-hoc business processes.

After having identified the gap in the literature, in the *design* stage we propose a Social BPM framework to fill in the research gap and address the limitations of the traditional BPM systems. Our Social BPM framework is inspired by goal-based modelling (Paternò, 2002) and contains 3 main concepts, namely the *role* and *task recommenders* and *social tagging* which supports the recommender mechanisms. The concepts of a Social BPM framework are designed and the architecture of each of these concepts are presented and discussed. This Social BPM framework is then validated in the *evaluation* stage against the research questions set at the beginning of our research. To do this, a prototype implementation is produced and a number of case studies are run with real data and users in order to assess and evaluate the proposed solution.

The results from these case studies are analysed using qualitative and quantitative methods to assess whether this framework has managed to address the limitations of the traditional BPM model or not. Finally, a number of limitations are identified and presented with regards to the evaluation methodologies applied and future work is discussed.

1.6 Thesis Structure

This chapter (Chapter 1) presented the motivation and background of the research. Furthermore the aims and objectives of the research have been presented in order to give direction and focus to what is to be achieved throughout this research. The scope of the research has also been defined in order to clarify what this thesis intends to cover and what is beyond its scope. Finally the methodology adopted to undertake this research was presented and the steps taken during each of its phases.

The remaining of the thesis comprises the following chapters:

Chapter 2 (Background and Related Work) investigates the state of the art in BPM research, identifies the gaps and limitations, and presents the attempts made to overcome those gaps. The background to the emergence of Social BPM is discussed and the gap which this research aims to investigate is identified.

Chapter 3 (Social BPM Framework Design) discusses the structure of our solution and presents the underlying design of the Social BPM framework. A set of functional requirements is formed as a result of this which results in a design architecture that is the basis for the implementation of the framework.

Chapter 4 (Prototype Implementation and Evaluation) evaluates the Social BPM framework and compares the outcome to the original research questions presented in Chapter 1. As part of the evaluation a proof of concept prototype is implemented and a case study is run with real user participants to validate the functionality of the Social BPM framework.

Chapter 5 (Conclusion) concludes the thesis by reflecting on the overall approach of the research, the contributions, revisiting research questions and objectives, limitations and future work.

CHAPTER 2: BACKGROUND AND RELATED WORK

2.1 Introduction

This chapter discusses the background of the research and the state of the art. Additionally it positions our research in the overall Business Process Management context discussing where it fits and the reason why research in Social BPM has been chosen. It does this in the following way: Section 2.2 discusses the literature on BPM, explaining what a process is, BPM in different disciplines, the limitations of the traditional BPM model and the attempts made to overcome these limitations. In Section 2.3 our specific research area is discussed, explaining how Social BPM can overcome some of the limitations of the traditional BPM systems. This chapter continues to discuss the various definitions proposed in regards to Social BPM, the potentials and limitations of this approach and finally presents the various approaches towards Social BPM in the literature. Lastly, Section 2.4 discusses the concept of social software and explains the social technologies used in BPM and in our Social BPM framework. This chapter ends with a conclusion Section 2.5.

2.2 Business Process Management (BPM)

In this section, we first discuss the definitions and different types of processes. Then we explain the emergence of BPM and the different understandings which have been presented. This is followed by expanding on the main stages involved in the BPM lifecycle, describing each of these stages and also presenting some examples of BPM tools which are currently used in industry and finally we discuss some of the limitations and downfalls of BPM and set the context for future sections.

2.2.1 What are business processes?

Before we discuss BPM, it is important to have an understanding of what is meant by a “process”.

There are has been a number of explanations in regards to the definition of a “business process” (see Fig. 2.1). Most of these are similar with only limited discrepancy. Fig. 2.1 aligns each definition to a specific process type, in order to determine which ones of these definitions are more suitable in our research.

The definitions which are explicit in stating the processes are a set of *predefined* activities have been aligned to structured processes. These seem to be mainly in the context of a rigid traditional BPM framework where all the steps before the execution of the processes are pre-engineered. In the second category of process types, only one definition mentioned *partially* designed/ordered activities which are in line with semi-structured processes. Finally, the definitions which do not specify whether the processes are predefined or not, it is assumed that they can be designed at any point; therefore they have been aligned to the ad-hoc processes as shown in Fig. 2.1.

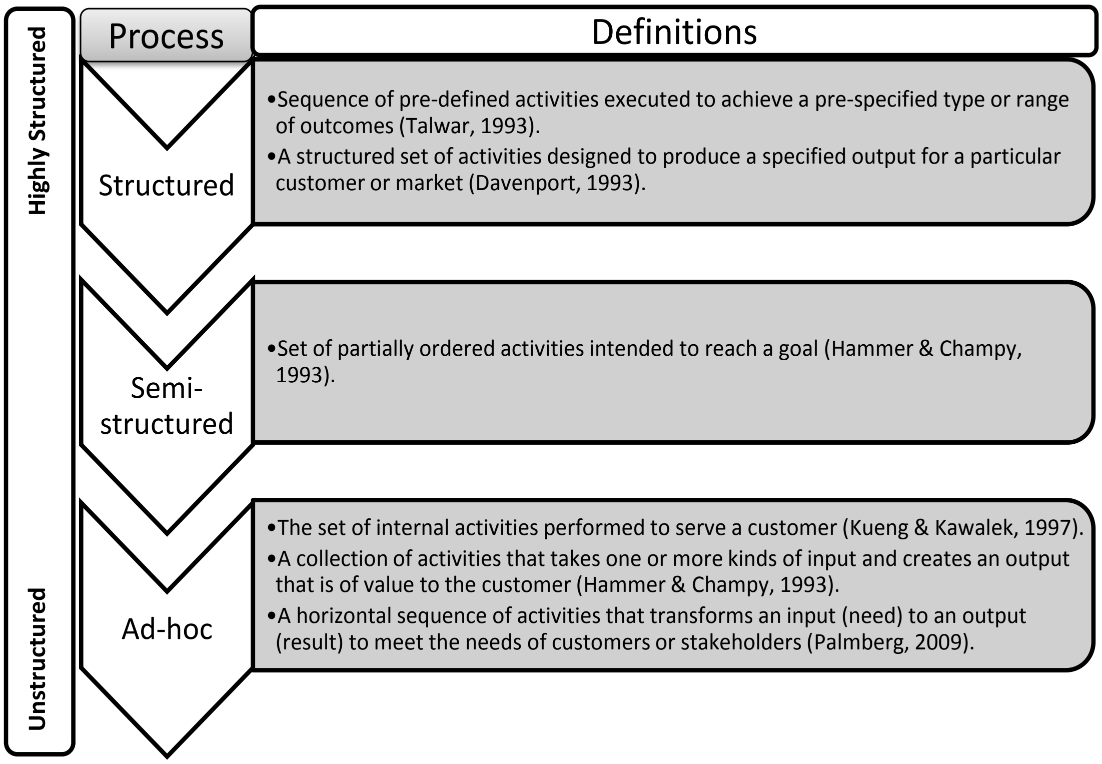


Fig.2.1 Definitions of a Business Process aligned to process types

Based on the definitions of Fig. 2.1, three types of processes can be defined (Huth et al., 2001):

Ad-hoc processes: The execution path of such processes is completely defined at runtime. These approaches usually apply to processes which run for a short period of time. It is difficult to structure such processes and normally not worthwhile to automate using a structured process modelling approach, because the frequency of their execution is little. They may reappear or be modified at later stages of process execution. Such processes are typically designed during runtime, or they are done in parallel, thus their build time and run time are merged. Social processes are typical examples of ad-hoc processes, for example the process of organising a night out. A group of friends just discuss and come up with an idea and go with it, there is no predefined flow which is followed here.

Structured/predefined processes: These types of processes are fully structured and remain unchanged during process execution. These processes are normally used in the production stage of Workflow Management Systems (WfMS). WfMS are the "computerized facilitation or automation of a business process, in whole or part" (WfMC, 1999). Structured processes usually consist of highly recurrent structures where the same predefined processes are executed over and over again. In this type of business processes, there is a clear separation between the design and running of the processes. An example of such processes is hardcoded programmed applications, for instance the process of placing an order in an ERP system. Every step of the process is predefined and imposed on the user to follow in order to create an order.

Semi-structured processes: These processes are in between ad-hoc and structured processes. Processes are partially open, but the initiator expects that a structure will be established for the tasks by the process executers. For instance in the healthcare sector, consider the process of admitting and discharging of a patient. The admission has certain procedure which is predefined, however when the doctor is examining the patient, the process flow varies depending on the type of diagnosis they receive. They might be referred to a specialist, admitted to the hospital or be advised to take another route. Finally after the treatment is completed, there is a specified process which needs to be followed for the patient to be discharged. This is a typical semi-structured process where parts of the process are defined and other parts are not.

In the context of our research which is geared towards Social BPM, the processes do not necessarily have to be pre-defined. The activities related to each process can be designed and executed on the fly which is from the characteristics of ad-hoc processes.

Finally, as far as the lifespan of processes is concerned, two types of processes can be defined (Ould, 1995). The *first* is a process which starts and ends at a specific time

(Davenport, 1993); the *second* is a sort of process which is constantly running. In other words, processes can be *short* or *long-running*. This temporal categorisation of the processes can be applied to any of the process types explained above.

What is addressed in traditional BPM systems is related to the effective management of mainly structured processes. In ad-hoc processes, because there is no explicit separation between the design and running of the processes, the current traditional BPM tools have not been able to support them.

The remainder of this chapter discusses the different approaches towards BPM as presented in Fig. 2.2. Traditional BPM which is aligned to structured processes, flexible BPM which is aligned to semi-structured process are presented in the next two sections. In the end the need and concept of Social BPM is discussed which is aligned to ad-hoc processes that is the subject of our discussion in this research.

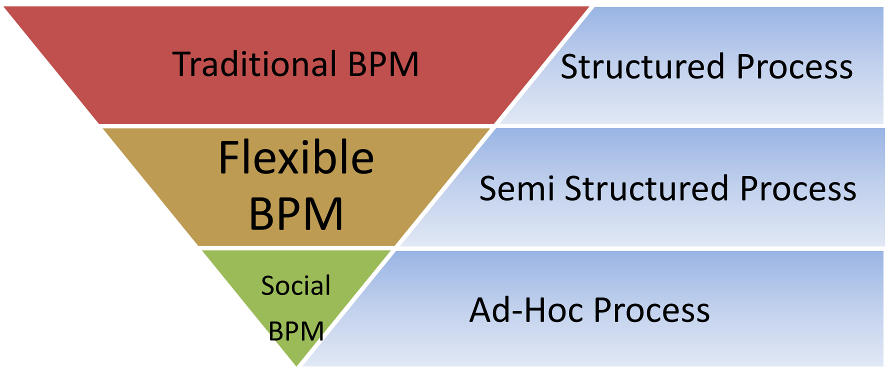


Fig.2.2 Process types supported by BPM

2.2.2 Emergence of BPM

The impact of IT influencing business process has roots in (Hammer & Champy, 1993; Hammer & Champy, 1992) Business Process Reengineering (BPR) framework and Davenport(1993)'s book on how IT advancement and innovation can facilitate BPR. However there is a distinct difference between BPR and BPM. BPR usually calls for a radical elimination of existing business process models, whilst BPM aims to gradually improve and manage business processes through an incremental and iterative approach (Ryan et al., 2009).

Research in Business Process Management started and evolved immensely since the late 1980s and was triggered by seminal work published by Davenport & Short (1990) and Hammer & Champy (1993). Before then, the support to business processes was provided by ad-hoc software applications. BPM systems were initially introduced as "document routing systems dispatching documents in an organization" and were traditionally referred to as WFMSs (Wohed et al., 2009). Not long after this, gradually the theories related to BPM were implemented and started being used in practice (Houy, 2010) and today most corporations have adopted some sort of BPM model for the management of their business processes.

Although Business Process Management is a discipline widely used across almost all large corporations and a known term in research circles, there is not a unique understanding of what BPM actually means. Antonucci & Goeke (2011) argue that there is still no universally accepted definition of BPM; Table 2.1 looks at some of these definitions.

Table 2.1 Research Area

BPM Definitions	
1	The automation of a business process, in whole or part, during which documents, information or tasks are passed from one participant to another for action, according to a set of procedural rules (Lawrence, 1997).
2	Supporting business processes using methods, techniques, and software to design, enact, control, and analyse operational processes involving humans, organizations, applications, documents and other sources of information (Van der Aalst, 2009).
3	A generic software system that is driven by explicit process designs to enact and manage operational business processes (Van der Aalst, 2003).
4	BPM provides an approach and platform to take full control of the business processes right from the outset of their initiation until the end, through a systematic application of management, measurement and improvement of the company processes (Lee & Dale, 1998).
5	A field for involving any combination of modelling, automation, execution, control, measurement and optimization of business activity flows, in support of enterprise goals, spanning systems, employees, customers and partners within and beyond the enterprise boundaries (Palmer & Schoof, 2014).
6	The goal of BPM to be to create a process-centric, customer-focused organization that integrates management, people, process and technology for both operational and strategic improvement (Mathiesen et al., 2011).
7	BPM is a discipline where Information Technology and management intersect, to ensure the smooth running, monitoring, designing and improving of business processes (Filipowska, 2009).

8	BPM includes concepts, methods, and techniques to support the design, administration, configuration, enactment, and analysis of business processes (Weske, 2007).

The first definition appears to be a primitive definition of BPM and only captures the running and execution of the processes and only for very structured processes, however, as BPM has advanced over the years, its scope has been extended to cover other stages of the BPM lifecycle too. Therefore BPM is responsible for the designing, running, managing and monitoring of the business process right from the beginning all the way to the end. Others (Lee & Dale, 1998; Elzinga et al., 1995; Hung, 2006) focus more on the improvement and measurement aspects of BPM in their definition and refer to the general management of the business processes without detailing further.

In summary, although there is a variation in the definitions given for BPM, and different authors concentrate on certain aspects of BPM more than others, it can be said that BPM deals with the management of all aspects of business processes in organizations.

2.2.3 BPM Lifecycle and tools

As there are a number of different definitions for BPM, there are also various views on the overall BPM lifecycle and the stages it entails. ABPMP (2009) considers 6 main phases for the BPM lifecycle, namely: planning, analysis, design and modelling, implementation, monitoring and control, refinement. Furthermore Elzinga et al. (1995) lists the following steps: preparation, process selection, process description, process improvement selection and implementation.

According to Van der Aalst (2009), the BPM lifecycle consists of four main stages: process design, system configuration or implementation, process enactment/runtime, diagnosis or improvement, as presented in Fig. 2.3. Other researches (zur Muehlen & Rosemann, 2004; Weske, 2007; Van der Aalst, 2009; Lee & Dale, 1998) have also mentioned similar 4 stages to Van der Aalst (2009). For the purpose of our research we have adopted the model proposed by Van der Aalst (2009), due to its simplicity and the comprehensive nature of the phases it covers.

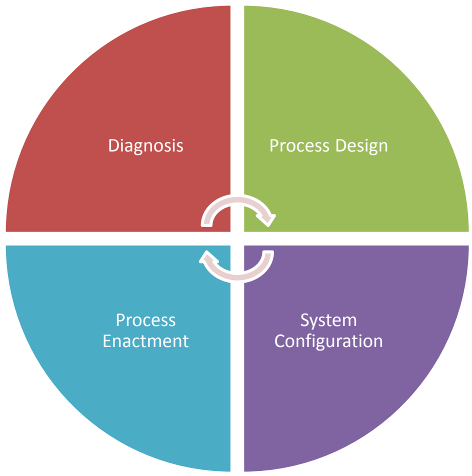


Fig.2.3 Van Der Aalst et al.'s BPM Model (Van der Aalst, 2009)

Each phase of the BPM lifecycle is supported by different components of a Process-Aware Information System (PAIS) (Dumas et al., 2007) and involves a specific set of different stakeholders.

Process Design: This is the first stage of BPM lifecycle in which the processes or procedures are designed into the BPM System. This is typically done by graphically modelling the processes into the BPM system using notations such as BPMN[3] and EPC[4].

System Configuration: In this phase the processes and underlying system infrastructure are implemented in the BPM System. Designation of roles, creating rules and process constraints are typically introduced in this phase which are used during process execution.

[3] http://www.bpmn.org/
[4] http://www.ariscommunity.com/users/rbaureis/2010-03-22-basic-rules-epc-modelling

Process Enactment: During this phase the design and implemented processes are executed. This is often automated in BPM suites and executed without the need for manual intervention.

Diagnosis: Finally in this stage of the BPM lifecycle the BPM analyst analyses the overall performance of the business processes and identifies the areas which need improvement. This analysis assists reducing the loopholes in the business processes and offers an improvement to the BPM lifecycle; this is done through evaluating the process through the right process metrics.

In order to exemplify the BPM technology we discuss how two implemented BPM suites (one open source and one commercial) support the phases of the BPM lifecycle in Fig. 2.3.

***YAWL* (Yet Another Workflow Language)** [5] is a BPM system which is based on modelling languages in order to handle complex data transformations and support full integration with organisation resources.

The first step is process design/discovery; this is supported by YAWL Editor and illustrated in Fig. 2.4. YAWL has its own modelling notation which is based on an extension of Petri-Nets (Wang, 2007).

[5] http://www.yawlfoundation.org/

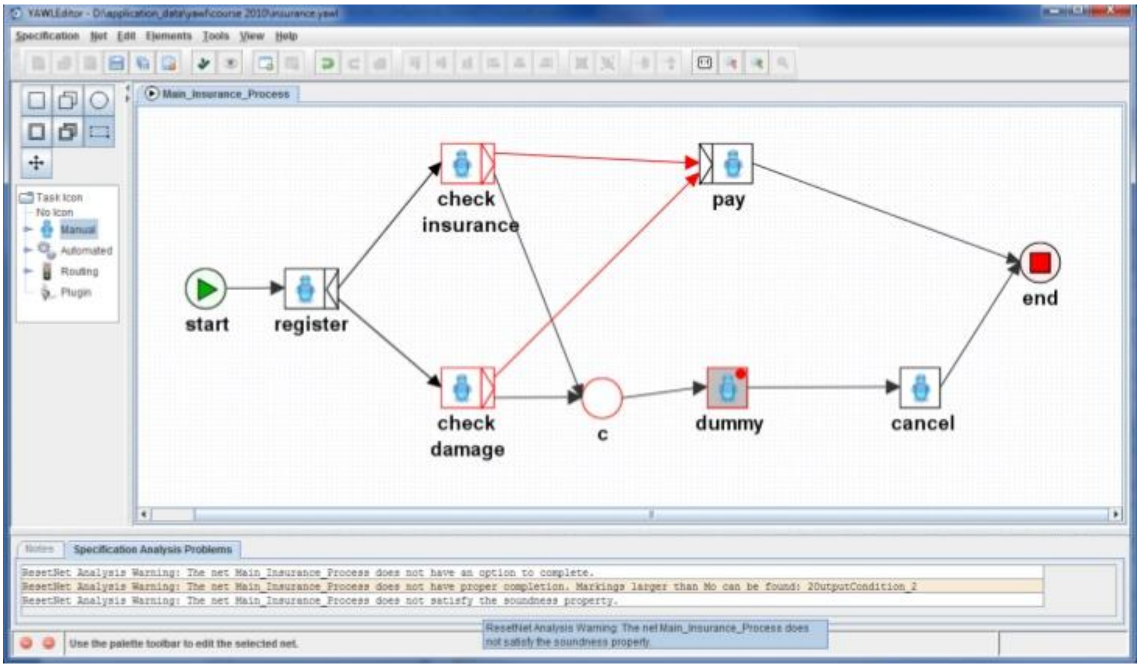


Fig.2.4 Process design in YAWL

In the next stage, the process is configured; roles and resources are assigned to the various designed tasks as shown in Fig. 2.5. The system admin goes through each position, and assigns roles and authorisations to the given position, this is necessary to determine who is involved in the execution of the process.

Fig.2.5 Process configuration in YAWL

In phase three as presented in Fig. 2.5, the tasks and linked and executed. This is done in YAWL editor which supports the enactment of the designed and configured processes. Often these tasks can be automated and run without human intervention. For example in Fig. 2.6, during the execution of the process, a task is offered to the user and they are able to accept and carry out the task or reject it.

Fig.2.6 The work queue

Finally, once the process is being/has been run, YAWL monitors the performance of the execution. Monitoring process execution enables diagnosis of the process downfalls and limitations and drives process improvements going forward. Fig. 2.7 presents a snapshot of the summary/analysis of a task which has been executed.

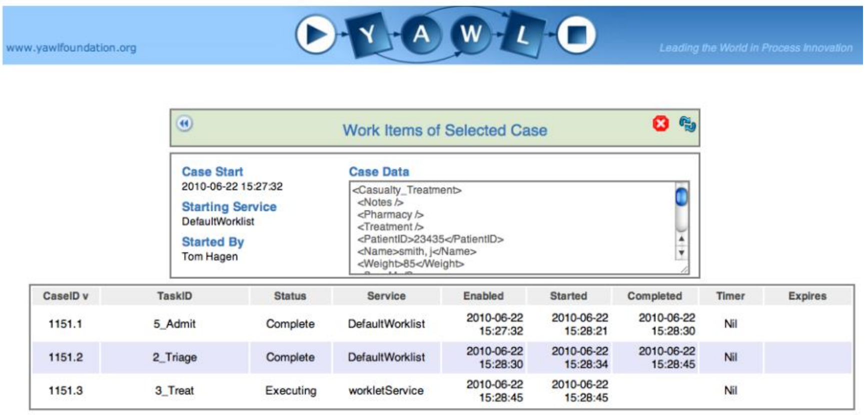


Fig.2.7 Process monitoring in YAWL

Another example of a widely used and recognised BPM tool which is used is ARIS[6] (Architecture of Integrated Information Systems). This BPM suite is a free-of-charge modelling tool for business process analysis and management. It supports different modelling notations such as BPMN2, Event-driven Process Chains, organizational charts, process landscapes and whiteboards.

Similar to any other tool, ARIS enables process design using a graphical notation as presented in Fig. 2.8 (BPMN). This is to visually map the documented process and define in which section/department each of the tasks take place. Each of these tasks can be assigned and aligned to the organisational chart to assign the actors/resources who are responsible for each task.

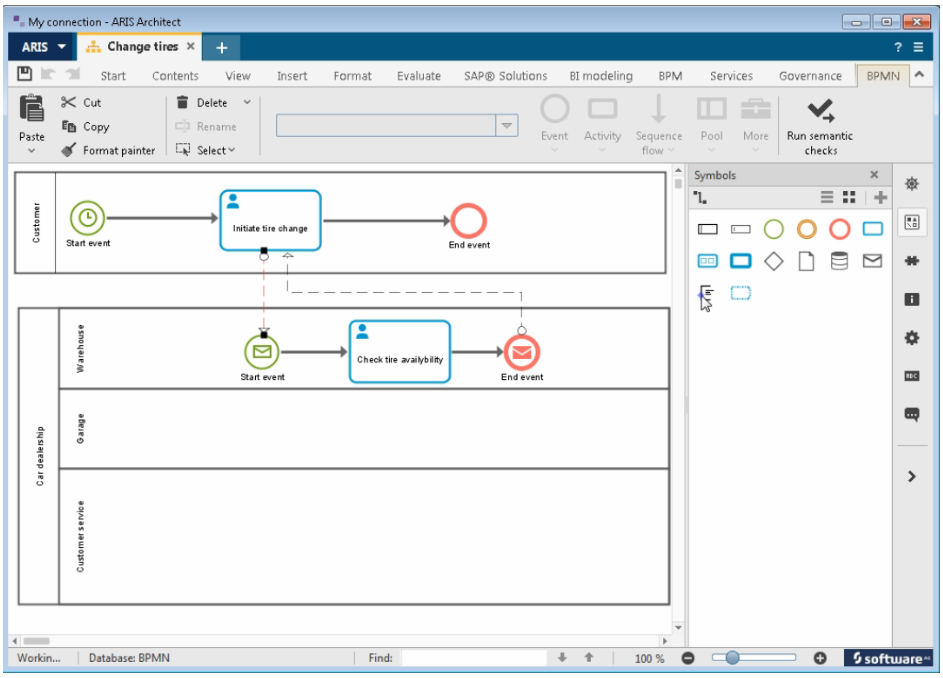


Fig.2.8 Process design in ARIS

Process enactment and diagnosis/evaluation is also supported by AIRS BPM suite. The tasks are executed, and become coloured once then have been completed and the

[6] https://en.wikipedia.org/wiki/ARIS_Express

output for the overall process is produced as illustrated in Fig. 2.9. This data is then used for process analysis and process optimization.

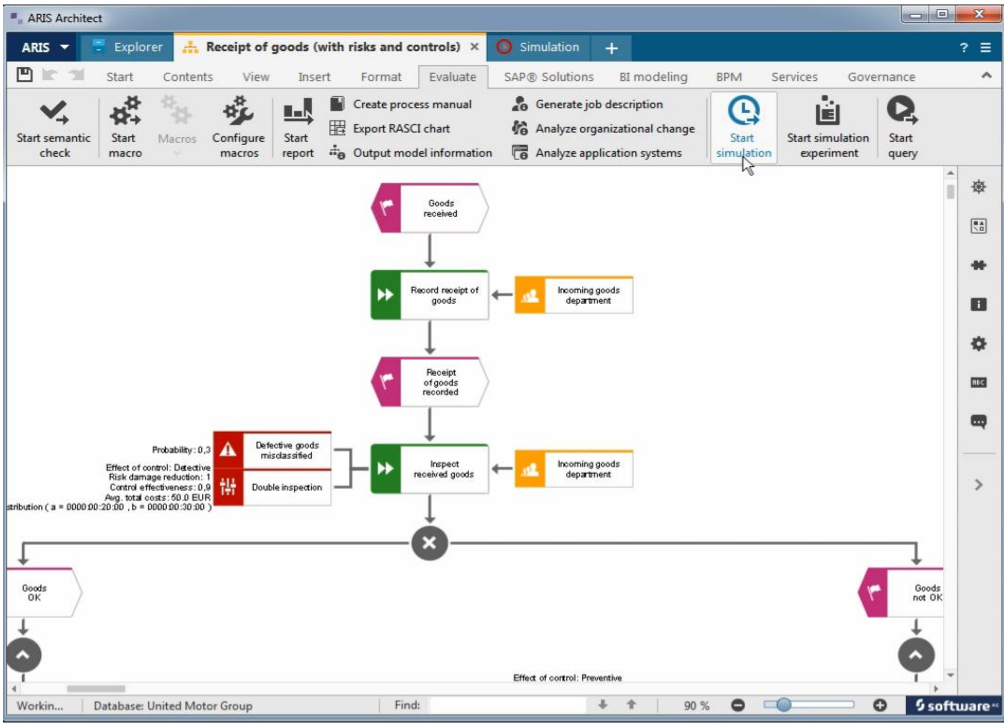


Fig.2.9 Process enactment in ARIS

Based on process models and organizational structures, the simulation enables a comparison of actual and target processes in terms of excitability and efficiency. The focus can also be laid on cost, execution time, or resource usage. This answers questions on throughput times, weak points, bottlenecks, resource requirements,[7] and can be utilised for process improvement and optimisation.

Considering the two main BPM tools which we have briefly analysed we find that although such tools support the BPM lifecycle through its different phases of design, configuration, implementation and diagnosis, they only support the structured or at most semi-structured process types. Ad-hoc processes are not supported by the BPM model or tools.

[7] http://www.ariscommunity.com/help/videos/aris-9

In all of these tools, there is a clear separation between the design and execution phases and the order of these stages needs to be followed. There are a number of limitations associated to this type of traditional BPM model and tools which are discussed in the next section.

2.2.4 Limitations of Traditional BPM

The evolution of BPM over the years suggests that there are still areas of limitations within the BPM lifecycle, which we discuss in the remainder of this section.

Traditional approaches to BPM present the following limitations:

Lack of Information Dissemination: BPM normally follows a top-down approach, where processes are designed by a group of individuals and passed on to end users to follow (Schmidt & Nurcan, 2009a; Palmer, 2011). This approach often prevents useful process knowledge (such as suggestions for improvements) of the end-users to be shared within the organisation. There are many users in an organisation with different backgrounds, who can contribute positively and share their knowledge throughout the organisation. However, traditional BPM often limits such dissemination of knowledge due to strict organisational layers. Although such knowledge can be captured in focus groups and workshops, this usually only happens during the design phase of the processes.

Model-Reality Divide: As a result of the top-down approach and the gap between the end users who execute the processes and the process designers who design the processes, the designed processes may not be followed correctly. This consequently creates a gap between the designed process and the process that is executed (Filipowska et al., 2011; Schmidt & Nurcan, 2009a; Palmer, 2011). For instance, because the users have not been involved in the design of the processes, they may often find shortcuts to execute specific activities, which better reflects their understanding of the process.

Information Pass-On Threshold and Lost Innovation: Useful feedback from users is not captured in process design due to rigid hierarchical controls in the design and deployment phases. As a result, valuable first-hand knowledge to improve processes may remain unused (Filipowska et al., 2011; Schmidt & Nurcan, 2009a). For instance, if a user has an innovative idea to improve the business processes, due to the rigid hierarchical barriers in process design, they will not be able to voice their input and contribute towards the improvement of the processes. Such a lack of information dissemination causes loss in innovation and often prevents the generation of new creative ideas.

Strict Access-Control: Strict access control is present in most traditional BPM approaches, that is, only users who have been selected and given specific access are allowed to execute the processes (Wohed et al., 2009). This limits the level of participation of users into the business process life-cycle. For instance, there may be users who are not directly involved in a specific process who, however, may be able to contribute effectively to the process design. Because of strict authorization controls in place, they will often be prevented access beyond what they have been granted permission to view. This will also lead to lost innovation and lack of knowledge dissemination.

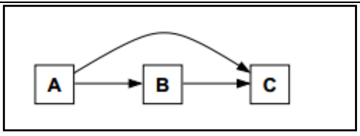
These properties of the standard BPM cycle make it unsuitable for so-called ad-hoc processes which are under the consideration in this research.

2.2.5 Flexible BPM

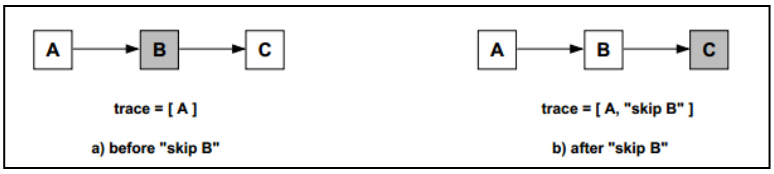
Limitations in the traditional BPM approach have triggered research that is inspired by other emerging trends. Liu & Zhao (2009) suggest that BPM allows organisations to create flexibility and adapt dynamic collaboration in order to keep up with the changing of the global market conditions. Flexibility and collaboration appear to be the way forward for the improvement of the BPM lifecycle. Additionally change and flexibility are typical of semi-structured and ad-hoc processes which is the focus of our discussion here.

