Crossing the Chasm Between the Real World and Business Process Management

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Abstract: While agility is a core challenge in todays competitive business, software-based business process modeling and execution approaches often refer to strict and inflexible formalization. Complementary, we propose an extension of the business process model by integrating information from the Internet of Things to increase flexibility. Along with orchestration tools and knowledge worker support, new dimensions within the data and the business process model are supposed to significantly improve business process management.

1 Introduction

Half-value periods of competitive advantages shrink and competitive edges need to be adjusted permanently [PM85]. Agile business processes are hence needed. For that, transparency over real world activities is important. The integration of information in a fast and value-directed way can contribute to business improvement. So, an integrated concept for information retrieval, analysis, and processing is required.

While a lot of today's research deals with business process automation, our concept is based on the assumption that not each and every business process can be automated. To put this into perspective, our concept hence reflects Goldratt's theory of constraints [GC84]. Complex business processes require knowledge workers that analyze and synthesize information to develop appropriate solutions. Though full automation is not feasible, knowledge workers have to be provided with all relevant information and powerful support concepts such as conducted business process orchestration. So, our concept focuses dynamic business processes. Though a lot of research has been performed in this field, a lack of acceptance can be constituted as the underlying data basis has never been sufficient [PvdA06]. In this paper, today's information blind spots during business process design, planning, and execution will be revealed. Then, the data basis will be leveraged by integrating reality based object information from the Internet of Things (IoT). Consequently, a systematic concept will be introduced that transforms the IoT-based extended data model into an extended business process model. The enhanced models, finally, enable agile business process management, which, in our concept, implies the fast and flexible (re-)composition of business processes. Thus, components of this consistent and homogeneous concept are presented in detail. Finally, we try to close the gap between pure efficiency and pure responsiveness and to improve the performance of business processes.

2 Initial Example

Motivation. In industrial manufacturing, maintenance management requires maintenance service managers to define general maintenance services and to plan specific process instances according to the respective customer needs.

Status quo. The daily job of a maintenance manager demands industry domain knowledge, process management skills, the analysis and synthesis of information, as well as decision capability. When a customer calls a service provider, information has to be put in context. The employee investigates if designed maintenance processes fit to the environmental context, the specific customer situation, and to resource availability. Business process instance planning needs to be adapted accordingly. For instance, if a formerly unknown error occurs, the recommended maintenance process needs to reflect this fact. The resulting customer-specific maintenance services requires the continuous adaptation of pre-defined processes. Particularly in such a change-ridden environment, adaptation may be even necessary during process execution, e.g. if an unexpected error shows-up during the on-site visit of a maintenance engineer. All in all, the number of process instance variants increases over time. In addition, the pre-designed master services have to be re-revised as well, if process instance specifications continuously deviate from the pre-designed master process; e.g. if process delivery permanently exceeds limits, the predefined process time needs to be adjusted. Moreover, changes such as in legal regulations, may require to re-engineer business process design. So, design of master maintenance services is also exposed to continuous change, albeit not as often as instance variants.

Opportunities. Transparency is a key prerequisite for any agile business process management activity. By using IoT-technology, real world information can be included into business processes. For instance, smart tags attached to devices can send information in terms of working status and environmental conditions such as humidity etc. Respective information can then be used by the maintenance service manager for the specific process instance planning. Likewise, transparency over process deviations can significantly improve the design of master service processes. Moreover, business process models should be enriched to cover the IoT-based information input and reflect any potential process changes. Transparency is relevant to reactive and proactive measures. The earlier a lead indicator can be identified and communicated, the better processes can be adjusted.

3 Blind Spots and Related Work

To put our initial example into perspective, this chapter generalizes the presented challenges and opportunities. While business processes can be described as interplay of resources of different functional units by means of activities, business process models are expected to describe them on a meta level. Moreover, for business process instantiation, a process planning and execution system is required, which delegates and tracks activities in the scope of the business process model. In this chapter we systemize the findings of the initial example to identify two generic blind spots in business process models and to demonstrate the need for agile business process orchestration.

3.1 Blind spot I – Business Process Instance Planning and Execution

The lack of transparency and timely delay with respect to information that is relevant to business process instance planning and execution is enormous. For instance, information about the physical state of things and the current position of resources is often not up-to-date or not available at all.

The blind spots in business process planning and execution reflect the awareness of the environment. The IoT is a powerful infrastructure that can provide status information and increase the information value of the business process instance model. Tracking technologies enable the detection of environment state and changes thereof. The term IoT encapsulates a variety of sensor based technologies like RFID which provide event and status information to connect information systems and the physical world [Mat05]. Such real world integration still lacks means to connect such devices and integrate them in a standardized way into existing business process management systems. We see two demands: standardized collection and business oriented processing of the accessible information. [Sch07] proposes smart tags to create a general object memory, standardizing the storage and distribution of information collected during the lifetime of a product. The IoT generates high value event streams of data which need to be organized and processed. [Luc02] describes complex event processing (CEP) as useful approach to find patterns of interest in streams of real world information, enabling the aggregation of such information to events. Such events need to be contextualized with respect to the business. [VAESW08] proposes an extended modeling approach, which integrates event and process modeling.

