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ABSTRACT

Business Process Management Systems (BPMSs) are increasingly implemented in and across organizations. However, the current combination of functionality, concepts and characteristics in BPMSs is very much based on an industrial-based view of the economy while western economies are rapidly moving towards an information and service economy in which the ratio of knowledge workers is rising dramatically. Compared to the 'old' type of worker the knowledge worker is typically highly educated, used to collaborating with other knowledge workers and less likely to be sensitive to a controlling style of management in the execution of his or her work. While many organizations are initiating business process improvement projects to improve their processes, this is done with BPM-systems that are based on an old paradigm and therefore unable to support dynamic and collaborative processes. In this paper we propose a new architecture for BPM-systems that include functionality to support knowledge workers in their dynamic and collaborative activities and processes.

INTRODUCTION

Lately, Business Process Management (BPM) and Service Oriented Architectures (SOAs) receive much attention from practitioners and scholars alike. Software vendors use the fuzz and provide new labels on new and existing software products; IT-consultancy companies increase their services with BPM and SOA consultancy and implementation. BPM and SOA are considered as promising IS/IT strategies.

From the eighties and nineties, we identify two major business trends that seem to relate to BPM: Total Quality Management (TQM) and Business Process Reengineering (BPR) (Deming 1982, Hammer and Champy 1993). In the same period there was a rise in the implementation and use of new types of information systems like Enterprise Resource Planning (ERP) systems, Workflow Management (WFM) systems, advanced planning systems and more. What started as the automation of a company's internal processes soon focused on digitization of supply chains (Davis and Spekman 2003). Among others the Internet and associated network standardization made this possible. Since the year 2000 all these trends seem to converge into new types of information systems, that some (Smith & Fingar, 2003) call Business Process Management Systems (BPMSs). A BPMS can be defined as "a generic software system that is driven by explicit process designs to enact and manage operational business processes" (Weske et al., 2004). While Aalst et al. (2003) find that Business Process Management includes methods,

techniques, and tools to support the design, enactment, management, and analysis of business processes. In this way it can be considered as an extension of classical Workflow Management (WfM) systems and approaches. In these definitions BPM clearly is based on the industrial-based view of the economy in which activities and processes are clearly defined and standardized as much as possible. Based on the current status of many BPMSs it is possible to conclude that a BPMS solution needs to be able to analyse and model processes within and across organizational boundaries, execute the modelled processes, measure their performance and use this as an input to optimization. This in essence means that support of processes by a BPMS starts in design-time.

However in the past century, there has been a shift from the agricultural- and industrial- based economy to a more service- and knowledge-based economy (Takala, Suwansaranyu & Phusavat, 2006). This has led to a dramatically increase of the proportion of knowledge workers in the workforce. The first author who refers to the term knowledge workers is Drucker (1959). He defined knowledge workers as "workers that work with intangible resources". Besides the definition of Drucker, there are more authors that refer to knowledge workers. An example is the definition of Bennet (2003): "knowledge workers are individuals whose work effort is centered around creating, using, sharing and applying knowledge". In 1994 Drucker rephrased his definition of knowledge workers as: "high level employees who apply theoretical and analytical knowledge, acquired through formal education, to developing new products or services". In other words, knowledge work is human mental work performed to generate useful information and knowledge (Davis, 2002).

Based on the above it can be stated that the nature of knowledge work is more complex than the type of work that was typical to the industrial age and therefore also more difficult to manage and control.

Although knowledge work has been an important topic in both practice and science many organizations are still focusing on creating more efficient business processes by trying to automate tasks, activities and processes with BPM-systems based on the old paradigm. However as Fingar (2006) stated: "Processes don't do work, people do". Today the missing link in many process improvement initiatives is more attention for the role of knowledge workers within processes, resulting in a task-technology misfit (Goodhue & Thompson, 1995). A clear case for more awareness for the way that knowledge work is carried out is made by Harrison-Broniski (2005) in his seminal work 'Human Interactions: The Heart and Soul of Business Process Management'. In this book Harrison-Broninski states that organizations should be actively engaged in managing the collaboration between knowledge workers within and outside of the organization. The term that he uses for this is Human Interaction Management (HIM). However because almost all of the BPM-systems on the market today don't offer functionality to support HIM many organizations are not able to manage, support and control the collaboration between knowledge workers. Therefore in this paper we answer the following research question: What functionality should be added to BPM-systems to support knowledge workers in their dynamic and collaborative activities and processes?

