UNIVERSITY OF AGDER

Dynamic Business Process Management

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Abstract.

Open e-PRIOR is an open source e-Procurement system developed by the European Commission. Currently Open e-PRIOR system is handling simple choreographies based on the exchange of a single main object. However, these different objects are related and part of larger business process and by handling the objects separately the full overview is lost.

Business process management (BPM) helps organizations to understand and maintain complicated business workflow. This master thesis focuses on how BPM can provide a way to monitor the full business process and provide information to the stakeholders using the e-Prior system.

The first part of the thesis explores the business context and relevant capabilities of the open e-PRIOR system. Secondly candidate BPM tools are compared against the modeling needs to select the most suitable one. Thereafter, Logical view of open e-PRIOR is re-designed and a new logical model of the open e-PRIOR system is proposed by implementing business process management system. Finally, a business process management task is designed and implemented by a business process management tool.

Preface

This master was submitted to support requirements for master of Information Communication Technology (ICT) degree. This project work was done by collaboration between University of Agder and European commission organization. The project was supervised by Mikael Snaprud .

First, I need to appreciate valuable assistance of European commission members Fausto Rubino and Kelly Liljemo, in this project. Also, I would like to thank my supervisor Mikael Snaprud for his assistance and support through project period.

Grimstad, Jun 2012

Soroush Kahkesh

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Chapter1. Introduction

Business process management provides integrity for an organization against any kind of interior and exterior operational changes [1]. Many companies operations have been changed by using business process management. Industries use this method as a solution for improving quality of services and saving financial resources.

The main goals of the project include; identify open e-PRIOR system needs to implement business project management system on open e-PRIOR, evaluate business project management tools among available productions in the market, select a suitable tool for design business process management system, and update current architecture of open e-PRIOR system.

1.1. Background and motivation

Background

E-Procurement is known as a significant source of productivity in the world [2]. Many companies around the world are interested in developing e-services and replace it with traditional paper base systems .Today, electronic invoice and message delivery have an important role in the world and most of the countries use this technology [2]. For example, Scandinavian countries are pioneer in developing e-invoice systems, and replace paperless with traditional paper-base system is a significant policy for them [3]. Furthermore, we cannot ignore regarding economy crisis many companies around the world struggle to decrease their costs. For accomplishing this target electronic message delivery helps them to save remarkable amount of their budgets [2] [3].

Motivation

Profitability is the main motivation of using Business Process Management (BPM). To understand reason of profitability, we need to perceive the concepts of this system.

Today, most of the companies need to be highly flexible, and change their tactics quickly in the dynamic business environment to stay competitive in the market. Advanced technologies development, increase demands for having flexible business plans.

Open e-PRIOR system provides services for remarkable number of customers and suppliers. Definitely, this system faces with high amount of workload in every working hour. Control and manage workflows, are the main purposes of designing and implementing, business process management system for open e-PRIOR.

We can find some benefits of business process management for open e-PRIOR system below [4] [5]:

1.   Helps to have efficient business plan.

2.   Satisfy customers by innovation in providing services

3.   Helps to manage and use resources in the better manner to avoid wasting

4.   Reduction costs and increase profit

5.   Create positive competition environment. Motivate companies to have innovation in planning and creativity for solving business problems

6.   Provides strong idea for producers to create new technologies.

1.2. Problem statement

Interoperability is a significant concept for providing European public services [6]. Despite, exchanging data between systems is the provision of European public services; interoperability is a wide subject which provides capability of organization to collaborate in an integrated environment.The European Commission considers different levels of interoperability [6], as follows:

- Technical Interoperability: Planning of technical issues involved in linking computer systems and services

- Semantic Interoperability: Precise meaning of exchanged information which is preserved and understood by all parties

- Organisational Interoperability: Coordinated processes in which different organisations achieve a previously agreed and mutually beneficial goal

- Legal Interoperability: Aligned legislation so; exchanged data is based on the proper legal weight

Organizational interoperability is the main focus of this project.

Upgrade architecture of current open e-PRIOR, Include Implementing BPM system on open e-PRIOR and define   services, functions, and entities for business process management are the main goals of this project. At the end we expect to have a model which supply customers and operators demands.

Figure 1 shows general view of problems in this project. To achieve final point in our project and create business process management system, three important phases must be done. The first and second phases are considered as main concepts of this project. The Third phase should be developed by open e-PRIOR developers.

In the first phase, we need to select a suitable tool by respecting open e-PRIOR needs among available tools in the market. In the second Phase, we need to re-design open e-PRIOR architecture and implement a business process management system on open e-PRIOR system.
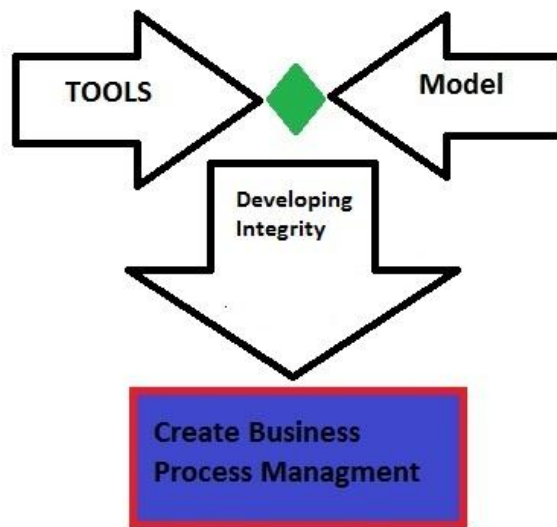
Figure 1.Problem Phases

The Third phase approaches us to final point for creating business process management system. Although, the third phase is not included in this project scope, entire phases are related to each other strongly. Implement, integrate, and develop (third phase) of a BPM system is feasible by using a suitable BPM tool and model.

1.3. Method

1.3.1. Solution Approach

The research follows four relevant steps for accomplishing all the project objectives. By taking each step we will be able to approach project goals. Regarding figure 2, analysis business process needs, Identify candidate business process management tools, define evaluation framework and tools selection, and update current open e-PRIOR system are the main proposed solution in this project.
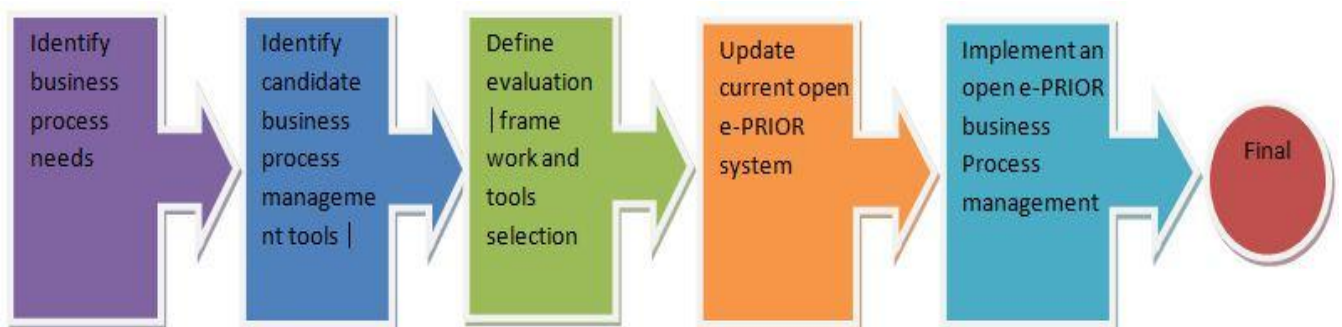
Figure 2.Solution steps

The following steps indicate the planned progress of the master project to solve the problems;

Step1. Identify Open e-PRIOR requirements.

In this part we need to explore the project needs. In this step we need to understand what are the factors for implementing, business process management systems.

