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MODELLING COLLABORATION PROCESSES THROUGH DESIGN PATTERNS

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Abstract. Enterprise 2.0 has been introduced in the SME (Small Medium Enterprise) modifying common organizational and operative practices. This brings the 'knowledge workers' to change their working practices through the use of web 2.0 communication tools. Unfortunately, these tools do not allow intercepting and tracing the exchanged data, which can produce a loss of information. This is an important problem in an enterprise context because knowledge of the exchanged information can increase the efficiency and competitiveness of the company. In this article we demonstrate that it is possible to extract this knowledge by an abstraction process of the new operative practices, named collaboration processes, thanks to the use of design patterns. Therefore, we propose design patterns for the collaboration processes useful for modelling typical Enterprise 2.0 activities, having the goal of making more flexible and traceable the use of emerging operative practices.

Keywords: Collaboration process, design pattern, Enterprise 2.0, web 2.0, collaboration tools

1 INTRODUCTION

In recent years, as a consequence of emerging communication methods that gradually won the day also in a business context, the term *Enterprise 2.0* has been introduced. Enterprise 2.0 allows the use of social networking tools within compa-

nies, or between companies and their partners or customers, and helps people to connect or collaborate through computer-mediated communication, creating online communities [1]. Enterprise 2.0 stimulates collaboration and knowledge sharing, not only in large companies, but also in small and medium sized ones. Therefore, new operative practices that accompany and complete existing ones have been introduced. As a consequence, in addition to traditional business processes that define the working practice of a company, it is possible to identify several *collaboration processes* as defined by Nial Cook [2]. Collaboration processes are characterized by a strong and not-predefined collaboration among the employees in order to achieve common goals. This collaboration is carried out through a combination of traditional communication tools (e-mail, telephone, direct conversation) and *web 2.0* facilities (chat, social networks, blogs, wikis, etc.). The employees involved in a collaboration process are free to choose their favourite *collaboration tool*. Therefore, there is no predefined workbench within the company: the single employee is the only one who knows and understands his needs, building and modifying his workbench. With Enterprise 2.0, employees are now becoming knowledge workers [3] and they are the ones best equipped to understand the customer and the business processes [4].

The use of Enterprise 2.0 tools allows people to be significantly more productive, but they need to be trained or receive facilitation support [5]. It is very important that the aid comes from the companies' information systems and IT infrastructure. The real problem is the discrepancy between the social needs, the knowledge worker experience [6] and the information systems [7]. Very often, the information system is not ready to allow the execution of collaboration processes, so knowledge workers use their own *collaboration tools* outside the system itself, with the consequence of a loss of information useful for the companies. These collaboration processes require new functionalities compared to traditional information systems, such as facilities for communication, file sharing, knowledge networking, calendaring and scheduling [8], and so on.

In order to align the information systems to the new user needs, we exploit the traditional approach of BPM (Business Process Management): to outline the business driven for BPM, to articulate the targeted process, and to have a clear agenda for deployment strategies [9]. In other words, it is important, first, to describe the flow of the business process, using some graphical notation, and next to identify some best practices in order to apply them to the specific context. The visualization of business processes in the form of process models has increased in popularity and importance [10]. The real challenge is to derive process models efficiently (i.e. consuming less resources and time) and effectively (i.e. at a high quality to meet specific needs).

As a consequence, the problem becomes identifying and designing collaboration processes in order to integrate them in the information system. In order to solve this problem it is necessary to understand the current process (in our case, the collaboration process), and to aim towards a better process (in our case, supporting the knowledge worker experience). To do so, the best practices in the sector must be analysed and the current business processes must be re-designed.

A pattern based approach can be useful to re-design processes [3]. In fact, the concept of pattern has been effective in practical contexts and will probably be suitable in others [11]. The pattern based approach has been inherited from the traditional approach to the design of business processes (www.workflowpatterns.org), and from the software engineering sector [12]. Several researches propose the use of workflow patterns as a means to categorize recurring problems and solutions in modelling business processes [13].

The basic benefit of such patterns is that the fundamental elements can be reused and, hence, better knowledge management, efficiency, and effectiveness can be reached when they are applied within projects. Therefore, patterns can be considered as building blocks that allow designers to compose solutions in order to obtain meaningful artifacts with minimal effort. In the context of Enterprise 2.0, very few research works have been made, probably, in our opinion, because it is very complex to design business processes that do not follow a well defined flow. Collaboration processes can be designed, as explained in [14], using *design patterns* of BPMN notation.

In this article, five business process collaboration patterns have been identified using an approach that takes into account the common practices proposed in [15] for the identification of design patterns in collaborative learning contexts. The discovered collaboration patterns, named Enterprise 2.0 design patterns, are useful to design business processes in order to facilitate the introduction of collaboration within information systems and to trace the exchanged data among the knowledge workers involved.