RESEARCH APPROACH

At the start of this research we looked at different types of research approaches as described in literature. This was done to determine which activities should be undertaken to be able to answer our research question. First we looked at analytic theories that analyze 'what is'. "These theories are the most basic type of theory. They describe or classify specific dimensions or characteristics of individuals, groups, situations, or events by summarizing the commonalities found in discrete observations" (Fawcett & Downs, 1986; Gregor, 2006). The 'analysis and description' theory could be applicable because we want to describe the phenomena of knowledge workers whom collaborate and whose actions cannot be supported by the current BPM-systems offering. But because our research goes beyond analysis and description and also explains how and why BPMS does not cover the needed functionality this research could also be labelled as 'theory for explaining' (Gregor, 2006). Finally we also present a preliminary overview of functionality needed to support collaborative work. In other words we state how to do something and that is part of the 'theory for design and action'. This type of theory is about methods and justificatory theoretical knowledge that are used in the development of information systems (Gregor 2002a; Gregor & Jones, 2004; Walls et al., 1992). Hevner et al. (2004) in their seminal work on design science state that the design-science paradigm seeks to extend the boundaries of human and organizational capabilities by creating new and innovative artefacts which are then validated by applying them in practice. Because we are not planning to immediately applying our findings in practice we only partially adhere to design science research.

Based on the literature analysis we decided that our research will be based on two major activities. First a literature study is done to explain why the BPM-systems that are currently on the market are not capable in supporting collaborative work. This is done by describing the architecture of existing BPM systems (section 3) and the task characteristics of work executed by knowledge workers (section 4). The second part of the paper consists of describing how interaction between knowledge workers could be supported (by information systems) in such a way that organizations get more in control (section 5). And a market survey of existing information systems that have the potential to decrease the task-technology gap for knowledge workers (section 6). This is needed to be compliant with governance regulations but also gives business the opportunity to increase productivity of their employees and the organizational processes. Finally we end this paper with conclusions and further research suggestions.

CURRENT BPM-SYSTEMS ARCHITECTURE

Organizations that want to actively engage in managing collaboration between knowledge workers need to create an (or adjust their) organizational design that is able to support knowledge workers in a proper manner. The scientific discipline within the information systems domain that focuses on designing organizations is enterprise architecture (Robinson & Gout, 2007). Enterprise architecture describes in a systematic way the structure of an organization from various perspectives. Perspectives that can be distinguished are (Robinson & Gout, 2007): activity architecture, information architecture, data architecture, software architecture and technical architecture. The first view elaborates on the activities and processes of an organization whereas the information architecture described the information required and generated during the execution of the activities. Supporting the activities, process and information gathering are the software and data architecture; the latter storing the data in such a manner that it can be used by

the software, information and activity architecture. An overview of the technical solution making all of this possible is shown in the technical architecture.

A BPM-system is a collection of information system technologies to improve the efficiency, effectiveness and governance of business processes (Shaw, 2007). Information systems in this perspective are defined as the combination of the software-, data- and technical architecture. Analysis and research with respect to current, and to be developed, BPM-System Reference Architecture can be conducted in two ways: single system architecture analysis or reference architecture analysis (Yourdon, 1989; Rumbaugh et al., 1991; Kazman et al., 1993). Scholars have defined preferable ways for conducting research with regards to both situations. Single system functionality is primarily analyzed by object oriented or structured analysis of the actual system while reference architectures are often the result of a domain analysis (Kazman et al., 1993). In this paper the focus is on reference architectures therefore domain analysis is the preferred way of conducting research leading to a reference architecture which supports knowledge workers. The domain analysis executed adheres to Arango's (1988) methodology by first studying existing BPM-system reference architectures after which the bottlenecks/gaps and the sources of these gaps are recognized. The last step is to identify which of the existing architecture can be reused and which additional architecture is needed to close the identified gaps. Providing structure and internal validity the technology-to performance chain defined by Goodhue and Thompson (1995) is used as for method for analyzing bottlenecks. Reviewing current literature on BPM-systems architecture leads to the identification of three focus areas: service oriented architectures (Baina et al., 2003; Costa et al., 2004, Brahe, 2007), specific process architectures (Anzbock & Dustdar, 2004; Danial & Ward, 2006) and BPMS reference architectures (WFMC, 1999; Glabbeek & Stork, Sheer, & Nuttgens, 2000; Shaw et al., 2007; Weske, 2007).