3.2 Blind Spot II – Business Process Design

A lack of transparency is often identified while (re-)designing business processes. Control instances on the process execution, beyond mere approval of task execution, are necessary to observe the deviations and the reliability of the designed generic process models.

Again, IoT is the needed transparency driver for (re-)designing business processes such as master maintenance processes. Generation of new business processes as well as redesign and re-engineering is a well known demand [KG95] that is supported by numerous methodologies [MWC06]. Still, most methodologies are realized based on project teams or consultants which are not integrated in the actual execution process in a company, but try to understand it based on domain knowledge, interviews, and observation. These processes are triggered by the decision towards organizational change, e.g. by implementing a new IT-infrastructure which is no optimal foundation for the realization of continuous process optimizing redesign and re-engineering life-cycles [KGT95]. The integration of IoT information and process performance on design level is an important aspect. [SS10] propose an extended model to integrate internal and external information into the business process design. Moreover, [HHF06] demonstrate that the process redesign and re-engineering can be directly supported by integrating process execution information. Such information has been described in the previous section as generated by the IoT and included into the extended modeling approach [VAESW08].

3.3 Business Process Orchestration

Agility is no core capability of business process management, which, finally, leads to a mismatch between reality and model.

Different examples to automate process flexibilization exist, e.g. change patterns [WRR07] or business rules [vEIP08]. Knowledge involvement into event response and process execution is a key aspect in today's business environment [Rem02]. Different efforts of blending research results from the domain of knowledge work with business process management exist. Examples of these efforts are a context aware business process management system providing different interaction interfaces [Cha04] or a framework enabling individualized process execution [LBC09].

4 A Weaved Net of Bridges and Orchestration

4.1 Overall Concept

The changed understanding of the business processes modeled in IT systems results in business process design, which is increasingly consistent with real world challenges by realizing all the aspects depicted in Figure 1. The basic order of the illustrated concept is fivefold and comprises the business process models and the business process instance models.

The resulting process of model transformation starts on the mapping of real world representations in the business process model:

- IoT-information increases the number of perceived attributes (red funnel / see Sect. 4.2)
- Attributes get assigned to the business process design (arrow F / see Sect. 4.3).

  The business process model results in an extended business process instance model:
- Model assigned attributes are linked to process instance models (blue arrows / see Sect. 4.3).
- Resulting instance model attributes get then nurtured by IoT-based specific data sets (red dashes / see Sect. 4.2).
- Bridges symbolize knowledge worker support by means of orchestration and decision support (see Sect. 4.4).

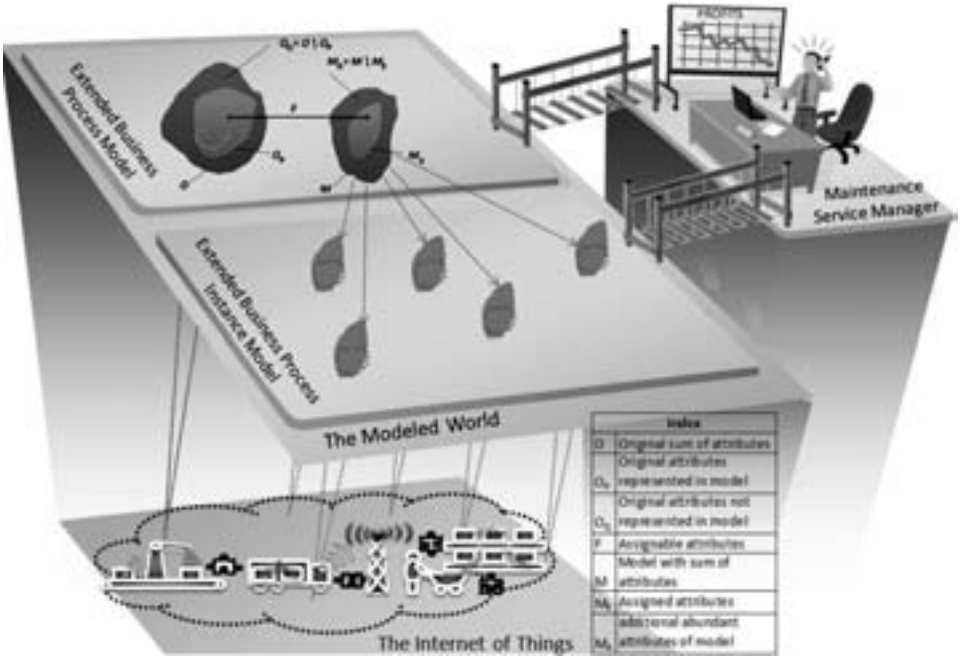

Figure 1: A Weaved Net of Bridges and Orchestration

4.2 Blind Spot I – Enlightened

Awareness of the environment is one of the key prerequisites in our solution concept. Particularly during business process instance planning and execution, real-world information is needed for optimal process performance. Accordingly, relevant information retrieval rules have to be identified. In our concept, events are indicators for a change of state in the environment and represent a core component of information classification. In the following we describe our definition of event categories in the IoT environment and their impact on agile processes, described in more detail in [SS10].

