Challenges in the Convergence of Business Process Management and Service Oriented Architecture

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Abstract. The paper addresses the challenges in the integration of business process management (BPM) and service-oriented architecture (SOA). BPM and SOA make up together a more complete solution environment than separately but there are still obstacles in implementing them both in the same project. The main challenges are related to inadequate support for transition from model to implementation, architectural governance and error and exception handling. The paper proposes functionalities that BPM and SOA tools should include to ensure better support for BPM-SOA projects.

Keywords: Business process management, service-oriented architecture, convergence

1 Introduction

SOA and BPM are two concepts which are initially developed independently from different points of view. The differences between BPM and SOA can be listed as below:

Table 1. Difference between BPM and SOA [1]

<table>
<thead>
<tr>
<th>BPM</th>
<th>SOA</th>
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<tbody>
<tr>
<td>Business-driven</td>
<td>IT-driven</td>
</tr>
<tr>
<td>Top-down process approach</td>
<td>Bottom-up architectural</td>
</tr>
<tr>
<td>Reuses process model</td>
<td>Reuses service implementation</td>
</tr>
<tr>
<td>Project-oriented</td>
<td>Enterprise infrastructure-oriented</td>
</tr>
<tr>
<td>Success measured by business metrics and Key Performance Indicators (KPIs)</td>
<td>Success measured by architectural metrics, logical consistency, ease of integration, and cost of change.</td>
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As both concepts gain more maturity, it is hotly discussed that SOA and BPM can work together and reach the harmonious world of business and IT. The success of BPM requires the improvement of IT architecture, this part of the work is done by SOA. "There will always been a need to integrate applications and automate business processes. The tools will follow whatever architecture is prevailing in the market. SOA is the favored architecture. That means all companies that do application deployment things need to support this architecture."[2]. BPM and SOA serve the same final goal: Business agility, flexibility to respond to change, reusability to cut costs and increase efficiency and closer alignment between IT and business [2].

Even though the benefits of bringing BPM and SOA together are commonly agreed, the roadmap of convergence is still not clear.

The objective of this paper is trying to solve the following research questions:
- How is the situation of BPM and SOA working together in reality?
- What are the challenges during the process of integration between SOA and BPM?
- What are possible solutions for the challenges in the convergence?

This paper will introduce the developing roadmap of BPM and SOA, present what is the current situation of convergence between BPM and SOA, find out the main challenges of the convergence process and try to offer the possible solutions for discussed hurdles.

1. BPM and SOA

1.1 Definition of BPM

Business process management (BPM) has been defined in many ways: Zairi [3] describes BPM "as a structured approach to analyze and continually improve fundamental activities such as manufacturing, marketing, communications and other major elements of a company’s operations". Lindsay, Downs and Lunn [4] see BPM as an attempt to "better understand a business’s key mechanisms in order to improve, and in some cases radically change, the business performance by identifying opportunities for new business opportunities, for outsourcing, for improving business efficiency and for areas within the business where technology can be used to support business processes". Papazaglou and van den Heuvel [5] define BPM as “the term used to describe the new generation of technology that provides end-to-end visibility and control over all parts of a long-lived, multistep information request or transaction/process that spans multiple applications and human actors in one or more enterprises".
1.2 The development of BPM

Smith and Fingar [6] concluded that the development of BPM has three waves: the first wave happened in 1920’s when Fredrick Taylor defined the new management concept of “methods and procedures analysis”.

The second wave appeared decades ago. Many new management theories and technologies were offered such as: Business Process Reengineering, Six sigma, Workflow etc. But inflexible and limited functional software applications rarely offer business managers a practical way to implement and manage the lifecycle of business process life cycle.

The third wave of BPM enables a united value chain where companies, their customers and trading partners together create an optimizing new business processes. BPM suppose to enhance the business agility, provides a platform for sharing end to end business processes, and supports top-down and bottom-up process modeling. The third wave of BPM becomes a new base to build competitive advantage with the strong support of new IT technology.

1.3 Definition of SOA

According to Papazoglou [5], SOA is “an emerging approach that addresses the requirements of loosely coupled, standards-based, and protocol independent distributed computing, mapping enterprise information systems appropriately to the overall business process flow.”

Some principles of SOA are widely accepted:
1. Service loose coupling: Service contracts impose low consumer coupling requirements and are themselves decoupled from their surrounding environment [7].
2. Service abstraction: Service contracts only contain essential information and information about services is limited to what is published in service contracts [8].
3. Service reusability: Services contain and express agnostic logic and can be positioned as reusable enterprise resources [9].