Stpe2. Identify candidate business process management tools.

In this step we need to find necessary tools for business process management. In this case we need to analysis features of tools.

Step3. Define evaluation framework and selecting a tool

In this step we need to define a framework to help us in evaluating and comparing tools. Then we need to select a BPM tool.

Step4. Update current open e-PRIOR system

In this step we supposed to re-design open e-PRIOR model. Update logical layer and Define interactions between open e-PRIOR system and business process management system is the main challenge in this phase.

Step5. Implement open e-PRIOR business process management

In this step we suppose to design and implement a business process management data exchange profile by using selected tools and updated model in the 3rd and 4th steps respectively.

1.3.2. Research method

In the problem statement (chapter 1.2) section the main issues of master thesis described. In the solution approach (chapter 1.3) five different steps are defined to lead us to projects goals. In this chapter we describe proposed solutions and the method to approach the project objectives.

1.3.2.1 Build an overview of the Open e-PRIOR functionality and identify Open e-PRIOR requirements

Since business process management system supposed to be implemented on the open e-PRIOR, mechanism and architecture need to be evaluated accurately. Open e-PRIOR has a complicated mechanism. Each layer of open e-PRIOR architecture includes several protocols and components. So; in the first step, we need to have an accurate research about open e-PRIOR mechanism. In this case, it is necessary to find out about foundations which open e-PRIOR is based on them such communication protocols (TCP/IP), web-server applications, and databases. In this step European commission documents need to be explored as source of information.

Beside this, we must perceive objectives and mechanism of business process management (BPM) system and tools. Understand BPM mechanism helps us to define direction of our research in the open e-PRIR field. Furthermore we can find out, what we are the requirements (needs) to create and

implement business process management on open e-PRIOR system. Following method helps us to find and introduce project needs respectively. Project needs prepare a background for finding a suitable tool in the next phase of research. To define project needs following steps (Figure3) must be taken:

1. Explore and understand open e-PRIOR concept Includes architecture, protocols, platforms, and working mechanism.

2. Explore and understand business process management mechanism and objectives, to find out requirements for implementing and integrating.

3. Answer a logical questions," Is it required for running BPM?"

4. Identify and define open e-PRIOR needs, for implementing and integrating BPM system.
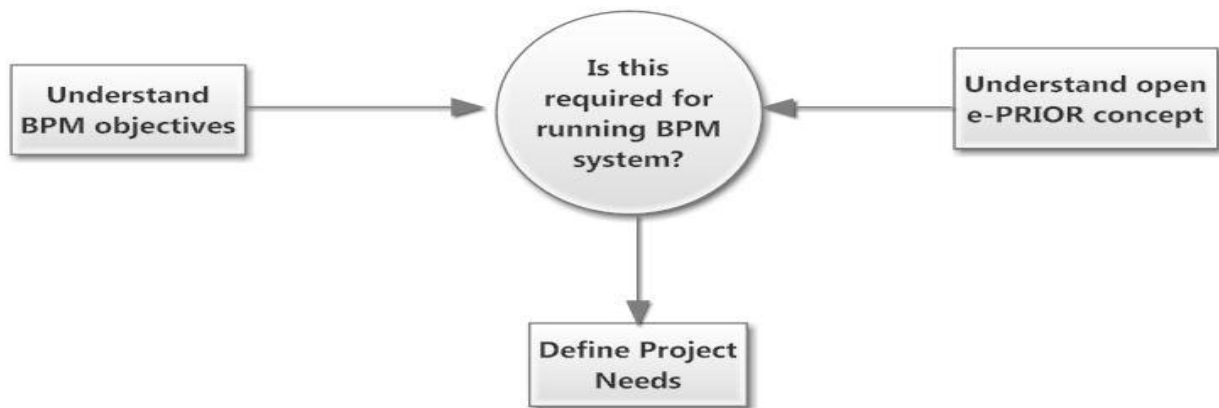
Figure 3.Define project needs process

1.3.2.2. Identify candidate business process management tools

Brief explore through the BPM products webpages shows, there are plenty of available open-source business process management tools in the market. Select the strongest options as candidate tools among available BPM tools in the market, is the main objective of this step. Since time limitation is an important concern in this research, testing entire available tools is not a practical solution. Hence, we needed to rely on the prior research and successful experience of developers in this case. A comprehensive research helps us to find out about BPM qualifications and select the most efficient as candidate tools. The candidate tools in this project are the numbers of famous and popular business process management tools in the market and several developers have positive idea about usability of them.

1.3.2.3. Define evaluation framework and selecting a tool

Since, select a suitable tool has a tangible effect on our project achievement. We decided to define a strategy to compare tools and reach a reasonable conclusion about candidate tools. Our strategy is

based on the tools features, project needs, and criteria. Figure 4 clarify strategy, for comparing and selecting a tool.

Entire business process management (BPM) tools are created base on a common logic. Refer to researches [8] [9] [18], BPM tools include several features. To avoid losing project direction and optimize evaluation, we need to consider specific groups of features that are related to project needs (Each feature supports numbers of our needs).
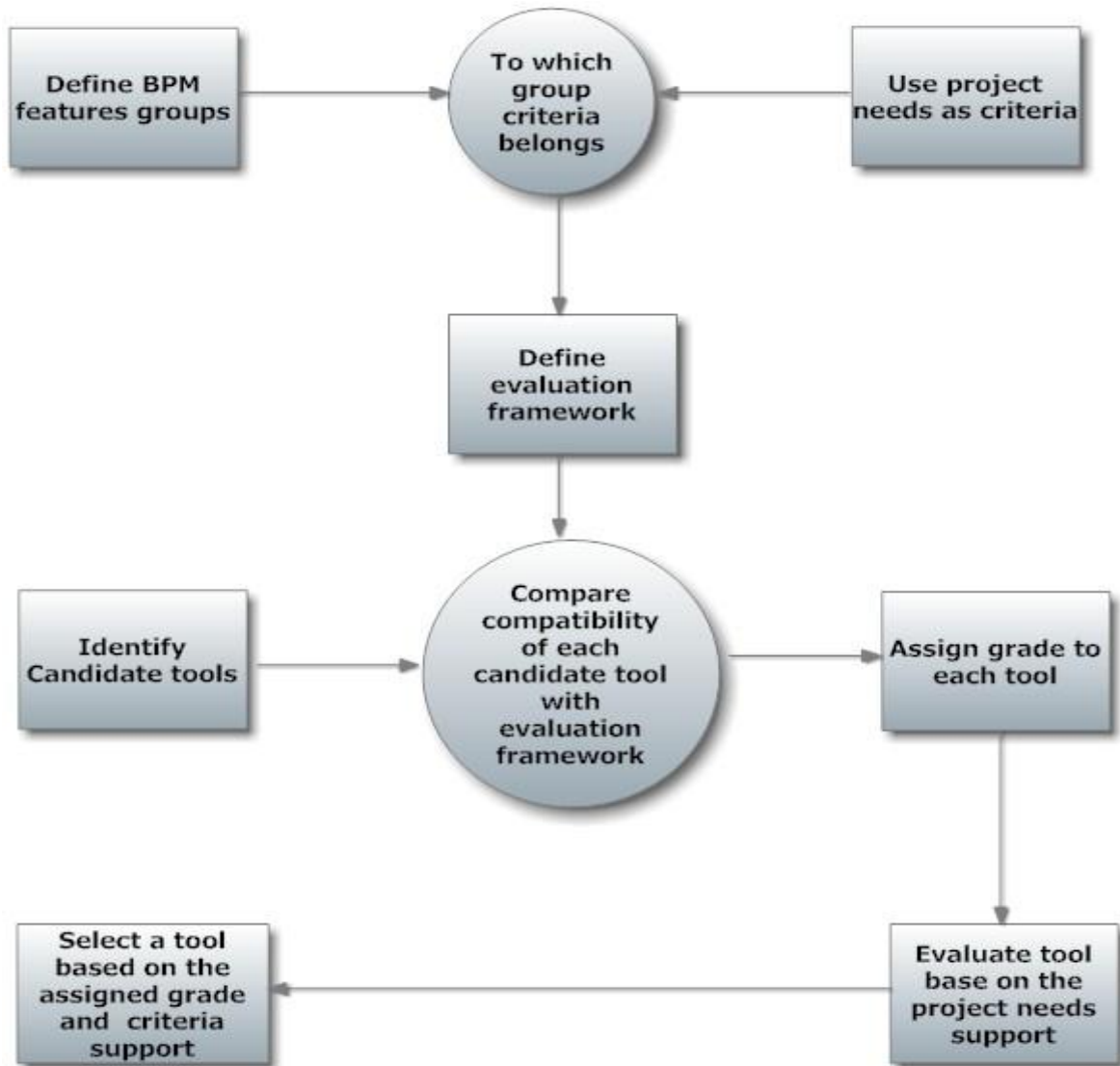
Figure 4.Strategy of finding suitable BPM tool