Modern workflow systems need to provide flexiblity, but process aware execution at runtime that do not force users into a pre-defined way of doing their work (Burkhart & Loos, 2010) as it was promoted by traditional workflow engines (Dorn et al., 2010). The ability to change the dynamic nature of enterprises today is one of the most important factors of a company's success.

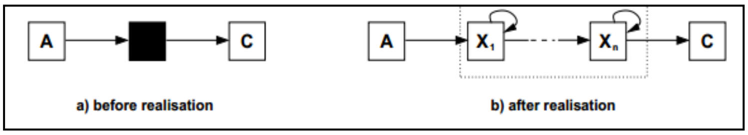
Over the past years there has been a range of definitions in regards to the notion of 'flexibility'. Although they all share a common principle, there are subtle differences between these definitions. For instance, in (Reijers et al., 2003) "[flexible] process models define the normal way of achieving a goal, but still offer the possibility to alter this way based on available case data", and this ability of alteration is referred to as flexibility. Adams et al., (2005) promote the idea that "[flexible] processes simply provide a guide-line while the appropriate way of handling single tasks is chosen on as – needed basis". Sadiq et al., (2001) on the other hand defines flexibility as "the ability to deal with processes that are only partially defined at build-time" (Burkhart & Loos, 2010). From a business standpoint, flexibility could be defined as the ability to change the way tasks/processes are handled without facing serious complexity issues (Burkhart & Loos, 2010). More in detail, Schonenberg et al., (2008) define 4 categories of flexibility types in business processes; these are presented in Fig. 2.10.



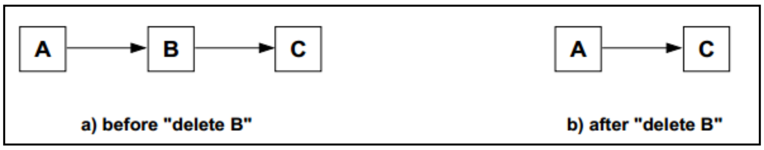
a)Flexibility by design (Schonenberg et al., 2008)



b)Flexibility by deviation (Schonenberg et al., 2008)



c)Flexibility by under specification (Antonucci & Goeke,2011)



d)Flexibility by change (Schonenberg et al., 2008)

Fig.2.10 Approaches to process flexibility

a) Flexibility by Design: this is the ability to allow different execution paths during runtime of the process instance.

B) Flexibility by Deviation: refers to the ability to deviate from the execution path during runtime, without altering the process model.

c) Flexibility by under specification: this is the ability to enact an incomplete process during runtime, i.e. process does not have sufficient information to allow it to be executed.

d) Flexibility by Change: refers to the ability to modify the process model during execution such that the currently executing process instances are moved to a new process model.

Adaptive Case management (ACM) (Motahari-Nezhad, 2013) is also another approach which focuses on the goal to be achieved and leaves the determination of how to achieve that goal to the knowledge worker (i.e. the user) (Motahari-Nezhad, 2013). Although Adaptive Case management is not new and references to this term go back to the 1980s, it has been used in contrast to traditional BPM systems, primarily because of the flexibility it offers (Motahari-Nezhad, 2013). The term adaptive case management refers to managing the work needed to handle a case in a flexible manner by adhering to the principle of planning-by-doing, considering the work context, and the ability to accommodate changes in the environment and the work context Burns et al., (2011). ACM is described as an approach which is based on 'learning by doing' (Walters & Holling, 1990), learning not only includes the system responses, but also learning to fill gaps or improve understanding of key parts of the system where our knowledge is lacking (Argent, 2009).

The approach adopted in ACM is mainly related to experiment and learning through them in order to improve the knowledge gaps. The main principles which ACM relies on are describing, predicting, doing and learning (Argent, 2009), which are more concerned with performing an action and learning from it which do not overcome the limitations of BPM. Process flexibility is needed to address and support ad-hoc processes which are designed during execution which ACM does not facilitate.

Furthermore although these approaches towards flexible BPM offer a degree of flexibility to the designed processes and tasks, there is still a structure and execution path defined. This type of approach towards flexible BPM seems to be in line with semi-structured processes. It goes beyond the structured processes which is supported and handled by traditional BPM systems, and allows a certain level of deviation and alteration from the main execution path which is from the characteristics of semi-structured processes.

To summarise, we argue that approaches to flexible BPM are still vulnerable towards a subset of the downfalls of traditional BPM systems, particularly in the context of ad-hoc processes. Consider the following examples which would still apply:

Model-Reality Divide: Due to the fact that in flexible BPM there is still a separation between the design and execution phase, the problem of the model-reality divide would still be a risk. Flexible BPM supports alteration of execution path which would be in discrepancy with the original designed processes.

Information Pass-On Threshold and Lost Innovation: Flexible BPM only introduces changes related to the processes and tasks, not the actors. It does not introduce a collaborative platform for all actors to be involved in the design and execution of the processes. As a result of this lack of collaboration and hierarchical actor boundaries, suggestions and innovative ideas by the users would most probably get lost and unnoticed.

Strict Access-Control: Due to the boundaries and separation of design and execution phases in flexible BPM, there are strict authorisations controls, and access rights are given to actors based on the roles they have in the BPM lifecycle.

Information Dissemination: Given the organisational boundaries and strict access controls, information dissemination throughout the organisation and between the users will also be limited which is another limitation that is found in traditional and flexible BPM approaches.

Given the above, the need for an approach to overcome these limitations and support ad-hoc processes is highlighted. The execution of ad-hoc processes is the starting point of a bottom-up approach (Bögel et al., 2014), which is key in overcoming the limitations of traditional BPM systems.

We have presented the areas supported by traditional and flexible BPM approaches and positioned our research which is Social BPM. We showed how workflow management systems have evolved into Business Process Management and then narrowed down to flexible BPM approaches. The gap found in this evolution is Social BPM which is then expanded and explored in this research. Social BPM takes a step further than flexible BPM and supports ad-hoc processes where the execution path design during process execution and allows collaborative participation from the wider community.

The next section discusses the concept of Social BPM which is another approach towards overcoming the limitations of the traditional BPM systems.

2.3 Social BPM

2.3.1 Definition

Research in Social BPM formally started in 2008 (Nurcan & Schmidt, 2009) and it has evolved ever since, this research emerged by the integration of social software and BPM. Social Business Process Management is a collective effort from several users to ensure smooth and efficient execution of business processes. There is consensus that by working together and creating a platform for social collaboration engagement, the social community can benefit from the 'wisdom of the crowd' i.e. the exploration of tacit knowledge amongst the participants (Surowiecki, 2004). This could eventually produce better quality processes and result in best practices.

Social BPM enables a large variety of users with varying degrees of training and background to contribute their domain knowledge into process performance (Pflanzl & Vossen, 2013). This is achieved through creating an "architecture of participation" (Erol et al., 2010) in which everyone feels part of the process execution. Social BPM is not without its own limitations as it will be discussed later. For example, bias input from the users need to be avoided in order for the contribution to be a real reflection of the users' efforts (Bruno et al., 2011).

Although there have been a number of definitions suggested for the concept of Social BPM, there is not a unique understanding of how Social BPM operates. Table 2.2 presents the different definitions of Social BPM:

Table 2.2 Definitions of Social BPM

	Social BPM Definitions
1	A methodology for bringing more and diverse voices into process improvement activities (Richardson, 2010).
2	A concept that describes collaboratively designed and iterated processes (Sinur, 2010).
3	Development and improvement of processes through the use of social technologies and techniques (Richardson, 2010a).
4	An emerging concept that marries the flexibility and pervasiveness of social media with the management discipline of BPM (ComputerWorldUK, 2012).
5	Social BPM is derived from empowering the skilled business user with platform for collaboration between not only trusted colleagues, but also to identify and connect with individuals with whom we may have had no prior contact (Palmer, 2011).

6	Social BPM fuses business process management practices with social networking applications, with the aim of enhancing the enterprise performance by means of a controlled participation of external stakeholders to process design and enactment (Brambilla & Fraternali, 2012).
7	Social BPM is the practice of actively involving all relevant stakeholders into BPM through the use of social software and its underlying principles (Pflanzl & Vossen, 2013).

The key element in Social BPM is user and stakeholder engagement (Sinur, 2010; Pflanzl & Vossen, 2013), similarly what appears to be common and key in Social BPM according these definition are: Collaboration, User engagement/participation, Process Improvement and Social software. Therefore, for the purpose of this research we combine these definitions and suggest the following definition of Social BPM:

A methodology to enable collaboration and user participation through social software in order to enhance and improve BPM lifecycle.

In Social BPM, the users are involved in the designing of the processes right from the outset and are part of a wider user community group all the way to execution and evaluation of the processes. Therefore, in order for a Social BPM approach to be a success it is vital to ensure the engagement of stakeholders and keeping them motivated to contribute towards the processes (Pflanzl & Vossen, 2013). This is contrary to the traditional BPM model where the processes are designed by a specific group of experts and then imposed on the users to follow. On the other hand, in Social BPM there is a seamless integration of design stage and enactment as the processes to achieve the set goals are often executed and discovered on the fly. Furthermore, Social BPM accounts for the unplanned participation of different users in order to complete the enactment of the process steps more efficiently (Kemsley, 2011).

2.3.2 Social BPM Literature

Social Business Process Management is an approach which has been introduced in order to overcome the limitations of the traditional and flexible BPM systems. The foundations of Social BPM as a distinct research topic lie in the workshop on Business Process Management and Social Software (BPMS2), which has been carried out in conjunction with the International Conference on Business Process Management since 2008 (Nurcan & Schmidt, 2009).

Publications in the area of Social BPM can be broadly categorised in the following areas:

1. Attempts to design a Social BPM framework (Brambilla & Fraternali, 2012; Brambilla et al., 2011; Silva et al., 2010; Brambilla et al., 2011a).
2. Literature on Social BPM in general and the theory of it, discussing its benefits, limitations and how it has emerged (Filipowska et al., 2011; Wohed et al., 2009; Schmidt & Nurcan, 2009; Erol et al., 2010; Brambilla et al., 2011; Alexopoulou et al., 2013), and the challenges raised by the adoptation of Social BPM in organisations (Bruno et al., 2011; Pflanzl & Vossen, 2013; Pflanzl & Vossen, 2014; Alexopoulou et al., 2013).

This thesis discusses the literature in the first category of research analysing the approaches to generating a Social BPM framework and identifying the current gaps in this area. Then we discuss the advantages and limitations of Social BPM in general in the second category.

2.3.3 Approaches to Social BPM

The first category of literature in Social BPM is research into developing a framework to support socially enabled BPM. Here we shall touch upon two of these main approaches namely the BPMN Social Extension (Brambilla & Fraternali, 2012; Brambilla et al., 2011; Brambilla et al., 2011a) and AGILIPO (Silva et al., 2010). After this, we will then look at some of the Social BPM tools and technologies which are used in industry.

I. BPMN Social Extension:

(Brambilla & Fraternali, 2012; Brambilla et al., 2011; Brambilla et al., 2011a) in their approach towards designing a Social BPM framework propose a social extension to the existing BPMN language to cater for social processes.

The first social extension to BPMN (Brambilla et al., 2011) is related to the actors, their level of access, visibility of process status and level of social participation they each have. Fig. 2.11 shows the types of roles considered in this approach.

Role type	Internal performer	Internal Observer	External Observer
Icon			
Description	Directly affect case and activity advancement	May produce events and artifacts that indirectly affect case and activity advancement	Can be informed and participate through social network platforms

Fig.2.11 BPMN Social extension roles (Brambilla et al., 2011)

Furthermore Brambilla et al., (2011a) introduces extra notations in order to denote social activities such as setting up polls, dynamic enrolment, social sourcing, voting and ranking/commenting as presented in Fig. 2.12.

Task type	Social broadcast	Social posting	Invitation to activity	Commenting	Voting	Login to join	Invitation to join a network	Search for actor's information
Annotation icon								
Description	Data flow to a community pool	Data flow to a single user in a comm. pool	Dynamic enrolment to a task in the process case	Comment the activity	Voting (y/n) on an activity, either within a social network platform or directly in the BPM system	Login using a social profile	Invitation between community users	Lookup query to the community to search for an actor with specific profile attributes

Fig.2.12 BPMN Social extension social activities (Brambilla et al., 2011a)

Finally the concept of community pool which is the main extension to BPMN is introduced. This is defined as the pool devoted to social activities: it may represent a public social network or an enterprise social network (Brambilla et al., 2011). This is supported by different type of activity notations which have been introduced as social extensions such as community executed activity and activity inheritance in order to avoid duplication of activities as presented in the Fig. 2.13.

Requirement	**BPMN notation**	**Comment**
Actor category and community pool		Annotation in the pool/lane header, respectively for: Internal performer, internal observer, external observer. The last two categories characterize **community pools**
Activity inheritance	Hierarchical definition of user roles	To avoid duplication of activities, hierarchies of roles with inheritance of task execution can be defined
Community executed activity	*Ad hoc* Activity within a community pool	A sub-process or a task delegated to a community of observer users. Ad hoc mark denotes complex / non-structured interactions
User vs. Automatic Gateways		The execution of the choice is performed by a human or by an automatic procedure /rule

Fig.2.13 Social requirements for BPMN (Brambilla et al., 2011)

To conclude presenting this approach towards a Social BPM framework by (Brambilla & Fraternali, 2012; Brambilla et al., 2011l; Brambilla et al., 2011a) the following presents a simple process of 'enrolment' using a social extension to the BPMN language. In Fig. 2.14 a simple enrolment process is presented, an invitation is sent to the social community and the details of the social network is collected and the user is able to complete their registration and sign in. The focus of the social extension here is making the designing and running of the processes easier by incorporating social software such as using social tool to invite a large number of people or a social facility to gather information from all those in the social network.

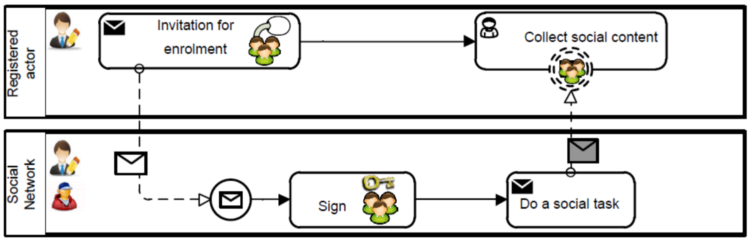


Fig.2.14 Dynamic enrolment pattern (Brambilla et al., 2011a)

This approach, although it does introduce social elements in the BPM lifecycle, it does not lead to a fully socially integrated BPM framework and although it might potentially address some of the limitations proposed by the BPM model, a number of serious issues will still remain.

Some of the reasons and limitations of this approach are the following:

- In this approach, the BPM developers are using some social software applications to enhance their experience of BPM and facilitate it in an easier and faster fashion. The key here is that the engagement of the users (who design the process) during the execution of the processes is still missing. In fact if the total integration of social software and BPM did take place, it will eliminate the need of a specific group of designers or analysts designing a set of processes (Swenson, 2010). This would still result in model-reality divide downfall.
- The categorisation of the actors to three different types and authorisation boundaries in normal circumstances is typical of BPM models which are not in line with the characteristics of social software. In fact such authorisation

boundaries are one of the main reasons for lost innovation and lack of information dissemination in an organisation.

- The processes are pre-defined and social software is used to assist the execution of these processes. This model would support structured or at most semi-structured processes, not ad-hoc processes which is the subject of our research. Although ad-hoc type tasks/activities have been introduced in the social BPMN language extension, this is only a task which is embedded in the overall predefined process which again will not support totally ad-hoc processes.
- The presented approach also ignores collaboration and the use of social elements during runtime. In Social BPM everyone contributes to the design and execution of the processes, not just a specific group of authorised actors and only in a specific stage (Swenson, 2010).

Overall this approach only provides social add-on features to make the BPM experience easier, but the sequential workflows remain the same and still suffer from some of the limitations of traditional BPM models.

II. AGILIPO:

In AGILIPO, Silva et al., (2010) investigates and proposes a framework for embedding social software features into business process tools. This research primarily focuses on the human-intensive aspects of business processes, where human participation is required for activities operation. In this research a new approach to BPM is presented which is human-centred and is supported by a collaborative environment.

AGILIPO supports unplanned exceptions during process execution where the users are able to design on a case by case status. Fig. 2.15 presents the different parties involved in the modelling (i.e. designing) of the processes and the user who executes them.

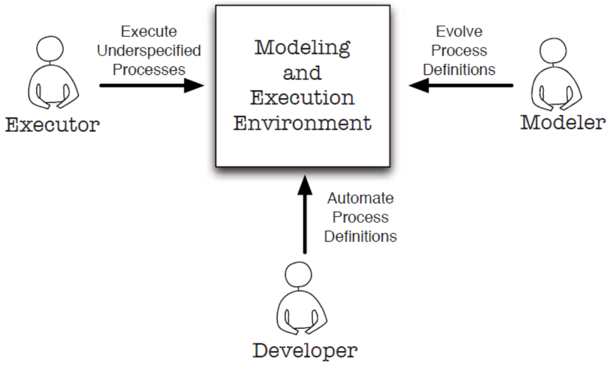


Fig.2.15 Modelling and execution environment (Silva et al., 2010)

In this approach the processes do not need to be fully designed, they can be incomplete which is where the human-centric elements play a vital role. An incomplete process definition is specified by a set of activities that describe part, but not all, of the process instances behaviour (Silva et al., 2010).

The incomplete process is made up of a number of tasks/activities, these activities can either be automated or non-automated where automated activities usually contain hardcoded functionality and require programming to implement them. To clarify what is meant by supporting incomplete processes through human-centric collaboration which is the heartland of what is discussed in AGILIPO consider the following example (Silva et al., 2010):

In an online book store the *Selling* process has three main activities: *AddBookToOrder* followed by either *PayWithCheck* or *PayWithCreditCard*. However imagine that when the client goes to the physical store, they would like to pay by cash which is not a predefined activity, the employee may then create an instance of a generic activity and associate it to the current instance of the *Selling* process before they are able to receive the cash and complete the *Selling* process. The added task during the execution of the process is considered as an exception in this approach. Fig. 2.16

presents a prototype of an example of a process type interface for the *Selling* business process which has just been discussed.

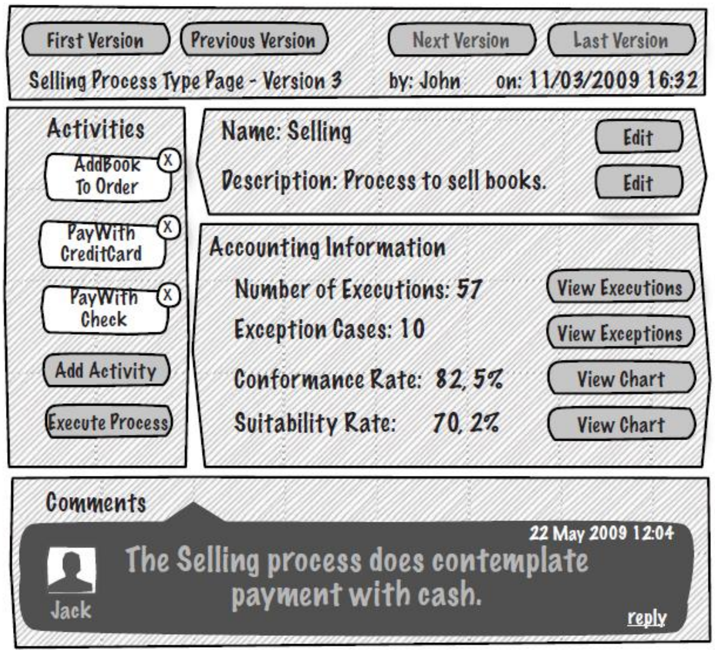


Fig.2.16 Process type interface example. (Silva et al., 2010)

Overall, as discussed AGILIPO empowers people to perform business process based on their tacit knowledge and judgment where an exception activity/task can be created. The created tasks can then later on be designed by the modellers as one of the options available as part of the normal process without the need to have to create an exceptional event.

This approach is a step forward from what was discussed previously about social extensions to BPMN since its main focus is supporting incomplete processes. Furthermore, it allows designing during the execution of the processes in exceptional circumstances and empowers users to utilise their tacit knowledge and address the process gaps instantaneously where and when necessary.

This approach still suffers from a number of limitations and leaves the challenges of BPM approaches unanswered, although this is a step forward in the right direction. The following points are potential downfalls of this approach:

- This approach fills the gap and supports un-structured processes (*Incompleteness* (Silva et al., 2010)) where part of the process is defined already the incomplete part of the process (if any) is designed and executed on the fly, this is different to ad-hoc processes where the execution path and task is not designed at all. Additionally, in AGILIPO even the exceptional cases where tasks are designed on the fly, if this is repeated a few times, it will be considered to be pre-defined in the processes. Therefore, even the support for unplanned task is utilised to enable more accurate and comprehensive designing of the process so future executions of the process do not face similar gaps. Although this is a positive step forward in catering for unplanned tasks, this does not change the processes from being un-structured to ad-hoc, because at least part of the process is designed.
- As presented in Fig. 2.15, there is a clear distinction between the modellers (process designers) and the executors. This could potentially lead to the model-reality divide issue since the AS/IS processes designed by the modellers may differ from the actual processes executed by the executors.
- Clear distinction between modellers and executors mean authorisation boundaries which is contrary to the characteristics of Social BPM and could lead to loss in innovation and lacking of information dissemination. The users being able to use their tacit knowledge (*Empower people*) (Silva et al., 2010) to design exceptional task on a case-by-case basis (*Design at the instance level*)(Silva et al., 2010) is a great step towards exploiting explicit knowledge, however for a great part of the remaining predefined tasks and activities this is not the case.

Overall AGILIPO is a positive step towards Social BPM, however it does not fully overcome and address the gaps in BPM. There still remains a need to take a step further in this direction in order to support ad-hoc type processes which is where there still seems to be a gap.

2.3.4 Potentials of Social BPM

The literature identified the following advantages of Social BPM:

Exploitation of weak ties and implicit knowledge: Social BPM allows the discovery of tacit and informal knowledge, which is normally difficult to capture. This will consequently improve process execution and design (Kemsley, 2011; Brambilla & Fraternali, 2012). Additionally, it fosters the creation of weak ties, which allow spontaneous creation of contacts between non-predetermined individuals (Bruno et al., 2011). While traditional BPM mostly relies on relationships based on rigid hierarchical structure, Social BPM focuses more on such spontaneous connections among individuals, which enable them to get hold of information that are not accessible via the rigid structure typical of traditional BPM.

Transparency of information sharing: In Social BPM, the design and execution of business processes are more visible to the stakeholders and all activities are logged (Brambilla & Fraternali, 2012; Erol et al., 2010). Although in traditional BPM systems there is some level of transparency, access to information is often limited to those who have been authorised to participate to specific processes. In Social BPM, there is a principle of global visibility and authorisation extended to all users and stakeholders of the processes.

Decision distribution and participation: A wider range of input and participation is received in Social BPM, which allows better informed decisions for process improvement (Brambilla & Fraternali, 2012; Richardson, 2010). This may facilitate the improvement of best practices through continuous enhancement. While, in fact, in traditional BPM the best practices are imposed on the organisation, in the form for instance of standard process templates, Social BPM enables collecting feedback by the community of stakeholders to improve such best practice and better fit them to the organisational context.

Knowledge sharing: Knowledge dissemination is improved drastically in Social BPM (Brambilla& Fraternali, 2012; Richardson, 2010; Erol et al., 2010). This is because there is no strict access control to process data, and, as a consequence, all users are able to participate in the processes. Moreover, the transparency enabled by Social BPM fosters knowledge dissemination among users and stakeholders, either implicit or explicit. This increases general user expertise and enhances both the execution and design of the business processes.

2.3.5 Limitations of Social BPM

At the same time, a number of potential limitations have also been identified in Social BPM; these include but are not limited to the following categories:

Steep learning effort: Social software applications incorporated in the BPM lifecycle can require a process of learning in order for the users to get familiar with them. This learning process would also involve a major cultural shift with the organization, which could be challenging (Filipowska et al., 2011; Kemsley, 2011).

Security breach: Social BPM enables users from within and outside the boundaries of the business to participate in process design and execution. Whilst this itself is an advantage, it can also be misused and hinder the security of the system. Therefore, there either needs to be controls in place (such as banning inappropriately behaving users) or the use of Social BPM has to be avoided for critical business cases, such as human resources processes, in which sensitive information and procedures should not be disclosed to the broader community (Brambilla & Fraternali, 2012; Erol et al., 2010).

Drop in quality of input: Since all community members are able to participate in the Social BPM lifecycle, this could mean a drop in the quality of the contributions. This needs to be addressed by putting quality measures and controls in place in order to ensure that only user input meeting the standard of desired quality in considered in the design and execution of processes (Brambilla & Fraternali, 2012).

Difficulty to evaluate: Due to the distributed benefits of social software, it would be difficult to measure typical benefits of Social BPM, such as the creation of weak ties and tacit knowledge captured (Erol et al., 2010).

2.3.6 Research Gap

Having discussed the present approaches to date in the area of Social BPM, it is clear that there is still a research gap which needs to be explored in order to overcome the limitations of the traditional BPM models. To move forward the following areas need to be investigated and addressed:

- Elimination of distinctions between ‘designers’ and ‘executors’ in the Social BPM framework. This is in order to avoid the typical issue of model-reality divide as faced by current approaches in BPM as well as Social BPM.
- Integration/merging of the design and execution phase in the BPM model. So that there is no explicit or ordered distinction between the two.
- Elimination of pre-defined tasks in the processes, in order to support ad-hoc type processes.
- Exploiting and utilising tacit and explicit knowledge of the users in order to maximise innovation and knowledge dissemination.

The above can be achieved through incorporating an approach where the users are both designers and executors. Additionally the tasks executed in the past are simply recommended to the users without them being pre-designed. This method will on the one hand exploit process and users' tacit knowledge and on another allow the system to support ad-hoc processes since there are no pre-defined processes.

The next section discusses social technologies and in particular recommendations which is the backbone of the proposed framework going forward and also social tagging which will be used to drive and support the recommendations in the Social BPM framework.

2.4 Social Technology for BPM

2.4.1 Social Software

Abbattista et al. (2008) defines social software as a general term encompassing a set of tools and applications that enable group interaction and computer-mediated communication. In other words, social software provides a platform for the collaboration and communication of different individuals, groups and parties through a computer-mediated medium. All parties have nearly the same level of access and authorisation to view, add or edit the content. According to Schmidt & Nurcan (2009a), social software is software that supports the interaction of human beings and production of artefacts by combining the input from independent contributors without predetermining how it is done. Vossen & Hagemann (2007) focuses on the evolving nature of social software and defines it as software that gets better the more people use it.

Today, the trend of growth in the usage of social software is increasing rapidly. According to checkfacebook.com in 2012[8], the social networking giant Facebook had about 1 billion users which is approximately a fifth of the world's population. This way of new communication has also spread and is used for informal business networks such as LinkedIn with over 400 million professional users in over 200 countries[9]. Social software follows a more egalitarian approach compared to traditional approaches where senior management determine the role and authorisation level given to the users. Therefore, the role of trust and reputation is highlighted in social software users (Schmidt & Nurcan, 2009a).

The aim of social software is the enabling of interaction between different individuals and parties. Some of its key principles are:

Weak Ties: Some relationships in organizations are based on hierarchical structure and where the business processes are well defined, these relationships are referred to as 'Strong Ties' (Granovetter, 1983); on the other hand there are connections between individuals which enables them to get hold of information that are not accessible via strong ties imposed by corporate hierarchy (Schmidt & Nurcan, 2009a). Weak ties allow spontaneous creation of contacts between non-predetermined individuals (Bruno et al., 2011).

Social Production: Enabling of innovative and unexpected contributions and feedback regardless of geographical location (Abbattista et al., 2008; Kemsley, 2011). This collective re-iterating evaluation by various users of the system inputting information is aimed to improve the quality of the available content. It should be noted that one of the conditions for this process and evaluation is the independence of the users, to avoid any inputs based on biased opinions (Bruno et al., 2011; Filipowska et al., 2011). With the

[8] http://www.checkfacebook.com
[9] https://press.linkedin.com/about-linkedin

increase of the number of inputs, the social network also grows and individuals are able to view contents entered by others in real-time (Abbattista et al., 2008).

Egalitarianism: In social software, the role of trust is increased within organizations and the idea is that all the contributors have the same rights to contribute; this will encourage and maximize participation and should result in achieving the best solution (Bruno et al., 2011).

Mutual Service Provisioning: Social software transforms the organization's model from a one-way service system offered by the corporation to a service-exchange system (Bruno et al., 2011). This way the customer will not only be offered the end product but rather the output and the production will be based on the interaction with the customer, and the customer's feedback and input is considered during the production process.

Some examples of social technologies which typically have the characteristics above are wikis, blogs, tagging and social bookmarking, instant messaging, reputation systems and social links (Schmidt & Nurcan, 2009a). We find that in all of these technologies both the content and context are considered valuable and enables continuous assessment of the content.

2.4.2 Social Technologies

In this section some of the main tools which are used as social technologies today are presented:

Wikis: Collaboration is the key in wikis (Schmidt & Nurcan, 2009a); the editing mechanism enables a range of users to contribute to content creation in a wiki. Both the context and content information are captured in wikis by the contributors. The access of many wikis is unrestricted which hinders the quality of the information present, however the versioning mechanism assists in tracking the changes and coordinating the contributions from users.

Blogs: In blogs, the contribution of the users are identified as separate entities. This is contrary to wikis where users can override each other's comments, although blog entries can be used to annotate other entries or content.

Tagging: Tagging provides context to a specific content and it enables the reuse and referring to that content in the future. The tags are chosen freely and are not part of a classified hierarchy contrary to taxonomies.

Social Bookmarking: Social bookmarking is the collaborative collection of bookmarks. In social bookmarking, a tagging mechanism is used to collaboratively organise the bookmarks collected.

Recommender and Reputation Systems: Many recommender systems for selling products use individual reviews or the customer's purchasing history to recommend a range of products (Schmidt & Nurcan, 2009a). For example a book is recommended to a customer on Amazon, based on the similar types of books he has searched and purchased in the past.