The article is structured as follows: Section 2 reports on the most important related works about design patterns and their application to business process design. Section 3 presents the approach adopted to identify business process collaboration patterns introducing the case study selected in cooperation with the company that took part in the research. Section 4 gives a detailed specification of Enterprise 2.0 identified design patterns. Section 5 describes how design patterns have been applied to the case study defined in Section 3. Finally, in Section 6 the conclusions summarize our key messages and sketch future research directions.

2 RELATED WORKS

Over the years, the concept of patterns has been applied in several fields. The idea was proposed by Christopher Alexander in his book *A pattern language* [16] where he scientifically describes an architectural system through 253 patterns that solve common problems of cities. The concept of patterns has been adopted and applied in the field of software engineering by the 'Gang of Four' in their famous book *Design Patterns: Elements of Reusable Object-Oriented Software* [17]. It has been applied in recent research in business process management (`www.workflowpattern.com`) and other research works such as [18] that predict the proliferation of patterns for BPM. In [19] its use has described and evaluated workflow management technologies.

Several methods in the identification of patterns have been proposed in the international scientific literature, such as bottom-up and top-down approaches [15], or a combination of these two [20]. Once identified, business process patterns have been used in different contexts for the re-design of the business process flow. An example is in [21] where the authors present business processes patterns in order to enhance the design of the public health care business process. Another example is in [22] where the authors propose a methodology for business process re-design; the methodology consists of using the process context to discover the process nature and then applying the workflow patterns to the evaluating and enhancing of the current process in the given context.

The previous works clarify the importance of business process patterns in order to design and re-design a business process flow made up of pre-defined activities assigned to specific stakeholders. In such collaboration processes it is very complicated to define who does what and when. The patterns, and in particular the collaboration patterns, still are helpful to designers. The concept of collaboration patterns has been introduced in the definition of *virtual organization*. A virtual organization is 'a temporary alliance of independent enterprises that come together to share skills, core competencies and resources in order to better respond to business opportunities, supporting cooperation through computer networks' [23]. The importance of such collaboration patterns in virtual organizations has been stressed in [24] where collaboration patterns were defined as a segments of work or parts of collaboration. The authors highlighted that the reuse of collaboration patterns can be an advantage in collaborative environments, such as virtual organizations, where there is an increasing need for modelling, executing, monitoring, and supporting the dynamic nature of collaborations.

In [5] there is another work that proposes some collaboration patterns related to the virtual organization. These patterns are aggregations of detailed activities into larger-scale units. In that paper, the authors present a shared workspace system in order to collect and make available observations of a virtual organization. The real value of business patterns may be appreciated when it is possible to use the patterns in the design of business processes that describe the way of operation of the companies. Graphical models can be used to represent the patterns.

In the (not collaborative) business patterns research area there are some representation examples that exploit BPMN notation [25], see for example [26]. The concept of collaboration patterns, instead, has been treated from the sociological point of view [5] and there are very few works about graphical representations. An example of collaboration business process patterns is in [14] where the author describes guidelines for the development of business process models using BPMN 1.2. These guidelines focus on the use of the elements in order to correctly, consistently and clearly design artifacts, but do not focus on syntax and semantics. The report provides guidance for modellers who need to capture typical process semantics in order to build a high level design. The report describes both the elementary patterns and the collaboration ones from which we took our cue to identify the set of design patterns presented in this article. The importance of representing collaboration

business processes, in general, and collaboration patterns, in particular, is shown by the introduction of BPMN 2.0 [27]. BPMN 2.0 contains several additional elements and new types of diagrams, especially to improve the modelling of processes that span several independent organizations. In particular, BPMN 2.0 introduces the collaboration diagram and the choreography diagram.

3 STUDY APPROACH

In this section we present the method used to identify the proposed collaboration patterns. An action research approach was chosen, with the goal of producing immediate practical and research outcomes. The research has been carried out in cooperation with an Italian company that operates in the ICT field. The approach used takes into account the company's needs and the best practices currently available for the identification and application of the design patterns. In particular, the method proposed by [15] is used as a guideline. Our approach is structured in five steps, as shown in Figure 1.

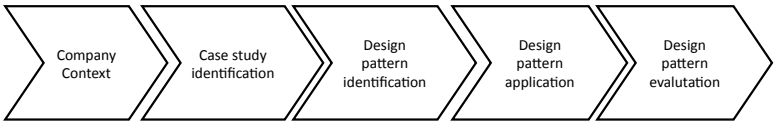

Fig. 1. The approach adopted to identify business process collaboration patterns

The description continues as follows: this section deals with the activities related to the definition of the Company Context and the Case study identification. Section 4 deals with Business pattern identification and Section 5 describes the application of the Business pattern to the case study. Business pattern evaluation is not covered by this article. As we explain in Section 6, it will be the topic of another work that will be submitted when the company that funds the research completes a software test environment exploiting social network analysis techniques able to automatically detect interaction patterns and compare them to the proposed collaboration patterns.