To perform mentioned strategy, we need to take following steps:

1. Identify relevant business process management tools features inside different groups.

2. Use criteria (Project needs) to create framework (chapter 1.3.2.1).

3. Answer a question: "to which group this criterion belongs?"

4. Define evaluation framework.

5. Identify and describe candidate tools (chapter 1.3.2.2) features (By using evaluation matrix).

6. Compare compatibility of BPM tools features with evaluation frame.

7. Assign a grade to each BPM tool, regarding support of evaluation framework criteria.

8. Evaluate and describe criteria support by candidate tools.

9. Select a tool among candidates based on the criteria support and assigned grade.

Comparing process, need to be done in a logical manner. Create an evaluation matrix (table 1) is a common method for juxtaposing different tools and comparing capabilities of them with main system (open e-PRIOR).

Table 1.Comparison Table Sample

Criteria	Evaluation result	Why this criteria matters	Priority of criteria	Grade
Evaluation criteria regarding project needs	Yes/No	Brief description about criteria	High/Normal/Low	1/0

- Criteria: by respecting project's needs, criteria are defined to introduce comparison factors.

- Evaluation result: depend on support of criteria by tools we assign "Yes" or "No".

- Why this criteria matter: provides feedback about defined criteria.

- Priority of criteria: Allocate priority level of criteria depends on project coach decision about criteria's importance.

- Grade: If candidate tools support defined criteria fully (all the criteria in a cell), grade "1" will is assigned to it. Otherwise, grade "0" will be assigned to it.

In the conclusion part of selecting tool, Grade and efficiency of tools are evaluated. A business process management tool with high grades and support of preferred priority (high level) will be selected among candidate tools.

1.3.2.4. Update current open e-PRIOR architecture

Update logical architecture of open e-PRIOR is a significant target in this section. For updating open e-PRIOR system, we need to look for a solution to implement business process management system. Sine changing architecture of open e-PRIOR is not a target for this project, we needed to find a solution to harmonize business process management and open e-PRIOR activities. In this case regarding open e-PRIOR availability, we define and add functions, services, and components to orchestrate business process management system activities on open e-PRIOR architecture. In

addition, Explore and evaluate other successful BPM designs lead us to have better idea and creativity in designing.

1.3.2.5. Implement open e-PRIOR business process management

Open e-PRIOR includes several profiles for processing documents. In this section, we try to design and implement a data exchanging profile (procurement) by using previous section results. In the first step we design an open e-PRIOR data exchange profile by using updated architecture. In the second step, we implement designed profile (procurement) by using selected tool. In this section we show applicability of our updated model (defined services) and clarify mechanism of business process management systems and tools.

1.4. Limitations and key assumptions

1.4.1. Limitation

This master project is a small contribution to support a wider project which is defined by the European commission. In this project we try to concentrate on updating current open e-PRIOR architecture and provide a background for integrating open e-PRIOR and BPM systems.

In this project we do not consider programming concepts .This project aims to discuss about theories and propose a method for designing a model. However, this model is not a final solution which should be used in the real world. Normally, a model can be changed by programming teams when they try to implement it.

Open e-PRIOR is an international program that can be used by several companies and organizations. We strongly need to have a wide view to predict project managers' and users demands. Probably it is difficult to predict all the future changes which a system can be faced. But we need to estimate about incoming problems and design a flexible prototype to avoid deficiencies.

1.4.2. Assumption

The Open e-PRIOR system is a wide system by considerable number of users which is used by several countries in Europe. Open e-PRIOR need to be developed to have optimized performance and respond expectations.

1.5. Contributions to knowledge

Theory of this project can be used in the computer science fields. Results of this project are directly relevant to architecture of an e-procurement system. This research can provide better understanding of business process management and open e-PRIOR architecture. So, theory of project can be developed and used by people who want to concentrate on the e-procurement, business process management and architecture of open-source systems.

Results of this project can be utilized by people who involve in the workflow management projects and open up a door for future of business process management topic. However, the primary intended audience is the European commission and the staff working on the e-PRIOR project.

1.6. Thesis outline

Chapter 2

This chapter Introduces, basic mechanism of open e-PRIOR system and evaluates related concepts to this project

Chapter 3

This chapter includes process of introducing and comparing business process management (BPM) tools. This chapter is ended by selecting an efficient tool.

Chapter 4

This chapter focuses on re-designing current architecture of open e-PRIOR system and implementing business process management system on it.

Chapter 5

This chapter includes, designing an open e-RIOR e-procurement process by selected business process management tool in chapter 3.

Chapter2. Introduction to Open e-PRIOR

2.1. What is Open e-PRIOR

Open e-PRIOR is an open-source e-Procurement project which is developed by the European Commission [8]. The financial resource of project was provided by former IDABC and current ISA program [7] [8]. Stimulation the implementation and re-use of interoperable mechanisms in Europe are the main targets of this project.

Open e-PRIOR is a service-oriented application. European commission, European Union agencies and institution are able to exchange documents via e-PRIOR and over PEPPOL network. Figure 5 shows the e-PRIOR and PEPPOL network transactions.
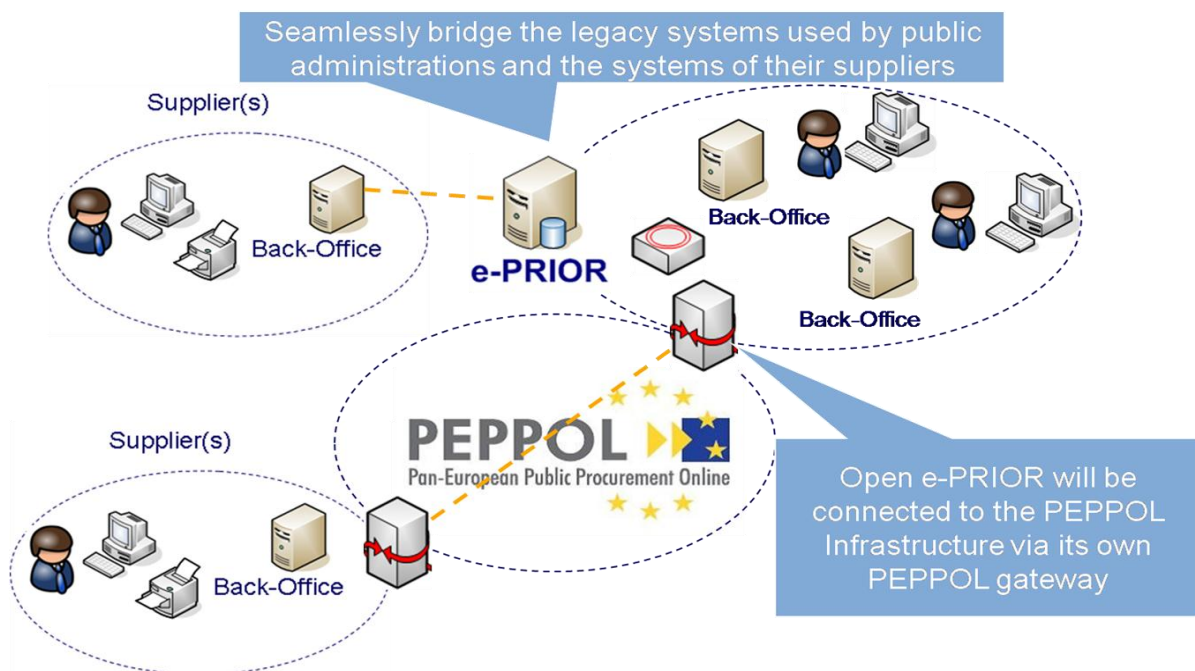
Figure 5.Open e-PRIOR and PEOPPL Network [7]