Social Links: The main purpose of social links is to create contacts and relationships between participants. These contacts are established by one person and requires the acceptance of the other party. Social networking sites such as Facebook or LinkedIn use a similar mechanism.

Polls: Social polls allow the engagement of the audience and capturing their opinion. The results can be easily filtered by demographics, social attributes or any other attributes which the data is available for.

In the context of BPM, the social extension to BPMN proposed by (Brambilla & Fraternali, 2012; Brambilla et al., 2011; Brambilla et al., 2011a) primarily uses polls, social links and social bookmarking to facilitate BPM. Other technologies such as blogs (Schmidt & Nurcan, 2009a) are primarily used as interaction mechanisms documenting the thread of communication which can be particularly useful during the execution phase of BPM.

Out of these technologies social tagging is currently used in different contexts, such as libraries, museums, online archives, education and social entertainment or networking. The tags are used to capture knowledge about specific content from users and communities in terms of their preference, interests or chosen categories. For example in the website LibraryThing[10] people share and tag their personal book collections and currently members have added nearly 20 million tags to 15 million books, making it the second largest library in North America (Smith, 2008). In this example, knowledge about the books is being captured by the tags, such as categorising the books as romance, fiction or science for instance. Given the popularity of social tagging and the benefit it brings about by capturing various resources, we use this technology in the context of Social BPM.

2.4.3 Social Tagging

Del.icio.us was the first website to employ social tagging, and today it has many competitors (Smith, 2008). Social tagging has become a part of most of the social networking sites over the past few years. In other contexts, social tagging assists in integrating models into knowledge management systems (Bruno et al., 2011). Existing models consider tagging as an activity where an individual user assigns a set of tags to a resource (Scerri & Breslin, 2008), however so far this has not been applied in the context of business process management in order to capture emergent process knowledge, such as user skills.

Tagging is the assignment of unrestricted keywords to all kinds of content and it becomes social when tags are shared among users and different users are allowed to tag

[10] www.librarything.com

the same content unit (Cantador et al., 2011; Prilla, 2008). A basic tagging model consists of three main elements as presented in Fig. 2.17: *users* who are the people who perform tagging, *resources* which are items that users tag and tags which are keywords added by users and also meta-data of the tagged resources (Smith, 2008).

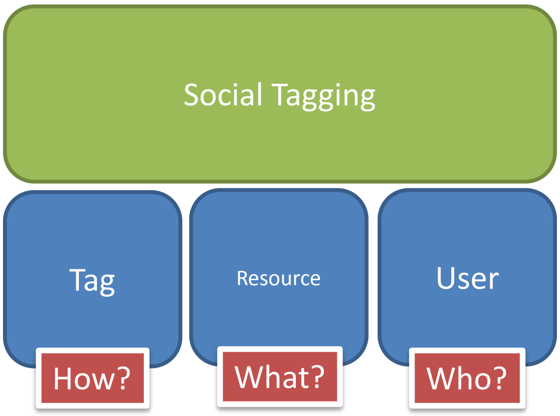


Fig.2.17 Social tagging structure

Tags themselves have been categorised into various different types, for example Pflanzl & Vossen (2013) talk about the following types of tags:

- Content-based, which are tags that describe the content of items such as objects and living things that appear in a context, for example, “cat”, “house”.
- Context-based, which relate to tags that provide contextual information about the items, such as the geographical location where and when a photo was taken, for example, “summer”, “September”.
- Subjective, which are the tags which express opinions and qualities of the items, for example, “happy”, “new”.
- Organisational, in which tags define personal usage and tasks or indicate to a personal reference, for example. “sale orders”.

Generally in business processes, context and content-based tagging would be mostly relevant. This is because the context in which the process or tasks take place can be valuable for capturing process knowledge and utilising it in future occurrences. Similarly the content itself is what could be used by users which may not have been involved in a particular process previously. Therefore, context-based tags assist to locate and utilise the content of the processes which have been executed. The tags used are not classified by terms from a controlled vocabulary, but by a cloud of tags 'Tag Cloud'. A tag cloud is the weighted set of tags associated with an object and they are used to show the frequency of a specific used tag (Schmidt & Nurcan, 2009a).

As far as tagging in Social BPM is concerned, social tagging assists in engaging the wider community in the process design and execution, and it also allows for capturing process knowledge to be used by other users in the future. Although social software has been used previously by Koschmider et al. (2009) in order to generate social networks from historical process logs, there is no process-based recommendation by the Social BPM model to support the users during the different stages of BPM. Qu H et al. (2008) have also discussed automated social recommendation in the context of BPM, however again the model of the user process networks suggested in this research remains sequential and the recommendation is based on repeating or sharing common tasks. This is different to our approach, since we consider the integration of the design and execution phases of the processes. Moreover, in our framework the recommendations could be modified and are just a means for utilising previous captured process knowledge which have been annotated based on a number of criterion and not any tasks as suggested by Qu H et al. (2008).

Furthermore, Prilla (2008) propose a social tagging approach to integrate process models into Knowledge Management (KM) platforms. The tagged items are matched to the KM application categories and can be retrieved from the KM application. This approach is mostly concerned with categorisation and management of knowledge rather than supporting collaborative process design and enactment.

2.4.4 Recommendation

Recommender systems became popular and an important area of research since the emerging of researches in collaborative filtering in the mid-90s (Ekstrand, 2011). Recommender systems (Balabanovic & Shoham, 1997; Koschmider & Oberweis, 2010) have been mainly used in e-commerce, content presentation, entertainment and services (Koschmider & Oberweis 2010), however they have not been used previously in the context of Social BPM.

Recommender systems, function based on personalized information agents who recommend items based on user's preferences, needs and interests (Terveen & Hill, 2001). There are different types of algorithms which the recommender systems use in order to make their suggestions. For example content-based recommendation is based on recommendations made in the past. Collaborative recommendation (or collaborative filtering systems) unlike content based recommendation, is based on the items previously rated by other users with similar tastes (Adomavicius, 2015), and the hybrid approach combines different recommendation algorithms to avoid the limitations of each of the systems (Burkhart et al., 2012).

What is discussed here and is used in our Social BPM framework is related to process recommendations. Previously there have been discussions about flexibility of processes through process recommendation. For example, Burkhart (2011) introduces the idea of pre-process step recommendations which is the matching of an external event onto a specific process step and presenting it to the user. Post-process step recommendations on the other hand includes recommendations beyond the immediate process step and it assumes that the user carries out the immediate underlying process step and thus suggests a suitable follow up action (Burkhart, 2011).

The traditional BPM models do not support the required flexibility and agility for Social BPM when it comes to rapid changing and unpredictable process steps, this makes flexibility of the processes during runtime impossible (Burkhart & Loos, 2010). Therefore our proposed recommender process aims to provide a level of flexibility based on the users course of action and guide the user until all the goals are fulfilled. Recommendations are made based on previous experiences in fulfilling specific process goals (Pesic & Van der Aalst, 2006); these are tagged by the user used as a basis for recommendation in our system and also allows unplanned participation and process flexibility on the fly during processes enactment (Richardson, 2010a).

Such a recommender system in the Social BPM framework enables a major shift from the inflexible and static workflow model to a dynamic, flexible and collaborative social flow of interactions which are guided by the Social BPM system. The recommendations in Social BPM are driven based on the tags used by the users which allow the community to benefit from the tagged process knowledge.

Chapter 3 of this research expands on the usage of recommendation and social tagging in our Social BPM framework and illustrates the design of our framework explaining how a recommendation mechanism can be supported by social tagging in order to overcome the limitations of the traditional BPM systems.

2.5 Conclusion

Business process management is a methodology through which the organisations improve their business processes in order to achieve their aims and objectives.

Structured processes are supported by traditional BPM systems; these have posed a number of limitations. In order to overcome these limitations and also support semi-structured business processes, a number of approaches to flexible BPM has been proposed over the years. Although they have greatly contributed towards the improvement of BPM, in the best case they support semi-structured process. Therefore Social BPM has emerged as a solution to the limitations of traditional BPM systems and as a methodology to go beyond flexible approaches to BPM and support ad-hoc processes which is where the gap exists in the literature.

A review of Social BPM has been presented and the approaches to date in this area have been discussed. It appears that the attempts towards a Social BPM framework is limited to including social extensions to the already existing BPM notation. As discussed, such approaches where there is a distinction between the design and runtime of the processes and a hierarchical user classification, still pose the limitations which are related to model-reality divide, lack of information dissemination, lack of exploitation of process and user knowledge.

In the next chapter of this research we propose the design of our Social BPM framework, illustrating how the presented gap is addressed.

CHAPTER 3: SOCIAL BPM FRAMEWORK DESIGN

3.1 Introduction

In this chapter, the underlying design of our Social BPM framework is presented and the main components constituting the Social BPM framework are explained using a running example. In Section 3.3 the conceptual model of the framework is presented, identifying the key entities and their relationships in our framework. Section 3.4 expands on the models illustrated in the previous section and elaborates on the main components of the framework, namely social tagging, the task and role recommenders. In Section 3.5, the requirements of our framework are elicited and architecture to address these requirements is designed, which will be used for the implementation phase. This chapter ends with a conclusion Section 3.6.

3.2 Functional Requirements

Based on the literature review and research gaps identified in Chapter 2, we derive a list of functional requirements for our Social BPM framework presented in this chapter.

FR1 – The framework will allow tagging of the process content

FR2 – The framework will allow tagging of the users

FR3 – The framework will support the discussion between the users

FR4 – The framework will recommend relevant tasks to the users

FR5 – The framework will present users with their expertise

These are the requirements which will be expanded upon and discussed in detail throughout this chapter and the detailed functionality and behaviour of the Social BPM framework will be explained. After the framework is presented, these functional requirements will be further specialised/expanded into the specific requirements of a software system implementing the framework.

3.3 The Framework

Following the traditional approach of software engineering (Löwe, et al., 2001), our Social BPM framework is defined by a static "conceptual" view and a dynamic "behavioural" view. The former view illustrates the main entities and concepts in our framework and the relationships among entities. The latter view depicts the information and action flow between the identified entities.

As far as the identification of entities is concerned, Fig. 3.1 presents the 3 main areas captured in our Social BPM framework. *First* is the process definition and execution, which is supported by the processes, tasks, and process and task instances entities. *Second* is the community, which is captured through the definition of community members and active members, and *third* is the knowledge management area, which is enabled by social tagging and role/task recommendation.

Fig.3.1 Main Areas of Social BPM Conceptual Model

The following sections present in more detail the static and behavioural views underpinning our framework.

3.3.1 Conceptual Design

Fig. 3.2 shows the conceptual model underpinning our framework. This structure has taken inspirations from goal-based modelling (Paternò, 2002) and it considers the entities identified before to define a Social BPM framework. Although goal-based modelling approach has been used extensively in requirements engineering (Van Lamsweerde & Letier, 2000), they have not been adopted in the context of Social BPM. Goals are states which are reached through the execution of a number of steps (Filipowska, 2009) or desired modification of the state of an application (Paternò, 2002) and they provide the intention behind the tasks which need to be performed (Rangiha & Karakostas, 2013). Goal-based modelling allows the capturing of the 'what' without specifying the 'how' (Filipowska, 2009).

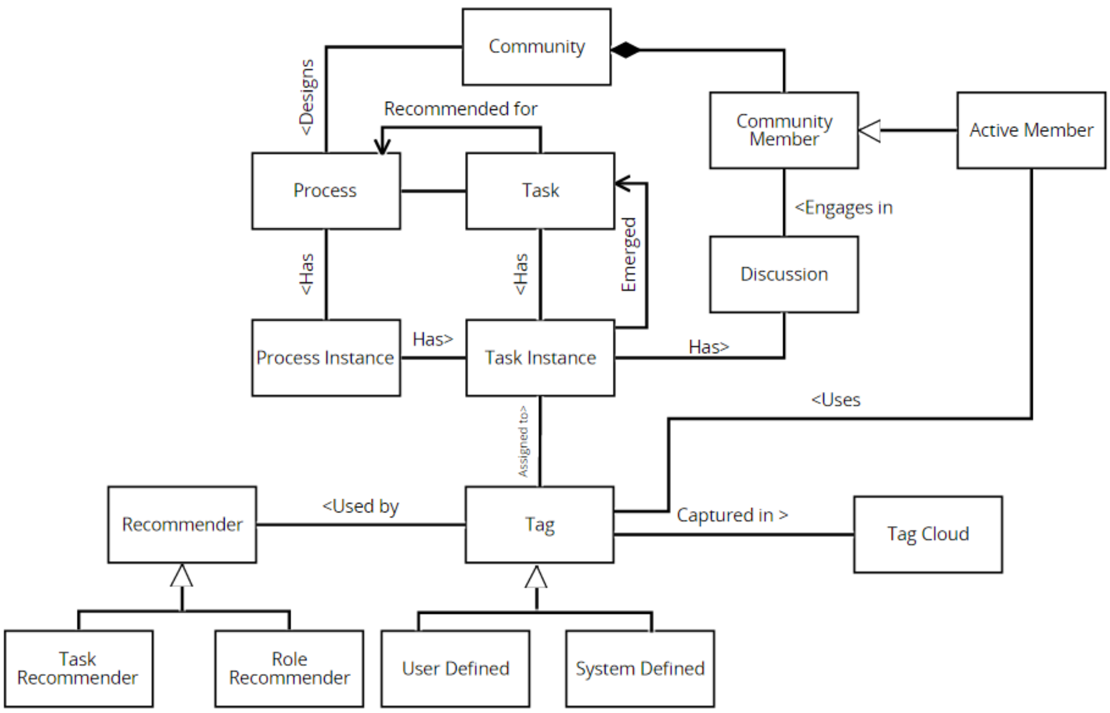


Fig.3.2 Social BPM Static View

In our framework the *what* is captured by the *process* and *task*, and the *how* is achieved through the *discussion*. During the discussion the community members collectively discuss the execution of a task and how to achieve it as a community.

A *process* in our framework may have one or multiple *tasks* that need to be completed. Tasks are activities that have to be performed to complete a process (Paternò, 2002). A *process instance* is an occurrence of a particular process and a *task instance* is an occurrence of a particular task within a process instance. Sometimes a task can emerge from within a task instance (see the relation “emerged” in Fig. 3.2), that is, when an activity is found as part of an existing task instance, this can be created as a new task and be used separately in future executions.

As far as actors are concerned, we distinguish between community members and active members. The *community members* participate in the design and execution of processes and determine when new instances of *processes* should be started. Community members collaboratively discuss to design processes, i.e. deciding which tasks should be part of a process and assign community members to tasks. *Active members* are community members more similar to process owners (Hammer & Stanton, 1999) and *experts* (Forestier et al., 2011) in social networks. Process owners take the initiative and are responsible for the overall design and execution of the process, to ensure deadlines are met and that the discussions among community members related to the tasks come to a decision and conclusion. Similarly an active member captures the knowledge emerging from process execution through tagging and is proactive during the discussions. Tagging can be used to recognise other members and recommend them for their valuable contribution during process execution. Generally, the active members are likely to have more experience and expertise for one or more given processes. Although in reality there is no explicitly defined split between community members and active members, we have included such separation in our framework to show that some members are more active than others, and those are the ones who take the initiative of tagging and recommending other community members. Thus, any community member, when they become proactive and more engaged in the processes, will be considered an active member which is an implicit role, who would tag discussions and recommend other members.

Tags are keywords used by active members to capture task instances during the design and execution of process instances (Smith, 2008). There are two categories of tags, the *system-defined* tags are used for tasks and are populated automatically by the system. They refer to the process and the tasks that have been defined within the process. *User-defined* tags are added by the active members to the tasks to specify the skill-set the task refers to. The tag cloud is a method of presenting tags, in which the more frequently used tags are presented and re-emphasized, to facilitate reuse (Smith, 2008).

Smith, (2008) discusses collaborative and simple tagging. The former refers to a tagging in which each user has their own unique set of tags for a resource, and those tags can be aggregated to create consensus view of each resource. Simple tagging, on the other hand, refers to the tagging of the original resource only, without aggregate view of tags for resources. The user-defined tags in our framework initially start off as simple tagging (Smith, 2008) and users choose unique terms for the content they would like to add. The initially simple tagging will potentially evolve, becoming collaborative, as community members may start using other used tags in the cloud.

Tags represent the basis of the *task* and *role recommender* and capture process knowledge and user expertise/experience. For any given process instance, the framework recommends to the community all the tasks performed in previous instances of similar processes (task recommendation). The role recommender suggests a list of community members to participate in tasks, with their expertise, which is based on their performance, as well as the tasks they have previously participated in that specific process. The two main mechanisms of our framework assist the members in reusing previously captured process knowledge and recommend tasks, as well as presenting community members with their skill set which have been recommended and tagged by previous active members.

We clarify our framework by applying it in the context of a running example of a typical social business process, i.e. the organisation of a study circle in a non-profit organisation. This example is adopted from a real process, which is also the object of the empirical evaluation of our framework presented in Chapter 4.

A group of community members would like to organise a *Study Circle*, that is, a type of an invited talk, in which a specific subject is discussed by an expert in a specific field. Some typical tasks involved in organising a study circle are setting a date and time, inviting a speaker, booking a venue, ordering food, designing a poster and advertising. The community does not have a standard way of executing such process, because the tasks involved will change every time, often during the organisation of the talk, because of several factors, such as the availability and preferences of the speaker, the number of interested participants, or the scheduled date. To support this in a social way, any of the community members should be able to initiate the process, setting an agenda as to what tasks have initially to be achieved (i.e. the most frequently used tasks in previous occurrences).

Our framework supports the design of the process by capturing the knowledge of the community members via tagging and making it available to improve the design and execution of the process.

Considering our conceptual model in Fig. 3.2, the process in our running example refers to *Study Circle*, and the specific occurrence, such as *Study Circle 2015* and *Study Circle 2014*, are examples of process instances. Examples of tasks in this context are *Booking Speaker* and *Booking Venue*, which need be fulfilled in order for the process to be completed. The community members are the users from the social community who are involved in organising the Study Circle. The system-defined tags in this case study put the tasks into context, so they specify the process the tasks refer to, which will be *Study Circle*. The user-defined tag would be related to the specific content of the task, for example the task *Booking Speaker* may be tagged with *Networking Contacts* by an active member of the community. This would mean that the community members involved in the execution of this task should have a good network of contacts. The tag cloud would store these tags used with their frequency, and others can also make use of them in the future. Task and role recommendation mechanisms would be elaborated further using the same running example in the future sections.

3.3.2 Behavioural Model

Fig. 3.3 presents the behavioural view of our framework, illustrating the different activities from the outset of process initiation until the end of its execution that are supported by our framework.

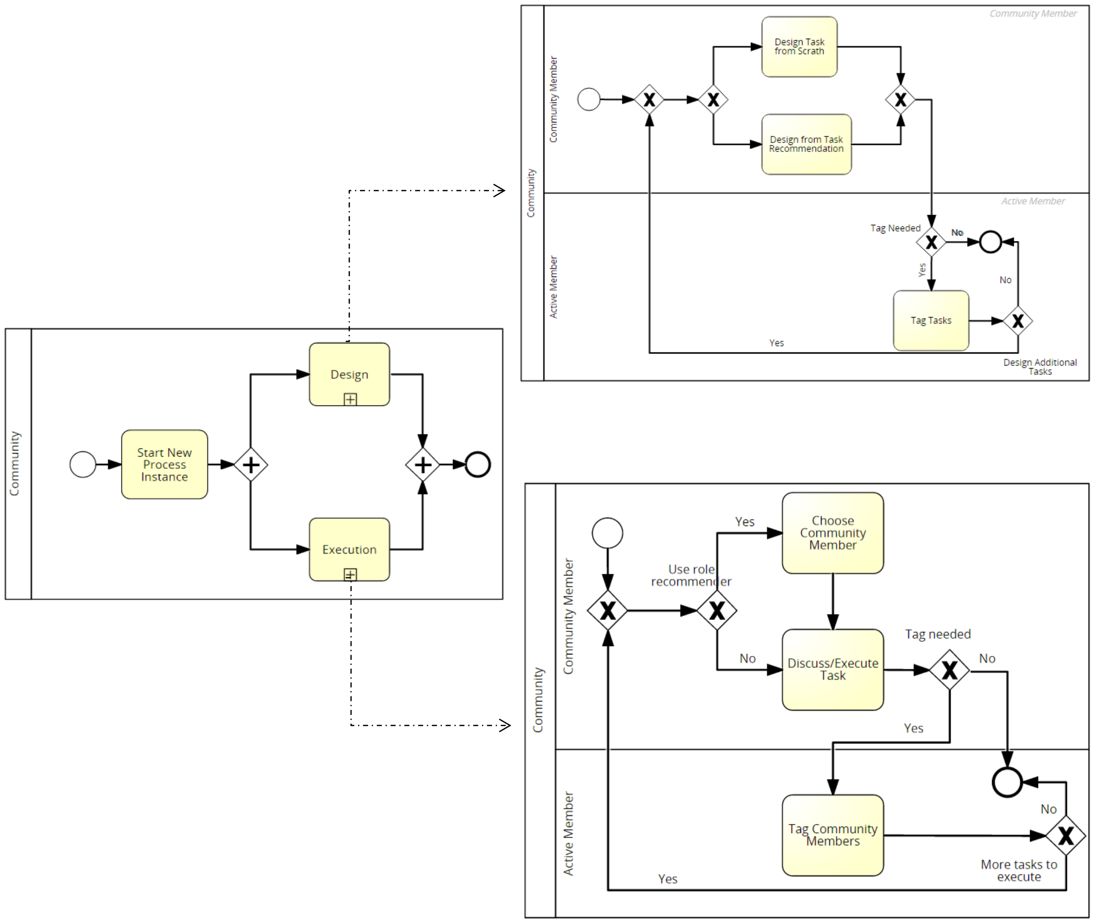


Fig.3.3 Social BPM Behavioural View

Fig. 3.3 shows that the task design and execution in our framework are blended and performed in parallel as typical of ad-hoc processes. The model defines how the elements of the conceptual model interact during process design and enactment. There is no explicit segregation between process design and execution in Social BPM, what is designed in the behavioural view is an implicit design to show where and how each component of the Social BPM framework contributes. While defining tasks in a process, the community members may use the recommendation provided by our framework. Similarly during the execution of the tasks, previously tagged community members (who were tagged by active members) are recommended to support the execution of the process. During the execution or after, active members may also use social tagging in order to tag task instances and community members who have had a positive contribution during the discussions. This will then be used during future executions by the role and task recommendations.

Combining the two main components of our framework (role and task recommendation), during process execution, the previously recommended community members are suggested by the system so that they could be considered for their expertise in the execution of the task. Furthermore, a list of tasks are recommended for the community members to consider as part of performing the specific task (task instance).

Consider the Study Circle running example introduced earlier, as part of the process design for Study Circle 2015, the community members define a number of tasks such as *Booking Speaker*, *Deciding Date & Time*, *and Publicising*. They also have the option to utilise the task recommendation and see the tasks which have been performed to execute the previous instances of the Study Circle process, e.g. in 2014. Each recommended task instance is identified with the number of times they have been executed in the past in order to support the community members identifying the most common tasks which are normally performed.

In parallel to defining the tasks to be executed (which can be ongoing), the role recommendation supports the execution of the tasks. This is done by suggesting community members who have participated in specific tasks previously and who can be selected in the current process execution. For instance, a specific community member had participated in *publicity* the Study Circle in 2014. Because of that, they are suggested to be considered to contribute towards completing the *publicity* task in 2015. Alternatively, any other community member may be selected to complete the execution of the specific tasks.

It becomes clear, therefore, that in task and role recommendation, social tagging provides support by *firstly* capturing the previous tasks executed for a given process and *secondly* by recommending (tagging) community members with contribution to specific tasks. Thus social tagging is the underlying component supporting the main facets of our Social BPM, that is, task and role recommendation, which are discussed in the next section.

3.4 Social Process Design and Execution

At the core of our framework lies social tagging, role recommendation and task recommendations. In this section these concepts are elaborated further to illustrate how they are each used to support Social BPM.

3.4.1 Social Tagging

Tagging is the assignment of unrestricted keywords to all kinds of content and it becomes social when tags are shared among users and different users are allowed to tag the same content unit (Cantador et al., 2011; Prilla, 2008). As mentioned in Chapter 2, a basic tagging model consists of three main elements: *users* who are the people who perform tagging, *resources* which are items that users tag, and *tags* which are keywords added by users and also meta-data of the tagged resources (Smith, 2008).

In our research we are incorporating and utilising social tagging into the context of Social BPM for the purpose of process knowledge discovery. In our framework, (in principle) tagging can happen at any time, but normally (in practice) this is done by active members in the post-execution phase (i.e. after the task or/and the overall process is executed). After or during the execution of the tasks related to a process, the active community members go through the discussions and tag the segments which are useful process knowledge for future executions

Fig. 3.4 shows how the basic concepts of social tagging are reflected in our proposed Social BPM framework.

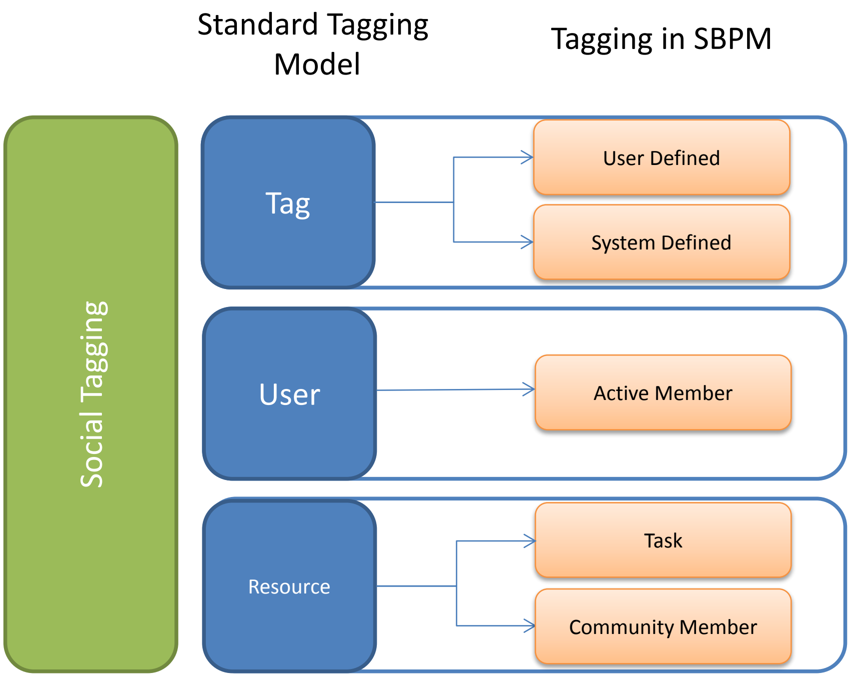


Fig.3.4 Standard Tagging (Smith, 2008) VS Tagging in Social BPM

Tags: As mentioned previously, there are two types of tags in our framework, user and system-defined tags. The latter refers to the process the tasks are related to and the former are added to specify the skill-set the task refers to.

User: The active members of the community in our framework tag the resources. Active members tag the resources based on their judgment and usefulness of the process knowledge captured in the discussions. There is no hierarchical differentiation between the normal community members and active members; the latter are simply community members which are more active and involved in the tagging of the resources.

Resources: This third element of tagging, i.e. the resources, is mapped to the concepts of tasks and community members in our framework. The process knowledge produced during task execution is the resource which is tagged. Additionally the community members who have contributed positively during the process design/execution are also resources which can be tagged for their valuable contribution.

In order to get support from the system, an active member who participates in the process uses tags to describe the type of the process according to some taxonomy (Although it does not need to always have a taxonomy), which may be defined with the help of the tag cloud within the community. This is in order to get assistance from the task recommender component. Going forward, every time the community is running a process, the task recommender will display a list of relevant tasks that were carried out in previous instances of the process. During or after the execution of the process, there are two categories of tags which can be used by the active member to tag the resource. The *first* category of tags is used to identify the process in which the task instance belongs to (system defined tag). The *second* category of tag which is used is to explain the type of the tasks and the expertise that is needed by community members for their execution which are the main topic of the task instances (user defined tag). The system defined tags are similar to the context-based tags in which they provide contextual information about the tasks. On the other hand the user defined tags are similar to subjective tags which express the type and qualities of the tasks (Cantador et al., 2011).

To summarize describing the different types of tags, consider tags associated to a task instance to be T. T is a tuple and consists of $< S, U >$ where S is system defined tag and $S = \{p\}$ where p is a process name. U is a user defined tag and $U = \{Skill_i\}_{i=1 \dots N}$, N skills are identified as useful for a task.

In our running example, the system defined tag S for a specific task captures the process p to which the task belongs to, which is Study Circle. In the second category (user defined tag U), task can be tagged to explain their type. For instance, *Book a Speaker* can be tagged with tag *contacts* and *network* $S = \{Contacts, Network\}$ to identify the skill set related to this specific task. The knowledge captured by this last category of tags will be used in the role recommender to identify the strengths of the community member who should execute tasks.

As an example, Fig. 3.5 shows an example discussion for the execution of the task instances *book a speaker* and *design flyer* of the process instance *study circle 2015*. Fatima, a community member Cm who participated in two tasks in the past (*Book a Speaker* and *Design Flyer*), was recommended/tagged by Ali, who is an active member, in the *design flyer* task, for instance because she has volunteered to design a poster for the event and did that successfully and on time. This task has been tagged with the task *publicity*, which shows the skills of Fatima in the area of publicity. Publicity is part of a specific set of tags used by the community interested in the process *Study Circle* to specify competencies related to the types of tasks that are likely to be performed in the process. Additionally Hassan, who is another community member, has also been tagged as part of the *book a speaker* task instance with the skills *contacts* and *network*. This indicates that Hassan has a good network of people who are useful when booking a speaker.