Service Orientated Architecture (hence SOA) is an overall architecture approach which has not been specifically designed for BPM-systems. It advocates the use of small and reusable information system elements such that software applications can be deployed and maintained in a more agile and flexible manner (Brahe, 2007; Weske, 2007). Research conducted around SOA within the BPM field focuses on making processes flexible and agile and to bridge a gap between BPM technology and service oriented architecture with the use of service composition (Weske, 2007). As SOA is an overall architecture approach which in the BPM domain mainly focuses on the technical architecture layer it is left out of the scope of the domain analysis. Also out of scope of this review is literature focusing on the technical architecture of business processes for specific domain. Examples of such literature is Anzbock and Dustdar (2004) which described an architecture for modelling medical e-services, Maanmar (2006) who focuses on an technical architecture for mobile devices ad Danial and Ward (2006) who elaborate on an architecture for e-government solutions.

The last, and with regards to the domain analysis most important, category is literature discussing overall BPM-systems reference frameworks. According to Shaw et al. (2007) there is a limited amount of research available that in a sophisticated manner analyzes BPM-systems reference architectures, the authors concur with this. In the same paper Shaw et al. (2007) propose a BPM-systems reference framework: the BPMS pyramid architecture. Existing out of twelve different building blocks the framework indicates three different components within a BPM-system. Layer one representing the top of the pyramid (one building block): the enactable

process model. An enactable process model is a model that is designed in a specific language which allows it to be executed by a BPM-system (Warboys et al., 1999). Layers two and three both represent a specific part of the BPM-system namely the logic underlying the process model (five building blocks) and the information system support (six building blocks). The five building blocks representing the logic of the process model describes the formal model, the modelling language used, the modelling grammar, the abstraction level and the real world subjects modelled. Additionally the information system pillar describes the software and technical infrastructure needed to model and execute the business processes.

Based on a knowledge management view of business processes Jung et al. (2007) propose a reference framework consisting out of six elements. The six elements of the architecture are based on the lifecycle phases of a business process (model): creation, modelling, pre analysis, enactment, post analysis and evolution. Data created and/or modified in one of the components is stored in one of three repositories which represent the central part of the architecture. Repository one, see figure 1, stores the information with regards to the actual process model, example are: creation date, author, goal, and version but also the roles, flow, activities and gateways drawn within the process. Actual execution data of a specific process model e.g. participants, data, throughput time, resources used is stored in the instance knowledge repository. Additional information about the execution of a specific process retrieved from users is stored in the knowledge repository. Generating information about the process models must happen in a chronologic order meaning that before the enactment part of the architecture can execute a business process it must be modelled such that the repository contains template information.

Figure 1: Knowledge of an enacted business process model (Jung et al., 2007).

Components of process template knowledge

Structural elements		Detail elements	Description
Basic Process Elements	Process Header Information	Creation Date, Author, Description, Goal, Version, etc.	Meta data and description for the process model
	Composing Activities, Flow & Condition	Activities, Transition, Condition	Information about activities, the components of process model, flow information among activities, and conditions required to execute the process
	Participant	Role, Organizational Unit, Human, System	Activity performers
	Related Data	Relevant Data, Application Data	List of data required to perform activities
	Resource	Application	List of resources required to perform activities
Elements Required for Reusing Process as Knowledge	Static Analysis & Simulation Parameter/Result	Static Analysis Result, Cost Estimation, Time Estimation (waiting time, working time, duration) Simulation Result	Static analysis results of process model, simulation input parameters and simulation results
	Evaluation Information	Criteria, Value	Evaluation criteria for process instances, aggregated process performance measure value