The European Commission runs e-procurement project with several service providers. The main target of this project is to provide real-life experience with e-Invoicing. The e-PRIOR provides exchanging XML e-procurement to the commission's e-PRIOR system. An automatic mechanism checks integrity in the back-office to approve invoice validation. This mechanism host inside the data system and has been developed by commission's infrastructure. This mechanism assists suppliers and users to upload and download XML messages via web services.

We can see overview of e-PRIOR and PEPPOL (access point) services below:

Table 2.Open e-PRIOR and PEPPOL Services

Services	Open e-PRIOR	PEPPOL
Submit invoice	✓	✓
Submit CreditNote	✓	✓
Submit Attached Document	✓	✓
View Document	✓	
Query Request	✓	
Status Request	✓	
Retrieve Request	✓	
Submit Request	✓	✓
Submit Catalogue	✓	✓

2.2. Interactions between Open e-PRIOR and PEPPOL network

This section clarifies the main interactions between open e-PRIOR and PEPPOL for submitting documents. There two major transactions between PEPPOL and open e-PRIOR:

- Receive documents from supplier via PEPPOL and forward them to e-PRIOR.

- Send documents from customers' office to suppliers via PEOPPL.

Figure 6 shows architecture of open e-PRIOR and PEPPOL and help us to perceive the scenario of sending and receiving documents:

- Supplier forwards document to open e-PRIOR access point via PEPPOL access point.

- SMP supports supplier access point in routing documents process.

- Open e-PRIOR access point forward documents to open e-PRIOR.

- Document will be forwarded to customer's office after processing by open e-PRIOR.

If response needs to be generated following steps will be taken:

- The back office sends response to open e-PRIOR.

- Open e-PRIOR forward it to access point.

- SMP supports e-PRIOR access point in forwarding process.

- Open e-PRIOR access point forwards it to supplier access point.

- In the final step message will be sent to supplier's office.
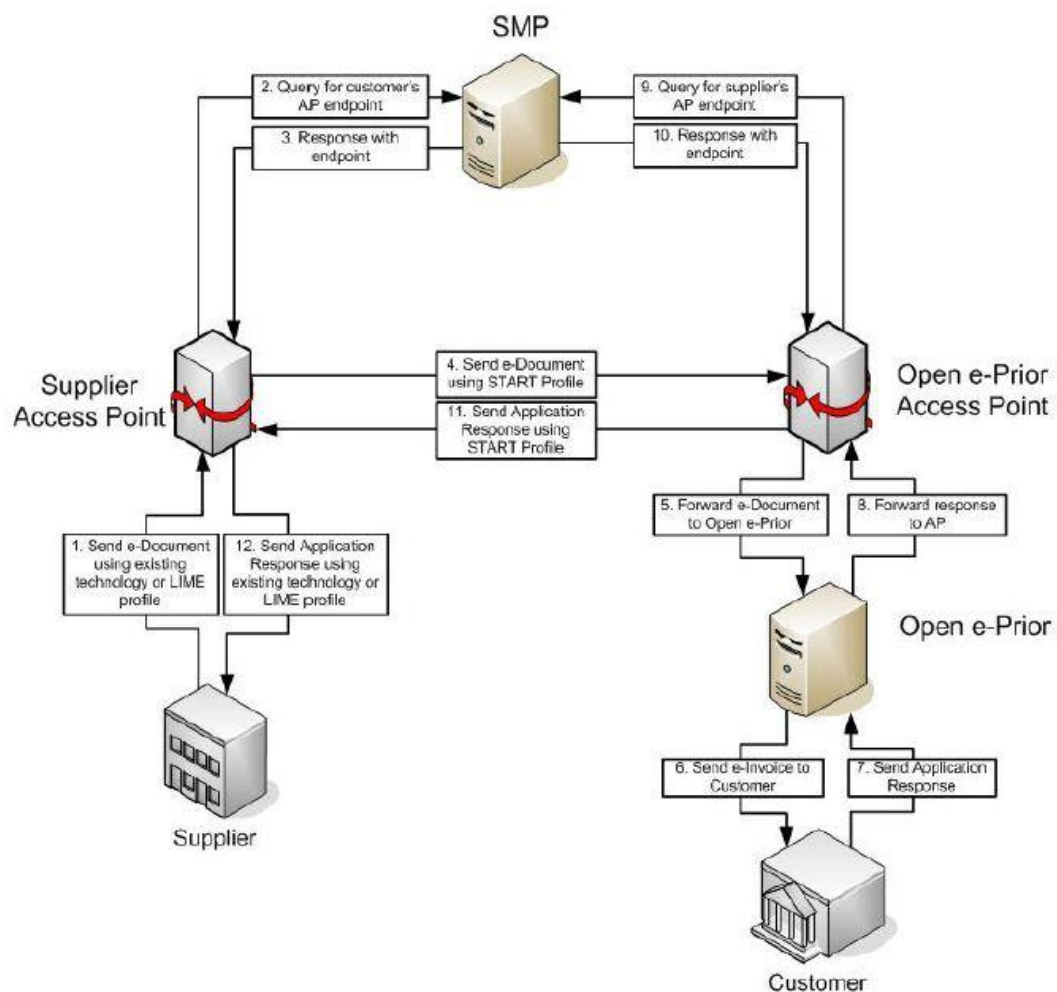
Figure 6.Open e-PRIOR and PEOPPLE interactions [8]

2.3. Current Open e-PRIOR business process management system

This section provides brief introduction of business layer and elements of it. Following this, we clarify role of process management in the current open e-PRIOR system.

2.3.1. Business Layer

• Supplier Integration Bus: it is system entry point and manages services in service oriented architecture. Entire external world (PEPPOL network and internet) interactions cross through bus. Bus includes significant functionalities such access management and logging.

• Access Management: Every transaction in the system must be authenticated. Access management helps to protect system from any unauthenticated access.

• Logging: It helps to log accesses and actions to the system. Log files provide information about the details of workflow actions and people roles.

• Process Manager: It harmonizes system services. Managing workflow is a solution for complex interaction and a process manager helps us in this case.

• The Customer Integration Bus: It is entry points to the system for the Customers.

• Persistent Data: It keeps track of entire messages in the system. The recorded information includes relative to Suppliers, System back-office interfaces, internal internationalized codes and legal information.

2.3.2. Role of process management

In this section, the role of process management is described. Also following questions are answered:

1. Where we need process management?

2. Why we need process management?

To answer first questions two different scenarios are evaluated. Then business process management model is evaluated to answer second question.