Potential relevant events are events generated out of the real world along a pre-defined set of input information sources. By using CEP, relevant events will be identified, structured, and aggregated out of the potential relevant event pool. So, the information quantity gets transformed into valuable information quality. Relevant events, then, present the information source for event subscribers. The resulting events, are input parameters for agile business process adjustments, which can be performed on a business process design or instance level. In general, an event taxonomy is introduced that ensures that all events are classified in a way that they can be integrated into business processes. The environmental blind spot is hence transformed into event based inputs for the extended business process model and hence enables agile business process management.

4.3 Blind Spot II – Enlightened

The design phase of agile business process management is an ongoing effort of business process improvement, re-engineering, and creation. An effort based on information that is extracted and generated during the process instances. IoT events are blended with process status change logs capturing changes in the process execution and the activity tracking implemented in the Human-Process Interaction Platform (see Sect. 4.4).

By associating process models with relevant execution data and assigned events, processes can be analyzed with respect to their efficiency. Efficiency addresses not only the execution time of processes, but additionally the variance of a set of actual process executions and involved variance triggers. As a result decisions towards process redesign and re-engineering can be made. For our modeling approach such decisions especially imply the transfer of information between the strict process model and the underlying knowledge base. As such elements of the knowledge base are upgraded to actual process steps or downgraded to recommendations in the knowledge base. Depending on the impact of these information transfers the dimension of a redesign or a re-engineering can be observed. Beyond redesign and re-engineering the identification of new processes can also be supported by the analysis of the actual execution data. All in all, we achieve an enhanced business process model on a design level that builds the foundation for adequate attributes within business process instances.

4.4 Conducted Orchestration

Process change involves the adaptation of a process. We discussed different methods to automate process change (see 3.3). Nevertheless, these methods are not applied in reality as knowledge bases on process variance are small and their integration into existing models is a tedious task. The necessary knowledge is often only accessible through people's expertise. We define the manual adaptation of a process as conducted process orchestration. For this task we will describe a twofold approach focusing on modeling and adaptation of business processes.

Modeling core process and variance. The modeling integrates process modeling and a connected knowledge base. Our dictum is the separation of areas of variability from a core process. The core process is modeled by standard approaches, e.g. petri nets or π calculus based. For each human activity involved in the process a link to a knowledge base exists, which is realized as ontology. The ontology collects problems that occurred during the respective step of the execution process, decisions which were made, resources used, and subtasks which were created.

Human-Process Interaction Platform. The individual execution of process tasks needs to be made explicit by providing a dedicated environment. Several concepts have been developed in the domain of computer supported collaborative work which suite this demand. Our approach is linking a workbench for work organization with a whiteboard for task-specific service and information composition. Thus, we can contextualize user work with respect to processes they belong to and the information consumed and created. As

visible in Fig. 2 the individual is aware of the process he is embedded in (Nr.1), is informed about events which affect the business process, related best practices (Nr.4), and has a workspace which allows the interaction with the process (Nr.2 and 3). The effect: the difference between the role of a process planner and a process executor vanishes. So, the business process executor being empowered to re-plan becomes part of the business process instance definition and planning. Re-planning is done permanently in industry settings, but it is not reflected in the business process instances due to the lack of necessary expressiveness. Our proposed extended modeling used as empowerment of the executor enables agile process execution that is mirrored in a business process management system.

Figure 2: Human-Process Interaction Platform

5 Conclusion

The proposed concept of the weaved net of bridges and orchestration is a systematic approach towards agile business process management. It enhances the business process model in terms of IoT events and empowers knowledge workers to interact with the business process by conducted orchestration. Additionally, our concept enables ex-post analysis of process instances applicable in a business process improvement lifecycle. In sum, the performance of business process instances as well as the design of business process models can be improved. Thus, the chasm in terms of information divide between the real world and knowledge workers is bridged.

Further work is needed in the development of the presented components and the architecture. Within our research project prototypes have been developed that exactly address these challenges (e.g. Fig. 2). Moreover, the concept will be further refined and realized in an integrated overall architecture. The latter, finally, will be used to evaluate the overall applicability of the described approach. To demonstrate a broad applicability, various tests in different industry domains are in the scope of our project. The technical implementation as well as the demonstration in real world environments are hence in the scope of our daily work on the way to bridge the chasm towards agile business process management.

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