A third general reference framework is proposed by the Workflow Management Coalition (hence WFMC) which consist out of five components: process definition tools, workflow engine, administration and monitoring tools, workflow client applications and invoked applications (WFMC, 2010). Orchestrating the communication between the four components, the workflow engine is the central part of the architecture. It receives the modelled processes from the definition tools after which is uses the client applications and other workflow engines to monitor and exchange activities. The workflow engine can also invoke third party applications such as business rules engines (WFMC, 2010). The three reference frameworks discussed but also the specific process architectures examined (Anzbock & Dustda, 2004; Danial & Ward, 2006; Maanmar, 2006) have a common denominator in their architecture: an enactable business process model. As state before an enactable process model is a business process modelled in a

specific language such that it can be executed by a BPM-system (Warboys et al., 1999). To create enactable process models knowledge is needed about various aspects of the process such as flow, activities, roles etc, see Figure 1. When knowledge workers execute a process many elements of this information is not know upfront for example which activities are executed, the flow in which they are executed and who will participate. The question thus is: "Can the current reference architectures function without the enacted process models?" For the analysed architecture the answers to this question is no. All of the architecture will not properly function without the enacted model. This unfolds the main bottleneck with current BPM-system reference architectures and their support of work executed by knowledge workers: the architectures are not able to support the ad-hoc activities and therefore processes in which knowledge work is performed. An additional but similar bottleneck is that all architectures assume that the applications used are known upfront.

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BUSINESS PROCESSES AND KNOWLEDGE WORKERS

The previous section elaborated on existing BPM-system reference architectures and identified the main bottleneck regarding the support of knowledge workers: the use of enacted process models According to Goodhue and Thompson (1995) and Goodhue, Klein and Salavatore (2000) bottlenecks regarding the use of information systems can be classified into two categories namely task and technology characteristics. Both characteristics together measure the task-technology fit. This in turn influences the utilization of information systems and the performance of the organization. This section elaborates on the current task-technology misfit by explaining the kind of tasks executed by knowledge workers in comparison to non knowledge workers identifying three task characteristics causing task-technology misfit with current BPM architectures.

A Business Process ≠ A Business Process

Within scientific and professional literature many different definitions of business processes exist (Davenport & Short, 1990; Hammer & Champy, 1994; Jeston & Nellis, 2006; Weske,

2007). Although the many differences in the definitions used, four characteristics reappear in all of them: (1) the execution of task(s), (2) in a certain sequence, (3) to reach a certain goal and (4) thereby creating value. Depending on the author(s) one or multiple elements are either defined very loosely (Jeston & Nellis, 2006) or very strict (Bulletpoint, 1996). If every process exist out of the execution of tasks in a certain sequence to reach a goal delivering value what is/are the characteristic(s) that distinguishes a traditional process from a dynamic process?

The characteristic separating traditional business processes from dynamic processes is: value creation; more specifically the manner in which value creation is realized. Based on the old paradigm of managing business process value is delivered by creating more efficient and effective processes by automating and reordering tasks and creating interlinked chains of processes (Davenport & Short, 1990; Hammer & Champy, 1994; Stabell & Fjledstad, 1998). Additional value realized by this approach is consistency of products / services delivered to customers. To achieve this manner of value creation organizations create business processes which are translated to enacted models used by BPMsystems to execute and monitor the process (Hammer & Champy, 1994; Kettinger et al., 1996; Jeston & Nellis, 2007). The possibility of creating enacted business process models is achieved by the fact that the information about the execution of individual task, the sequence of tasks, the goals and perceived value is already know before the process is executed. Davenport (2005) indicated that this information was available for 70 percent of the processes in 1920. By 1980 this information was available for only 30/40 percent of the processes (Takala et al., 2006). Although no specific numbers are available it is estimated that currently this information is only available for 20 percent of the processes executed in organisations (Fingar, 2006). For the remaining 80 percent of the processes organizations are not able to produce enough information to create an enacted business process model upfront. These processes are executed by knowledge workers which have to make decision about the activities to execute, in which order, which resources to use and very important with who to collaborate to achieve the most value (Gregerman, 1981; Stabell et al., 1998; Glomseth et al., 2007; Chan, 2009). Examples of processes and occupations with these characteristics are developing new products and services, designing marketing programs, creating strategies, law, engineering, architecture and research (Stabell et al., 1998).