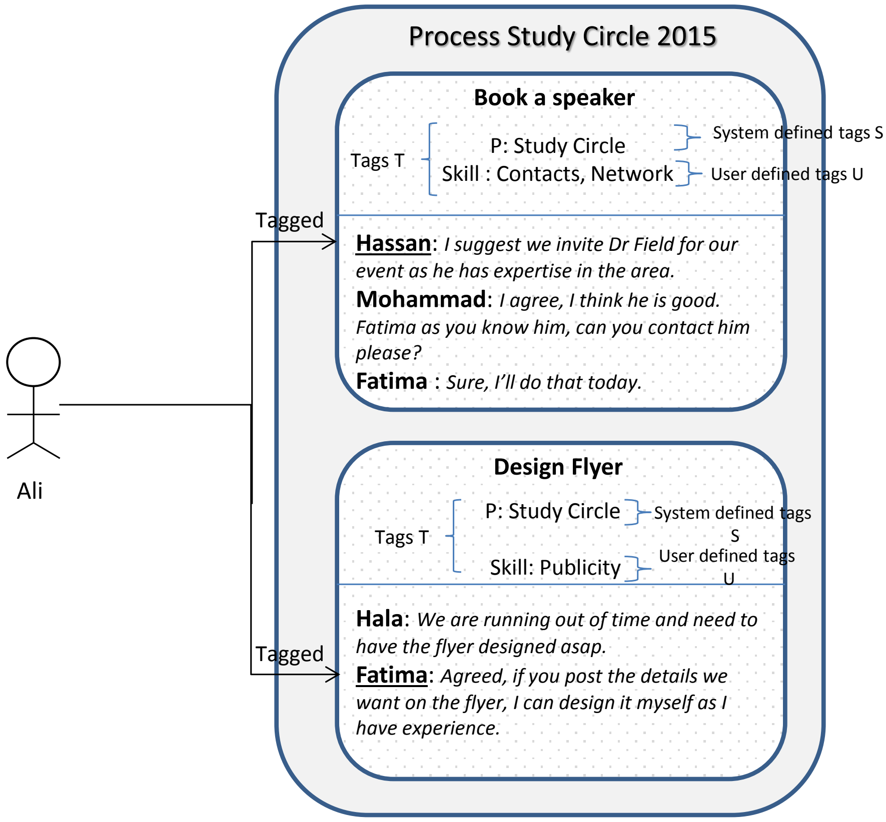


Fig.3.5 A Social BPM Tagging Example

Since there is no standard classification agreed by the community, active members, while tagging, are free to use any tag they like. The 'tag cloud' provides support to this phase, by showing the tags used in the past and their frequency of use (Smith, 2008). Because this is in a social environment, tagging is not imposed on anyone; therefore some tags might be missed or created inaccurately in this process. During the tagging process a number of scenarios could happen which have been presented in Table 3.1.

Table 3.1. Tagging scenarios

	Tag		Explanation	Possible Action
1	Semantically Correct	Exists in tag cloud	The tag used is correct; however a tag with similar meaning exists in the cloud	Active members can replace the tag with an existing tag which exists in the tag cloud
2	Semantically Correct	More accurate tag	The tag is not in the cloud, the tag carries a sensible meaning, however it can be improved and replaced with a more suitable tag	Active members can replace the tag with a more suitable tag for the context which is being used in
3	Missed		There is no tag used by the active members	Active members can add a tag where they see suitable
4	Incorrect		The tag used is not suitable for the content	Active members can replace or remove the tags which they feel is incorrect.

Our framework is based on the assumption that the active community members filter (i.e. decide corrections and suitability) and monitor tags and are able to correct them during their tagging exercise. Through this approach, gradually the tags will converge to a standard set of tags present in the tag cloud which is widely used by the community members. This is a natural convergence and not dictated by the system in any way. This applies to the 4 main scenarios presented in Table 3.1.

3.4.2 Process Design Supported by Task Recommendation

This section presents a more detailed view of how social tagging is used in the context of the task recommender in order to support process design. In this section a static and dynamic view of the task recommender component of the framework is presented and the running example is used in order to explain the design further.

I. Static View

The task recommender presents all the task instances which have been executed in previous executions of a specific process in addition to the tagged emerged tasks. This is in order to benefit from previous process knowledge that has been accumulated. The tags also capture the related discussions which have taken place in order for the community members to utilise the captured process knowledge and also know the context of the tag.

There have been various recommendation techniques for business process models that have inspired our task recommender approach. Attachment, structural, and textual recommendations (Kluza et al., 2003) are examples of these. Specifically, our framework exploits the attachment recommendation that supports designers during modelling tasks by suggesting appropriate tasks which are relevant in a specific business context. Furthermore, Chan et al. (2011) discuss a similar approach that helps process designers in modelling by providing a list of related services to the current designed model. In the task recommender component of our framework, relevant tasks are suggested to support community members during process design and execution.

Each task can have one or more task instances which are the occurrences of a task. The recommendation entity suggests these task instances which have been tagged in the same process that has been initiated to the community members. Every task instance has a discussion platform in which the specific tasks are executed/discussed in collaboration with members of the community. Additionally the tasks instances have a frequency which indicates the number of times the specific task (task instance) has been executed in the past. The most frequently executed task instances would be the common tasks which may be executed by the community members, though this is not imposed on them.

The active member, who usually engages in tagging, uses user defined tags in order to tag a specific task instance as explained in Section 3.3 Furthermore, there could be emerged tasks which can be spotted in the discussion within a specific task instance.

The active member is able to identify these, create new task instances and tag where necessary which will then be used by the recommendations and suggested to the community members. Finally, the system defined tags are assigned to the task instances which indicate part of which process they are and also to differentiate between a profile and task.

II. Dynamic View

Here, we present a behavioural view to the task recommendation mechanism and then use the running example to elaborate the framework.

Task instances are recommended for each process based on the tasks created for the same process in previous process instances. There can be cases where a task instance is captured within another task instance. These tasks are those that have emerged throughout the discussion which has been taken as part of another task instance. In such cases the active member creates an independent task instance and tag it, so this can also be suggested as part of the task recommendation.

The community members create and run the tasks during process execution, so the BPM design and enactment stage are integrated and the tasks are designed on the fly. It is also essential that the community members capture all the main tasks that should be performed in order to fulfil the overall process (Kueng & Kawalek, 1997). These tasks could be identified by looking at the most frequently executed out of the total task instances as illustrated in Fig. 3.6. In this figure (Fig. 3.6), the task instances with high number of executions compared to the total number of tasks would indicate that they are common tasks which need to be executed in each instance. Task instances with a lower number of executions are instances which have been rarely executed which may or may not be executed again.

For instance (see Fig. 3.6), task B has been completed and community members have provided their input, at this point the active member has realised that, as part of task B, there is another part of the discussion in which a different task has emerged, which would be useful in the future to consider as part of process X. This emerged task is captured and a new task (i.e. D in this case) is created. Task D will then be recommended going forward for anyone who is going to be running a process of type X in the future.

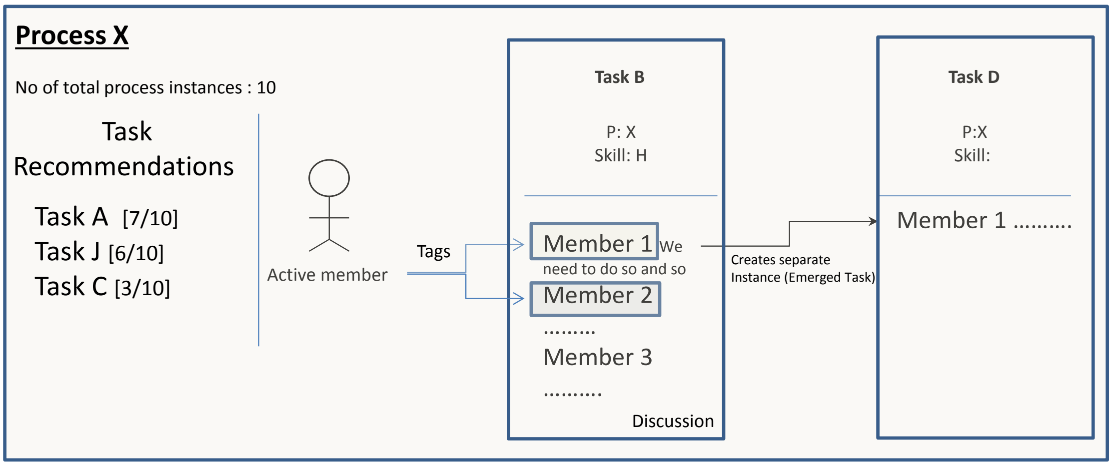


Fig. 3.6 Task Recommender in Social BPM

The community sets the agenda, that is, it determines the list of tasks that need to be carried out in the context of a specific process (this could be on-going and be added as they go along and might differ in different instances of the same process). The community can decide to run the recommended most frequently executed tasks as the initial list of tasks to be executed. Furthermore, they can design and run their own task instances or take idea from the recommendations.

In the running example, when a new process instance is started by the community, e.g. *Study circle in 2015*, the task recommender suggests all the tasks executed in previous instances of *Study Circle* (see Fig. 3.7) and also the number of times these have been executed compared to the total executed task instances in a specific process.

This allows the community members to get ideas about potential tasks they could also be considering for the current execution.

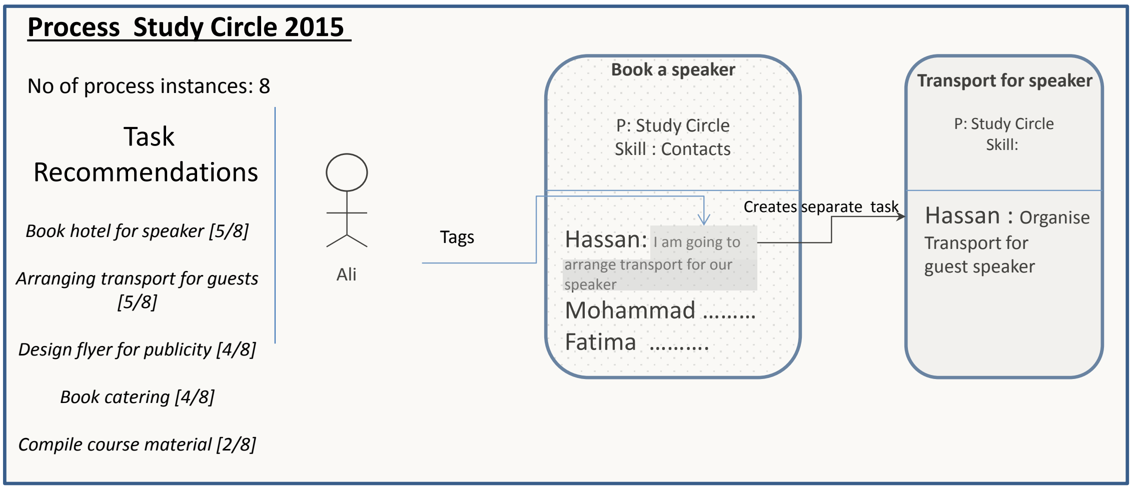


Fig. 3.7 Task-Recommendation in a Study Circle Process

The task recommendation is supported by social tagging, as the recommendations are made based on the process which the task has been tagged with, for example Study Circle in Fig. 3.7 which is system – defined tag allocated to the task. Additionally, if as part of the execution of a task, for example *book a speaker*, a new task has emerged (e.g. *Transport for speaker*) then the active members are able to tag this and create a separate task instance for this. The emerged task instance will then appear in the list of recommended tasks in the future to suggest to other community members to consider also arranging transport for their invited speaker when organising future study circles. In this case, the task instance *transport for speaker* has not been tagged with any user defined tag to indicate the skill related to it.

The next section discusses how the role recommendation mechanism supports process execution in our Social BPM framework.

3.4.3 Process Execution Supported by Role Recommendation

The role recommender which is used mainly during process execution is supported by social tagging as well. This section expands on the overall models presented earlier and discusses the detailed design of the role recommender component. This is done by presenting a static and dynamic view of the design and elaborate further on it using our running example.

I. Static View

Parallel to the design phase explained above, social tagging supports the role recommendation component during the enactment and execution of the process. Expanding the overall static model presented in Section 3.3.1, Fig. 3.8 presents a more detailed view of the role recommender mechanism.

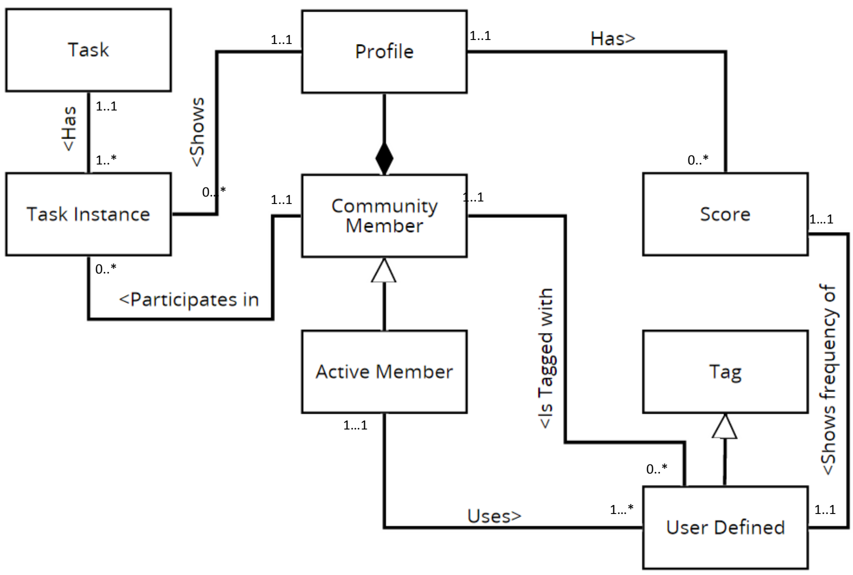


Fig.3.8 Task Recommendation Static View

All *community members* can participate in the execution of a *task instance* to fulfil its goals. The members with outstanding contribution can be tagged using a user defined tag by *active members* (similar to tagging the task instances during the process design).

The tagged community members accumulate *scores* for the number of times they have been tagged using a specific user defined tag. The role recommender presents the *profile* of the community members and show the task instances the member has participated in; it also shows the score for a specific user defined tag which illustrates the areas of their expertise. This information can then be used during process runtime to assist exploiting the knowledge of subject matter experts and tacit knowledge which would have remained unused otherwise.

The following section uses these entities and presents the behavioural view of the role recommender and makes use of the running example to make this clear.

II. Dynamic View

After or during the execution of tasks, the active members go through the discussion and recommend the community members who have offered valuable contribution to the task instances that have been executed. By engaging a wide range of community members, the community leverages the 'wisdom of the crowd' (Surowiecki, 2004), enabling the participation and input of individuals with different backgrounds and expertise. The active members primarily ensure the discussion in fulfilling a specific task is followed up till completion and not left abandoned. Furthermore they also go through the discussions after the completion of the process and tag segments that would be useful process knowledge to be utilised in future executions.

The profile of a member is a set of pairs (skill, score). The skills are derived from the tags in a specific task instance, and the score is incremented every time the member is tagged for their positive contribution. Additionally the profile of the members presents all the task instances the member has participated in.

The following presents a formal description of how the role recommendation works:

At a given point in time, there are K tasks defined in the system:

$$Task = \{task_1, \dots task_k, \dots task_K\}$$

These refer to all processes executed in the past. Note, in fact, that tags, i.e. skills, are associated only to tasks and not to processes.

Each task $task_j$ has a name and is associated to a set of K skills (through the tags specified by active members):

$$task_j = < name, \{skill_{j,k}\}_{\ k=1\dots K} >$$

For each task $task_j$, there are M task instances $ti_{j,m}$ defined in the system, that is:

$$\{ti_{j,m}\}_{m=1,\dots M}$$

There are N community members in the system:

$$Cm = \{cm_1, \dots cm_n, \dots cm_N\}$$

A tag is a function that associates a particular skill to a community member and a task instance and it is a function of time, that is, tags are assigned by active members at a specific point in time t:

$$T^t: (cm_n, ti_{j,m}) \rightarrow skill$$

Tagging of a task instance $ti_{j,m}$ updates the set of skills associated to the corresponding task $task_j$.

The profile of a generic community member cm_n can now be defined as a collection of P pairs "skills, score". The profile is also a function of time, as it evolves in time based on the tags assigned to the community member cm_n:

$$Pro^t(cm_n) = < skill_{p,n}, score_{p,n} >_{\ p=1,\dots,P}$$

Note that initially all scores are set to 0, that is, new community members enter the system without any particular skill.

Given a tag $T^t = (cm_n, ti_{j,m}, skill)$ at time t, the profile a community member (at time t+1) is updated as follows:

$$Pro^{(t+1)}\,(cm_n) = \begin{cases} [Pro^t \backslash < skill_{p,n}, score_p >] \cup < skill_{p,n}, score_p + 1 > & IF\ skill \in \{skill_{p,n}\} \\ Pro^t \cup < skill_{p,n}, 1 > & Otherwise \end{cases}$$

That is, the score assigned to the skills associated to the task $task_j$ for which the community member cm_n has been tagged is incremented by one unit if the skill already exists in the profile. Otherwise, a new skill is added to the profile, with score 1.

Fig. 3.9 presents this mechanism at a given time t where community members Cm have engaged in a discussion related to process $X. Cm_1$ has been tagged in task instance $ti\ A$, therefore $T =< Cm_1, ti\ A >$. This is the decision of the individual who is tagging based on the community members' contribution. This results in the profile p of Cm_1 scoring 1 for skill Type G as presented in Fig. 3.9, the rest of the profiles have score 0.

The knowledge captured through tags are also exploited to assign tasks to the community members who have the most experience and/or expertise to execute them.

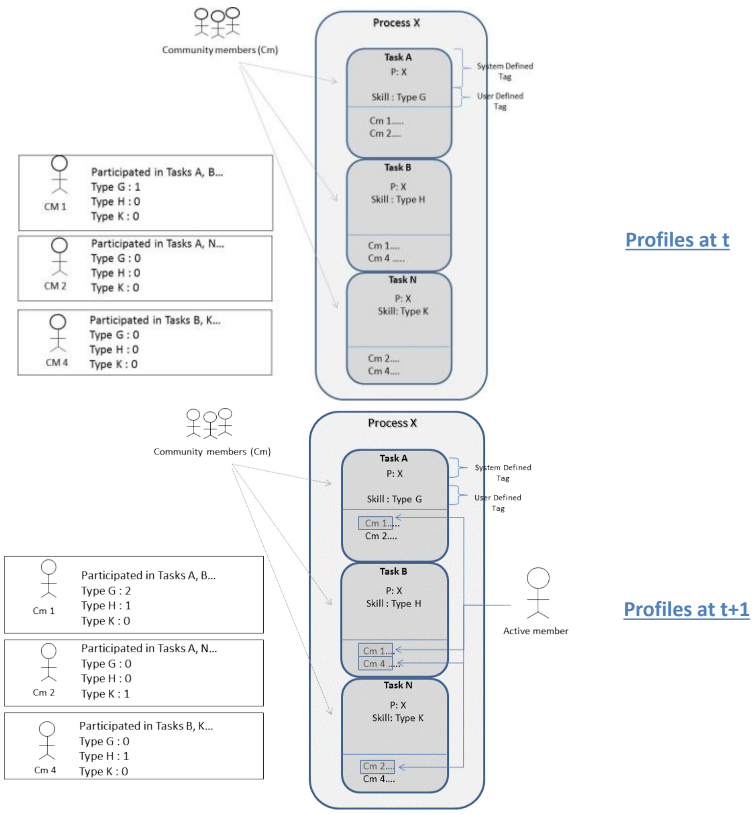


Fig.3.9 Role Recommendation in Social BPM (at t and t+1)

The second part of Fig. 3.9 presents the same scenario in stage 2 after tagging at $t + 1$. Here, Cm_1 has been tagged again in Task A ti with skill “type G” as well as in Task B with sill “Type H”. This has resulted in the profile p of Cm_1 to be updated and the score for skill “Type G” is incremented to 2 and the score for skill “Type H” is incremented to 1. Similarly Cm_2 has also been tagged in Task N with skill “Type K” which has resulted in their profile to have score 1. Finally Cm_4 has also been tagged in Task B with skill “Type H” which has resulted in their profile to have score 1.

Community members are listed with the previous tasks they have participated in, and also the number of times they have been recommended for having contributed in a task with a specific skill area. Skill sets are assigned to tasks by active members as they see suitable and recommend community members who have contributed positively in the specific task. This can be utilised as a resource centre which community members can contact to benefit from the process knowledge other community members have.

To explain this in a more specific instance, assume Cm_1 was of great help in the task that dealt with financial matters of a given process. If the community decided to recommend Cm_1 for his contribution, this would add to Cm_1's profile rating by increasing his rating for *financial expertise*. In the future when looking at member's profile, the accumulated scores for the different categories of tasks would be shown against each of the community members as illustrated in Fig. 3.9. This would help the community to select members for a particular task based on their previous contributions.

Ratings are generally used in order to evaluate how relevant or interesting a project/item/product is to the user (Rich, 1979). In our context we are using recommendation, i.e. rating, to evaluate the expertise and the value a specific user bring to a process. The approach adopted in our framework is similar to the like/dislike (Rich, 1979) category, which illustrates whether a user is interested in an item or not. The only difference is that, in our framework, *firstly* the recommendations are accumulated for each community member, and *secondly* the criteria of recommendation is based on positive valuable contribution towards process enactment.

In our Study Circle running example, the list of community members Cm presented is used to find out who has experience for instance in finding and contacting speakers, designing a flyer, and creating a Facebook event ti. In the first part of Fig. 3.10 the profiles for members Fatima and Hassan are captured at time t which have score 0. At $t + 1$ Hassan has been recommended (tagged) in the task instance Book a speaker, similarly Fatima has been recommended for designing a flyer, these tasks instances have been tagged with skill sets called *Network Contact* and *Publicity* respectively, therefore the score of Fatima and Hassan have both been incremented by 1 in their profile p.

As explained before, the profile also presents the overall task instances the member has participated in regardless of whether they have been tagged or not. This will support the execution of the process by engaging and consulting expert and experienced individuals in the future.

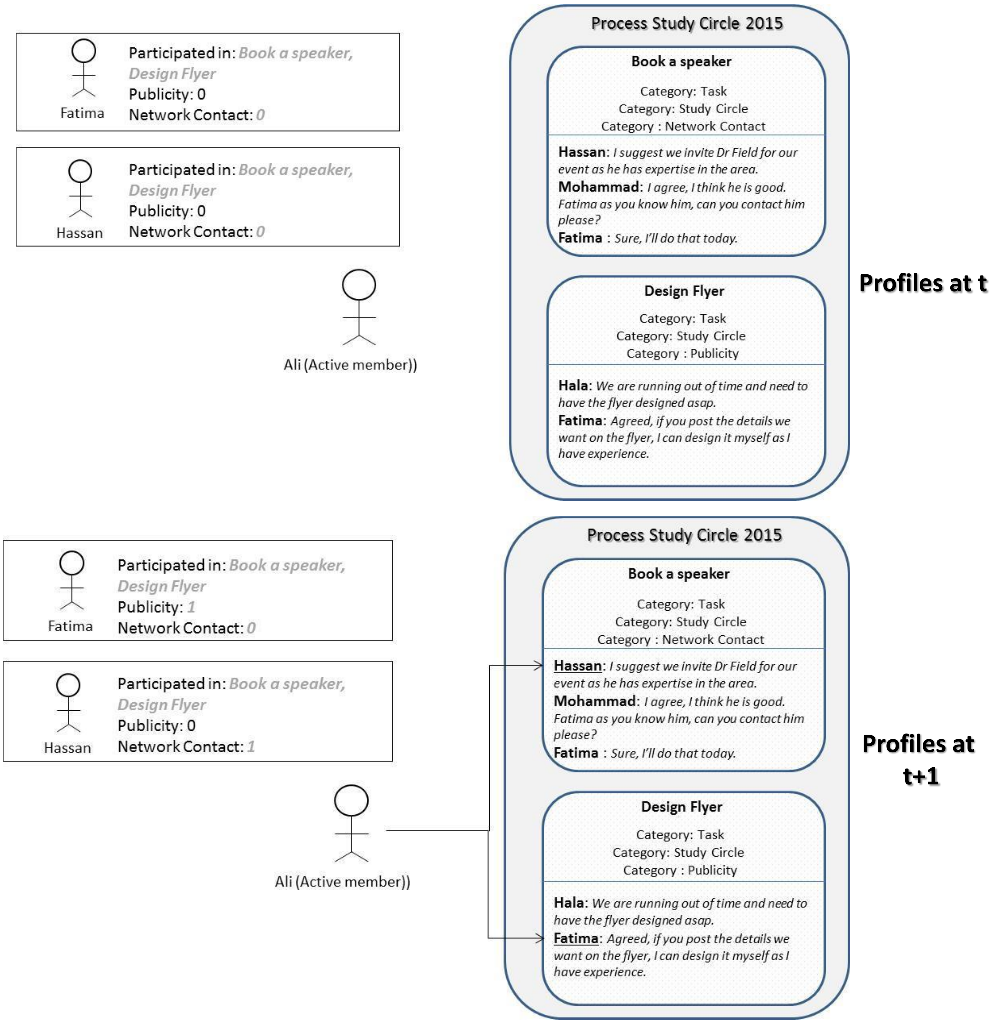


Fig.3.10 Role-Recommendation in a Study Circle Process (at t and t+1)

To conclude, the role recommender does not choose specific community members for the task, because the knowledge of who has been good at what could be biased, incomplete or inaccurate. Thus, such recommendations need to be used only as an approximate indication and not accurate measurements of members' skill sets. The community members are not obliged to utilise this at all times, and it is left to them to refer to in the times they need support in accomplishing specific tasks. Similar to the tasks, tagging/recommending community members could face the scenarios presented in Table 3.2:

Table 3.2. Tagging community members

	Tag	Explanation	Improvement Cycle	Possible Action
1	Missed	The community member has had a positive contribution, however they have not been recommended/tagged	The missed tags can be modified and added	An active member can recommend and tag the community member which he/she thinks has contributed positively
2	Incorrect	The community member has been recommended incorrectly, i.e. they do not have the mentioned skill set	An active member can remove an incorrectly assigned tag	An active member modifies the tag at any point based on their own judgment, this can of course then be changed by active members as well.

Although the improvements and overriding of the active members in the future to correct the tags can also be incorrect or missed, however this is an attempt for improvement and the complete and accurate tagging of the beneficial resources.

3.5 Architecture Supporting the Implementation of Social BPM

Based on the Social BPM framework presented so far we derive a list of functional requirements of a software application supporting the framework in Table 3.3. These are the basis for the implementation of the prototype presented in Chapter 4.

Table 3.3. Social BPM Requirements

Requirement	Description
REQ1	Allows user defined tagging of the task instances by Active Members
REQ2	Allows user defined tagging of the members by Active Members
REQ3	Presents community members and the task instances they have participated in
REQ4	Presents users with the frequency they have been tagged in a specific category (Score)
REQ5	Supports discussion for task execution by the community members

REQ6	Stores and manages user profiles
REQ7	Allows system defined tagging of the task instances by Active Members
REQ8	Presents the number of times a task instance has been executed compared to the total number of task instances
REQ9	Supports the tagging of emerged task instances
REQ10	Presents the task instances which have been executed in the instances of a specific process

Each of these requirements are captured by the implementation of a component (Ci) within the Social BPM system. The requirements are grouped together and addressed by the same component as presented below:

C_1: Role Recommender implement: {REQ3, REQ4}

C_2: Task Recommender implement: {REQ8, REQ10}

C_3: **User Profile Management** implement: {REQ6}

C_4: Tagging implement: {REQ1, REQ2, REQ7, REQ9}

C_5: Process Execution (Discussion) implement: {REQ5}

The main entity which supports the other components is C_4. As presented in previous sections, both the task recommender C_2 and the role recommender C_1 are enabled by the support of social tagging. The profile of the community members are stored in a profile repository which the user profile C_3 uses in order for the recommendation to take place. Finally, C_5 supports the discussion platform for the community members which in principle could run independent of the other components in the architecture and at the same time it is connected to task and role recommender as well as the tagging component. This shows that our framework can be easily integrated with any software platform supporting discussion-based task execution, e.g. forums or Wiki pages.

The executed tasks are also all stored in a task repository which the task recommender C_2 uses in order to make recommendations. The tagging mechanism C_4 fulfils a key role in being the source of the recommendations made by attaching tags to the task instances and community members.

Fig. 3.11 presents the components which implement the listed requirements and illustrates how each of these are linked to one another and the data repositories.

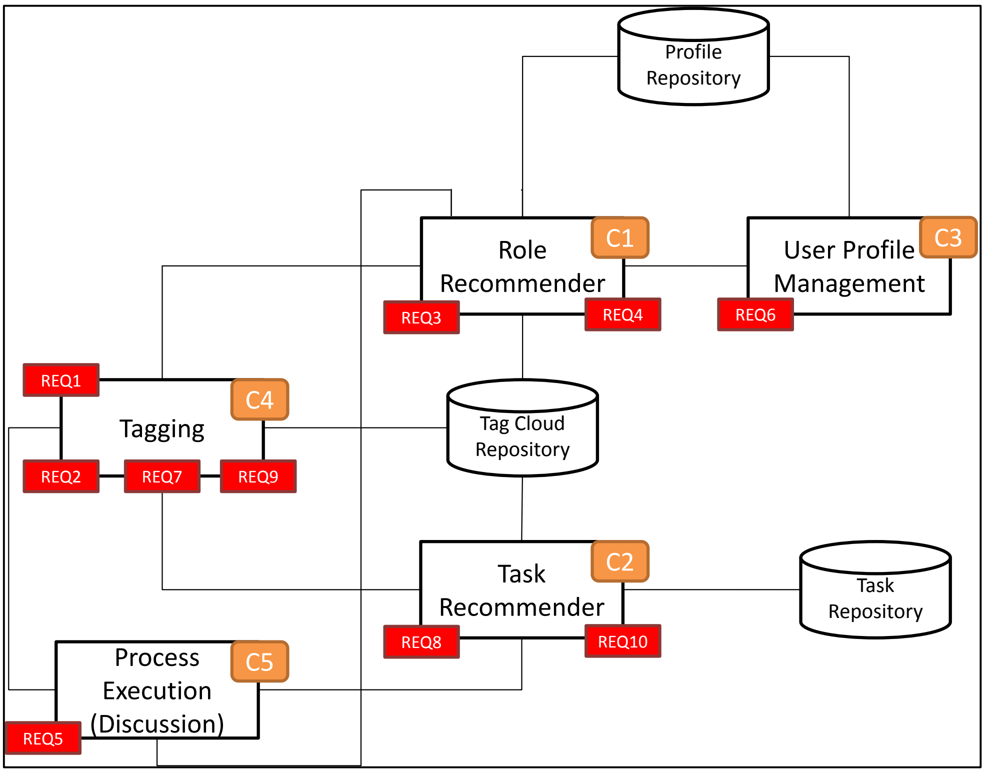


Fig.3.11 System Architecture

The list of the requirements which are captured by one of the mentioned components are used as the main facets in the implementation of the prototype.

3.6 Conclusion

Having researched the literature in the area of Social BPM and identified the gap in Chapter 2, in this chapter the underlying design of our Social BPM framework has been presented which is used for a prototype implementation for the purpose of evaluation in the upcoming chapters.