1.4 Evolution of SOA

Road to SOA is long-term process. SOA needs to be adopted step by step. The implementation can usually be divided into the following phases according to the maturity level of the application frontend and services [10]:

Fundamental SOA is the start stage and simple to implement. Still it is important to give a strong platform for enterprise application landscape. In this stage application frontend is the most heavyweight.

In networked SOA more implementation are dealt with the backend. Intermediary services are added for bridging technical and conceptual gaps and providing a good base for reuse.

The stage of process enabled SOA is still too difficult to reach by most of the companies, in this stage SOA is suppose to fully support BPM by maintain the
process-centric service dynamically. Application frontends only take care of user interface and interaction.

2 Convergence of Business Process Management and Service Oriented Architecture

2.1 Definition of Convergence

To convergence signifies that two things or issues incline towards each other and meet at some point. In the context of BPM and SOA, convergence refers to a situation in which BPM and SOA can be easily used together in the same context, for example, in a project. It is important to note that convergence in this context does not signify that the two concepts would become one. Instead, to converge here means to find a pragmatic solution for coexisting.

BPM views enterprise architecture from top-down or business process perspective and SOA from bottom-up or from the viewpoint of single services. In practice, the convergence can refer to the same product covering both points of view [11]. Since SOA exists as a concept while BPM exists both as a concept and a set of tools [12], the convergence has often been understood as an extension of BPM suites to support SOA.

2. Benefits of BPM-SOA Convergence

BPM and SOA make up together a more complete solution environment than they do separately [12]. The BPM-SOA convergence holds the promise that business process modeling and SOA implementation could form a unified, semi-automated process. Model could be used directly for implementation. [13] Further, BPM-on-SOA would result in so-called managed flexibility, which means that organizations would be able to create and quickly reconfigure reusable services consumed by several processes [1].

BPM can improve the implementation of SOA projects and solutions. BPM tools can help develop, publish and orchestrate services. They can contribute to better coherence between the architecture and its macro context, i.e. business processes. BPM suites include often process monitoring and management tools which can aid in the continuous development of SOA. BPM methodologies can guide the decision making process related to SOA initiatives by identifying the highest impact processes and services [12].

On the other hand, SOA has much to offer for BPM projects. SOA principles, such as loose-coupled and coarse-grained services can ensure that the most important services are being developed and that they are modeled on the appropriate level of granularity [12]. The loose-coupling provided by a SOA integration platform supports the continuous development of BPM efforts. More specifically, when there is a need
to modify processes, it can be accomplished without changes in the integration technology [1].

2.2 The Current State of Convergence

The convergence of BPM and SOA is still at early stages. BPM systems include seldom SOA artifacts such as service registries or enterprise service bus (ESB). Thus they do not support locating existing services to match process activities. Neither do SOA systems support BPM as they do not take into account the special requirements of human tasks that are an essential part of a typical business process [14].

3 Challenges in BPM-SOA Projects

There are very few published reports on projects in which both SOA and BPM are implemented. The most analytical and in-depth report on a SOA-BPM project deals with a Danish bank called Danske Bank and its experiences in two separate projects [15]. It is reasonable to think that the challenges in these two projects are typical of BPM-SOA projects in general.

3.1 Challenges due to Inexperience in Business Process Modeling

Danske Bank started the projects by defining a business model based on the existing work practices. Then a solution architect together with business analysts created a solution model, which served as a requirements specification and a contract for the developer in charge of the implementation [15].

Inexperience in BPM-SOA projects caused time-consuming iteration in creating the solution model, when the first version did not capture exceptions in the main process or all relevant information. In this context, we refer to a process in which all phases take place as expected and there is no need for considering exceptions. More specifically, the solution model did not break activities down in such detail that was needed for implementation, did not describe dependencies or sequences of activities and did not define which data was to be used in activities [15].

3.2 Inadequate Architectural Governance

Although Danske Bank had been implementing SOA, the governance of SOA was not at an adequate level. First, this caused challenges in the project when service operations had not been listed nor documented in the service library. Thus it was difficult to locate required services. Second, since the services had not been named in an easily understandable way, it was impossible to understand what the service was about without contacting the person responsible for the service. Third, there were no enterprise standards for return codes, which meant that exception handling had to be
implemented separately for each service invocation. Fourth, required services were not of the needed granularity, which resulted in additional work when the requested changes had to be made in the existing services [15].

Fifth, BPEL (business process execution language) process development involved lot of work related to fault handling. Services return specific return codes when their encounter so-called business faults, for example when services are invoked with incorrect data. To be able to make the correct error handling, these return codes need to be known in advance. In these cases, return codes typically were not documented in the service library [15].