If knowledge workers decide upon the activities that they are going to execute and which resource to use themselves, does this then mean that we can say nothing about the execution of the process? From the paradigm of traditional business process we cannot but from the paradigm of value shops, knowledge management and interaction management, insights can be given into the process knowledge workers use to solve challenges / issues. Five high level iterative steps can be distinguished in this process namely: problem-finding and acquisition, problem-solving, choice, execution, control and evaluation (Stabell et al., 1998; Harrison-Broninski, 2005; Glomseth et al., 2007). During the first step the problem is formulated and overall approaches to solve the problem are formulated. After the overall approach has been formulated alternative solutions are evaluated; from the solutions an actual choice is made which is executed. The last step is to measure and evaluate the solution implemented and if needed go back to problem finding. The activities executed during the five steps are not predefined and the intensity of a step depends on the actual case to be solved. The same applies to the resources used in the different steps (Stabell et al., 1998; Harrison-Broninski, 2005; Glomseth et al., 2007). To illustrate this imagine a complex medical case in which the patient already has been misdiagnosed and the right diagnose has not yet been established. In this specific case a medical

specialist is consulted who takes over the case (Abbott, 1988). The specialist looks at the charts, orders additional blood tests (traditional 'standards' processes) and consults with colleagues about the best approach. After the solutions have been proposed a choice is made about the actual treatment. After the treatment has started the patient conditions get worse and the medical specialist starts consulting more colleagues but also his colleagues start consulting other colleagues starting the process of problem formulation again. The cycle will stay iterative till the patient receives a treatment that cures him.

Characteristics of collaboration between knowledge workers

The previous paragraph described the difference between the old paradigm (hence value chain) and new paradigm (hence dynamic processes). This paragraph will elaborate on the characteristics causing task-technology misfit of tasks executed by knowledge workers supported by current BPM architectures. This misfit can be attributed to the following characteristics: communication, kind of knowledge, optionality and modality.

Communication is defined as the activity of expressing information (to people). Within value chains communication is initiated by the BPM-system, the receiving party in this case are the employees that have to execute the tasks assigned to them by the system (Weske, 2007). Although sometimes communication between employees is possible and maybe necessary the act of communication is still initiated and structured by the BPM-system based on the process model. Communication in dynamic processes is initiated by the knowledge workers executing the process. The information systems used to facilitate the act of communication is of secondary importance (Stabell et al., 1998; McDermott, 1999; Harisson-Broninski, 2005). Whereas communication between BPM-systems and employees in a value chain is about procedures and work routines communication between knowledge workers has additional functions. During communication between knowledge workers unwritten work routines, personal tools, stories and wisdom about case-effect relationship are exchanged, thereby facilitating the creation of new knowledge which can be used to solve work related issues (McDermott, 1999). Communication and working with other knowledge workers therefore improves the performance of the individual worker and eventually the team (Gregerman, 1981; McDermott, 1999). From a business process management view it is desirable to capture the, electronic, communication between knowledge workers with regards to a specific case (a story). Reasons for this are the development of best practices, compliance and management/governance of business processes.

Explicit versus tacit knowledge is the second characteristic that differs between the two types of business processes. Within the knowledge management community this distinction is very familiar and many papers discuss the difference and codification of the two types (McDermott, 1999; Wegner & Snyder, 2000; Binney, 2001). Traditional BPM-system architectures are designed to use and manage explicit knowledge by codifying the information into enacted process models. Dynamic processes on the other hand rely far more on tacit knowledge and therefore cannot be codified upfront (Lytle & Coulson, 2009; Burkhard, Horan, & Leih, 2009). An architecture dealing with processes that mainly consist out of human interaction needs to be able to codify real-time information related to the process executed e.g. documents, time stamps, email traffic, communication, internal and external employees involved (Këpuska et al., 2008).

The last distinction between value chain and dynamic processes is the optionality and modality of system use (Biney, 2001). BPM-systems supporting value chains do not provide employees with the choice which software to use when executing a task. In addition they also have limited options available for presenting information to the employees. With regards to dynamic processes the modality and optionality in choice of information representation and system use increases. Knowledge workers often have a preferred way of working and data & information presentations (Binney, 2001; McDermott, 1999). This leads to the use of personal tools and information representations thereby decreasing the predictability of software use. A typical example of this is a knowledge worker that gets sales data from a central system copies this to an excel file, runs the numbers and sends the sales forecast to the management.

Due to the combination of changing tasks characteristics and the steady state of supporting information technology (BPM systems) a task-technology misfit has emerged. In the remaining of this paper a solution is proposed to get both characteristics set realigned by proposing a new BPM systems architecture.