2.3.2.1. Submit invoice by supplier

In this scenario a Supplier submits an invoice, by using the Interface of open e-PRIOR or PEPPOL Access Point, through the PEPPOL network. In this case invoice cross through supplier service bus and reaches to process management point. In this point, business process management system must make decision about incoming workflow. Figure 7 clarify supplier bus and process management point.
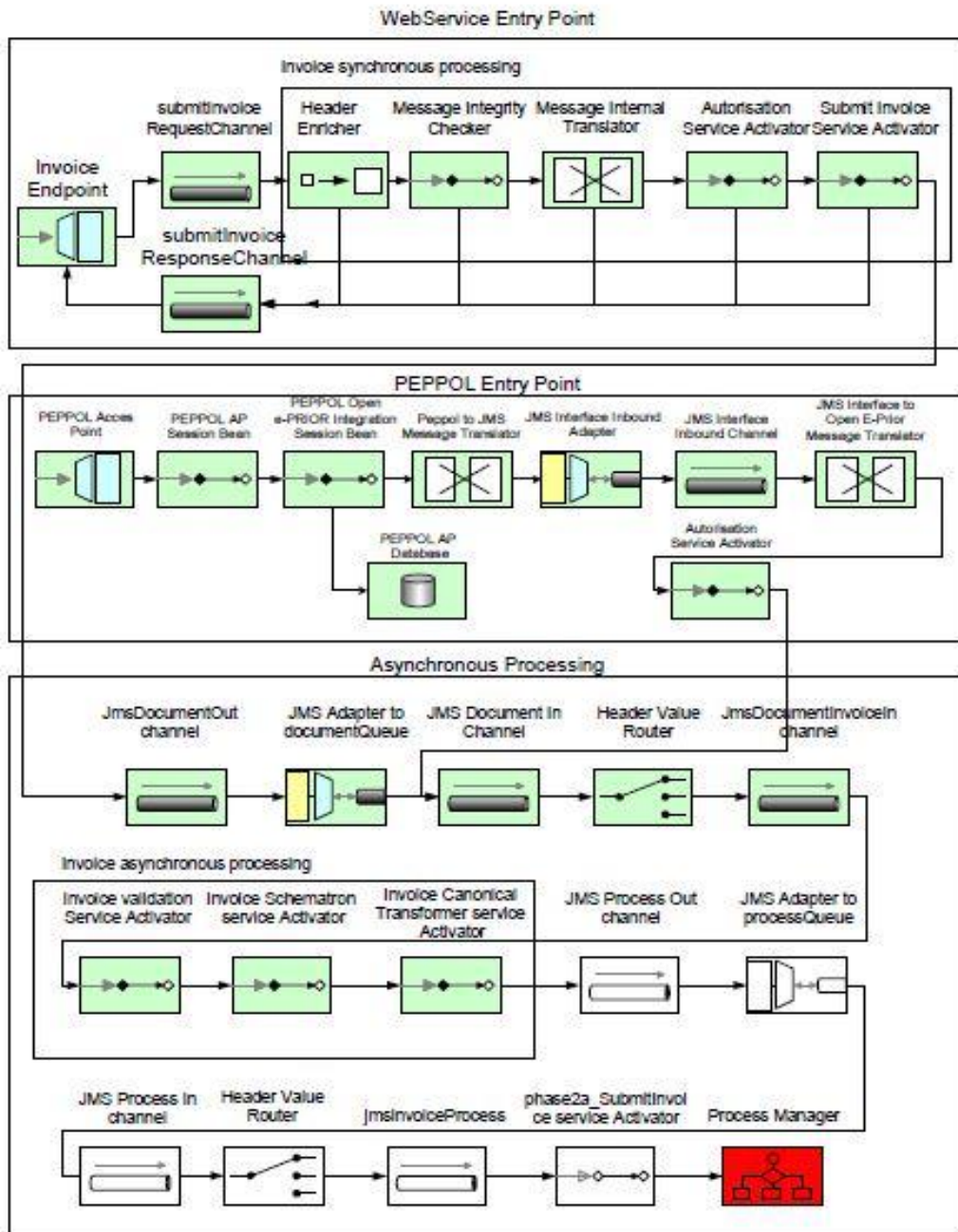
Figure 7.Supplier bus and BPM [8]

2.3.2.2. Customer submits an order

It is an open e-PRIOR service for submitting order to supplier by customers. This service provided by JMS queue. This service uses the Service Bus Layer and Process Manager Layer.

Customers submit an Order by using the JMS queue. The documents are processed by the Service Bus and convert to internal format of service bus. Then documents will be checked and sent to channels by a router.

Then service bus is used as entry points of incoming order. After performing authorization process message will be transformed into open e-PRIOR format. Finally, output will be sent to process management point and a decision must be made for handling workflow. Figure 8 helps us to perceive this mechanism.
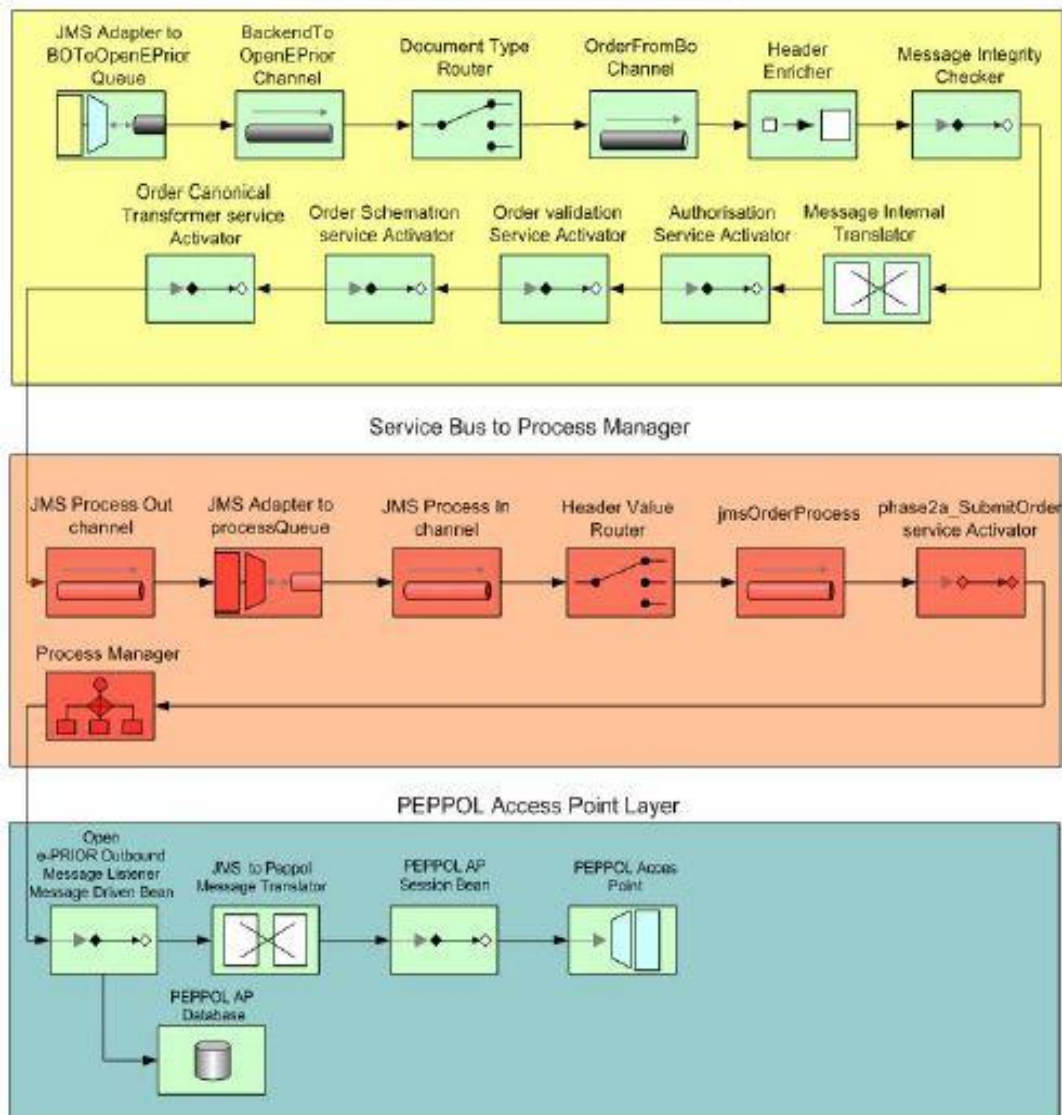
Figure 8.Customer bus and BPM [8]