The inadequate level of architectural governance was visible also during the project, when the developer at some point ceased to update the solution model. Consequently, the solution model lost its value as a design and documentation [15].

### 3.3 Inadequacies in BPM Tools

The inadequacies in the used tools resulted in time-consuming manual work. The transformation of models directly into code did not function properly from the viewpoint of business requirements in the Danske Bank case. Commercial development tools did not allow customization of the transformation rules, which would have been needed. Instead, the transformation of models into code had to be done manually [15].

### 3.4 Testing of Services and Processes

Testing of services and processes in a BPM-SOA context proses special challenges since the collaborations can be large. Danske Bank had been obliged to build test and simulation frameworks since there were none available on the market. Danske Bank had also built a validation engine which checked a workflow against specified coding styles [15].

### 4 Challenges in the Convergence of BPM and SOA

In this chapter, we will study the challenges related to the business process management and service oriented architecture on a more general level. Since BPM exists – contrary to SOA – as a set of tools, a great part of the challenges are related to the immaturity of BPM tools.

### 4.1 Lacking of general perspective

Combining BPM and SOA forces two worlds to collide, each of them has a very different perspective. Convergence of BPM and SOA brings huge challenges both for business analysis and IT workers. The mind share gap can only be fully eliminated if
the business users themselves configure and code their own process [12]. On one hand, it is difficult to require business people have professional IT knowledge and skills, on the other hand, IT workers hardly can fully grasp the requirements and process of business process.

4.2 No proper standards support

Both BPM and SOA are in the developing phases. The technology is not yet steady and mature. New languages and standards are appearing all the time. Each of them have their own support and against. There are always many discussions about them between IT vendors.

XML technology is fundamental to SOA, most of current SOA projects are based on Web service and XML. The first generation Web services architecture had developed three main standards: WSDL, SOAP, and UDDI. Among them WSDL and SOAP have become core technologies that build upon the XML layer to define the fundamental communications framework for SOA.

Only XML is not enough to support application integration. ESB (Enterprise Service Bus) is important to provide an integration platform that utilize Web service standard to support a wide variety of communications patterns over multiple transport protocols [5]. As SOA grows, BPEL is increasingly used for modeling business process. BPEL is an XML-based standard which facilitating the orchestration Web service.

Traditionally BPM and SOA are pursued by different vendors with different interests. Current BPM and SOA standards are not designed to work together. BPMN and BPEL are very difficult sometimes impossible to map into each other. “This is a particular challenge, taking into account the relative complexity associated with most BPM/SOA standards. At the same time, organizations that want to gain a first mover advantage in implementing converged BPM-SOA solutions would endure higher cost in implementing emerging standards that would take time to become fully accepted” [1].

4.3 Immaturity of Tools

BPM system are still immature. They do not fulfill all expectations. Companies implementing BPM seem to be obliged to extend existing systems on their own, since the existing systems cannot meet all business requirements.

The idea of BPM is to bridge the gap between business and IT people by providing them a common ground on which they can work together. BPM tools have yet not achieved this objective, since it is reported their use requires involvement of experienced IT-focused BPM users[15].

The industrial breakthrough of BPM is still to be expected. Also BPEL, which is sometimes classified as a SOA-related tool, is still evolving, which is seen in, for example, in the fast-paced publication of new versions [15].
4.4 Inadequate Support for Transactions and Error and Exception Handling

There are no standards for transactional behavior for services or automated processes and even when there will be, BPM-SOA solutions will need to operate together with legacy systems that do not follow those standards. Support for transactions signifies that component steps of an automated process can be committed or rolled back if the end-to-end process requires. Similarly, the result of a service invocation can be committed or undone based on the result of the overall end-to-end process. Without support for transactions, a process and its services can become desynchronized [12].

To compensate for the lack of standards, it is necessary to find a pragmatic solution. The pragmatic solution in this case refers to mechanisms for error- and exception-handling [12].

Unfortunately, BPM solutions or BPEL do not deal with errors and exceptions on a level required in real life. For example, BPEL does not provide support for repeating a failed activity or representing an event-driven process [16].

4.5 Transition from Model to Implementation is Manual

Currently BPM tools have just recently started to develop code generation and cross-discipline model exchange capabilities. Until these capabilities have been developed further, the transition from business modeling to the implementation is at best semi-manual [16]. When models are not easily transformed into generated code, BPEL still requires the active involvement of experienced technical specialists [17].

4.6 Governance

Mature SOA implementations need to support the distributed cooperative management of tightly coupled interdependencies across organizational boundaries [17]. Consequently, governance is needed.