STORIES AND THE HUMAN COLLABORATION BUS

So far we have described how organizations and their environment are rapidly changing and that the old industrial era paradigms are becoming less able to support, manage and control the activities and processes of companies. As a consequence the attention for process orientation has grown considerably in the last decade, and also the market for software companies offering information systems to analyze, model, execute and control processes is maturing quickly. However even these concepts are still very much based on the notion of being able to determine upfront which tasks, roles and processes are needed in an organization. In this view workers are still little more than part of an engineered system without a free will and with no room for their own interpretations and adaptation of the tasks they are assigned to do. This however will not be tolerated by a growing highly educated workforce that sees work no longer as just a means to pay for the bills but also as part of their way of living, their social environment and thus their identity. Moreover also managers realize that to attain agility in their organizations, employees should be more empowered to work in a more flexible manner without 'old' organizational structures and hierarchies hindering the work. In short, the number of knowledge workers is rapidly rising and the way in which they work is totally different and no longer restricted to the boundaries of their company.

To support this new way of working in a manner that realizes both a higher effectiveness of knowledge workers and keeps the organization in control we propose to add extra functionality to (or on top of) the current business process management systems architecture as described in section 3. Central to the added functionality is the concept of story telling. Our lives are filled with stories. As a kid we grew up in a world of stories whether they were out of books or our own (make-believe) stories, and as grown-ups we are constantly part of stories that we also try to capture and record. For example, who doesn't have family albums filled with pictures of lives events such as births, weddings, birthdays, Christmas, thanksgiving etc. And while sometimes we can't choose our stories (such as our family) we often actively create our stories. For instance holidays are planned well in advance and everybody knows their role in the story and its final goal. So while stories are very normal in every day life this all of a sudden seems to end when we work because then we are part of a process that is designed and controlled based on an

engineering perspective. However putting stories in the middle of our concept to support knowledge workers who engage in their dynamic collaborative processes (see Figure 2), helps us to understand various notions (Loggen, 2009, p. 44) such as:

- The story in which knowledge workers participate usually has goals and when met, the story ends (or the story is abandoned earlier).

- Knowledge workers each play certain roles while collaborating and in these roles they interact in various ways and perform activities to develop the story (and reach the goals).

- There are rules (and if people don't play by the rules a quick reaction can be expected).

- There is power - somebody controls the roles assignments and the evolution of the story.

- Communication within the story has a specific context with a specific language, where specific terms are related to specific concepts. However this communication and thus the story can be harshly broken by other emergent events (the financial crises all of a sudden broke a lot of the rules in business financing and thereby disrupted a lot of collaborations in networked organizations, thus changing the patterns of many stories).

Figure 2: The concept of story in relation to collaborative processes.
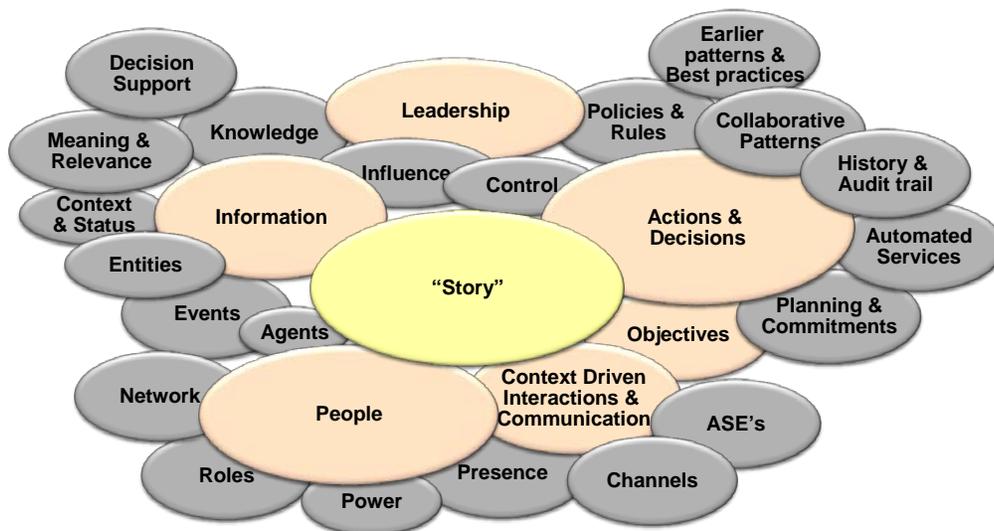
As can be seen in Figure 2 there are a lot of aspects surrounding our story concept. Not only does a story have objectives that need to be reached by the people that are participating and which are set in a specific context, there also has to be a lead character or group of lead characters and during the story information is used but also created. There are many different ways of supporting a real life collaboration story between knowledge workers but the most important part of this new paradigm is that organizations can no longer push the technologies that are to be used