3.1 Company Context

An Italian company that operates in the ICT sector commissioned the research. It has several branches spread all over the world. Three main branches are present in three Italian regions and another two branches at Seoul (Korea) and Cape Town (South Africa). The company is based on three main competence areas (consulting, communication, technology). Each of them is characterized by specific skills spanning from e-commerce advisory to software and system development. The company has 140 employees that operate in five business units spread all over the globe. Clearly, in such a context the optimization of collaboration among resources, very

often distributed among several business units and involved in different projects, becomes a key aspect for the efficiency of the company. Table 1 summarizes the company profile.

Business sector	ICT
# employees	140
# branches	5
Geographical distribution	Italy, Korea, South Africa
# business units	5
# employees for each business unit	Technology: 42 Consulting: 23 Communication: 20 Lecce: 26 Treviso: 11

Table 1. Company profile

3.2 Case Study Identification

The case study identification has been obtained through ten focus groups with top management and business unit directors who have identified two main processes:

Budget creation: the process that allows estimating costs and human resources needed for a given time period related to a new incoming project.

Purchase order: the procedure that allows the company to control the purchasing of products and services from external suppliers.

In this article the budget creation case study is presented. It has been selected because it is very suitable for the identification and empirical evaluation of the proposed design patterns. In fact, it requires a high degree of collaboration among participants to define a common and correct quotation of the budget (as will be shown in the next section). The creation of the budget is an unstructured work and it generates much semi-structured information.

The analysis has been carried out in an empirical way because the logs of e-mails and chats were not available due to privacy laws. Therefore, it has not been possible to use social network analysis tools in order to obtain numerical data about the interaction among employees. The software that the company uses to manage the budget is not proper for managing collaboration and it is mainly adopted to archive information related to the process. The pattern identification has been obtained by interviewing key actors. We have analysed about 350 instances of the budget creation process, where about 40 employees have been involved (the number of budget creation processes and employees was obtained by exploring the software database). Ad hoc questionnaires were used as a basis for interviewing people and employees (about 20 interviews). The most evident problem that arose was the

loss of information exchanged by knowledge workers due to an uncontrolled use of web 2.0 tools.

3.2.1 Budget Creation Case Study

The budget creation case describes the process of budget management. Within the company, business management is supported by a system able to verify project costs. The first step for starting a business is budget creation. This process is needed to define needed economic resources in terms of:

- Human resources;
- Infrastructural resources (hardware and software);
- Resources for suppliers and external advisors;
- Training resources;
- Logistics resources.

The company is equipped with a software system to manage budget creation but this system only takes into account the data produced in each task without tracing all the information exchanged among actors. The involved actors are:

- Managing Director (MD);
- Client Manager (CM);
- Project Manager (PM);
- Finance Controller (FC);
- Business Unit Manager (BM);
- Head of Human Resources (HHR).

All actors deal with any aspect of the business, from negotiation with the client, to approval costs and resources management. The information regarding budget definition are:

- Client name;
- Project name;
- Tasks;
- Quotation for each task.

The sub cases involved in the budget creation process are:

- The CM defines the information to share with the client.
- The FC verifies the correct execution of the process and the updating of the management system.
- The CM can autonomously define the quotation or can require a consultation with one or more BMs *(collaborative activity)*.

- The CM can autonomously identify a PM or can require a consultation with one or more of the BMs *(collaborative activity)*.
- The CM can delegate to the selected PM the definition of a budget to share with client.
- The PM can autonomously define the quotation or can require a consultation with one CM and one or more of the BMs *(collaborative activity)*.
- The PM must require the approval of his quotation to the CM and all BMs involved in the project.
- The CM negotiates the price with the client, sharing with him the scheduled tasks and the related quotations.
- The MD must evaluate and approve the proposed budget before starting with project tasks.
- The MD can require a new budget redefinition from PM.
- The PM can autonomously define the resources involved in the project and require a binding consultation with HHR *(collaborative activity)*.
- The PM can monitor tasks asking for periodic reports to the involved resources *(collaborative activity)*.

The high number of collaborative activities involved in the process brought us to choose this process in order to verify and evaluate the proposed Enterprise 2.0 design patterns.

3.2.2 Purchase Order Case Study

The purchase order case describes the process regarding all tasks to fulfil an order of goods or services needed to carry out the business of the company. This process allows the company to obtain resources and it is based on a well-defined schema. The purchase order process involves several figures, such as the Managing Director (MD), Client Manager (CM), Project Manager (PM), Finance Controller (FC), BU Manager (BM), Head of Human Resources (HHR), Supplier (S) and can start from any branch of the company. Some requests can be autonomously dispatched by the branch that requires the goods or services while other requests require the approval by the main branch and then, directly, by the Managing Director. This process does not have any collaborative activity at all and the tasks follow a well-defined sequence; for this reason we rejected it for our article goal.