Strnadl [18] defines SOA-BPM governance as follows: “SOA/BPM specifies the decision rights and accountability framework to encourage desirable behavior in the context of SOA and BPM. This consists of leadership, organizational structure and processes to direct and control the enterprise in order to sustain and extend the organization's strategies and objectives by utilizing SOA and BPM methodologies and tools.” The definition covers both design-time and run-time related governance.

There are governance tools on the market but they lack a holistic BPM-SOA approach. The current tools are mainly either SOA registries or business system management (BSM) specific. Strnadl reports, however, of a product called CentraSite, which is a BPM/SOA governance solution [18]. Also other software vendors have started to develop dependency management systems such as IBM Websphere Service Registry and Repository, but integrating such a system into a complex existing infrastructure is difficult [17].
5 Recommendations to Help Solve the Challenges

5.1 Summary of Challenges in the Convergence of BPM and SOA

In the Danske Bank case, the challenges can be classified into four issues. First, BPM tools did not support inexperienced users in modeling processes on the required level. Consequently, users did not include exceptions, did not break processes down and did not include relevant data. Second, there was no architectural governance, which would have ensured that services or processes were listed and documented or that common standards would have been followed. Third, tools did not transform models into code. The transformation had to be done manually. In addition, tools did not allow customization which the business requirements needed. Fourth, there was no proper tool support for testing of processes and services.

The findings of challenges in the convergence of BPM and SOA on a macro level are similar. The challenges reported include lack of automation in the transformation of models into code. Also the need for architectural governance has been listed as one of the key issues in the success of BPM-SOA projects. Finally, the importance of error and exception handling came up both in the Danske Bank case and more general level reports. However, support for transactions came up as a new issue among the industry-wide challenges.

We will suggest separate recommendations relating to each of these challenges in the current chapter.

5.2 Business Process Modeling Tools to Support Inexperienced Users

Brahe [15] suggests that model-driven tool support should help users create models on the right level of accuracy the first time around. As reported in the Danske Bank case, this would help avoid time-consuming iterations during the implementation phase. It is necessary to note that in some cases the end result would not have been as good as it after all was in the Danske Bank case since some other developer might not have been as ready to undertake all those iterations. Instead, the problems could have emerged only in the testing phase or even later, when it would have been even more expensive to iterate. For this reason, Brahe [15] suggests that the BPM system should include functionalities to check that all necessary information is specified in the solution model and that the information is valid: This would support first-time users and help avoid time-consuming iterations [15].
5.3 Concepts and Tools to Support Architectural Governance

Governance needs to exist foremost as a concept and an organizational discipline issue but there is a room also for systems that support governance. Strnadl [18] proposes that a holistic BPM and SOA governance should meet the following requirements:

1. Registry functionalities for collecting documentation on services, processes, roles etc.
2. Service discovery and process lifecycle management support capabilities:
   a) Service search and locating mechanisms, b) service discovery, binding and endpoint management, c) SOA service and process lifecycle management support
3. Mechanisms for dynamically evoking services
4. Artifact management capabilities:
   a) Extensible data model, b) classification of artifacts with user-defined taxonomies, c) association of artifacts with other artifacts across architectural layers
5. Policy and standard enforcement capabilities:
   a) Validation capabilities to check adherence to standards and policies, b) policy definition, monitoring and enforcement mechanisms
6. Administration capabilities:
   a) reporting and analysis mechanisms, b) monitoring of service level agreements, etc [18].

We can see that the proposition includes the traditional SOA registry and repository functionalities as well as extended capabilities for service discovery and process lifecycle management, policy and standard enforcement, and service and process administration. We will look at these new issues separately in the following paragraphs.

Service discovery and process lifecycle management

It is common that processes need to be changed during the lifecycle of a BPM-SOA implementation. Thus it is necessary to find available services. One aspect of service discovery is in control when services are documented in a service registry. Another side of the challenges is locating services run-time. Kamoun [1] states: “It is also important to provide run-time process management tools that capture the actual state of the running system. Such tools will allow a change in the running process to be automatically reflected on the application and composition and vice versa.”

Policy and standard enforcement

On both system and organizational levels, there is a need for defining standards and prototypes on BPM solutions and services – and for ensuring that standards are being followed [12]. One of the tasks of policy and standard enforcement is to specify the right level of service granularity [1]. BPM-SOA implementations require discipline in the follow-up of policies and standards. Validation tools and enforcement functionalities provide valuable help in this long-term task.

Administration functionalities

Governance is a critical part of BPM-SOA solutions since the management of large collaborations and loosely-coupled SOA applications depends on the correct
performance of each component. Failure or change in a single application component can result in the failure of several interdependent applications. Consequently, it is necessary to monitor the health of each application [5].