2.4. Project needs

Identify projects needs assists us to have better understanding of project foundation which help us in selecting suitable tools. The idea of selecting a BPM tool is based on the open e-PRIOR needs for integrating BPM system. Our business process management tool must be able to support following factors:

1. Support Jboss and Weblogic application servers.
2. Support HSQL, Oracle, and MySQL databases.
3. Support HTTP(s), TCP/IP, and JMS communication protocols.
4. Support WS-security, WSDL, and WSDM web services.
5. Support XML, BPMN, and multiple version of processing
6. Support stand-alone enterprise service bus.
7. Support J2EE Standard.
8. Support Process monitoring.
9. Support transaction management.
10. Support event management.

Chapter3. Evaluation of existing business process management (BPM) tools

3.1. What is business process management?

Business process management (BPM) is a mechanism which, propose an efficient solution for managing workflow in organizations and bring them flexibility in the case of changing environment [9]. Business process architecture includes set of activities which approaches organizations to their goals. Business goals of companies and e-business concepts prone them to look for a solution via business process management. Business process management system is a solution which is proposed by business process management tools.

3.2. What is business process management tool?

Business process management tools provide the capability of optimizing outputs of business process management lifecycle. It provides process modeling, execution, monitoring, and optimization [9]. Figure 9 Illustrates, business process management tools, lifecycle optimization.
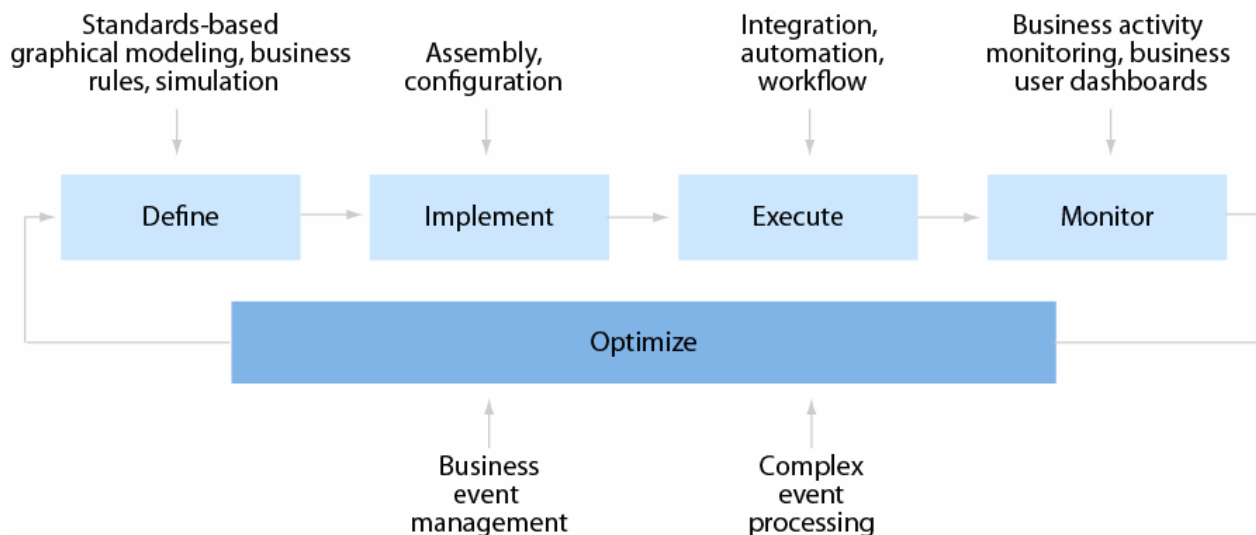
Figure 9.BPM tools mechanism [9]

Unfortunately, business process management tools are quite expensive productions so; most of the developers, designers, and small organizations are not able to utilize it easily. Probably, during recent economy crisis most of companies have a tangible problem to spend remarkable amount of their budgets for these tools. However, the technology world proposed a solution in this case. Open-source business process management tools bring hope for designers and most of the people who are involved in this field. Financial advantages and license flexibility of open-source business process management tools are good reasons to convince customers. Although, in some fields open-source software is not a powerful way for designing, in the business process management these productions have shown their merits.

3.3. Evaluation Framework and candidate tools

In the software development market most of the companies have a tight competition to have newest innovation in their productions. Definitely, most of the products have several capabilities for running business management projects. But it is necessary to understand which of them lead us to achieve project goals.

To verify a framework and create a list of criteria for comparing features of tools, we need to identify common features and key functions between tools features as project needs (chapter 2.4). There is a remarkable point that, we must consider project needs as comparison criteria.

Based on the logic, to have better comparison we need to create a framework for evaluating and comparing tools. Regarding provided information by project needs and tools features, several categories are introduced to form our evaluation framework. Figure 10 shows the evaluation framework categories. Blue bubbles; represent business process management tools features groups. Brown bubbles, contain our requirements (project needs) which are categorized inside tools feature groups.
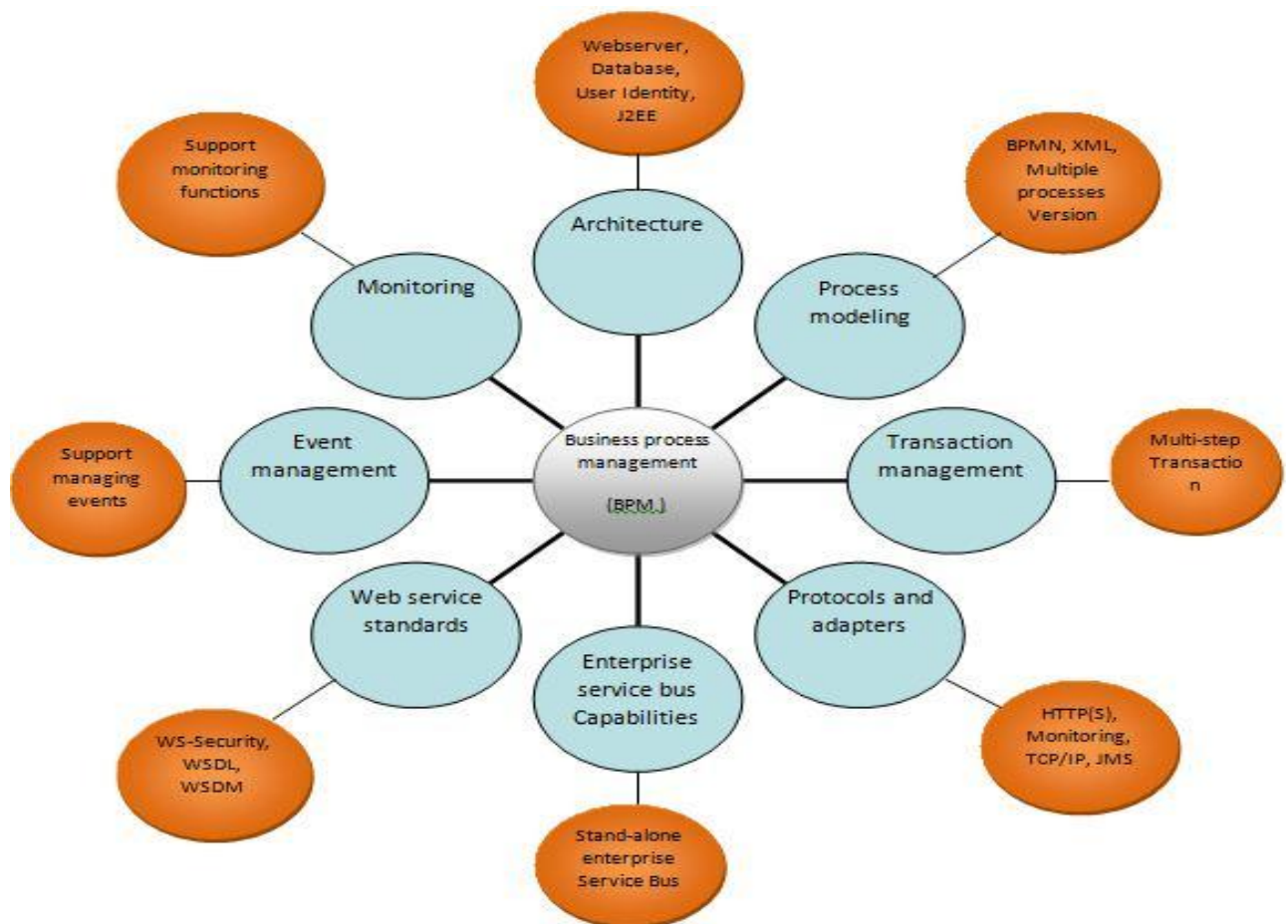
Figure 10.Framework and criteria