in these dynamic processes. Even if the collaboration is part of a project within one organisation, knowledge workers will want to use the means that they are comfortable with and that they also use in other stories. This concept of modality (see section 4) means that a large part of the story may be enacted in online environments like Facebook, Google docs, LinkedIn, the Process Factory, Zimbra, Jive, and Zoho, while for information that is part of a specific organization ERP or BPM system could be used together with Microsoft office and different legacy systems. All these different systems need to be able to interact and support the story and at the same time there should be some type of controlling method that enforces the rules of the story, creates a history for auditing and governance purposes, that stores the context of the story and the general storyline. For this control method we propose the concept of the Human Collaboration Bus (HCB) as depicted in Figure 3.

Figure 3: The Human Collaboration Bus concept.
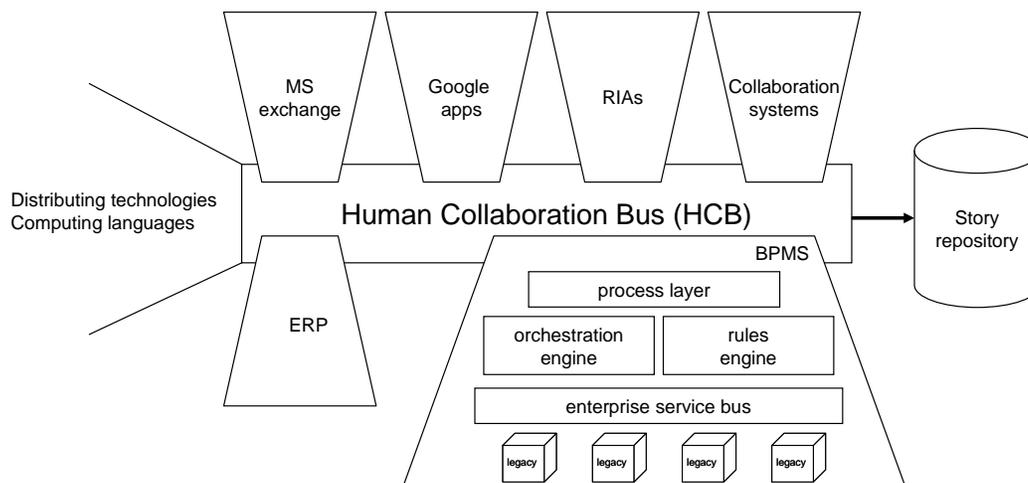
The HCB should not be seen as another software application but as a concept that contains technologies that will be different depending on the story that is told. The only constant in the HCB is the story repository. The story repository is the central storage of all stories that have been told, are told and will be told. Preferably third parties will offer a story repository in the Cloud that can be used by any organization or person that has a role in a specific story (& also other providers of story repositories when different stories connect and interact), however a single organization or a network of organizations could also provide a private story repository in support of their knowledge workers collaborating in dynamic processes.

The HCB is central to the integration of all technology and semantic communication between all participants in a story. As we explained, participants in a collaborative story typically will use different tools in communicating and will also typically communicate in terms that are specific to their context (educational level, work domain, country etc.), the HCB connects the tools used and stores the communication and context. A HCB can also (re)use information from systems such as ERP, CRM and others if the story requires so. Depending on the situation the HCB concept can be an add-on to a BPM-system but it can also be provided separate from it, for instance in the Cloud by a third party. However the HCB will only give full added value if functionality offered by BPM-systems can be used, this is because BPM-systems give access to the structured

processes which will almost always have a role in a story. Also it is practical to reuse functionality that BPM-systems contain to integrate legacy systems, realize orchestration and choreography, monitoring and control, enforce rules etc. Just keep in mind that the flexibility of the collaboration is paramount and that using a BPM-system should not lead to efforts to structure and control the story in design time.