4 ENTERPRISE 2.0 DESIGN PATTERNS IDENTIFICATION

For trying to design the collaborative and dynamic aspects of a company, it is not enough to standardize the operative practices introduced by Enterprise 2.0. Nevertheless it is important to introduce a standardization of these new practices within

the information system for two main reasons: to guide the adoption of collaborative technologies within the company in a controlled way, and to avoid the loss of information. It is important, following the BPM approach, not only to identify the business process patterns but also to represent them in some notation in order to simplify the reading and comprehension of each pattern. To do so, in this article we use BPMN 1.2. This choice is due to the need to have a notation well known to the company and supported by technological tools. BPMN 1.2 is the de-facto standard for business process design and it is supported by a set of tools that allows us to rapidly verify the design. Finally, the use of BPMN 1.2 in the design of collaboration processes does not force the designer to learn new notation but allows the designer to use, in a best way, his/her analysis capacity in order to identify and design the collaborative aspects.

The Enterprise 2.0 design patterns presented in this article answer the following needs:

- To manage the collaboration among actors that must complete a work without a pre-defined and pre-structured sequence of tasks.
- To allow the use of web 2.0 tools within the company in a controlled way.
- To allow tracing and storing the largest amount of the unstructured information typically exchanged using web 2.0 tools (chat, wikis, forums, VoIP, videoconferences, e-mails).
- To identify (if possible), emerging methods that characterize Enterprise 2.0.

The patterns here identified do not support all the situations of Enterprise 2.0 but provide a clear idea about the abstraction process useful to identify each pattern. The patterns may be used in separate contexts or may be aggregated in order to design specific situations. We present in Figure 2 the conceptual map that can be used as an overview of the rest of the article. In this conceptual map there are two types of notation:

- Abstract pattern (*in italics*): this pattern does not have a design related to it but only a description. The pattern must not have an instance but can be instantiated through a concrete pattern.
- Concrete pattern or pattern (in normal): this pattern has a design related to it. The pattern may have an instance by a configuration of the parameters that characterize it. It can be an instantiation of an abstract pattern. A concrete pattern may use another pattern.

The relationships defined between the previous types of notation are:

- Uses: this allows us to activate another pattern inside the pattern, configuring existing parameters.
- Specialize: this allows us to define a concrete pattern starting from an abstract pattern.

The syntax used to describe the pattern is:

$$\text{P}\langle\text{N}\rangle\langle\text{Version}\rangle\_\langle\text{Pattern Name}\rangle \quad (1)$$

where:

- P means that we refer to a pattern;
- ⟨N⟩ is a number that identifies the pattern;
- ⟨Version⟩ is an upper case letter (A, B, C, etc.) to identify the version of the pattern;
- ⟨Pattern Name⟩ is the name assigned to the pattern.

The conceptual map depicted in Figure 2 represents the following Enterprise 2.0 design patterns:

- P1_Collaborative Decision Making: it allows designing a scenario where the collaboration activity refers to the possibility of sharing the decision about a specific topic. The pattern involves several types of actors and several actors of the same type.
- P2_Collaborative Editing: it has the goal to design a scenario where more actors can cooperate to obtain an artifact or to take a collaborative decision.
- P3A_Collaborate and P3B_Collaborate Enhanced: during a collaboration activity that makes use of web 2.0 tools, it allows aggregating information coming from collaboration. After the use of web 2.0 collaboration tools, users review the activities. In the enhanced version users may decide to store the shared information.
- P4_Aggregate Activity Loop: it allows storing the information exchanged during a collaboration activity using web 2.0 tools.

We observe the presence of the abstract pattern P3_Collaborate that is the generalization of the pattern P3A_Collaborate and P3B_Collaborate Enhanced. In Table 2 is shown a list of patterns with the dependencies and relationships between them.

Pattern name	**Relationship**	**Dependence**
P1_Collaborative Decision Making	Uses	P2_Collaborative Editing
P2_Collaborative Editing	Uses	P3A_Collaborate P3B_Collaborate Enhanced
P3A_Collaborate	Specializes	P3_Collaborate
P3A_Collaborate	Uses	P4_Aggregate Activity Loop
P3B_Collaborate Enhanced	Specializes	P3_Collaborate
P3B_Collaborate Enhanced	Uses	P4_Aggregate Activity Loop
P4_Aggregate Activity Loop		

Table 2. List of patterns and their relationships and dependencies

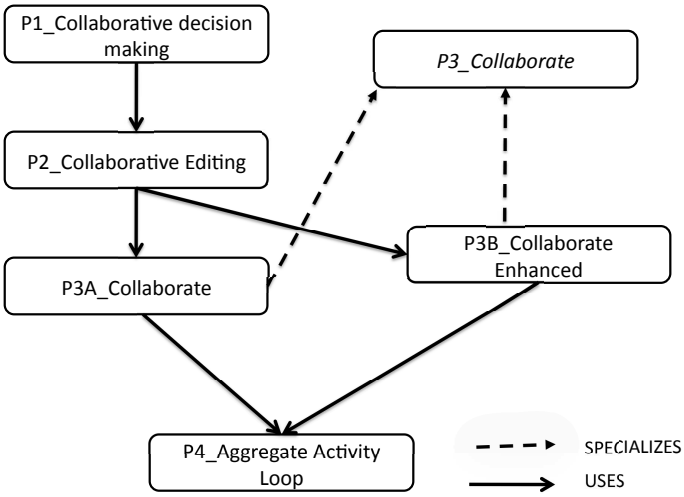

Fig. 2. Conceptual map of the proposed patterns

In the following, we provide the details of the identified patterns. The collaboration patterns are detailed through attributes that help understand the description of the problem and its solution. In particular, a collaboration pattern has:

- A name as a collaboration pattern identifier;
- A purpose that defines the motivations needed to identify the pattern;
- A description that describes the collaboration pattern in a natural language;
- A structure that defines the business process flow;
- An example that explains a possible use case where the pattern may be applied.

4.1 P1_Collaborative Decision Making Pattern

Name: P1_Collaborative Decision Making

Purpose: The pattern P1_Collaborative Decision Making allows including several actors in a collaboration activity where the goal is to take a decision about some topic and the decision involves several responsibilities.

Description the pattern allows designing a scenario where the collaboration activity is to decide about a specific topic and in this decision are involved several types of users and several users for each type. In this scenario there is the role of Moderator. Moderator has the task to prepare a draft to discuss and/or to modify the draft during the collaboration activity. After the discussion Moderator has the task of preparing the artifact that represents the results of the discussion. There are also two types of decision maker: Main Decision Maker, involved in the collaboration activity, and Decision Maker(s) (it is possible to

have one or more decision makers) that may contribute to the discussion of a topic (but he/she is not forced to participate in the discussion). The pattern P1_Collaborative Decision Making uses the pattern P2_Collaborative Editing.

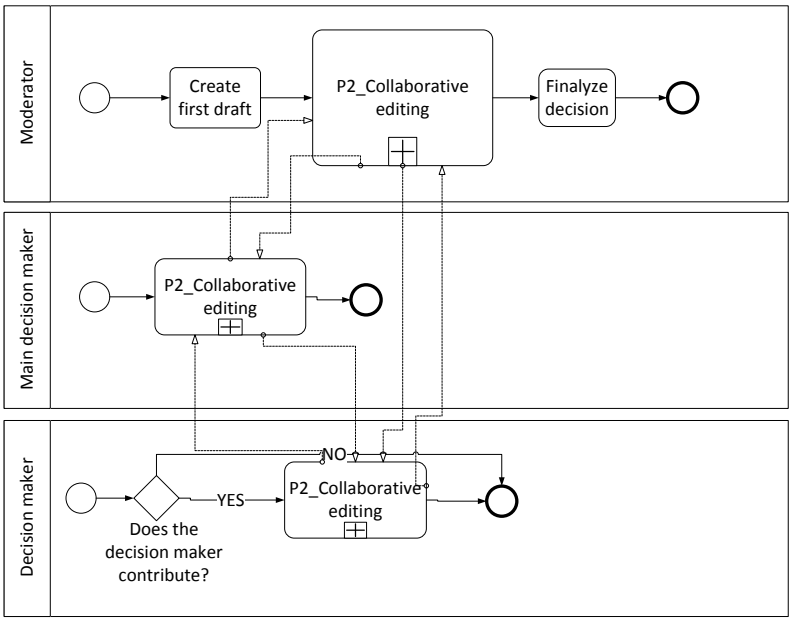

Fig. 3. The P1_Collaborative Decision Making pattern structure

Structure: The pattern foresees the presence of three actors: Moderator (one moderator), Main Decision Maker (one main decision maker) and Decision Maker (one or many). The first action is taken by Moderator, it creates a first draft of the artifact that is the subject of the cooperation. The artifact can be modified by the three actors at the same time, but probably in different places (the collaborative editing pattern will be presented later). The Main Decision Maker must participate in the collaboration activity because he/she must accept the choice and/or the produced artifact. Each of the other decision makers may decide to participate in the collaboration activity. After finalization of the collaborative editing, Moderator produces the artifact. In Figure 3 the reference model of the design pattern P1_Collaborative Decision Making is shown using BPMN 1.2. It is important to note that the incoming and outcoming message flow represents the collaboration between actors.

Example: An example of the use of this pattern is when the company plans a new project, the Project Manager consults the person responsible for the Business Unit involved in the project. In order to do so, the project manager defines a first draft of the plan and, in a collaborative way, the draft is enhanced thanks to the contribution of each responsible person of the business unit. The Project

Manager is the Moderator of the pattern; the person chiefly responsible for the business unit directly involved in the project is the Main Decision Maker while those responsible for the other business units that are not directly involved in the project plan are Decision Makers. A Decision Maker may choose to not contribute to the planning.

4.2 P2_Collaborative Editing Pattern

Name: P2_Collaborative Editing

Purpose: The pattern P2_Collaborative Editing allows representing the collaboration activity in a team that must work in a collaborative way. The goal is to allow the employee that belongs to the team to collaborate in the definition of an artifact.