There are several popular open-source tools in the business process management fields. Regarding our research, JBPM, Procesmaker, Intalio, Bonita, and Activiti are known as quite attractive productions among the customers. All these software have a common objective, to assists developers for designing a business process management system. Despite, having common objective, they have variety in features and capabilities.

Our objective in the next sections of this chapter is to, evaluate and compare candidate tools and find out which one of them can be efficient in designing business process system.

3.4. Identification of evaluation criteria

Table 3 is designed to help us for having accurate comparison. Regarding table 3, we suppose to explore inside the tools and find out if they support Project needs. As mentioned previously (Chapter 1.3.2.3), each cell may include more than one criteria (such protocol, database, or application server) but we consider each cell as a single unit in grading[1].

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[1] For example, in the database platforms cell (table 3-page 22), we require 3 different databases to be supported by a BPM tools. If evaluated tools support 1 or 2 of database it receives "0" as grade. But if it supports all the mentioned databases it receives "1" as grade.

Table 3.Comparison Table

Criteria	Evaluation result	Why this criteria matters	Priority of criteria	Grade
Architecture: This category of criteria, integrate tools with customers applications.				
Does this product support to be deployed on web logic and Jboss application servers?	Yes/No	Capability of providing services for software application.	High	0/1
Does this product support HSQL, Oracle, and MySQL?	Yes/No	Technical integration and license cost.	High	0/1
Does this product support J2EE standards?	Yes/No	Support API and runtime environment for developing networks and web services software.	High	0/1
Does it support Identification management?	Yes/No	Providing security components to manage user identities, profiles and relationship.	Normal	0/1
Process modeling: This category of criteria concentrates on user's demands for user interface modeling.				
Does this product support multiple versions of process the design?	Yes/No	Project element level.	Normal	0/1
Does this product support XML and BPMN?	Yes/No	Provides support for XML scheme and BPMN standards.	Normal	0/1

Protocols and adapters: This category includes capability of products in adapters and communication fields. These capabilities provide connection between tools and customer applications				
Does it support HTTP(S) and TCP/IP Protocols?	Yes/No	Capability of supporting communication protocols.	High	0/1
Does this product support JMS (Java Message Services)?	Yes/No	Supports Java message service	High	0/1
Does this product support SOAP over JMS?	Yes/No	Supports Java message protocol.	High	0/1
Transaction management: This category concern about efficiency of managing transaction to handle several applications.				
Does this product support multiple step transaction?	Yes/No	Capability of supporting multistep transaction for managing multitask processes and rollback in the case of error.	Low	0/1
Event management: This category shows capability of managing events. This category is used by users.				
Does this product have capability of defining events and add external events to process?	Yes/No	Supports event definition and complex event process. Tracking events and based on rule initiate action.	Low	0/1
Enterprise service bus (ESB) Capabilities: this category concern about sophistication of ESB functionality. Is solution-standard ESB Standalone or Embedded				
Does this product have standalone solution-standard?	Yes/No	The capability of using BPM mechanism regarding our strategy. It can run in any Java	High	0/1

		environment, embedded in your application or as an optional service.		
Web service standards: This category includes capability of products for supporting service oriented application.				
Does this product support WSDL?	Yes/No	Provides interface for web services to build composite applications.	Normal	0/1
Does this product support WS-Security?	Yes/No	Provides secure transaction between web services in different levels.	Normal	0/1
Does this product support Web Services Distributed Management (WSDM)	Yes/No	Provides managing and monitoring status of other services.	Normal	0/1
Monitoring: This category concern about capability of tools for business monitoring.				
Does this product have ability to filter, aggregate, track, and sort process instances?	Yes/No	Capability of easy controlling and managing processes.	Low	0/1

3.4.1 Tools features analysis

3.4.1.1.Processmaker

Processmaker is an open source business process management (BPM) tool [10]. Processmaker assist organizations to design and automate business processes. Create digital forms and fully management of workflows are important capabilities of process maker. This is web based software and users from different location can have access to it, so managing and coordinating workflows will be easy for groups and departments.

Following table illustrates tool features:

Table 4.Processmaker features

Criteria	Evaluation result	Grade
Architecture: This category of criteria, integrate tools with customers applications.		
Does this product support to be deployed on web logic and Jboss application servers?	Web logic-No/Jboss-Yes	0
Does this product support HSQL, Oracle, and MySQL?	HSQL-No/Oracle-Yes/MySQL-No	0
Does this product support J2EE standards?	No	0
Does it support Identification management?	Yes	1
Process modeling: This category of criteria concentrates on user's demands for user interface modeling.		
Does this product support multiple versions of process the design?	No	0
Does this product support XML and BPMN?	XML-Yes/BPMN-Yes	1

Protocols and adapters: This category includes capability of products in adapters and communication fields. These capabilities provide connection between tools and customer applications		
Does it support HTTP(S) and TCP/IP Protocols?	HTTPS-Yes/ TCP/IP-Yes	1
Does this product support JMS (Java Message Services)?	No	0
Does this product support SOAP over JMS?	No	0
Transaction management: This category concern about efficiency of managing transaction to handle several applications.		
Does this product support multiple step transaction?	Yes	1
Event management: This category shows capability of managing events. This category is used by users.		
Does this product have capability of defining events and add external events to process?	No	0
Enterprise service bus (ESB) Capabilities: this category concern about sophistication of ESB functionality. Is solution-standard ESB Standalone or Embedded		
Does this product have standalone solution-standard?	Yes	1
Web service standards: This category includes capability of products for supporting service oriented application.		
Does this product support WSDL?	Yes	1

Does this product support WS-Security?	Yes	1
Does this product support Web Services Distributed Management (WSDM)	No	0
Monitoring: This category concern about capability of tools for business monitoring.		
Does this product have ability to filter, aggregate, track, and sort process instances?	Yes	1
Total Grade: 8		

3.4.1.2. Bonita

It was created in the French national institute for researching in computer science area [11].it has tested and developed for several years. It was released as a software production in 2009.Bonita is an open source solution in business project management and provides futures to design, develop, run and monitor a business process in the different stages.