Three main elements have been identified as the core capabilities of our design, the task recommender, role recommender and social tagging. Tagging is not an independent component in this framework, but it provides support and enables the functionalities of the role and task recommenders. The task recommender supports the community members mainly during the design of the processes, and the role recommender supports the members during the execution phase. Though, there is no explicit segregation between these two phases, and they can be done simultaneously or in parallel. We have made this separation in our design to explain what takes place in each one specifically, independent of the other.

The task recommender enables the exploitation of process knowledge which has been used in the past executions. Similarly, the role recommender provides a mechanism of listing community members which have expertise and experience in specific areas (identified through tagging) which can be used during process execution. Therefore in summary there are two types of knowledge which support the Social BPM model, the *first* is the knowledge captures within the processes (which are recommended in the context of task instances through the task recommender), and the *second* is the tacit knowledge which is related to the community members (which are identified and presented through the role recommender).

A number of functional requirements have been listed and the main components have been designed as part of the system architecture in order to fulfil the functional requirements.

In Chapter 4 we take the proposed architecture and implement it as a proof of concept tool in order validate this framework through a real scenario case study.

CHAPTER 4: PROTOTYPE IMPLEMENTATION AND EVALUATION

4.1 Introduction

There are three different methods used to evaluate our framework. The first is to produce a proof of concept implementation based on the design of the Social BPM framework presented in Chapter 3. The second is to validate this framework by running a number of case studies and gathering feedback from users and observing them. Finally the third method evaluates the Social BPM framework against the original limitations of the traditional BPM systems found in the literature. Section 4.2 presents the overall evaluation approach of the research. Section 4.3 addresses the first stage of evaluation, discussing the proof of concept implementation and its underlying design. Section 4.4 addresses the second stage of the validation approach, presenting the results from case studies. Section 4.5 presents the third stage of our evaluation, that is, the author evaluation, in which the proposed framework is evaluated against the limitations of traditional BPM systems. Section 4.6 discusses the limitations of our evaluation and Section 4.7 revisits and assesses the research questions set in Chapter 1. Finally, the chapter ends with a conclusion in Section 4.8.

4.2 Evaluation Approach

Although the prototype is a pilot one, summative evaluation method amongst the many other approaches (Powell, 2006) has been adopted to validate the proposed framework. In particular there are three types of approaches we have taken to answer our research questions:

- Evaluation of buildability/feasibility of the Social BPM framework, which shows if the system designed in Chapter 3 can be built or not. This is covered by the implementation of the prototype.

- Validation of functional requirements, i.e. once built, does the prototype do what it is supposed to do? This is tested in the case studies mainly using observational data (first-hand data). If the case studies are successful, it means that the requirements of the Social BPM framework are implemented correctly.

- Validation of the usefulness of our Social BPM framework (Laitenberger & Dreyer, 1998) as far as reuse of process knowledge and collaborativeness is concerned. Usefulness is intended here as the extent to which a system/technology helps the users in achieving their goals. In our case this translates into the extent to which our framework and, in particular, the implemented prototype, supports users in designing and executing (ad-hoc) business processes by capturing and reusing emerging process knowledge. This also is evaluated in the case studies. In this case, we use both first-hand data and second-hand self-reporting data to evaluate the usefulness of our framework.

4.3 Proof of Concept Implementation

As part of first stage of evaluation, a prototype of the proposed Social BPM framework is implemented to identify the main components of the system and demonstrate its buildability/feasibility. This could be done adapting one of the following alternatives:

I. Develop prototype from scratch

Developing a tool from scratch for the purpose of evaluating the Social BPM framework would ensure all the functionalities and details of our design are implemented. The look and feel of the tool would also be decided based on the author's preference and going forward customising and altering the code would be fairly simple for the author as he has designed it from scratch.

II. Extend an existing framework

Implementing our Social BPM framework extending an existing framework is another alternative. This alternative seems more feasible as there are currently off the shelf tools that could be used for our purpose. This would take much less time to implement as we cannot devote much time to implement software from scratch. Additionally, the intended purpose of the prototype is not to be deployed and used at production level in real world organisations, rather it is to evaluate the framework which has been proposed as part of this research. This is also in line with the expectation set in the introduction of this thesis. Furthermore, being able to produce a proof of concept prototype for the proposed framework using an existing tool illustrates that our Social BPM framework can be integrated into already existing tools in order to produce a Social BPM tool, demonstrates the generalizability of our framework. Lastly, if there is an existing tool which could be used that fulfils the required criteria and can be customised/extended, there is no justification to invest in time and effort to build a tool from scratch.

4.3.1 Prototype Implementation Platform

There are quite a few BPM tools such as Pegasystems BPM suite[11] and Appian[12] currently available which are widely used in industry. These tools support the traditional BPM lifecycle presented and discussed in Chapter 2. As part of the prototype implementation of our Social BPM platform, extending the existing BPM tools are considered. However extending these tools is not feasible in the scope of our research, because *firstly* these tools are not open source and not available publicly. *Secondly* the existing BPM tools are designed such that there is a separation between the design and

[11] http://www.pega.com/bpm-suite
[12] http://www.appian.com/about-bpm/

the execution phase of the processes. This separation is one of the most significant downfalls of traditional BPM systems as discussed before, and goes against the design of our Social BPM framework. *Thirdly* normally for ad-hoc processes users do not use BPM systems, but they rely on more ad-hoc tools such as forums which is used by the users of our case study. Therefore they are more familiar using social technology rather than learning how to use the standard BPM tools, thus it makes more sense to use a platform which the users are more familiar with.

Out of the social platforms, we argue that wiki technology is the best choice for our prototype implementation. Wikis and social tools are two of the most important technologies for co-creating knowledge (Hasan et al., 2007) and for supporting collective intelligence (Gholami & Safavi, 2010). Our Social BPM framework is a paradigm that relies on collective intelligence about processes and tasks. Hence wiki is chosen as the technology to underpin it. Additionally, wikis support most of the features required by Social BPM, such as weak ties, social production, egalitarianism and mutual service provisioning (Bruno et al., 2011) as explained in Section 2.4. This makes the adaptation of wikis a viable option for our implementation.

Other researchers have started recently to exploit wikis in BPM. For example Liu & Zhao (2009) use a wiki engine for collaborative process modelling support and expose it to a real-world setting. The case-study shows how a small team of domain experts within a large office supply manufacturing company redesigned a recruiting process by using a wiki as their primary process modelling environment.

In our framework, wiki technology is used beyond the scope of process modelling to support community collaboration and tagging. Wiki technology, in fact, natively supports community collaboration and it also provides native mechanisms to capture tags. These features are not found in any other open-source BPM tools.

For the purpose of our prototype implementation, several wiki engines and tools both commercial and free (open source) are considered. The main selection criterion is ease of adaptation and being able to easily customize the tool to meet the design requirements. A wiki technology called Pimki[13] has been chosen as the basis for our implementation. Pimki is a Personal Information Manager based on wiki technology (Instiki wiki engine), it is open source, runs on Ruby and it aims at being a light-weight, flexible organiser for different types of contents. In our framework Pimki is integrated with graphviz[14], a tool to visualise interconnections between the pages, the structure of the process in terms of process participants, tasks, processes and their relationships, as we will show further in this chapter.

4.3.2 Prototype Design

We use the UML notation to show how the Social BPM framework presented in Chapter 3 is used as the underpinning design of the prototype. Fig. 4.1 presents the use case diagram of the Social BPM framework with the main actors and activities involved. As far as the actors are concerned, the prototype does not distinguish between active members and community members. A community member is referred to as an active member when they start tagging. In Pimki both the community and active member are referred to as users and have the same access rights. The distinction in the use case diagram comes in order to differentiate between the users who tag and other users who don't, but in practice the distinction of roles does not exist.

Any community member is able to initiate a process instance (initiate process instance use case), either designing task instances from scratch (design task) or following the recommendations given (reuse task) by the Social BPM system (i.e. create

[13] http://pimki.rubyforge.org/
[14] www.graphviz.org

new pages in Pimki corresponding to specific tasks). The users are then able to execute (discuss) a given task instance with other members and complete them collaboratively (discuss/execute task). There is also the option that the user utilises the recommended members which have a high score or experience for a given task (assign member to a task instance).

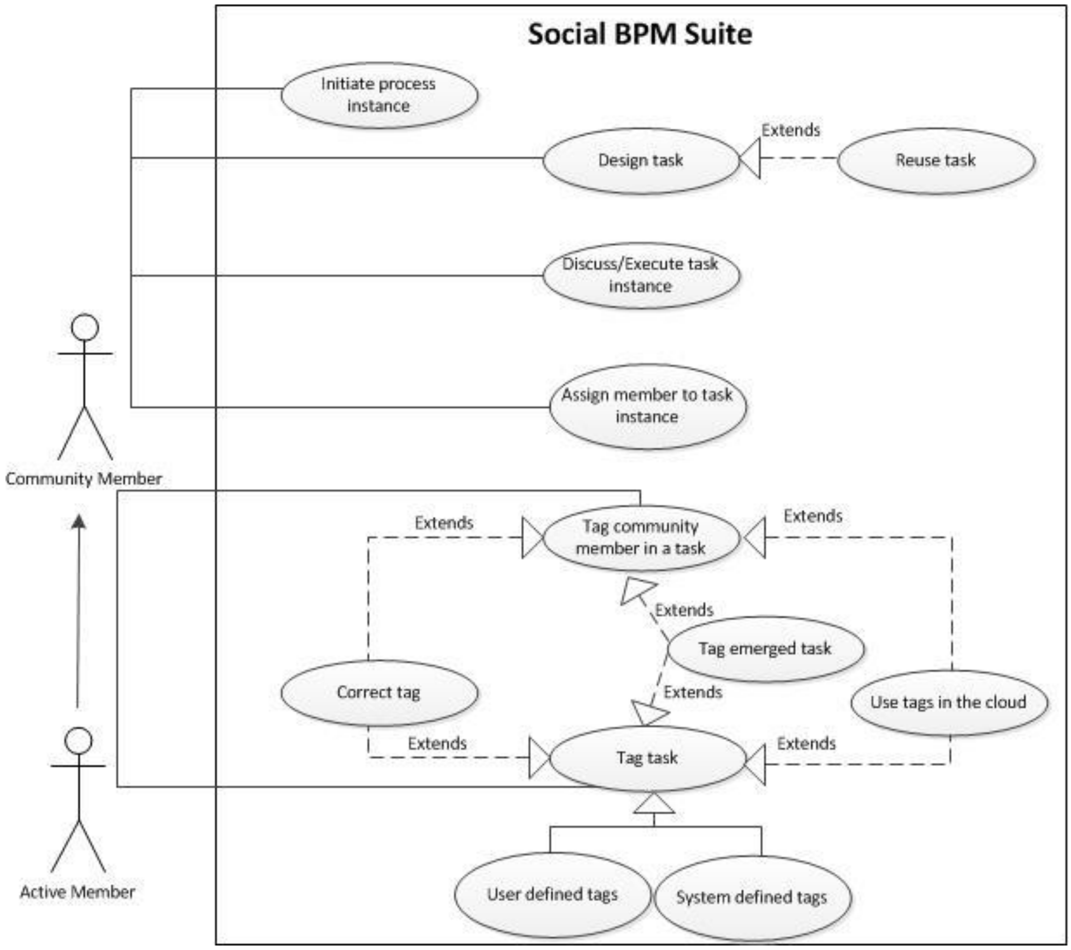


Fig.4.1 Social BPM use case diagram

After the discussion related to each task instance is completed, or even during the discussion, some users (active members) are able to tag some or all task instances (tag task) using system or/and user defined tags. Additionally the active members also tag members with positive contribution (tag community member in a task). The already existing or missing tags can also be corrected based on the judgment of the active member (correct tag), and finally during the discussions there may be points mentioned as part of specific task instances which can be task themselves, in such cases the active member can tag these emerged tasks and create new tasks which will then be picked up by the task recommender as well (tag emerged task).

Fig. 4.2 presents a sequence diagram showing how the task and role recommender operate in the prototype and how they are supported by social tagging. In Fig. 4.2 any user is able to initiate a process instance by either creating a page in the wiki (task instance) from scratch or taking the idea from one of the listed previously created pages (which are the task instances in a specific process). The users are able to either discuss and complete a given task or refer to an expert in the field which is indicated with users who have a high score in the profile for a given skill. The users are listed with their profiles which indicate their scores and previously contributed task instances (wiki pages). These are used to assist with the discussion and execution of a specific task instance.

After or during the completion of the task instances the users (active members) go through the tasks and tag or refine the existing tags. The tags can either be taken from the glossary (tag cloud repository) or they can be chosen by any of the users (active members). Additionally active members can tag the community members for their contribution in a discussion related to a specific task instance which will then be used and update their profile.

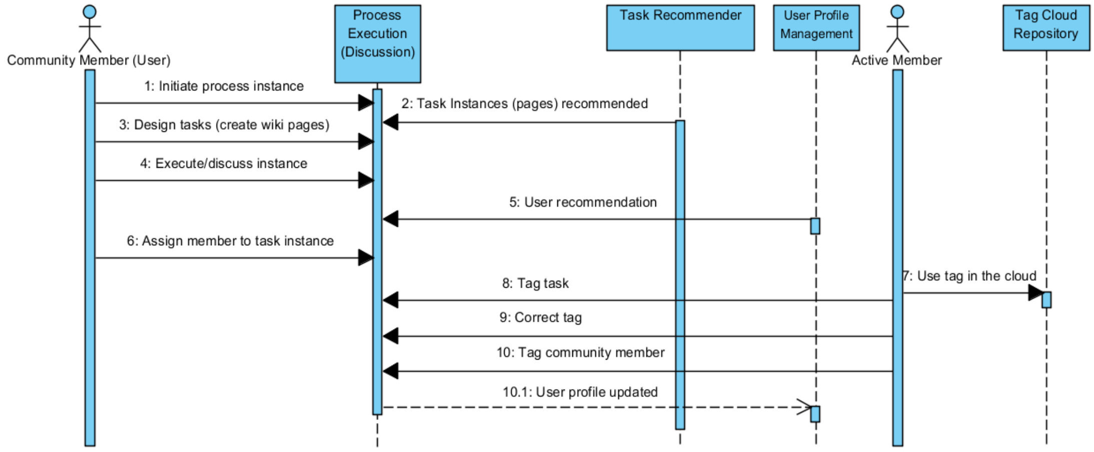


Fig.4.2 Social BPM sequence diagram

The following section describes the Pimki prototype and explains how each component of the tool is linked to the Social BPM framework design.

4.3.3 Implementation in Pimki

The implementation and modification in Pimki is based on the static diagram presented in Section 3.3.1. This section presents how each of the entities in our Social BPM framework corresponds to the features in Pimki. This is taken from the data loaded into the wiki related to the study circle example which we have been using through this thesis. Fig. 4.3 (a) and (b) show the process, process instance, member, community member, active member and the profile of the community member which is used by the role recommender.

In our prototype, processes and tasks are created as (wiki) pages, which the community members can contribute to. Pages are the building blocks of a wiki and can be uniquely named, stored and searched. The community decides the initial list of tasks and creates a new instance of the process in the system. In our prototype, this means to create a new page for the process with links to each page corresponding to individual tasks. Every task is a discrete entity in the prototype, so that the system can store and index it (using tags) and retrieve it later. Fig 4.3 (b) shows an example of the role recommendation, listing the tasks the member has participated in and their score against the different skills (i.e. Profile).

Fig. 4.3 (c) shows an example of how a community member can be tagged for their valuable contribution in suggesting an innovative task, i.e. suggesting giving the leftover food during the study circles to the homeless. The active community members choose, in this case, *food* as the user-defined tag that most suitably explains the type of the task.

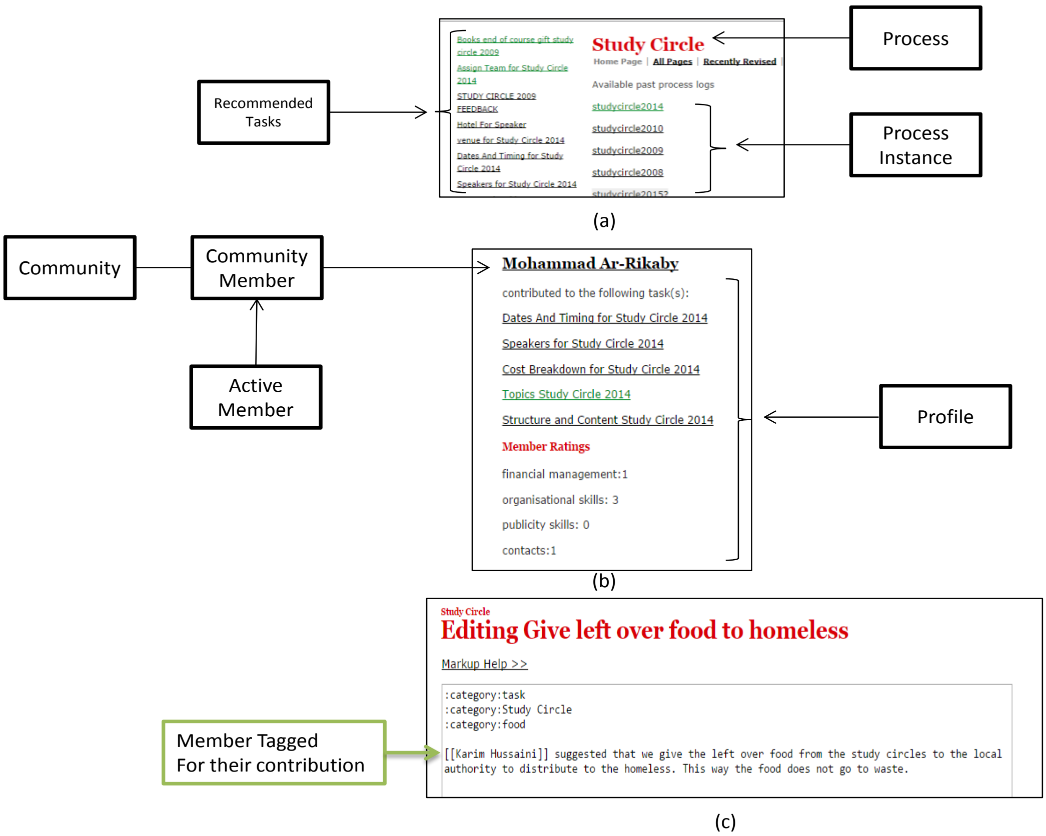


Fig.4.3 Pimki tool mapped to Social BPM design

Additionally, Fig. 4.4 (a) presents screenshots of how the different types of tags are presented and captured in a task instance and how a discussion looks like. The processes, process instances, tasks and task instances are referred to as pages in Pimki. The discussion is when the page is edited by the different users, and the community members are referred to as users in this prototype. The tag cloud is a feature which is not fully implemented as we shall explain later on, the tags used are all presented (Fig. 4.4 (b)), however they have not been emphasised (i.e. enlarged) based on their frequency of usage.

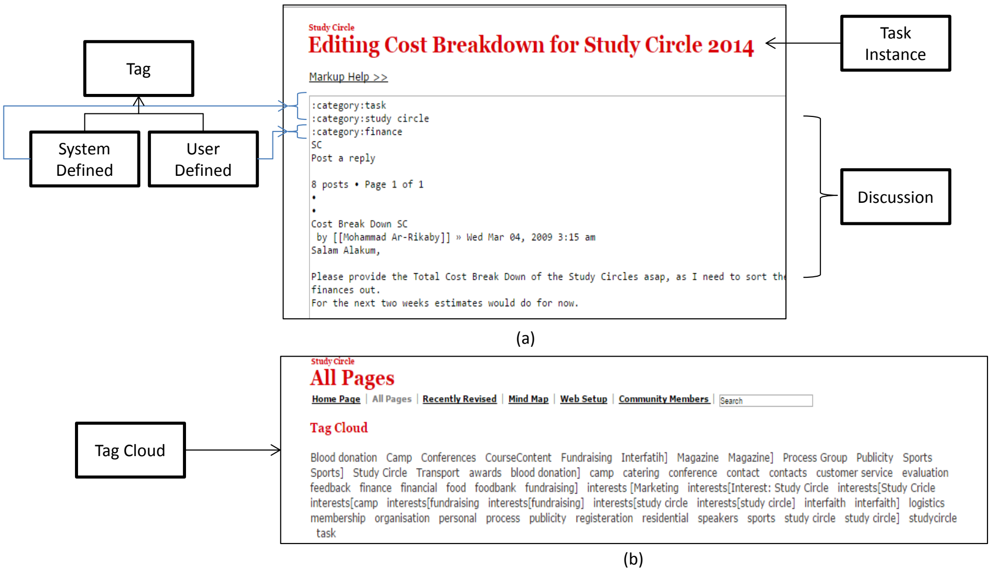


Fig.4.4 Pimki tool mapped to Social BPM design

To elaborate on this further, consider the following example of a community member (e.g. Fatima) who wishes to organise a study circle in Pimki. After creating a process instance (e.g. *Study circle 2015*) a number of task instances are recommended to the community member as presented in Fig. 4.3. Fatima now designed the task instances and uses the most repeated instances as the core tasks which need to be performed. Fig. 4.5 presents an example of this which shows tasks such as *Book a speaker*, *Venue* created:

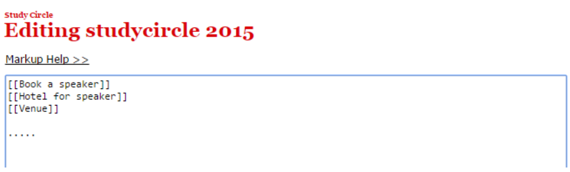
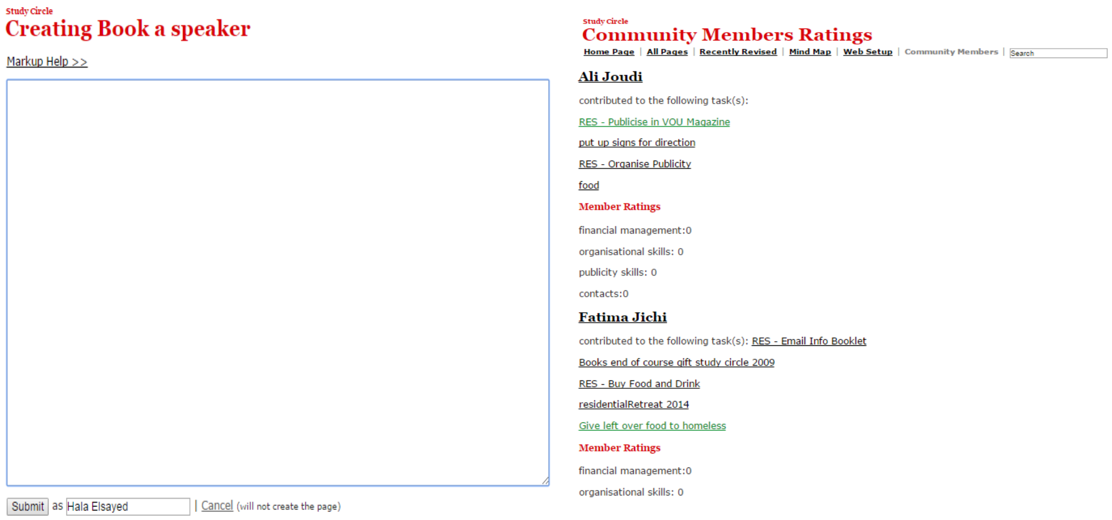


Fig.4.5 Task instance creation in Pimki

The community members now go through each of the task instances and discuss/execute until completion, or alternatively refer to the role recommender for suitable members with the skills and expertise to support the task execution. Fig. 4.6 (a) shows where the discussion related to the task instance *booking a speaker* takes place. Fig. 4.6 (b) presents the list of member profiles who could participate in the specific task instance.



(a) (b)

Fig.4.6 Task instance and user profile in Pimki

Community member Mohammad Ar-Rikabi has the experience and also required skill set (i.e. *contacts*) in order to *book a speaker* (Fig. 4.7). The community members collaboratively discuss and progress with the execution of the task instance (Fig. 4.8) and Mohammad has his expert contribution which benefits the task execution.

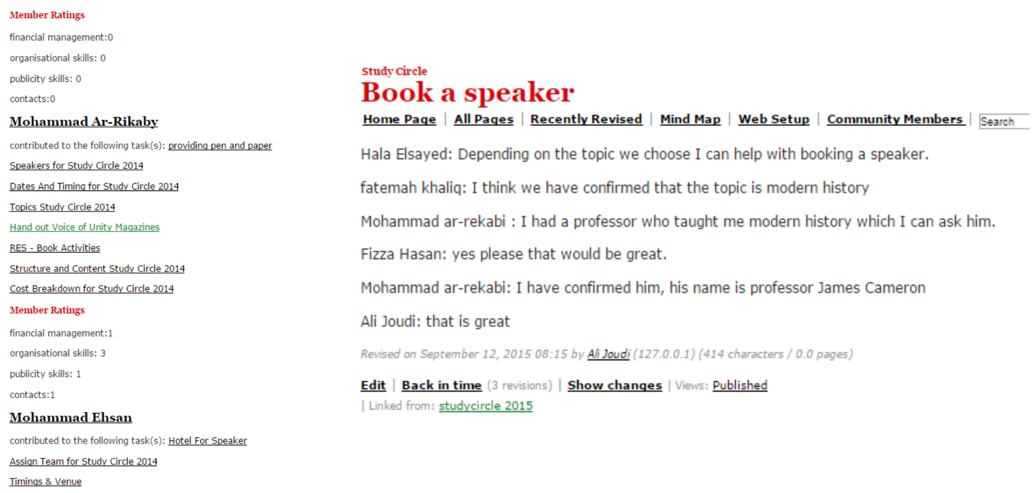


Fig.4.7 User profile and discussion in Pimki

Following the completion of the discussion (execution), one or more active members (in this case Ali Joudi) tags the task instance with user and system defined tags as presented in Fig. 4.8. In this case the tag cloud has been referred to and the key word *contact* has been chosen as the skill which most appropriately is related to this specific task instance (i.e. *Book a speaker*). Other members can also do the same for other task instances, or even refine and correct the existing tags.

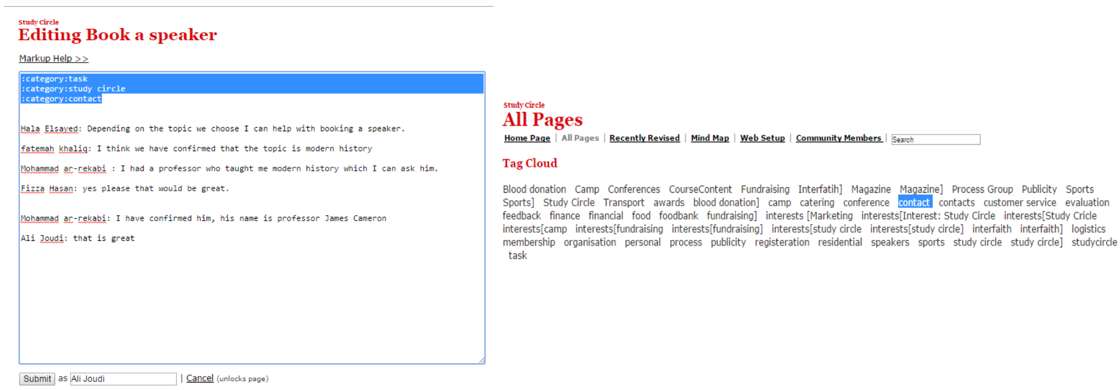


Fig.4.8 Tagging task instance in Pimki

The active member (Ali Joudi) can also tag the members who have contributed positively towards this process. In Fig. 4.9 Mohammad Ehsan has been tagged in the discussion because of a good suggestion he proposed during the discussion.

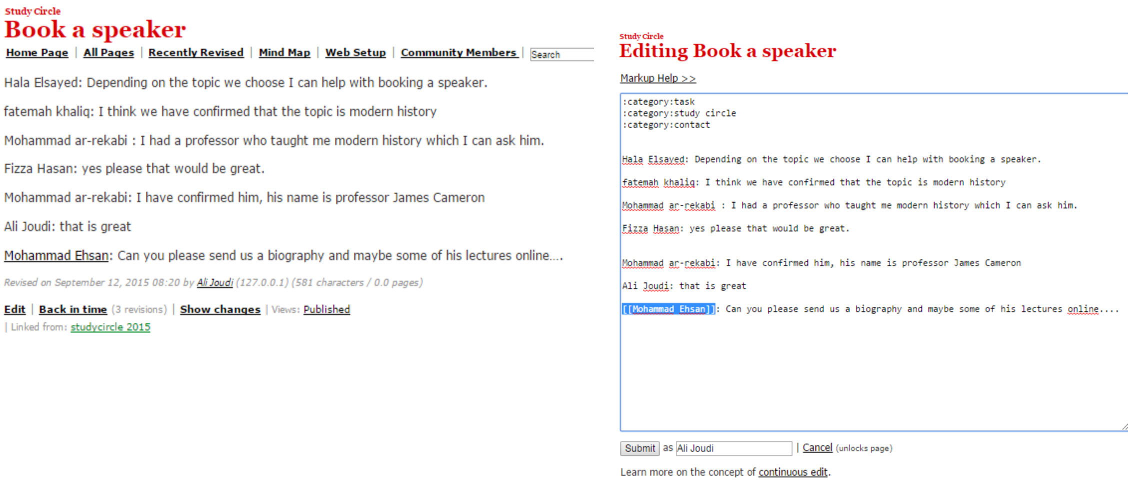


Fig.4.9 Tagging community member in Pimki

As a result of this tagging, Mohammad Ehsan's score for skill *Contact* is incremented to 1 and participation in the task instance *Book a speaker* has also been updated on his profile as presented in Fig. 4.10.

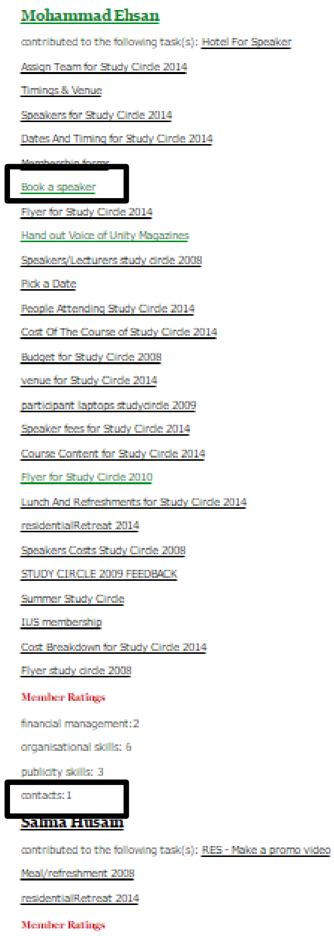


Fig.4.10 Tagging community member in Pimki

As mentioned previously, Pimki is open source and its source code is open for inspection and adaptation (under the open source Ruby language license). Our prototype, however, requires also ad-hoc extensions to Pimki for specific aspects of our framework. In particular, the following extensions are implemented:

- Pimki core is extended to present the tasks recommended for the design of a new process instance.
- Pimki core implementation is customised to support the user profile scores and retrieving the tasks they have participated in as part of the role recommendation.
- The adaptations we make to Pimki are regarding the use of custom mark-up tags to be able to categorise the created wiki pages according to process and task category and to tag them with their authors' identities.