TOOL EVALUATION

The functionality that we envisioned in the last paragraph for the HCB doesn't yet exist (as far as the researchers know). However it could be that there are already software solutions that may offer part of the functionality. To determine if this is the case we performed a scan of available software in the domains of Enterprise Resource Planning (ERP), Customer Relationship Management (CRM), Workflow Management (WfM) / Business Process Management, Project Management, and Collaboration tools. These are all software packages that might already offer functionality that is part of our HCB concept.

For the market scan we designed a five step research approach which consisted of the following steps:

1. The construction of a long-list of possible software solutions that might contain parts of HCB functionality; this was done by studying professional literature, websites (of suppliers & consultancy firms), blogs on collaboration, and short interviews with two Capgemini consultants that specialized in collaboration processes. The result of these activities was a list of 54 software packages (the complete list is available upon request to the authors).

2. Based on the Human Collaboration Bus concept as described in the last paragraph a detailed overview of characteristics of collaboration among knowledge workers and supporting IT functionality was developed and used as input for the construction of a survey. The survey questions were then validated by the consultants that were also involved in step 1.

3. The developed survey (consisting of yes & no questions) was sent to all 54 suppliers on the long list. If no response was received or if the surveys returned were missing information we contacted the suppliers with the request to participate or deliver the missing information. As some suppliers choose not to participate they were left out of the next steps of our research. Furthermore we also decided not to include those suppliers that didn't have at least 50% of the characteristics / functionality mentioned in the survey. This reduced the long list to 16 possible software solutions.

4. For the remaining 16 solutions a more detailed study was performed on the supported characteristics and offered functionality. Each supplier was asked to rate the characteristics / functionality in their software on a scale of 1 to 4 (bad, lacking, sufficient, good). Each package was rated on 31 items that were divided in four categories (the first 3 measuring characteristics of collaboration among knowledge workers & the fourth looking at specific software functionality) which were labelled:

collaboration, work processes, management of work, software functions. Based on the responses we calculated a score for each of the 16 suppliers.

5. The 10 highest scoring solutions from step 4 were the studied in more detail. For this we tried to get a trial version of the software to perform life testing. The test consisted of letting bachelor students use the software in their collaborations as part of performing projects for different courses. At the end of their project we had them report their experiences. Although this last step did provide us with interesting information we decided that the final top 10 should be based on the more objective scores calculated in step 4 instead of using the more subjective input of the student's experiences.

Based on the market scan we found the following 10 software solutions that in part provide HCB functionality (between brackets the final calculated score is stated, the complete list of characteristics & the scores are available upon request to the authors):

1. Cordys Process Factory (119)

2. Action Base (116)

3. Zoho (109)

4. JIVE (109)

5. eGroupWare (102)

6. Above IT – Zimbra (101)

7. Contact Office (98)

8. HumanEdj (96)

9. Instant Business Network (95)

10. Group Office (93)

Although the software packages mentioned in this top 10 provide some functionality that is needed to support knowledge workers in collaborative processes, none provide all the functions needed. So in conclusion this market scan has shown that there are still many opportunities for software companies to develop new functionality in support to human interaction management.

CONCLUSIONS AND FURTHER RESEARCH

In this paper we have shown that organizations who want to increase the productivity of their knowledge workers and make collaboration more effective and efficient need to change the way they support, manage and control these types of processes. The current industrial paradigm in which processes are structured in design time including their control mechanisms is giving way

to a new paradigm coined Human Interaction Management in which humans and their interactions are central.

To support this new paradigm we propose the concepts of story telling and the Human Collaboration Bus (HCB). Stories are central to our everyday way of life and consist of (lead) characters, roles, rules and goals which all play a part in a specific context during a certain amount of time. To manage and control the knowledge workers that are embedded in collaborative stories we created the concept of the HCB which provides a story repository that stores all the characteristics of a specific story (including interactions between stories) and that offers functionality to interact between different systems as part of human interactions and which manages the dynamic processes. Ideally the HCB concept is offered via the Cloud by independent third parties but closed solutions are also possible.

The concepts proposed in this paper are based on conceptual research and have not yet been tested in practice. As the market scan showed there was no single tool that offered full functionality to support knowledge workers in collaborative processes. However some software companies are showing promising visions in the way they are developing their software. Future research could therefore consist of combining functionality of different offers to create full support to collaborative processes of knowledge workers. The hereby created functionality could then be used in different research projects within our university domain to further test and validate the Human Collaboration Bus concept.

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