Description: The pattern P2_Collaborative Editing aims to design a scenario where several actors must collaborate in order to obtain an artifact or, in general, to take a decision in a collaborative way using web 2.0 tools. In this context there is a decision team that participates in this collaborative editing process. It is important to note that it is possible to use the pattern P2_Collaborative Editing with other collaboration patterns where there is the need to define a collaboration team. The collaboration team will be defined on the fly and it is made up of employees that, regardless of their roles, may acquire a role in the decision team and participate in the cooperation activity with a well defined goal. The pattern P2_Collaborative Editing may be used in any context where it is important to activate a team that must collaborate in order to complete a shared activity.

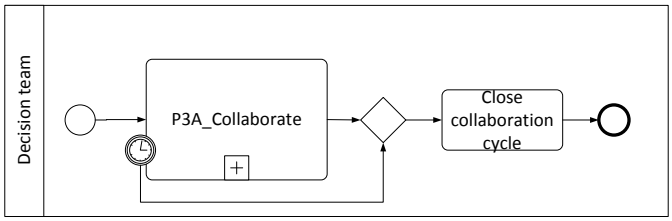

Fig. 4. The P2_Collaborative Editing pattern structure

Structure: The P2_Collaborative Editing pattern has only one actor, the Decision Team. It represents all the actors involved in the collaboration activity. The P2_Collaborative Editing pattern uses the pattern P3A_Collaborate or the pattern P3B_Collaborate Enhanced in order to collaborate during the editing. It is possible to activate the collaboration for a well defined period of time or it is possible that the collaboration pattern (P3A_Collaborate and P3B_Collaborate Enhanced) ends when the activities are sufficient for the goal of the decision team. All the members of the team review the artifact and the P2_Collaborative

Editing pattern may be closed. In Figure 4 the reference model of the design pattern P2_Collaborative Editing is shown using BPMN 1.2.

Example: An example of application of the pattern is as follows: when the collaboration team is defined, all the users of the team must cooperate in order to take a decision. To do so, they use collaboration tools such as wiki, forum, chat, etc. The collaboration process ends (the decision is taken and/or the artifact is complete) when the time for the activity ends or when the produced activities are sufficient. A concrete example is the definition of a new strategic goal: this new strategic goal may be defined by several business unit leaders. The business unit leader may use collaborative tools to take the decision. The process may end because the time needed to take the decision expires or because the leader of the business unit agrees with the strategic decision as the expiration date approaches.

4.3 P3A_Collaborate Pattern

Name: P3A_Collaborate

Purpose: The necessity to trace and to elicit knowledge from the activity that, until now, was managed through several web 2.0 tools, gives birth to the P3A_Collaborate pattern. This pattern tries to solve the main problem of the web 2.0 tools: there is freedom to use any collaboration tool to share information but, at the same time, it is very complex to elicit knowledge from the activities.

Description: The pattern P3A_Collaborate defines a scenario where it is important to trace information exchanged during a collaboration activity made up using one of the web 2.0 tools such as instant messaging, wiki, e-mail, etc. The pattern can be used in several contexts by any actors.

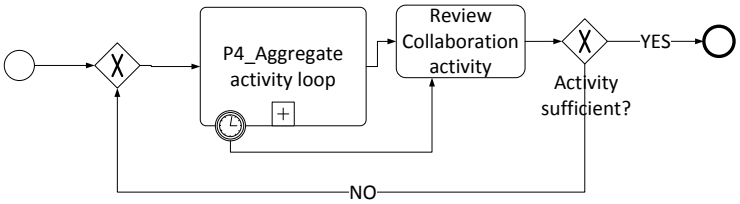

Fig. 5. The P3A_Collaborate pattern structure

Structure: The pattern P3A_Collaborate Pattern uses the pattern P4_Aggregate Activity Loop that aggregates the activities made using web 2.0 tools. After the end of the P4_Aggregate Activity Loop pattern, the involved actors review the activities and, if necessary, activate the collaboration again. The P4_Aggregate Activity Loop may end because the expiration date approaches or because the collaboration ends. In Figure 5 the reference model of the design pattern P3A_Collaborate Pattern is shown using BPMN 1.2.

Example: An example of the use of the pattern is the possibility to trace and to extract knowledge from an instant messaging conversation with the goal to evaluate and to share a budget. To do this activity it is important to approve the budget at the same time by more actors.

4.4 P3B_Collaborate Enhanced Pattern

Name: P3B_Collaborate Enhanced

Purpose: The necessity to trace and to elicit knowledge from the activity that, until now, was managed through several web 2.0 tools, gives birth to the P3B_Collaborate_Enhanced pattern. The pattern tries to solve the main problem of the web 2.0 tools: there is freedom to use any collaboration tool to share information but, at the same time, it is very complex to elicit knowledge from the activity. The pattern allows storing the information exchanged between actors.