As introduced in Section 4.3.1, graphviz [15] add on is also an extension which has been added to Pimki and is a way of representing structural information as diagrams of abstract graphs and networks. Specifically in our framework this add on feature *firstly* visualises the process structure, that is, the tasks that have been involved in a given instance of a process and *secondly* visualises the association between members and process instances, that is, who participated in what.

Fig. 4.11 presents one of the visual graphs drawn in Pimki using this extension. This figure presents a process instance (*Study Circle 2009*), the related tasks instances, and also the emerged task which is defined as a relationship in our overall static diagram presented in Chapter 3. The emerged task has been captured from the task instance in *publicity SC 2009* in this instance, and will be used and recommended like any other task instance.

[15] http://www.graphviz.org/

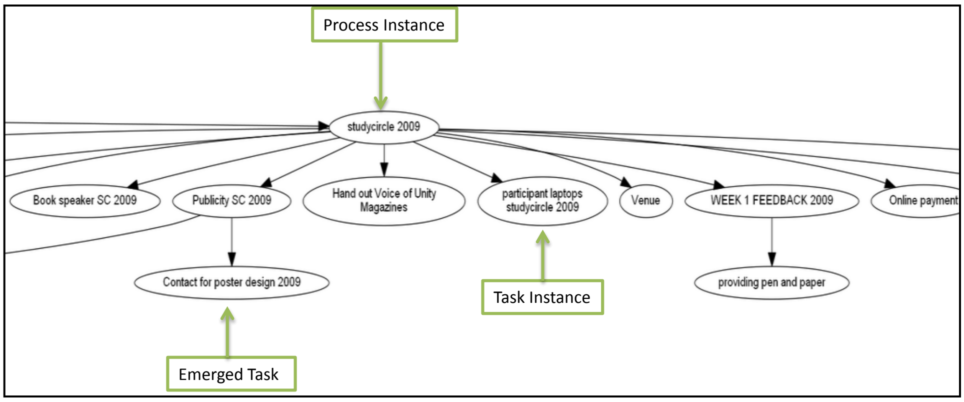


Fig.4.11 Study circle 2009 and related task instances in graphiz

Another example of what graphviz features is presented in Fig. 4.12 where the user defined tags (i.e. the skills related to each task instance) are presented visually. For example the task instances *cost of the course of study circle 2014* and *speaker fees for study circle 2014* have been tagged with the skill *financial* as presented in the following figure.

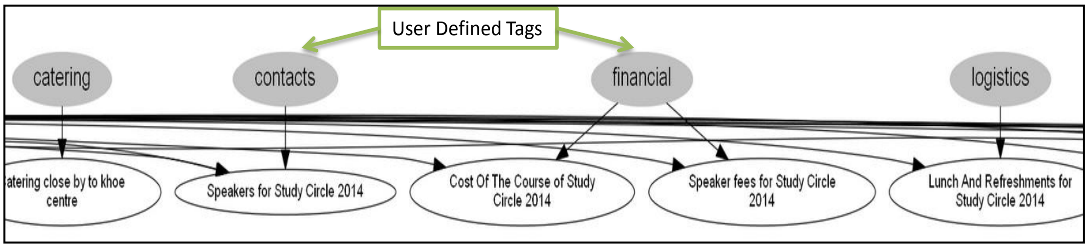


Fig.4.12 User defined tags related to task instances in Graphiz

Similarly a snapshot of the graphical presentation of the task instances the users have been involved in and have participated in is shown in Fig. 4.13. For example the member Ali Joudi has participated in *RES- organise publicity*, *RES – Publicise in VOU Magazine* and so on. This is recorded by Pimki by tracking who has edited a specific task instance (i.e. page).

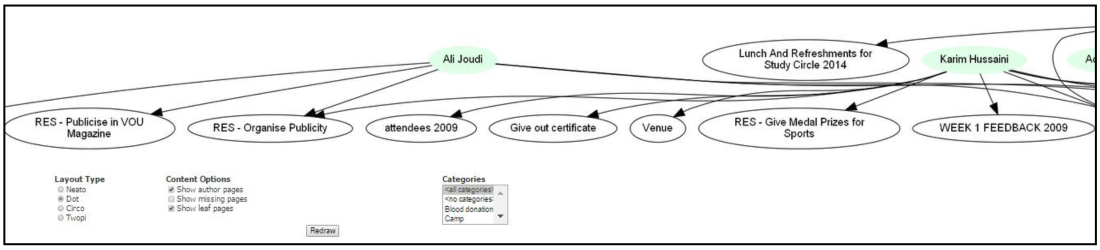


Fig.4.13 Members participation in task instances in Graphiz

In summary, Fig 4.14 present the task instance *hand out of VOU magazines* which is part of the process study circle and gives an overall feel of how the home page of our implemented Pimki prototype looks like and how some of the main entities of our framework are linked to it:

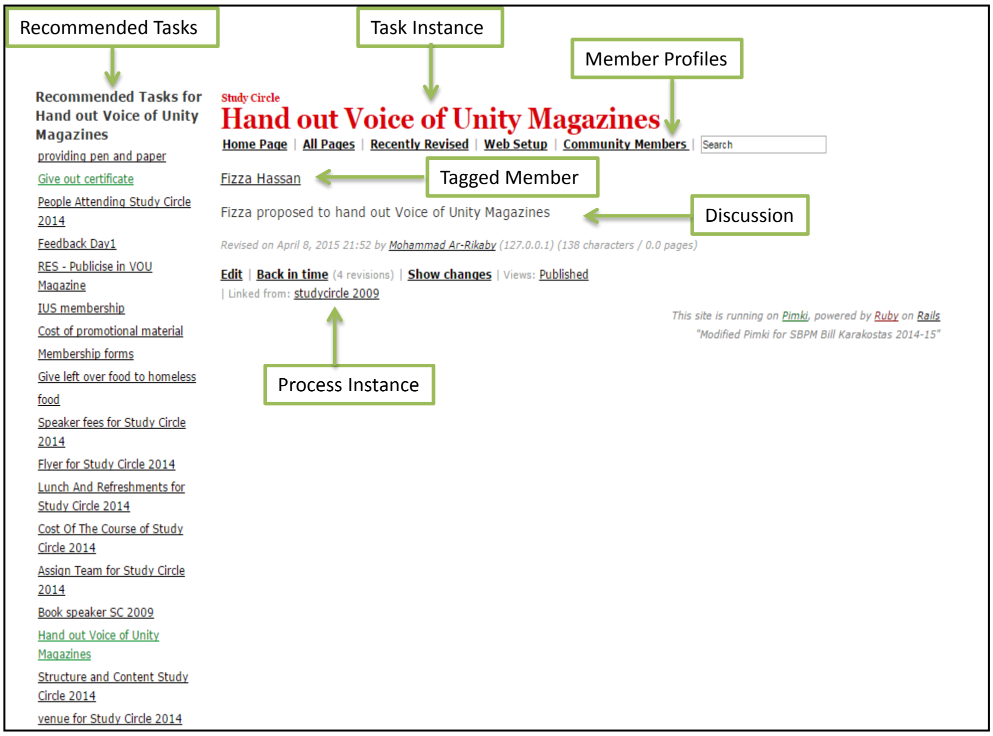


Fig.4.14 Overall view of task instance page in Pimki

4.4 Case study evaluation

In this section the next stage of evaluation is presented. As a case study, we select a registered charity organisation in the UK focusing on the development of mind, spirit and body of the youth[16]. The organisation has a total of 65 volunteers working in various projects, such as organising study circles, fundraising dinners, sport tournaments, and blood donation campaigns. To show the generalizability of our framework and limit the bias introduced by involving a limited number of participants in one specific setting, we use our framework in the context of two separate processes, involving different sets of users. The processes chosen are the organisation of a study circle (process 1), which we already introduced in our running example, and the organisation of a residential retreat for the organisation (process 2). The main reasons why these two processes have been chosen as the case study are:

1. They are representative examples of ad-hoc processes, which are the type of processes Social BPM addresses, i.e. there is no defined way of executing the process.
2. They are processes which have been executed in the existing platform the volunteers use a number of times, thus there is sufficient data which has been copied into Pimki for evaluation purposes.

The traditional platform used by the organisation for the execution of the chosen processes is a standard forum with different sections and sub-sections used to organise the topic of the discussions and different processes. Members register, log on and are able to participate in any of the projects they wish, although there are normally separate teams that work on different processes.

After the user logs in, they are able to view the different processes (projects) which the organisation is involved in. A screenshot of this is presented in Fig. 4.15.

[16] The real name of the charity organisation is kept confidential.

ARCHIVES PRE-2015

Mark subforums read

FORUM	TOPICS	POSTS	LAST POST
Football 08-09	18	188	by Marwan AlDawoud Sun Jun 07, 2009 5:37 pm
GENERAL PRE-2015	138	1194	by Mohammad Rickaby Fri Dec 19, 2014 4:08 pm
Archives - Sports	10	133	by Mohammad Ehsan Mon Sep 09, 2013 10:56 am
Archives - Study Circles	119	1567	by Kariem Hussaini Wed Dec 17, 2014 12:22 pm
Archives - London Iftars	80	1370	by Kariem Hussaini Wed Dec 17, 2014 12:25 pm
Archives - Educational Events Pre-2012	76	1491	by Hassan Joudi Sat Dec 20, 2014 11:32 pm
Archives - Cemetery Visits	5	164	by Mohammad Ehsan Mon Dec 22, 2014 10:44 am
Archives - Monday Night Project	3	67	by SalmaHusain Fri Jan 03, 2014 2:12 am
Archives - Social Events	43	1135	by Fatima Jichi Tue Dec 17, 2013 3:31 pm
Archives - Volunteers Zone	11	118	by Mohammad Ehsan Wed Jan 29, 2014 12:18 pm

NEWTOPIC Search this forum... Search

Mark topics read • 0 topics • Page 1 of 1

Fig.4.15 Main forum dashboard

The user is then able to select a topic of discussion and see the sections related to them (Fig. 4.16). Anyone who is registered on the system is able to view all the sections and topics on the forum as default. The exception to this is when the administrator creates special forum topics/sections which are to be accessed only by a selected number of individuals. For example discussions around the direction or strategy of the organisation which are usually discussed between senior directors of the organisation.

Cost Break Down SC by Mohammad Rickaby » Wed Mar 04, 2009 3:15 am	7	63	by Mohammad Rickaby Wed Mar 11, 2009 2:16 am
Week 3 by Mohammad Ehsan » Thu Mar 05, 2009 10:15 pm 1 2	12	58	by Mohammad Ehsan Sat Mar 07, 2009 6:24 pm
FEEDBACK - Second Week Study Circle by Mohammad Rickaby » Sat Feb 28, 2009 8:03 pm	9	64	by Zahra Imame Fri Mar 06, 2009 5:32 pm
People Attending. by Mohammad Ehsan » Thu Jan 22, 2009 11:21 pm 1 2 3	24	215	by Mahjabeen Fazel Sun Mar 01, 2009 4:42 pm
Study Circle Feedback Forms by Mohammad Rickaby » Sat Feb 28, 2009 8:06 pm	0	13	by Mohammad Rickaby Sat Feb 28, 2009 8:06 pm
Week 2 by Mohammad Ehsan » Fri Feb 27, 2009 5:26 pm	3	26	by Mohammad Rickaby Sat Feb 28, 2009 12:15 am
FEEDBACK - First Week Study Circle by Mohammad Rickaby » Sun Feb 22, 2009 7:21 pm	6	57	by Zahra Imame Thu Feb 26, 2009 4:09 pm
Structure & Content by Mohammad Rickaby » Fri Dec 12, 2008 1:47 am	11	127	by Mahjabeen Fazel Tue Feb 24, 2009 12:39 am
Lunch&Refreshments by Mohammad Ehsan » Thu Jan 22, 2009 11:42 pm	8	77	by Mohammad Ehsan Wed Feb 18, 2009 9:46 pm
Flyer by Mohammad Ehsan » Fri Jan 02, 2009 4:40 pm 1 2 3	25	212	by Mohammad Rickaby Tue Feb 17, 2009 11:56 pm
Venue by Mohammad Ehsan » Sun Nov 09, 2008 5:52 am	11	98	by Zahra Imame Mon Feb 16, 2009 11:11 pm
Speaker's Fees by Mohammad Rickaby » Sat Feb 14, 2009 2:37 pm	0	18	by Mohammad Rickaby Sat Feb 14, 2009 2:37 pm
Course Content by Mohammad Ehsan » Sun Jan 11, 2009 1:35 am	4	40	by Mohammad Ehsan Fri Jan 23, 2009 12:02 am
Cost of the Course by Mohammad Rickaby » Fri Dec 12, 2008 1:44 am 1 2 3	25	145	by Mohammad Ehsan Thu Jan 22, 2009 11:39 pm
Topic by Mohammad Rickaby » Sat Nov 08, 2008 3:37 pm 1 2 3	30	214	by Mohammad Ehsan Thu Jan 22, 2009 11:39 pm
Speakers by Mohammad Rickaby » Sat Nov 08, 2008 3:36 pm 1 2 3	26	196	by Mohammad Ehsan Thu Jan 22, 2009 11:38 pm
Dates & Timing by Mohammad Rickaby » Sat Nov 08, 2008 3:55 pm 1 2	13	106	by Mohammad Ehsan Mon Jan 19, 2009 12:28 am

Display topics from previous: All Topics Sort by Post time Descending Go

Fig.4.16 Tasks (topics) related to a study circle in the forum

Although all users are able to access the different projects on the forum, there are normally a number of core team members for each project and a team lead who is responsible for the overall delivery of the project. The volunteers discuss amongst each other various topics related to a specific project until they are all finalised. Fig. 4.17 shows an example of the discussion related to making a flyer for a study circle which is being organised.

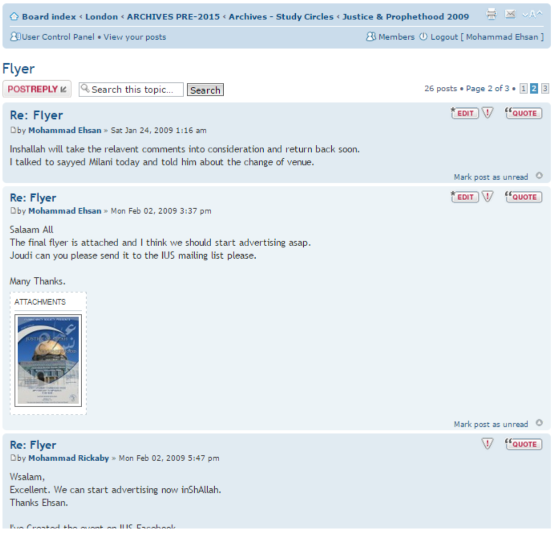


Fig.4.17 Discussion about the flyer on the forum.

The data from the discussions on the forum have been copied into our Pimki-based prototype to assist the running of the evaluation and make the overall process as real as possible.

In the first run, the process is organising a study circle and it is carried out by 4 volunteers which is the typical number of people who would execute such a process usually. We ensure there are at least 3 process instances (e.g. Study circle 2012 –14, Camp 2012 – 14) to ensure there is enough data for evaluation purposes and it is close to the real life scenario. In the second run, the chosen process is organising a residential retreat for the organisation, and 5 volunteers are involved in this process. A retreat is a type of a 2 or 3 days camp which consists of education, fun and sport activities. Typical tasks in organising a retreat are booking activities, transport to the venue, speakers, camp site and so on. The selected volunteers are chosen with different demographics presented in Table 4.1 to avoid any bias result and in order to keep the evaluation as real as possible (in real life, there are males and females with different age groups and varying number of year of experience who volunteer in the organisation).

Table 4.1 Demographics of volunteers in process 1 and 2

Process 1 : Organising a Study Circle			
	Age	Gender	Years with organisation
Community Member 1	28	Female	3
Community Member 2	25	Female	4
Community Member 3	25	Male	0
Community Member 4	29	Male	8

Process 2 : Organising a Residential Retreat			
	Age	Gender	Years with organisation
Community Member 5	32	Female	10
Community Member 6	28	Female	2
Community Member 7	23	Female	3
Community Member 8	24	Female	1
Community Member 9	29	Male	5

The two processes are run on 2 different occasions and by different participants with different levels of experience and length of being with the organisation as presented in Table 4.1. The data present in the tool are all based on real data copied over from the traditional forum which the organisation uses. The task instances run are also real, and they are discussed (i.e. executed) between the participants as they would normally discuss in real life. However, the actual booking of the speaker/catering/transport/venue etc. is not carried out, but the decision on each one of these are finalised through the discussion.

After the successful completion of process execution, the participants are asked to complete the questionnaires (Ronald & Connaway, 2004) produced in order to assess proposed framework. The evaluation focuses on validating the main components in our framework, namely the role and task recommender mechanisms, which are both supported by social tagging. The questions are modified from existing questionnaires (Davis, 1989) which evaluate the perceived usefulness of Technology Acceptance Model (TAM) (Lee et al., 2003).

4.4.1 Case Study Evaluation

As explained earlier, the main components of the Social BPM framework are evaluated through a case study by the participants who were given questionnaires to fill out. In addition to the questionnaire data (second hand data – refer to appendix A) collected from the users, observational data (first hand data) are also collected to avoid participants' personal bias in data collection. The following questions are used to gather first hand data to confirm the second hand data gathered from the user:

1. Did the user tag any segments of the discussion after the completion of the process? If so how many times?
2. Did the user use the role recommendation (Community member's mechanism)? If so how many times?
3. Did the user use the task recommendation mechanism? If so how many times?
4. Did using the role recommendation mechanism increase the collaborativeness of the process during execution?

I) Social Tagging

In order to be able to evaluate the role and task recommenders, the copied real data has to be tagged. The community members are asked to go through the discussions (both in process 1 and 2) in the processes and start tagging using the system and user defined tags. This is in order to capture the emerged tasks, normal task instances and other community members as part of other tasks.

Note that tagging process discussions is not normally used in current systems, so this is compared to not having a tagging mechanism at all.

The volunteers are asked the following questions in order to determine the usefulness of the proposed solution. The rationale behind asking these questions is to evaluate if the social tagging component is useful at all or not, and whether it assists the user to achieve what they are after easily.

1. Tagging the discussion helps others in decision making in the future.
2. Tagging the discussion by others helps me be more creative during process execution.
3. Tagging the discussion helps capture the emerged tasks which would have remained unnoticed and unused if not tagged, in the future.
4. The tag cloud is useful in terms of choosing previously used tags
5. Tagging assists in finding process information .
6. It is easy to go through the discussion text in order to find text to tag.

II) Task Recommender

After the tasks have been tagged, the users are asked to carry on with the execution of the process organising *study circle 2015* for instance and consider the recommendations. The users are then asked to answer the following questions to determine the usefulness of the proposed solution:

These questions are also based on evaluating the usefulness of the task recommender mechanism and if process knowledge from previous processes can be used.

1. Process knowledge from previous process instances can be reused.
2. Using the task recommender improves the collaborativeness of the processes through the community members.
3. The recommender provides the information I am looking for.
4. It is useful to have a task recommender during process execution.

III) Role Recommender

The users in both processes are asked to make use of the members profile as part of the role recommender, and answer the following questions to determine the usefulness of the proposed solution.

The basis for these questions are also to assess whether the role recommender mechanism during execution is a useful functionality to have or not and also whether it improves the quality of the overall execution and process outcome.

1. The role recommender (community members functionality in Pimki) is effort saving.
2. The role recommender helps the active members and other members to make better decisions by contacting suitable people for each task for example. (This is based on subjective criterion.)
3. The role recommender mechanism improves the quality of the processes executed.
4. It is beneficial to have a process owner responsible for the overall guiding and execution of the processes.
5. The role recommender makes the things I want to accomplish easier to get done.

4.4.2 Results and Analysis

Both quantitative and qualitative evaluation approaches have been used in order to capture the success of the framework as well as to find out the limitations of our framework and discuss how they could be addressed in the future. Each of these evaluation techniques have their own distinct advantages, however combining both qualitative and quantitative methods can result in a more accurate and thorough evaluation (Haynes, 2004).

I. Quantitative Data Analysis

Table 4.2 presents a summary of the quantitative feedback received (for the detailed results refer to appendix B) from the community members for each of these areas. Items are evaluated on a Likert scale between 1 – 7 (1 entirely disagree and 7 entirely agree). The main reason for using this approach in the evaluation stage is because generally quantitative evaluation yields relatively objective data (Weiss, 1998). The average score as well as standard deviation are calculated for each question to assist with analysing the data.

The first category of questions aim to evaluate the usefulness and collaborativeness of the task recommender which is primarily utilised during process design, although it overlaps with execution at times. According to Table 4.2 we find that overall the members found the task recommender quite useful in order to find and utilise previously captured process knowledge. Some seem to have faced some challenge in finding the information they were looking for (Question 3). This could be due to the number of tasks recommended from past executions which might have made finding the relevant information difficult. The values for all the standard deviations are < 2.7 which indicates a minor variation of scores by the users. Apart from question 3, the rest of the questions have an average score above 6 which indicate a positive response and feedback regarding the task recommendation component.

Table. 4.2. Quantitative Data Analysis – Number of observations = 9

	Questions	Avg.	Std Dev.
Task Recommendation	1. Process knowledge from previous process instances can be reused	6.3	2.4
	2. Using the task recommender improves the collaborativeness of the processes through the community members	6.4	2.4
	3. The recommender provides the information I am looking for	5.4	2.6
	4. Is it useful to have a task recommender during process execution	6.7	2.4
Role Recommendation	1. The role recommender (Community members) is effort saving	6.1	2.2
	2. The role recommender helps the process owners and other members to make better decisions by identifying suitable people for each task	6.2	2.4
	3. The role recommender mechanism improves the quality of the processes executed.	5.9	2.0
	4. It is beneficial to have a process owner responsible for the overall guiding and execution of the processes.	6.4	2.4
	5. The role recommender makes the tasks I want to accomplish easier to get done.	6.2	2.4
Social Tagging	1. Tagging the discussion helps others in decision making in the future	6.1	2.3
	2. Tagging the discussion by others helps me be more creative during process execution	5.0	2.3
	3. Tagging the discussion helps capture the emerged tasks which would have remained unnoticed and unused if not tagged, in the future	5.7	2.0
	4. The tag cloud is useful in terms of choosing previously used tags	6.4	2.4
	5. Tagging assists in finding process information.	6.4	2.1
	6. It is easy to go through the discussion text in order to find text to tag	4.1	1.2

The second category of questions focus on the concept of role recommendation and how it is used during process execution. According to Table 4.2, overall the feedback received from the members on this feature is more positive than the previous category as there is nobody who disagreed (ranked <4) with any aspects of the role recommendation feature. The average score for all the questions except question 3 are above 6 which again show the overall usefulness of the component. In question 3, only one person scored less than 6 which affected the average, the score does not show anything negative, it is just the judgment and how useful they have found the role assignment to be which is slightly less compared to other members.

The final category which the evaluation covered is related to social tagging. Because in order for the previous two components to be functional, the members would need to make use of social tagging. In this section, it appears that the community members mostly found it challenging to go through the discussions and tag various useful segments (Questions 2 and 6) with averages 5 and 4.1 respectively. The standard deviations (2.3 and 1.2 respectively) also show that other members are overall in agreement with one another. Such an outcome is expected since manual tagging would be difficult when it comes to reading through high volume of discussion logs.

Furthermore, first hand data is gathered as part of observing how the volunteers participate and use the system which is presented in Table 4.3. Questions 1 – 3 are aimed to see whether the volunteers used the functionalities of the system or not. All of the community members used the role and task recommenders a number of times during the evaluation of process 1 and 2. This indicates that after the introduction given about how they each work, the members are interested and found it useful to benefit from these features which were missing before. The number of times the functionalities have been used by the volunteers are presented against the total number of tasks executed in the specific process categories (7 tasks in total for process 1 and 5 tasks in total for process 2); this is to give some context to the frequency in which the functionalities have been used. However in question 1 which is related to the volunteers tagging the discussions, 2 of the members did not tag the discussion after or during the execution. This is inline with what was presented in the Table 4.3 which suggests the difficulty and effort required to go through a discussion and tag were suitable.

Table 4.3 Results from first hand data

	Questions	CM 1	CM 2	CM 3	CM 4	CM 5	CM 6	CM 7	CM 8	CM 9
1	Did the user tag any segments of the discussion after the completion of the process? If so how many times?	3/7 times	2/7 time	N/A	4/7 times	2/5 times	1/5 time	N/A	4/5 times	3/5 times
2	Did the user use the role recommendation (Community members mechanism)? If so how many times?	4/7 times	3/7 times	6/7 times	2/7 times	3/5 times	2/5 times	2/5 times	4/5 times	4/5 times
3	Did the user use the task recommendation mechanism? If so how many times?	3/7 times	2/7 times	4/7 times	3/7 times	1/5 time	1/5 time	2/5 times	3/5 times	4/5 times
4	Did using the role recommendation mechanism increase the collaborativeness of the process during execution?	Y	Y	Y	Y	Y	Y	N	Y	Y

The final observation is related to the collaborativeness of the Social BPM system and whether by recommending and presenting the member's profile it is improved or not. The observation of this is quite subjective and the judgment is based on judging whether the volunteer has been enabled to collaborate with the other volunteers by introducing the role recommender. Overall the observation is positive (8 volunteers out of 9 worked with others – presented in Table 4.3), and general increase of collaborativeness is observed by using the role recommender.

Overall, based on the data shown in Table 4.2, we argue that our framework is positively received by the community of users, who are able to yield many benefits from its implementation. There are areas, such as difficulty to scan the text and tag manually, which needs to be addressed in future research. These limitations are addressed later in Section 4.6.

II. Qualitative Data Results

Qualitative data is also collected from the users who participated in the case study (appendix B). A qualitative evaluation (Powell & Connaway, 2004) approach tends to provide a more holistic assessment of the problem than quantitative methods. It also gives more attention to subjective aspects of human behaviour that is a key player in our Social BPM framework and provides a greater perspective from the participant's viewpoint and enables to enter the evaluation without preconceptions or prepared instruments (Weiss, 1998).

The main two questions are about what the volunteers most and least liked about the functionality of the proof of concept prototype. Table 4.4 presents the summary of this feedback.

Table 4.4 Qualitative Data Results

Least Liked	Occurrence	Most Liked	Occurrence
Risk of not tagging due to difficulty/ lack of motivation	7 users	Utilising previous process knowledge	6 users
Too many tags could result in chaos and difficulty to find needed information	2 users	Easier to find suitable people through role recommendation to execute tasks	4 users
Utilising other tasks could reduce own creativity	1 user	Task recommendation increase creativity	1 user
Role Recommender scores not accurate	1 user		
Users with no scores won't be chosen	1 user		

As presented in Table 4.4 the least liked functionality of the platform is that the users find it difficult to go through the text and tag relevant section, this corroborates the results from the quantitative data as well. Furthermore, the most liked functionality is related to the exploitation and discovering of process knowledge which again is supported with the data received from the quantitative analysis.

4.5 Evaluation against the Literature

In Chapter 2 the main limitations and downfalls of traditional BPM were mentioned and discussed. Furthermore, the various approaches towards Social BPM and the gaps which exist in the literature were also presented. Here we shall evaluate our proposed Social BPM framework and analyse how it has addressed the limitations in the literature.

Lack of Information Dissemination: This limitation is related to the top-down approach in traditional BPM systems where processes are designed by a group of individuals and passed on end users to follow (Schmidt & Nurcan, 2009a; Palmer, 2011). This approach often prevents useful process knowledge of the end-users to be shared within the organisation. This limitation which existed due to hierarchical boundaries is lifted in the proposed Social BPM framework. That is primarily due to the fact that there is no hierarchy in the proposed model, therefore all users (members) are able to access and share the information and process knowledge shared by the rest of the community members. Not only does this model allow the dissemination of information, it also encourages the utilisation of previously executed process knowledge. This is enabled through the task and role recommendations which assist in the retrieval of information.

Model-Reality Divide: As a result of the top-down approach and the gap between the end users who execute the processes and the process designers who design the processes, the designed processes may not be followed correctly. This consequently creates a gap between the designed process and the process that is executed (Filipowska et al., 2011; Schmidt & Nurcan, 2009a; Palmer, 2011). With the integration of the design and execution phase in the BPM lifecycle the model-reality divide challenge is eliminated. The users design and execute the processes in parallel; therefore the executed processes are the same as what has been designed. In fact the processes are executed whilst being designed. When a discussion takes place in the proposed Social BPM framework, the task and process is being designed and because what has been designed and discussed has been a collective discussion, there will not be any discrepancy between the designed and executed process, or at most the discrepancy will be very minimal.

Information Pass-On Threshold and Lost Innovation: Useful feedback from users is not captured in process design due to rigid hierarchical controls in the design and deployment phases. As a result, valuable first-hand knowledge to improve processes may remain unused (Filipowska et al., 2011; Schmidt & Nurcan, 2009a). By recommending task instances and presenting the expertise and experience of the users, innovation is flourished and everyone is able to be part of the design and execution of a specific process. Therefore this limitation is also removed or minimised in our Social BPM framework.

Strict Access-Control: Only users who have been selected and given specific access are allowed to execute the processes (Wohed et al., 2009). This limits the level of participation of users into the business process life-cycle. This limitation is also eliminated in our framework. There is a universal access level for all the users which means any user is able to tag, contribute and be part of the execution of the processes. As it has been mentioned before, this will cause security concerns when dealing with classified information and processes.

Therefore by introducing social elements to the cycle of BPM, the main limitations which existed previously and were discussed in the literature are eliminated or drastically reduced.

4.6 Limitations of our evaluation

This section discusses the limitations related to each of the evaluation methods adopted.