Rouached et al. [13] propose an event-based process-mining approach for collecting information on business process activities and checking the consistency of the process. Analysis of the process execution is necessary in order to identify deviations between modeled and observed process. Findings can then be used to adapt the process [13]. In the Danske Bank case reported in the previous chapter, the enterprise had built a tool to generate graphical presentations of process instances to monitor operation of workflows [15].

There are several options for realizing functionalities that monitor and analyze the health of components, services and applications. The most important issue is that there are tools to support these activities.

5.4 Model-to-Implementation Tools to Allow Customization

BPM tools need to be developed further so that the tools can be used by business analysts without or with little contribution by IT specialists. The model-to-implementation phase has to be reduced so that modifications to the service configurations can be accomplished in a shorter time [5]. Therefore it is necessary to add automation in the model-to-implementation phase.

There is also a gap between the solution mode and the actual implementation due to the lack of extensions to support organization-specific standards. We can assume that many if not most organizations want to implement their own specific standards. Thus BPM tools should support them.

Brahe [15] suggests that model-driven tool support should include the following:
1. Enable including organization-specific modeling standards and transformation rules in the modeling tools: This would make it possible to generate code from the model, as the transformation would take into account enterprise-specific standards and patterns.
2. Check the consistency of the model and the generated code
3. Enable making smaller changes in the code [15].

In addition, there is a need for a pattern generator to generate parts of a workflow from a specification [15].

The automation should work also the other way round, i.e. from code to model. Business modeling tools would need to have BPEL import and export capabilities to make changes easier. This functionality would enable rapid changes in business process implementation [16].
5.5 Transaction Standards and Development of Error and Exception Handling

Kamoun [1] calls for industry-wide technology standards that allow the integration of business processes across heterogeneous deployment environments. Widely accepted standards on transactions would be the long-term solution. In the short term, it is necessary to find a practical solution in the form of development of error and exception handling.

Woodley & Gagnon [12] suggest the following improvements for dealing with errors and exceptions in BPM systems:
1. For handling business exceptions, BPM solutions should contain transitions and mechanisms for terminating a process appropriately.
2. For handling indeterminate exceptions, BPM solutions should provide mechanisms for avoiding termination of the process, for example, possibility of resubmission or manual intervention.
3. For handling true system errors, BPM solutions could provide mechanisms for avoiding termination of the process.
4. Issuing compensating transactions, i.e. invoking a service to cancel some previous step.
5. Providing mechanisms for manual intervention, such as capabilities for accessing process context data to update process information and invoking a service [12].

Also Strnadl suggested that mechanisms for dynamically invoking services among the requirements for a SOA-BPM governance approach.

5.6 Frameworks for Simulation and Testing of Processes and Services

Testing of services and processes in large collaborations is more complex than testing of single applications. There are more actors involved. Some kind of simulation and testing frameworks and systems need to reduce the risks in the production environment.

6 Limitations of the Study and Suggestions for Further Research

There are two limitations that need to be mentioned regarding the present study. First, our study is based on only literature review, so the result of our study is limited on a quite general scope. Further, as there are few reports on SOA-BPM projects, we had to rely on a limited number of case studies. More case studies would be suggested for analyzing the convergence in project level.

Second, our literature review has showed that even though the convergence of BPM and SOA is discussed a lot. Mainly they are talking about the possibility and the benefits of the convergence. Proper articles which related to the challenges and
solutions during the process of convergence are quite few. Further research is still required in this area. As both BPM and SOA are developing rapidly, we suggest the similar topic research should be done again in the future.

7 Conclusions

It is said that BPM and SOA are becoming two sides of the same coin [2]. The convergence of BPM and SOA seems to be an inevitable trend. But our study shows that the current situation of convergence is still in early stage. Mature models and methodologies of convergence are eager to be developed.

In this paper we explored the challenges and possible solutions of BPM and SOA convergence in individual projects as well as in industry level. In project level, companies still lack of experience in Business Process Modeling and choosing proper BPM tools to transfer the models into code. Testing of service and processes is specially demanding in the project. We would suggest that more consulting should be offered to companies relating to Business Process Modeling and testing.

In general level, the biggest challenge is that an integrated perspective needs to be reached from the top management. United perspective can offer a good platform for developing BPM-SOA standards and developing more mature tools.

Many measures can be taken to shrink the mindset gap. More education and training should be provided both for business and IT peoples to realize the trend of convergence. By allowing customization in model-to-implementation tools also shorten the gap between the designed solution and actual implementation.

Finally, governance is critical for BPM-SOA solutions, in governance the following issues are required:

- Service discovery and process lifecycle management
- Policy and standard enforcement
- Administration functionalities
References