Description: The goal of P3B_Collaborate Enhanced is to design a scenario where it is important to exchange information during a collaboration activity made up using a web 2.0 tool such as instant messaging, wiki, mail, etc. Compared to P3A_Collaborate, the P3B_Collaborate Enhanced pattern has the option of storing the collaboration activity or of discarding it.

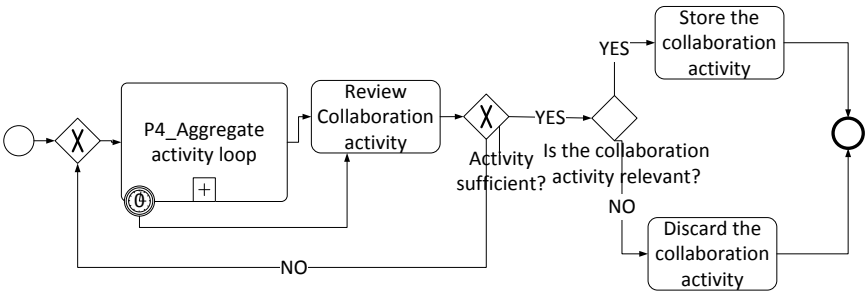

Fig. 6. The P3B_Collaborate Enhanced pattern structure

Structure: This pattern, just as the pattern P3A_Collaborate, uses the pattern P4_Aggregate Activity Loop that aggregates the activities made using a web 2.0 tool. After the end of the P4_Aggregate Activity Loop pattern, the involved actors review the activities and, if necessary, activate the collaboration again. When the review ends, the involved actors evaluate the possibility of repeating the P4_Aggregate Activity Loop. The actors also evaluate the possibility of storing the activity or of discarding it. The P4_Aggregate Activity Loop may end because the time expires or because the collaboration ends. In Figure 6 the reference model of the design pattern P3B_Collaborate Enhanced is shown using BPMN 1.2.

Example: An example of application of the pattern is the same as that of the example for the P3A_Collaborate pattern but, in this case, the information exchanged can be stored.

4.5 P4_Aggregate Activity Loop Pattern

Name: P4_Aggregate Activity Loop

Purpose: The pattern P4_Aggregate Activity Loop allows extracting structured information from the activities made using web 2.0 tools that generate unstructured information.

Description: The goal of the P4_Aggregate Activity Loop is to store information coming from activities that use web 2.0 tools.

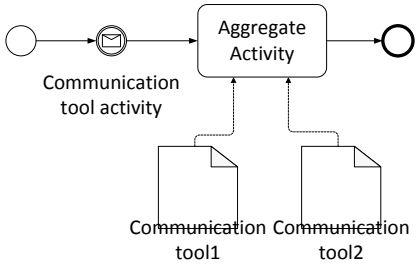

Fig. 7. The P4_Aggregate Activity Loop pattern structure

Structure: The pattern starts each time the actor uses one or more communication tools. In the pattern there is the possibility to elaborate and transform unstructured information into structured information. In Figure 7 the reference model of the design pattern P4_Aggregate Activity Loop is shown using BPMN 1.2.

Example: An example is the possibility to structure information coming from an instant messaging conference.

5 ENTERPRISE 2.0 DESIGN PATTERN APPLICATION

The previously described design patterns have been applied to the budget creation case study (Section 3). The budget creation process involves many employees; it is characterized by a massive use of web 2.0 tools during the collaboration activities, as shown in Table 3.

The table data have been obtained according to the following considerations:

- The number of collaboration activities has been empirically derived analysing the budget creation process (see the study approach in Section 3).
- The number of involved employees during the process execution has been obtained through interviews and focus groups with the company's employees.

(a)	# collaborative activities comprising the process	5
(b)	# involved employees during the process execution	40
(c)	# budgets/year	350
(d)	# collaborative activities/year	1 750
(e)	# different web 2.0 tools involved in the process	3 (skype, video conference, e-mail)
(f)	# web 2.0 tools' uses in the process	100
(g)	# web 2.0 tools' uses/year in the process	35 000

Table 3. Numerical details of the budget creation process

- The number of budgets per year has been derived analysing the intranet repository used by the company to manage the budget's lifecycle.
- The number of collaborative activities per year has been calculated as

$$(a) * (c). \tag{2}$$

- The number of different web 2.0 tools categories used during the process execution has been derived through interviews and focus groups with the company's employees.
- The number of web 2.0 tool instances used in the process execution has been derived analysing a sample of representative process instances. The obtained (average) value has been uniformly applied to all budget creation process instances.
- The number of web 2.0 tools' uses in the process per year has been calculated as:

$$(c) * (f). \tag{3}$$

This data shows a large information loss during the execution of the budget creation process and a lack of formalization in repetitive and, often, very similar activities. Therefore, the case study is useful to verify the pattern's capability of modelling a recurring situation, to demonstrate the pattern's neutrality to specific contexts and their composition, and to validate the aggregation capability in order to solve recurring problems. For this reason, the design patterns have been applied to all collaborative sub-cases that characterize the budget creation process. In particular, the following sub-cases have been modelled through Enterprise 2.0 patterns:

1. The CM can define quotation requiring a consultation with one or more BMs (Define quotation 1).
2. The CM can identify a PM requiring a consultation with one or more BMs (Identify the PM).
3. The PM can define quotation requiring a consultation with one CM and one or more BMs (Define quotation 2).