4.6.1 Proof of Concept Implementation's Limitations

Pimki like all wiki tools suffer from the same weakness which is also their strength which is primarily the lack of any support for structuring and controlling the authoring process. There is no inherent support for example to control that can create a new process or how new tasks can be structured and organised. The presented prototype has been used to evaluate certain concepts and assumptions related to Social BPM such as user role and task recommendation.

There are two main features which are not fully implemented in the prototype as they were not deemed necessary for the intended level of the prototype that mainly served to explore and validate key Social BPM concepts.

1. Full implementation of the tag cloud.

A tag cloud would look like what is presented in Fig. 4.18, the text which are enlarged show the most frequently repeated keywords.

Fig.4.18 Example of a tag cloud[17]

[17] http://www.nngroup.com/articles/tag-cloud-examples/

The overall idea of the tag cloud is implemented in our prototype and the keywords used for tagging are stored in it, however the frequency of their occurrence are not identified or presented in anyway as presented in Fig. 4.19. This would be a useful feature to have to assist the usage of the most popular/most used tags as oppose to the creation of new keywords with the similar meaning to a keyword which already exists in the cloud. However as mentioned, this does not affect the intended purpose of the prototype.

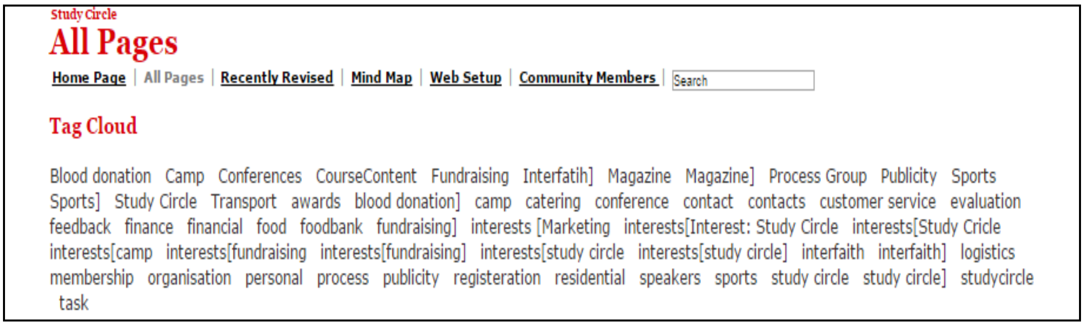


Fig.4.19 Tag cloud equivalent in Pimki

2. Presenting the frequency which the recommended task instances are executed compared to the total number of task instances.

As explained in Chapter 3, the task instances are recommended, and for the recommended task instances the number of times they have been executed compared to the overall task instances in a specific process have been included in the design of our framework. This is to assist and identify the most important and main task instances which is often repeated and should most probably be executed in each instance. What is implemented and modified in our Pimki implementation is that the task recommender presents the list of the task instances previously executed in a specific process as presented in Fig. 4.20; however their frequency is not included.

Fig.4.20 Task recommendation in Pimki

This is mainly due to the limitation and complexity which exists in Pimki in regards to adding these fields next to each recommended task instance. Because the task instances are created as links which are related to specific pages (i.e. task instances).

4.6.2 Case Study Evaluation Limitations

The case study which attempted to evaluate the second research question mentioned in Chapter 1 is successfully completed and the results have been analysed. As discussed the case study was run for two different processes, and with overall 9 participants. Although the reason for choosing the numbers involved are based on the real scenario situation, however the results would have been more accurate if the case study was run on more than 2 processes (Khare, 2012). The case study evaluation is limited to two scenarios (process 1 and 2) only due to the time constraints, and this can be evaluated in the future by for example repeating the study circle process with more than 1 group of volunteers. Additionally, the volunteers used the Pimki prototype to carry out the case study for the purpose of evaluating only the functionalities of the Social BPM system. However, as Pimki is only a prototype tool and not highly technical developed software with high standard GUI design, this could have influenced the responses from the volunteers and how they interact with the system. It was pointed out to the users to look through the interface design and focus on the functionalities present, however at times the ease of use and look and feel of the software has an impact on the responses.

4.6.3 Author's Evaluation Limitations

This evaluation compared the Social BPM framework with the limitations and downfalls of traditional BPM systems mentioned in the literature which motivated this research. Although the limitations mentioned in the literature chapter are addressed and analysed one by one, the captured limitations may not be a comprehensive list. We have tried our best in this research to discuss and address the main issues found in traditional BPM systems.

Furthermore, Social BPM overcomes the mentioned limitations, however it has a number of downfalls as presented in Chapter 2. Therefore, this research though it has solved some concerns related to BPM, it has opened the door for different types of limitations itself which needs to be discussed and analysed.

4.7 Revisiting the Research Questions

After having presented the results of the evaluation, in this section we revisit the research questions to understand to what extent they have been answered by our research.

1. *What are the key concepts that can drive the design of a Social BPM framework exploiting social tagging as a tool to capture and re-use process knowledge?*

This question is what directs the research, so our attempt to produce a Social BPM framework answers this question. That is done by firstly looking at the literature and secondly proposing a Social BPM framework and designing its key capabilities. This is done by fulfilling the following two objectives:

Objective 1: Perform a literature review of BPM and Social BPM to identify the key characteristics of a Social BPM framework.

***Objective* 2:** Design the key capabilities of a Social BPM framework that exploits social tagging.

As far as the first objective is concerned, the literature in the area of BPM and social software has been comprehensively researched and based on this the gap is identified and a framework is proposed.

Furthermore, the key capabilities of the Social BPM framework which have been identified and designed in this research are the role and task recommenders in addition to social tagging which supports the recommendation mechanism. These capabilities have been designed and the second objective has been met, however the design of these capabilities could be improved further. The role recommender in the proposed framework uses a simple method of scoring; this could be enhanced by taking other parameters of the members into account when calculating the score. Additionally, the design of task recommender could be enhanced further by categorising the recommended tasks into different sections based on the year/type of task for example. Finally social tagging which is the most challenging capability of the framework based on the evaluation could have a more comprehensive design. It is understandable and a valid point which the participants found it difficult to read through logs of text and discussion, this could be overcome with a more comprehensive design which includes automated tagging based on a number of criteria which the user can design as an example.

2. *Does the proposed Social BPM framework improve the collaborativeness and reuse of process knowledge during the design and enactment of business processes?*

This question is addressed through the central facets of our proposed system namely the role, task recommender and the social tagging mechanisms. By doing this the following two objectives are met:

***Objective* 3**: Build a prototype based on the proposed design for the purpose of evaluating the designed Social BPM framework

***Objective* 4:** Evaluate the Social BPM framework through the implemented prototypein real world settings.

The prototype has been built based on the Social BPM framework design and functional requirements for the purpose of evaluation and answering this research question. As far as the third objective is concerned, the implementation of the prototype demonstrates the overall buildability/feasibility of the Social BPM framework. There are certain aspects of the design which are not implemented as discussed in the Section 4.6. These are related to presenting the frequency which the recommended task instances were executed compared to the total number of task instances and also the implementation of the tag cloud. Although these have not been implemented in the proof of concept prototype due to time constraint (for the tag cloud) and the limitation which exists in adding the extra fields in Pimki (to show the frequency of the executed tasks over the total number of tasks), this does not affect the evaluation of the Social BPM framework and meeting the third objective. This might however influence the interaction of the participants with the prototype which is discussed in assessing the fourth objective.

As far as the fourth objective is concerned in addressing the second research question, this is achieved by running a number of case studies with real users and data to evaluate the collaborativeness, and reuse of process knowledge of the Social BPM framework through the designed prototype. It is concluded through the quantitative and qualitative analysis that process knowledge is generally captured and reused through the task recommender, however not having the frequency of the executed tasks presented to the users (due to the limitations of the prototype) could have affected the judgment of the users in identifying the core elements of the processes. Although this was minimised by ensuring there are participants with different years of experience with the charity organisation who would know the core tasks. Additionally based on the results, the response received about whether the Social BPM framework improves the reuse of process knowledge or not was positive. This capability was also mentioned as one of the characteristic which the users most liked about the framework.

Allowing discussion during process design and execution improves collaboration. This is particularly enabled through the role recommender as it utilises subject matter experts. This is also one of the most liked capabilities of the framework and all of the users found this capability useful which indicates the success of this aspect of the framework. The scores related to each user maybe based on bias tagging which would influence the level of expertise of the tagged person. However, this would not affect the collaboration between team members which is resulted from the role recommender. Therefore although this is not an accurate indication of individual's expertise (because this is based on the active members' judgment), however it is a beneficial guide to utilise during process execution. Of course others, who may not have been tagged/recommended for their contribution, need to be encouraged and motivated to participate and provide their valuable input which would ultimately lead them to becoming a subject matter expert and ranked for various skill categories.

Finally, tagging is one of the main challenges of the users which could have influenced their usage of the task and role recommenders, because they are both enabled by social tagging. This would be because of excessive or lack of use of tagging. There are naturally going to be people who would use tag a lot, some less and some won't use it at all; this is from the characteristics of social media which will exists regardless. However, various techniques such as introducing point systems for the members, or setting different types of incentives for those who tag could be used to encourage and motivate community members to tag the discussions.

4.8 Conclusion

This chapter presented 3 main approaches to evaluate the Social BPM framework. The research questions were revisited to assess whether the objectives of the research has been met or not. A proof of concept prototype was implemented in order to assess the buildability of the framework and present the main capabilities of the Social BPM framework to answer the first research question. The second question was answered and measured by running a case study with real data and participants in order to evaluate the usability and collaborativeness of the framework. And finally the third evaluation method adopted was an investigation on how the proposed framework addresses the gaps in traditional BPM systems.

There are a number of limitations with the evaluation approaches adopted as presented in this chapter, however overall the research questions are validated using the three different main methods to ensure an unbiased evaluation. Finally, the data and participants used for the case study were all real and copied directly from the live forum currently used in the charity organisation to keep the evaluation as close as possible to what takes place in the real world.

CHAPTER 5: CONCLUSION

5.1 Introduction

This is the concluding chapter of the thesis in which the contributions of this research are discussed from a number of different dimensions in Section 5.2. Furthermore, the limitations of this research are also presented in Section 5.3. The research by no means stops with this piece of work, therefore some areas of future research is also presented in Section 5.4 and the chapter is concluded with Section 5.5.

5.2 Research Contribution

The contribution of this research can be viewed from a number of perspectives which are discussed here:

Improvement of the state of the art: referring back to the main areas in literature with regards to Social BPM which is presented in Section 2.3, the research has contributed towards the literature in Social BPM and specifically the following two areas:

1. Attempts to design a Social BPM framework (Brambilla & Fraternali, 2012; Brambilla et al., 2011; Silva et al., 2010; Brambilla et al., 2011a).
2. Literature on Social BPM in general and the theory of it, discussing its benefits, limitations and how it has emerged (Filipowska et al., 2011; Wohed et al., 2009; Schmidt & Nurcan, 2009; Erol et al., 2010; Brambilla et al., 2011; Alexopoulou et al., 2013), and the challenges raised by the adaptation of Social BPM in organisations (Bruno et al., 2011; Pflanzl & Vossen, 2013; Pflanzl & Vossen, 2014; Alexopoulou et al., 2013).

As discussed in Chapter 2, the approaches towards a Social BPM framework in the first category of literature were limited to the inclusion of social extensions such as polls, dynamic enrolment, social sourcing, voting and ranking/commenting (Brambilla

& Fraternali, 2012; Brambilla et al., 2011l; Brambilla et al., 2011a), to the process design stage. In doing so, the separation between the process executors and designers still exists, which leads to the model-reality divide downfall. Furthermore, the authorisation boundaries which are typical of traditional BPM models still exist in these approaches, which are the main reason for lost innovation and lack of information dissemination in an organisation. Although (Silva et al., 2010) does attempt to empower people to use their tacit knowledge to design exceptional tasks on a case-by-case basis (*Design at the instance level*) (Silva et al., 2010), for the remaining predefined tasks and activities, which are normally the majority in Silva et al's (2010) approach, this is not the case. Finally, other attempts in the Social BM area (Brambilla & Fraternali, 2012; Brambilla et al., 2011l; Brambilla et al., 2011a; Silva et al., 2010) support structured or at most semi-structured processes, not fully ad-hoc processes as the framework presented in this thesis. For example, while ad-hoc type of tasks/activities have been introduced in the Social BPMN language extension (Brambilla et al., 2011a), ad-hoc tasks are still embedded in an overall predefined process during process design, which again does not support the scenario of fully ad-hoc processes.

The second category of literature has been used to identify the benefit and potentials of Social BPM and to understand how it attempts to overcome the limitations of traditional BPM systems. Our research in the area of Social BPM has extended this category of literature by identifying the key concepts in the Social BPM framework, namely, the role and task recommenders and social tagging. This research has also elaborated on how the proposed Social BPM addresses the limitations of BPM by mainly removing the separation between the process designers and executors, removing role authorisations for the users so everyone can contribute, reusing process knowledge gained during execution in the process design stage through the task recommender and utilising the tacit knowledge of the users through the role recommender.

Our approach towards Social BPM differs from the other discussed attempts as it allows the integration of social software during both design and process executions stages. It also removes the hierarchical user boundaries which have traditionally existed in process design and execution. The removal of these boundaries and special access rights addresses the strict access-control issue of traditional BPM and also the information pass-on threshold and lost innovation, as it allows all the users to contribute towards the design and execution of the business processes. More specifically, social tagging and the task recommendation are used to capture process knowledge and enables this to be utilized both in the process design and execution stages. This removes the model-reality divide limitation since there is no separation between the two stages of design and execution. Social tagging also supports the role recommendation mechanism in order to exploit the tacit knowledge which is with the users and enables this knowledge to be used during the execution and design of the processes. This allows the process knowledge gained by the users during process execution to be shared with others and overcome the lack of information dissemination challenge which exists in traditional BPM. Such an approach offers a solution to support ad-hoc processes and also to overcome the existing limitations of BPM systems.

Answering the research questions: revisiting the research questions set at the outset of the thesis, we find that the questions have been answered and objectives are met as discussed in Section 4.7.

- *What are the key concepts that can drive the design of a Social BPM framework exploiting social tagging as a tool to capture and re-use process knowledge?* A Social BPM framework with its components, namely the task and role recommender which are supported by social tagging has been designed. Our Social BPM framework enables the re-use of process knowledge in the process design and execution phases. Additionally, the design has been implemented as a proof of concept prototype to illustrate the buildability of the Social BPM framework.

- *Does the proposed Social BPM framework improve the collaborativeness and reuse of process knowledge during the design and enactment of business processes?* The proposed Social BPM framework has been evaluated through the implementation of a prototype and its use in a set of real world case studies. The evaluation presented in Chapter 4 has shown that the Social BPM framework has improved collaboration by removing user authorisation and the role recommender mechanism. Furthermore, the captured process knowledge through tags, are reused and recommended by the task recommender and removal of the boundaries between the process design and execution stages.

Publications: the list of publications resulting from the research presented in this thesis can be found in appendix C.

5.3 Research Limitations

The limitations of this research can be classified in a number of categories. Some of these limitations are related to the development and design of the framework and others related to the evaluation of the proposed Social BPM framework.

Methodology: This is related to the limited user involvement in the development of the framework. Users are involved only in the evaluation phase and not in the design of the framework. Users have only been engaged for the purpose of evaluating the framework after completion, however it would have been better if users where consulted during the design of the Social BPM framework as well. Engaging users from different backgrounds (expertise) could have suggested other approaches in developing the Social BPM framework. This limitation does not have an impact on the validity of the framework as users have been involved in the evaluation of the framework. However it may have had an impact on the resulting design which means that the Social BPM framework could have been designed and implemented differently.

There are also a number of limitations as far as the case study evaluation is concerned:

- *Limited number and type of participants:* The evaluation of the framework is limited to two different processes with a total of 9 participants. Although the number of people involved in the processes have been chosen on the basis of how the processes are run in real life, the evaluation could be improved by running the case study for more processes. There is no set number of times which the case study should be run, however if it is done more, the evaluation results would also be more accurate (Khare, 2012). Additionally, the case study experiment could have been done with BPM experts (practitioners and/or students) to get the views of a range of users. The limited number and type of participants involved in the case studies makes the results less rigours, but do not invalidate them. This is an issue particularly for quantitative results, which could have been more accurate.
- *Limited number of organisations involved:* The case study was only run on one organisation, this experiment could have been carried out on a number of different organisations which routinely run ad-hoc processes. This would have made the generalizability of the results higher. The impact of not doing this is also the same as above. The limited number of organisations involved in the case studies makes the results less rigorous and less generalizable, but does not invalidate them.

- *Overall prototype evaluation*: A number of aspects related to the "efficiency and performance" of the prototype implementation, e.g., scalability to large number of users, performance in terms of time efficiency in executing business logic under reasonable real world loads, has not been evaluated. The functionality of the prototype was not impacted by this, however if the performance of the Pimki tool was tested and improved, the judgments of the users with regards to the tool would have been less biased. Although the evaluation through the case study was only to assess the usefulness of our framework, it is natural that the experience of the user might have been affected by the performance and scalability of the system they interact with.

Implementation: The implementation of the prototype has been for the purpose of evaluation of the framework. Therefore the proof of concept prototype has a number of limitations as it has been discussed in Chapter 4. These can be summarised in the following points:

- *Full implementation of the tag cloud*: The overall idea of the tag cloud was implemented in our prototype and the keywords used for tagging where stored in it, however the frequency of their occurrence were not identified or presented in any way. This would be a useful feature to have to assist the usage of the most popular/most used tags as oppose to the creation of new keywords with the similar meaning to a keyword which already exists in the cloud. The lack of this feature does not have impact on the evaluation of the prototype as the tag key words where saved and presented in Pimki, although there was no tag cloud extension. This could easily be added by finding a suitable ad-on tag which can be incorporated into Pimki.

- *Presenting of the frequency which the recommended task instances were executed compared to the total number of task instances*: As explained in Chapter 3, the task instances are recommended, and for the recommended task instances the number of times they have been executed compared to the overall task instances in a specific process have been included in the design of our framework. This is to assist identify the most important and core task instances which is often repeated and should most probably be executed in each instance. What has been implemented and modified in our Pimki implementation is that the task recommender presents the list of the task instances previously executed in a specific process. However their frequency has not been included. This was mainly due to the limitation and complexity which existed in Pimki in regards to adding these fields next to each recommended task instance. Because the task instances are created as links which are related to specific pages (i.e. task instances). The presence of the frequency would have assisted the users to identify the core task instances which reoccur. The impact of this in the evaluation of the prototype was minimal as there were quite a few users who have many years of experience with the charity organisation and they knew the core task instances which are frequently executed.

Framework: The design of our Social BPM framework suffers also from a number of limitations:

- *Tagging:* Social tagging has been used extensively in our Social BPM framework to support role and task recommendation. One of the identified challenges of tagging is the lack of motivation for users to engage into tagging. There has been no attempts to devise methods to encourage the use of social tagging in our framework. This is one of the most important areas which would have been considered if the timeframe of the thesis would allow, because if social tagging is not utilised, then the capabilities of the framework would not result in the desired benefits.

- *Scoring system*: Although there is a scoring system designed for the users as part of the role recommender, this is quite simple. The scoring system is currently based on the tagging of the active members, which might be biased and not a real reflection of their expertise. Additionally, it does not include other parameters or details about what would be identified as valuable contribution which is the current criteria of tagging.

- *The use of natural language*: As it has previously been mentioned, the choice of words/spellings cannot be imposed on the users in the Social BPM framework. This also applies to process names and how they are used for tagging. The recommenders use tags and the task recommendation in specific recommends tasks based on the system defined tags which indicate the process name. However, if an incorrect / inaccurate / inconsistent process name has been used, the recommender will not be able to pick the specific task instances related to a given process. This particularly impacts the system where there is a large number of processes and navigating through them to find a similar process may be difficult. This could potentially be enhanced by categorising the processes, so when a user is about to initiate a process, they are able to easily see what other similar processes have been executed under a specific (i.e. similar) category and this will help them in choosing a consistent name for their processes and tags which use the process names (i.e. system defined tags). Alternatively, ontologies can be introduced in order to support and align the text/tags to the existing terms which refer to the same resource. These ontologies can be utilised as a way to reconcile different concepts expressed in natural language (Ghidini & Serafini, 2006; Fischer & Bauer, 2010).

- *Efficiency:* The design of the Social BPM framework could be optimised by investigating whether there are more efficient ways of designing the role and task recommenders or alternatively exploring if there is a way the efficiency and performance of the proposed framework could be improved. Although our framework does fulfil the set objectives and overcome the limitations of traditional BPM systems, there might be better design approaches which could be adopted to fulfil the same objectives.

5.4 Future Research

The research could be extended and investigated further to overcome the limitations mentioned in the previous section. A summary of future work is discussed here:

Design optimisation: some of the results from the case study participants alluded to the difficulty of tagging the discussion. This can be time consuming and a tedious action to carry out, which could discourage people from tagging which will result in flaws in the recommendations. Therefore, information retrieval and text extraction techniques (Shah et al., 2002; Kando, 1997) could be investigated and potentially adopted in order to optimise and improve the social tagging process.

Users may have different motivations for tagging, these include (Gupta et al., 2010): *Contribution and sharing* in which the users would like to add and categorise resource to add value and share with others. *Attract attention* because popular tags can be used to get the attention of others and gain popularity. *Opinion expressions*, because tags can convey value judgments that users have and would like to express with others. *Competition*, some users may like to compete with others in tagging resources to gain a certain bonus or benefit. These motivations could be addressed through different means to the users to encourage tagging. For example providing incentives for those who tag a certain number of times per month or setting up a competition amongst the users to assess the quality of tags based on a number of defined criteria. This will assist smarter ways of formulating recommendations based on social tagging.

Furthermore the following question could be investigated: is social tagging the only approach in designing a Social BPM framework, or is there other social elements and technologies which could be used for this?

Prototype: moving forward the un-implemented functions of the tool (task instance count and tag cloud extension) should be implemented and the look and feel of the tool to be improved and made user friendly. The prototype could potentially be deployed in the real world setting and whether it can also be extended in order to integrate real world BPM platforms needs to be assessed. This would improve the generalizability of the Social BPM tool. Additionally, the scoring system could be designed and implemented further by incorporating other parameters for the users such a dynamic mechanism which calculates the individual score (i.e. the number of times a member has been tagged) against the overall score (i.e. the number of times all the members have been tagged) per month.

Evaluation: as discussed in the limitations found in our evaluation, going forward the case study experiment could be run with more users, different organisations and more processes for a more accurate and generalizable kind of result.

Overall, investigating how tagging could be optimised in the context of Social BPM is an area which would require a long term research and would be a potential PhD topic.

That is to investigate different techniques of data mining and retrieval in order to tag the discussions based on certain criteria which the user would choose.

5.5 Conclusion

Overall all of the research questions set in the Chapter 1 of this thesis have been answered as presented earlier in this chapter. Our Social BPM framework offers a seamless integration of the design and execution stages of the processes, and also removes the hierarchical user boundaries between the design and execution phases. This is done through the integration of social software and more specifically by the support of social tagging and recommendation mechanisms. Such a framework offers a solution to support ad-hoc processes and also to overcome the existing limitations of BPM systems.

In this chapter, after having summarised the contribution of this research, we discussed the limitations of the proposed Social BPM framework and presented possible areas of future work.

In summary, our Social BPM framework has utilised a widely used social technology such as social tagging in order to enable process knowledge reuse and enhance user collaboration through the task and role recommendations. This has addressed and overcome the limitations of traditional BPM set out at the beginning of the thesis.

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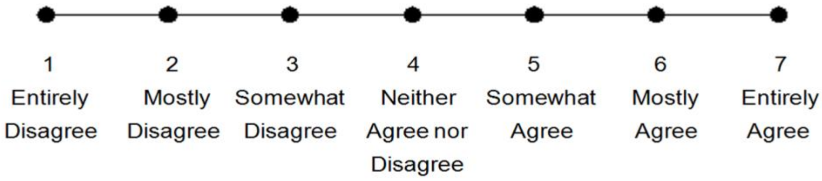
APPENDIX A – Questionnaire

Age: ………………… **Years with the organisation:………………..**

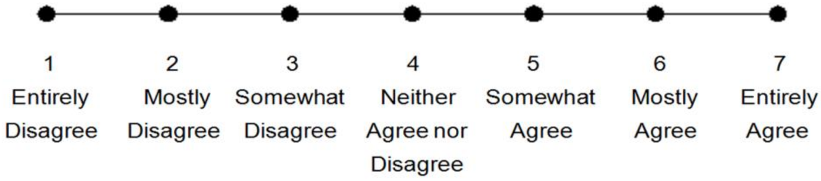
Gender: …………………

Tagging *Rank from 1 – 7 (7 is you strongly agree)*

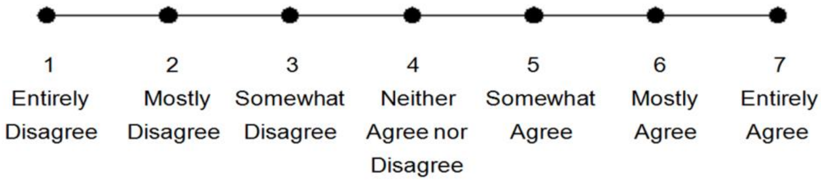
1. Tagging the discussion helps others in decision making in the future



2. Tagging the discussion by others helps me be more creative during process execution



3. Tagging the discussion helps capture the emerged tasks which would have remained unnoticed and unused if not tagged, in the future.



4. The tag cloud is useful in terms of choosing previously used tags

1	2	3	4	5	6	7
Entirely Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Entirely Agree

5. Tagging assists in finding process information.

1	2	3	4	5	6	7
Entirely Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Entirely Agree

6. It is easy to go through the discussion text in order to find text to tag.

1	2	3	4	5	6	7
Entirely Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Entirely Agree

Task Recommendation

1. Process knowledge from previous process instances can be reused

1	2	3	4	5	6	7
Entirely Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Entirely Agree

2. Using the task recommender improves the collaborativeness of the processes through the community members

1	2	3	4	5	6	7
Entirely Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Entirely Agree

3. The recommender provides the information I am looking for

1	2	3	4	5	6	7
Entirely Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Entirely Agree

4. Is it useful to have a task recommender during process execution

1	2	3	4	5	6	7
Entirely Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Entirely Agree

Role-Recommender Mechanism (Member Profile)

1. The role recommender (Community members) is effort saving

1	2	3	4	5	6	7
Entirely Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Entirely Agree

2. The role recommender helps the active members and other members to make Better decisions by identifying suitable people for each task (This is based on subjective criterion.).

1	2	3	4	5	6	7
Entirely Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Entirely Agree

3. The role recommender mechanism improves the quality of the processes executed.

1	2	3	4	5	6	7
Entirely Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Entirely Agree

4. It is beneficial to have a process owner responsible for the overall guiding and execution of the processes.

1	2	3	4	5	6	7
Entirely Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Entirely Agree

5. The role recommender makes the tasks I want to accomplish easier to get done.

1	2	3	4	5	6	7
Entirely Disagree	Mostly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Mostly Agree	Entirely Agree

Overall

1. What did you most like about the Social BPM approach?

2. What did you least like about the Social BPM approach?

Facilitator (Observation)

Did the user tag any segments of the discussion after the completion of the process? If so how many times?

Did the user use the role recommendation (Community member's mechanism)? If so how many times?

Did the user use the task recommendation mechanism? If so how many times?

Did using the role recommendation mechanism increase the collaborativeness of the process during execution?