4. The PM can autonomously define the involved resources for the project and must require a binding consultation with HHR (Identify resources).

Table 4 summarizes the modelling of the budget creation sub-cases obtained by the proposed Enterprise 2.0 design patterns.

6 CONCLUSIONS

Enterprise 2.0 established itself both in small-medium sized companies and in large-scale enterprises thanks to the use of web 2.0 communication tools; such tools support cooperative and synchronous interaction among employees. As knowledge workers, employees are involved in a set of collaboration processes and, very often, they are the only ones who know the information exchanged during the process activities. Traditional IT infrastructure does not trace and store this data. Therefore, the loss of the information translates into a decrease of company know-how.

The collaboration processes must be re-designed to avoid this loss of information while guaranteeing, at the same time, their coexistence with the non-collaborative (traditional) ones. A pattern based approach helps in defining the collaborative aspects of the business processes. The five design patterns proposed in this article have the goal of managing and controlling the operative practices of using web 2.0 that generate large amounts of unstructured information.

The proposed approach allows companies to identify and to design some collaboration activities recurring in the enterprise practices. The collaboration patterns can coexist with the traditional business process design. Compared with the state of the art [21], our approach is not focussed on a specific application domain but may be used in several situations where the problem of managing the collaboration arises. While the state of the art mainly deals with the sociological aspects of collaboration [5], we identified new collaboration patterns and we presented an example of their representation using BPMN 1.2. In order to discover them, we observed the operative practices of knowledge workers in some real business contexts, focussing on the their collaborative aspects. The patterns proposed in this article come from an abstraction process of a real case study (budget creation) but do not include all the possible recurring configurations. In order to define new Enterprise 2.0 patterns, a deeper study of other business processes is needed.

Our research continues in two directions. On the one hand, we will define new patterns in order to describe other typical situations of Enterprise 2.0. We are studying the following design patterns: Retrieve Contribution, Coordinate Contribution, Reminder, Deadline Agreement, Escalation. These patterns allow modelling processes where the use of web 2.0 tools is dominant.

On the other hand, we will evaluate the proposed patterns applying proper social network analysis techniques over data and meta-data exchanged among knowledge workers during collaborative activities in a technology enabled test environment. In fact, the company that took part in this research started the implementation of a new software infrastructure for Enterprise 2.0 information systems (named Kpeople),

Subcases	**Used Design Patterns**	**Notes**
Define quotation 1	P1_Collaborative Decision Making (P1) P2_Collaborative Editing (P2) P3B_Collaborate_Enhanced (P3B) P4_Aggregate_Activity_Loop (P4)	The P1 pattern is used with only two stakeholders because there are only two actors (CM and BM) involved in the process. The pattern P2 is used in order to allow the collaboration through web 2.0 communication tools (P4). The collaboration activity is stored through P3B.
Identify the PM	P1_Collaborative Decision Making (P1) P2_Collaborative Editing (P2) P3A_Collaborate (P3A) P4_Aggregate_Activity_Loop (P4)	The P1 pattern is used with only two stakeholders because there are only two actors (CM and BM) involved. The pattern P2 is used in order to allow the collaboration through web 2.0 communication tools (P4).
Define quotation 2	P1_Collaborative Decision Making (P1) P2_Collaborative Editing (P2) P3B_Collaborate_Enhanced(P3B) P4_Aggregate_Activity_Loop (P4)	The P1 pattern is used with three stakeholders: PM, CM and BMs but any BM can decide not to participate. The P2 pattern is used to allow the collaboration through web 2.0 communication tools (P4). The collaboration activity is stored through P3B.
Identify resources	P1_Collaborative Decision Making (P1) P2_Collaborative Editing (P2) P3A_Collaborate (P3A) P4_Aggregate_Activity_Loop (P4)	The P1 pattern is used with only two stakeholders because there are only two actors (PM and HHR) involved in the process. The P2 pattern is used to ask about resource availability.

Table 4. Enterprise 2.0 design patterns application

exploiting collaborative web 2.0 tools, dynamic process composition methods, and semantic engines. In particular, the system will be built upon an event driven architecture that, thanks to custom adapters, will trace and store events generated by traditional information systems (CMS, BI, CRM, ERP, etc.), communication tools (e-mail, VoIP), and web 2.0 facilities. Events will be connected and clustered using domain ontologies. Event streams may be analysed by social network analysis tools, which will be part of the infrastructure. The Kpeople system will be available in the next six months for experimental tests.[1] Moreover, the validation environment will provide the appropriate context to carry out automatic discovery of new design patterns. Other details about the evaluation architecture and its implementation are available at `http://kpeople.webscience.it`, the open source community website that describes the overall kpeople research project.

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