User Information:

Process : Organising a Study Circle			
	Age	**Gender**	**Years with organisation**
Community Member 1	28	Female	3
Community Member 2	25	Female	4
Community Member 3	25	Male	0
Community Member 4	29	Male	8

Process : Organising a Residential Retreat			
	Age	**Gender**	**Years with organisation**
Community Member 5	32	Female	10
Community Member 6	28	Female	2
Community Member 7	23	Female	3
Community Member 8	24	Female	1
Community Member 9	29	Male	5

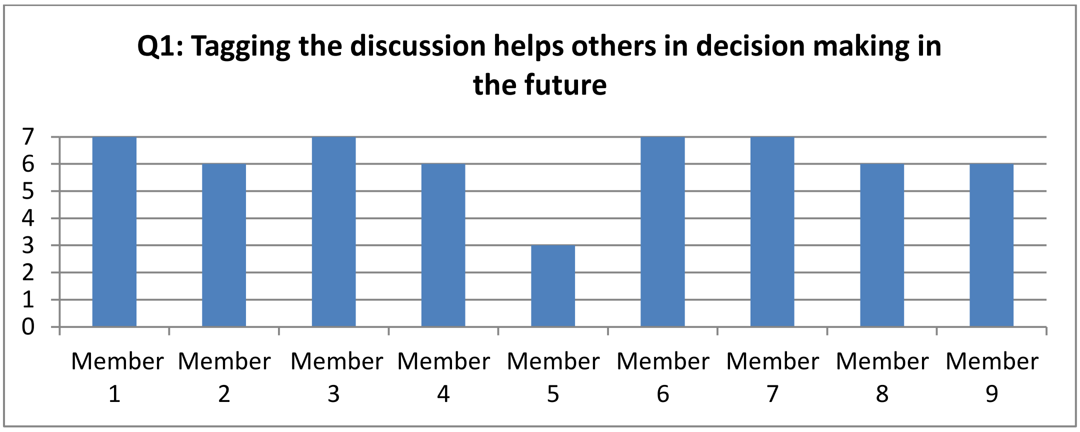
APPENDIX B – Results

User Responses:

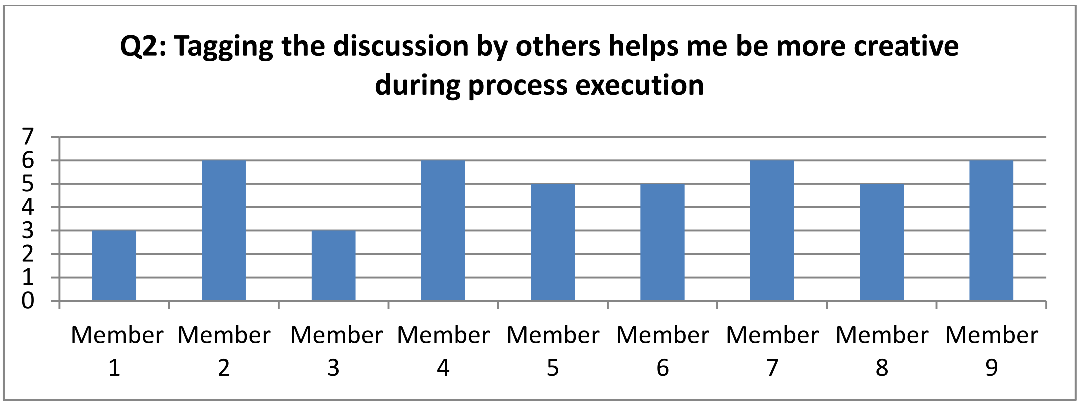
		CM 1	CM 2	CM 3	CM 4	CM 5	CM 6	CM 7	CM 8	CM 9
Tagging	Q1	7	6	7	6	3	7	7	6	6
	Q2	3	6	3	6	5	5	6	5	6
	Q3	6	5	7	5	4	7	7	5	5
	Q4	6	7	7	7	6	7	5	6	7
	Q5	7	6	7	6	6	7	7	6	6
	Q6	6	2	5	4	3	5	5	3	4
Task Recommendation	Q1	7	7	7	6	5	7	6	6	6
	Q2	6	7	7	6	6	7	7	6	6
	Q3	7	7	6	5	3	5	5	6	5
	Q4	7	7	7	7	6	7	6	6	7
Role Recommendation	Q1	6	6	7	6	4	7	7	6	6
	Q2	7	7	6	6	6	6	6	6	6
	Q3	6	6	6	6	6	6	5	6	6
	Q4	7	7	7	6	6	7	7	5	6
	Q5	7	7	7	6	5	6	6	6	6

Tagging *Rank from 1 – 7 (7 is you strongly agree)*

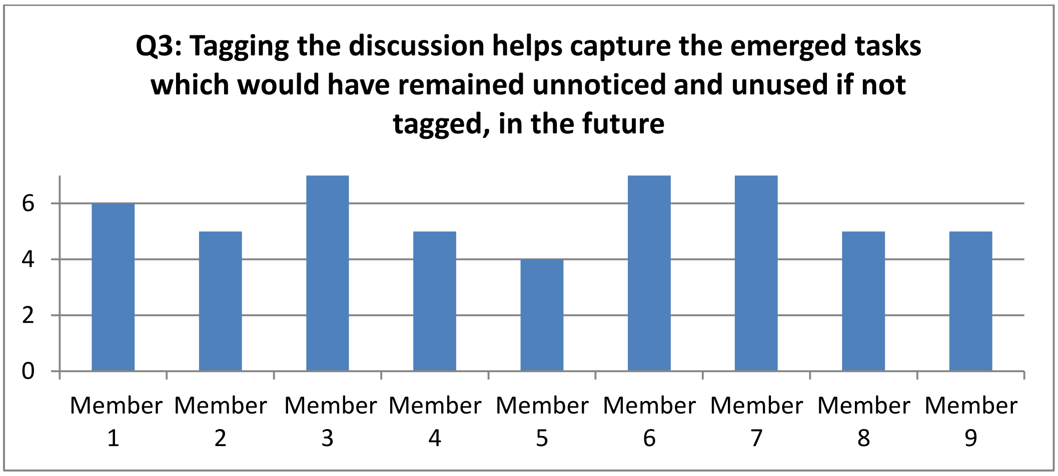
1. Tagging the discussion helps others in decision making in the future



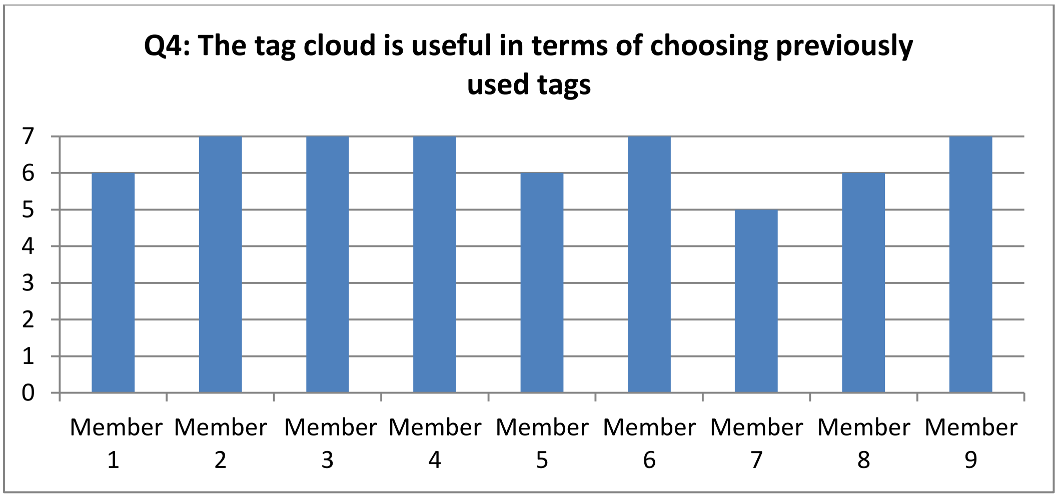
2. Tagging the discussion by others helps me be more creative during process execution



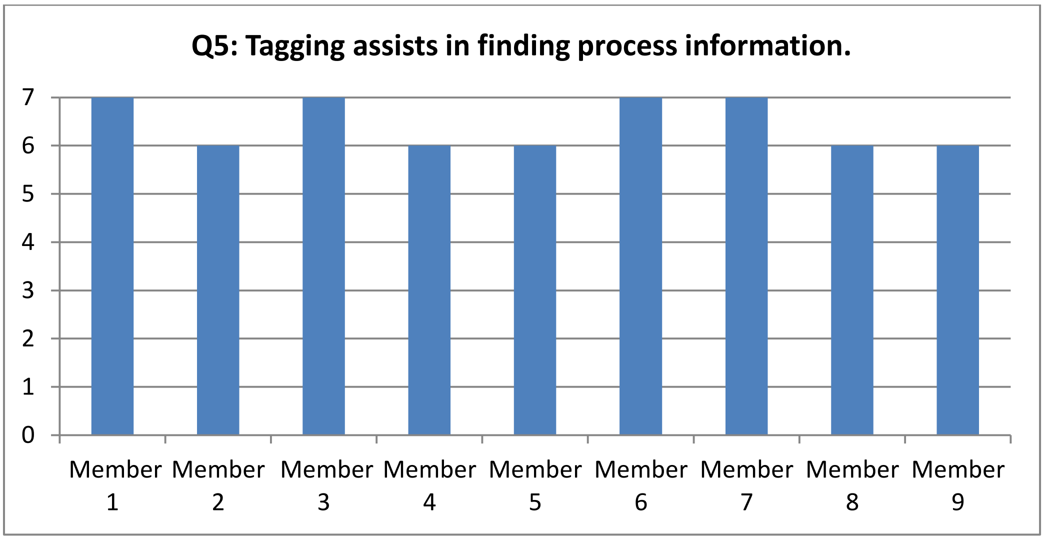
3. **Tagging the discussion helps capture the emerged tasks which would have remained unnoticed and unused if not tagged, in the future**



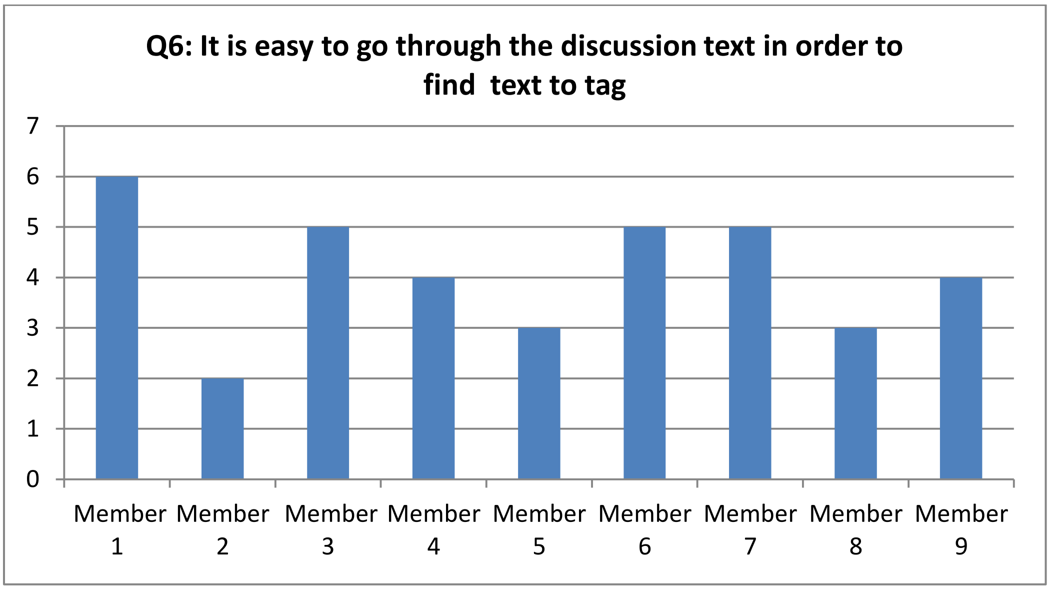
4. **The tag cloud is useful in terms of choosing previously used tags**



5. Tagging assists in finding process information

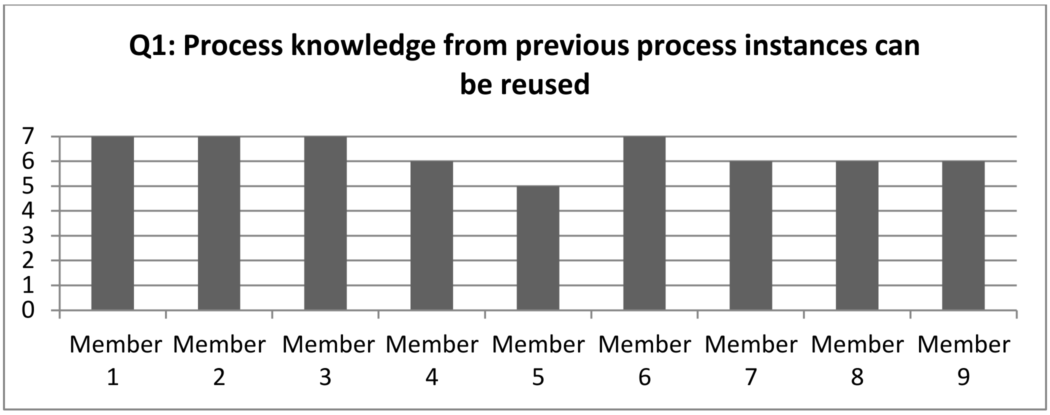


6. It is easy to go through the discussion text in order to find text to tag

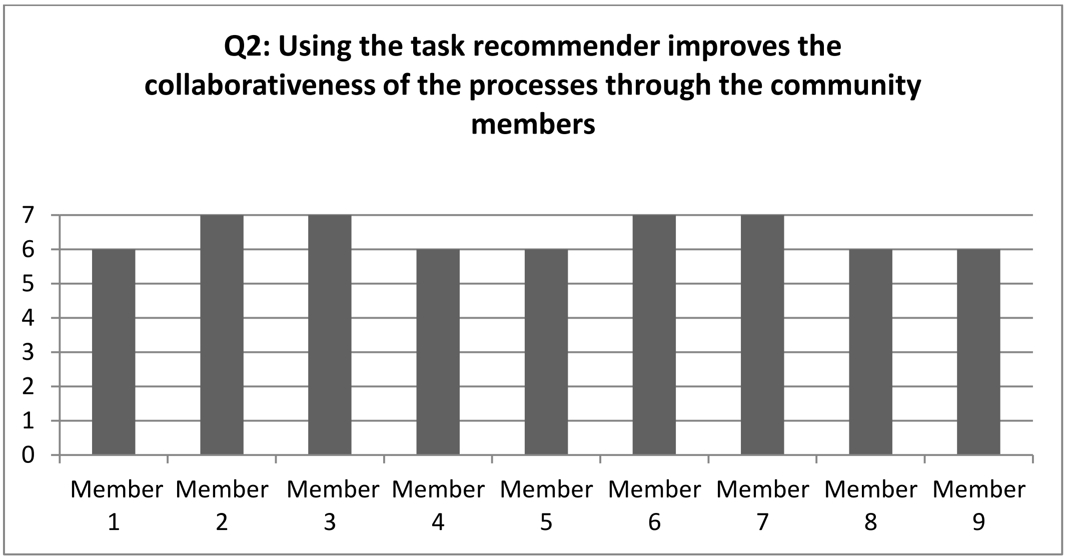


Task Recommendation

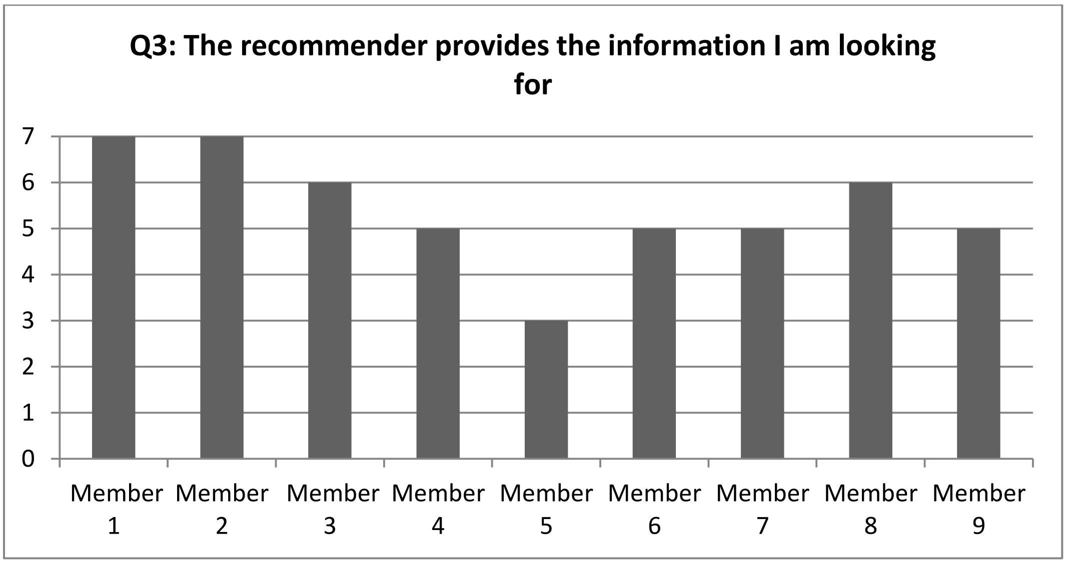
1. Process knowledge from previous process instances can be reused



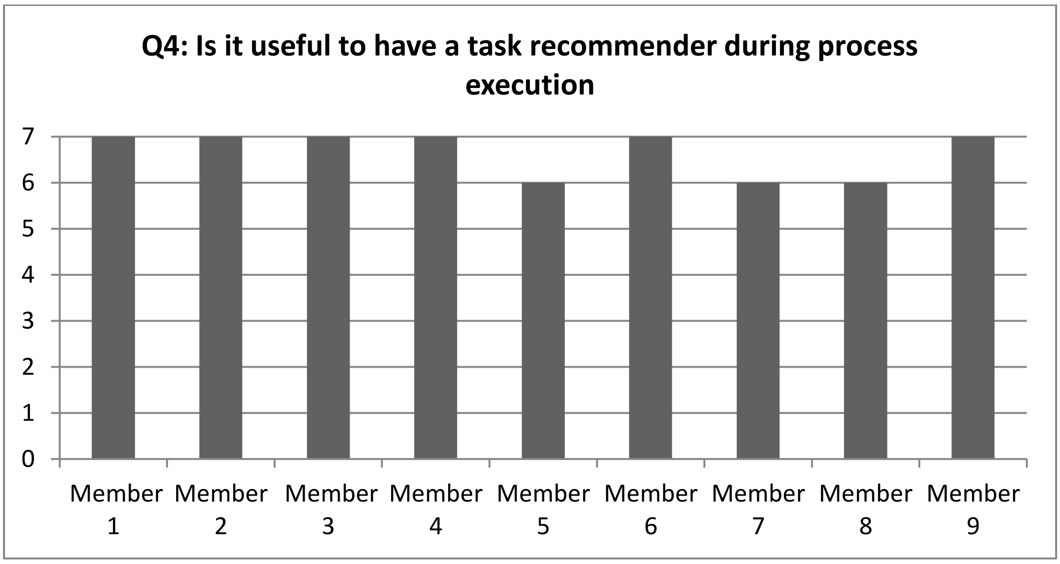
2. Using the task recommender improves the collaborativeness of the processes through the community members



3. **The recommender provides the information I am looking for**

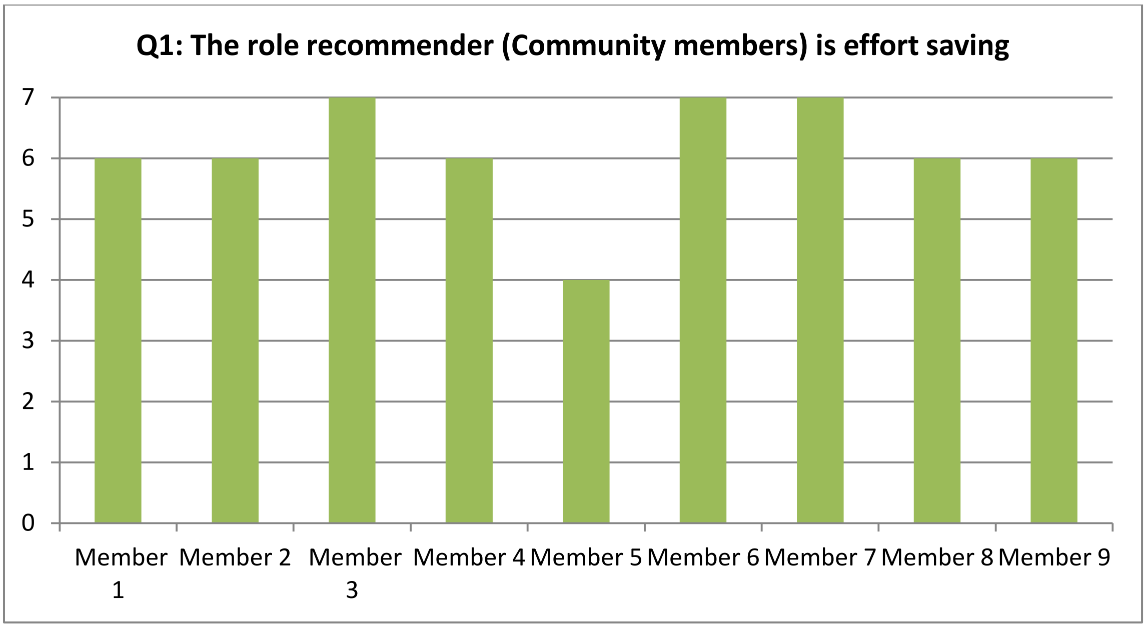


4. **Is it useful to have a task recommender during process execution**



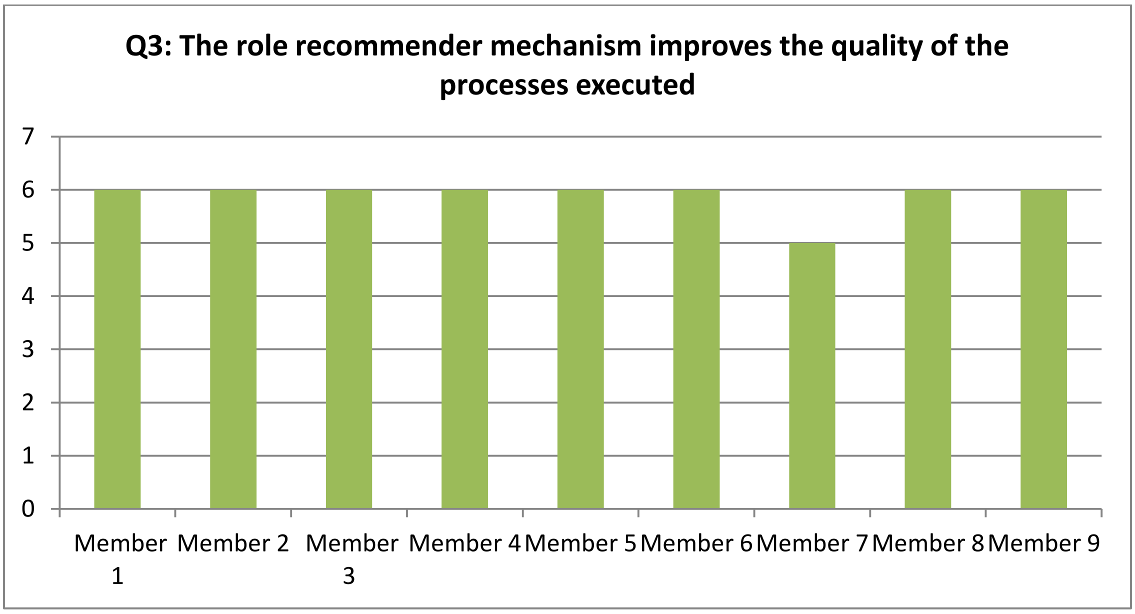
Role-Recommender Mechanism (Community Member)

1. The role recommender (Community members) is effort saving



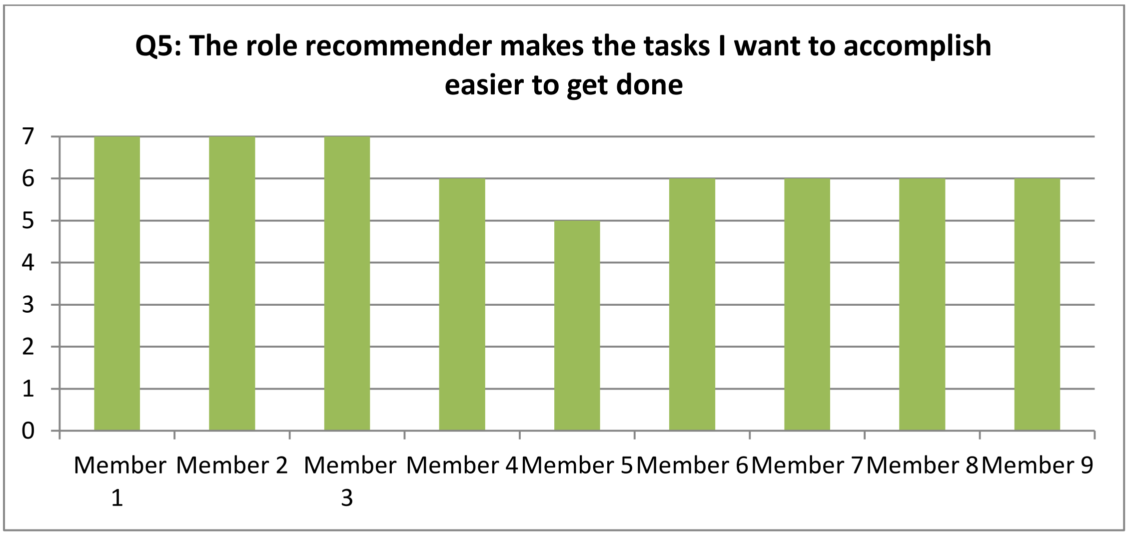
2. The role recommender helps the process owners and other members to make better decisions by identifying suitable people for each task

3. The role recommender mechanism improves the quality of the processes executed



4. It is beneficial to have a process owner responsible for the overall guiding and execution of the processes

5. The role recommender makes the tasks I want to accomplish easier to get done



Overall

What did you most like about the Social BPM approach?

Community member 1: It helps in using ideas and tasks from previous processes, therefore we make use of previous experiences.

Community member 2: Being able to make the process more efficient by being able to use specific topics which have previously been used and successful.

Community member 3: Easier to identify tasks and allocate them to experienced people by looking at experiences and expertise from previous processes.

Community member 4: I find it useful that instead of going through a process from scratch, I can benefit from the knowledge and experienced captured previously to save time and effort. Additionally I am able to see the scores and tasks each member has participated in before and utilise their experience in the running of the processes.

Community member 5: It's fairly simple to use once you have some experience around the system

The idea of having people names for the various tasks is good as it's easier for those planning a new camp who to contact

Community member 6 : I like the task recommender the most as it conveniently helps me find tasks that I might have not thought of.

Community member 7: Structuring of task recommendation and role recommendation is very useful, it simplifies the process of arranging any activities, and allows for collaboration between old and new volunteers/members.

The role recommender particularly is useful where a volunteer is unsure of who to turn to for help or who the best person for the job is.

Community member 8: Past ideas can be re-used

If it works it will make the process of organising activities more efficient.

And we can contact people according to their expertise.

Community member 9: In our traditional model, it is close to impossible to locate useful ideas and tasks which were mentioned/performed a few years ago, however the task recommender in the proposed solution allows the utilisation of this knowledge which would have been un-captured otherwise.

What did you least like about the Social BPM approach?

Community member 1: Having to go through the entire text to tag it. Would be good to have a system where it tags automatically based on the input 'words' or phrases that you enter

Community member 2: I find it hard to read all the text for tagging, maybe a summarised version of the text would be more useful.

Community member 3: If the task recommendation is used at the first stage of designing the processes (When brainstorming), it would decrease the creativity of the members, and prevent new ideas from emerging, since they will be very much relying on the tasks and roles from previous executions.

Community member4: The task of going through the text and tagging, searching through many discussions and logs is quite challenging and could be improved if this was automated and the data was presented in a more visual way rather than chunk of texts.

Community member 5: Tagged words to be in a word cloud would be easier to follow so people don't forget anything

People might go tagging 'happy' or they may not tag at all - both will have effects. Tagging happy will mean useless info being tagged. Non tagging can lead to missing essential information therefore rendering the task incomplete - therefore double the work

Someone needs to be appointed to check all tasks are taken note of and keep track of any incomplete

People tagged for tasks may have left the organisation so that may have its own issues - once they are known as not wanting to participate they should be deleted...is this built in the system?

User interface may assist better user interaction

Community member 6: I think one of the challenges is having an accurate point system for the role-recommender as some people who are really good at something might not necessarily have done a specific task often.

Community member 7: Voluntary process of tagging can breakdown if volunteers decide not to engage in this, a method of offering incentive or encouraging users to tag would improve sustainability.

Community member 8 : If nobody tags, the overall process will fail and we would not be able to benefit from the features present.

Tagging is not simple while reading through the threads of discussion.

Could easily get redundant data if used incorrectly.

If there are too many tags used throughout the years, it may recommender the user too many tasks which is difficult to navigate through (not user friendly).

Community member 9: In the role-assignment mechanism, only the members with expertise in a specific needed area are contacted, whilst there might be other individuals who are also experts but they have not been recommended, and therefore their knowledge and expertise would not be utilised.

Facilitator (Observation)

Did the user tag any segments of the discussion after the completion of the process? If so how many times?

Community member 1: Yes, 3 times

Community member 2: Yes, 2 times

Community member 3: No

Community member 4: Yes, 4 times

Community member 5: Yes, 2 times

Community member 6: Yes, 1 time

Community member 7: No

Community member 8: Yes, 4 times

Community member 9: Yes, 3 times

Did the user use the role recommendation (Community member's mechanism)? If so how many times?

Community member 1: Yes, 4 times

Community member 2: Yes, 3 times

Community member 3: Yes, 6 times

Community member 4: Yes, 2 times

Community member 5: Yes, 3 times

Community member 6: Yes, 2 times

Community member 7: Yes, 2 times

Community member 8: Yes, 4 times

Community member 9: Yes, 4 times

Did the user use the task recommendation mechanism? If so how many times?

Community member 1: Yes, 3 times

Community member 2: Yes, 2 times

Community member 3: Yes, 4 times

Community member 4: Yes, 3 times

Community member 5: Yes, 1 time

Community member 6: Yes, 1 time

Community member 7: Yes, 2 times

Community member 8: Yes, 3 times

Community member 9: Yes, 4 times

Did using the role recommendation mechanism increase the collaborativeness of the process during execution?

Community member 1: Yes

Community member 2: Yes

Community member 3: Yes

Community member 4: Yes

Community member 5: Yes

Community member 6: Yes

Community member 7: No

Community member 8: Yes

Community member 9: Yes

APPENDIX C – Publications

Conference Proceedings:

1. Rangiha, ME., Karakostas, B. (2013). Goal-Driven Social Business Process Management. *Proceeding The Science and Information Organization, Science and Information (SAI) Conference* (pp. 894 – 901). London, UK : IEEE. Retrieved from: http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6661848&tag=1
2. Rangiha, ME., Karakostas, B. (2013). Towards A Meta-Model for Goal-Based Social BPM: *Proceedings of BPM 2013 Workshops* (pp. 104 – 112). Beijing, China: Springer International Publishing. doi: 10.1007/978-3-319-06257-0_9.
3. Rangiha, ME., Karakostas, B. (2014). Process Recommendation and Role Assignment in Social Business Process Management. *Proceedings of the Science and Information Organization, Science and Information (SAI) Conference* (pp. 810 – 818). London, UK: IEEE. doi:10.1109/SAI.2014.6918279.
4. Rangiha, ME., Comuzzi, M., Karakostas, B. (2015). Role and task recommendation and social tagging to enable Social Business Process Management. *Proceedings of the 16th International Conference, BPMDS 2015, 20th International Conference, EMMSAD 2015, Held at CAiSE 2015* (pp. 68 - 82). Stockholm, Sweden: Springer International Publishing Switzerland. doi: 10.1007/978-3-319-19237-6_5.

5. Rangiha, ME., Karakostas, B. (2015). The Use of Social Tagging in Social Business Process Management. *Proceedings of 15th International Workshops IWCSN 2014, Org2 2014, PCS 2014, and QUAT 2014* (pp. 84 – 92). Thessaloniki, Greece: Springer International Publishing Switzerland. doi: 10.1007/978-3-319-20370-6_7.

Journal Papers:

1. Rangiha, ME., Karakostas, B. (2014). A Goal-Oriented Social Business Process Management Framework. *International Journal of Social, Behavioural, Educational, Economic and Management Engineering*, *8*(9), 2887 – 2893. Retrieved from: http://waset.org/publications/9999329/a-goal-oriented-social-business-process-management-framework
2. Rangiha, ME., Karakostas, B. (2014). Process Knowledge Discovery in Social BPM. *International Journal of Advanced Computer Science and Applications(IJACSA), Special Issue on Extended Papers from Science and Information Conference* (pp. 36 – 42). http://dx.doi.org/10.14569/SpecialIssue.2014.040305.
3. Rangiha, ME., Karakostas, B. (2013).A Socially Driven, Goal-Oriented Approach to Business Process Management. *International Journal of Advanced Computer Science and Applications(IJACSA), Special Issue on Extended Papers from Science and Information Conference* (pp. 8 – 13). http://dx.doi.org/10.14569/SpecialIssue.2013.030402.
4. Rangiha, ME., Comuzzi, M. (2015). A framework to capture and reuse process knowledge in business process design and execution using social tagging. *Business Process Management Journal* (In press).