Following table illustrates tool features:

Table 5.Bonita Features

Criteria	Evaluation result	Grade
Architecture: This category of criteria, integrate tools with customers applications.		
Does this product support to be deployed on web logic and Jboss application servers?	Weblogic-No/Jboss-Yes	0
Does this product support HSQL, Oracle, and MySQL?	HSQL-No/Oracle-Yes/MySQL-Yes	0
Does this product support J2EE standards?	Yes	1
Does it support Identification management?	Yes	1
Process modeling: This category of criteria concentrates on user's demands for user interface modeling.		
Does this product support multiple versions of process the design?	Yes	1
Does this product support XML and BPMN?	XML-Yes/BPMN-Yes	1
Protocols and adapters: This category includes capability of products in adapters and communication fields. These capabilities provide		

connection between tools and customer applications		
Does it support HTTP(S) and TCP/IP Protocols?	HTTPS-Yes/ TCP/IP-Yes	1
Does this product support JMS (Java Message Services)?	Yes	1
Does this product support SOAP over JMS?	Yes	1
Transaction management: This category concern about efficiency of managing transaction to handle several applications.		
Does this product support multiple step transaction?	Yes	1
Event management: This category shows capability of managing events. This category is used by users.		
Does this product have capability of defining events and add external events to process?	Yes	1
Enterprise service bus (ESB) Capabilities: this category concern about sophistication of ESB functionality. Is solution-standard ESB Standalone or Embedded		
Does this product have standalone solution-standard?	Yes	1
Web service standards: This category includes capability of products for supporting service oriented application.		
Does this product support WSDL?	Yes	1
Does this product support WS-Security?	Yes	1

Does this product support Web Services Distributed Management (WSDM)	Yes	1
Monitoring: This category concern about capability of tools for business monitoring.		
Does this product have ability to filter, aggregate, track, and sort process instances?	Yes	1
Total Grade:14		

3.4.1.3. JBPM

JBPM is an open-source workflow engine which executes business process. JBPM was written in Java and introduced under ASL (Apache License) in the market [12]. JBPM is known as flexible business process management software. Actually, this software translates business analysis to an understandable language for developers.

Following table illustrates tool features:

Table 6JBPM Features

Criteria	Evaluation result	Grade
Architecture: This category of criteria, integrate tools with customers applications.		
Does this product support to be deployed on web logic and Jboss application servers?	Weblogic-Yes/Jboss-Yes	1
Does this product support HSQL, Oracle, and MySQL ?	HSQL-Yes/ Oracle-Yes/MySQL-Yes	1
Does this product support J2EE standards?	Yes	1
Does it support Identification management?	Yes	1
Process modeling: This category of criteria concentrates on user's demands for user interface modeling.		
Does this product support multiple versions of process the design?	Yes	1
Does this product support XML and BPMN?	XML-Yes/ BPMN-Yes	1
Protocols and adapters: This category includes capability of products in adapters and communication fields. These capabilities provide		

connection between tools and customer applications		
Does it support HTTP(S) and TCP/IP Protocols?	HTTPS-Yes/ TCP/IP-Yes	1
Does this product support JMS (Java Message Services)?	Yes	1
Does this product support SOAP over JMS?	Yes	1
Transaction management: This category concern about efficiency of managing transaction to handle several applications.		
Does this product support multiple step transaction?	Yes	1
Event management: This category shows capability of managing events. This category is used by users.		
Does this product have capability of defining events and add external events to process?	Yes	1
Enterprise service bus (ESB) Capabilities: this category concern about sophistication of ESB functionality. Is solution-standard ESB Standalone or Embedded		
Does this product have standalone solution-standard?	Yes	1
Web service standards: This category includes capability of products for supporting service oriented application.		
Does this product support WSDL?	Yes	1
Does this product support WS-Security?	Yes	1

Does this product support Web Services Distributed Management (WSDM)	Yes	1
Monitoring: This category concern about capability of tools for business monitoring.		
Does this product have ability to filter, aggregate, track, and sort process instances?	Yes	1
Total Grade:16		

3.4.1.4.Intalio

Intalio BPM is an open-source business analyst's tool. Intalio is utilized by developers to design, deploy, and manage any business process. Intalio has been in the market since 10 years ago and several companies have used it for process management purposes [13]. Intalio is available in several editions. Intalio has powerful and high performance server engine which assist to run complex processes.

Following table illustrates tool features:

Table 7.Intalio Features

Criteria	Evaluation result	Grade
Architecture: This category of criteria, integrate tools with customers applications.		
Does this product support to be deployed on web logic and Jboss application servers?	Weblogic-No/Jboss-Yes	0
Does this product support HSQL, Oracle, and MySQL?	HSQL-No/Oracle-No/MYSQL-Yes	0
Does this product support J2EE standards?	Yes	1
Does it support Identification management?	No	0
Process modeling: This category of criteria concentrates on user's demands for user interface modeling.		
Does this product support multiple versions of process the design?	No	0
Does this product support XML and BPMN?	XML-Yes/ BPMN-No	0
Protocols and adapters: This category includes capability of products in adapters and communication fields. These capabilities provide		

connection between tools and customer applications		
Does it support HTTP(S) and TCP/IP Protocols?	HTTPS-Yes/ TCP/IP-Yes	1
Does this product support JMS (Java Message Services)?	No	0
Does this product support SOAP over JMS?	No	0
Transaction management: This category concern about efficiency of managing transaction to handle several applications.		
Does this product support multiple step transaction?	Yes	1
Event management: This category shows capability of managing events. This category is used by users.		
Does this product have capability of defining events and add external events to process?	No	0
Enterprise service bus (ESB) Capabilities: this category concern about sophistication of ESB functionality. Is solution-standard ESB Standalone or Embedded		
Does this product have standalone solution-standard?	No	0
Web service standards: This category includes capability of products for supporting service oriented application.		
Does this product support WSDL?	Yes	1
Does this product support WS-Security?	Yes	1

Does this product support Web Services Distributed Management (WSDM)	No	0
Monitoring: This category concern about capability of tools for business monitoring.		
Does this product have ability to filter, aggregate, track, and sort process instances?	No	0
Total Grade:5		

3.4.1.5. Activiti

Activiti is an open-source light-weight business process management tool [14]. Activiti has been popular among business people, developers and system admins. Activiti has super-fast process engine for Java. It is developed under Apache license and runs in Java application.

Following table illustrates tool features:

Table 8Activiti Features

Criteria	Evaluation result	Grade
Architecture: This category of criteria, integrate tools with customers applications.		
Does this product support to be deployed on web logic and Jboss application servers?	Weblogic-Yes/Jboss-No	0
Does this product support HSQL, Oracle, and MySQL ?	HSQL-No/Oracle-Yes/MySQL-Yes	0
Does this product support J2EE standards?	No	0
Does it support Identification management?	Yes	1
Process modeling: This category of criteria concentrates on user's demands for user interface modeling.		
Does this product support multiple versions of process the design?	No	0
Does this product support XML and BPMN?	XML-Yes/ BPMN-No	0

Protocols and adapters: This category includes capability of products in adapters and communication fields. These capabilities provide connection between tools and customer applications		
Does it support HTTP(S) and TCP/IP Protocols?	HTTP-Yes/ TCP/IP-No	0
Does this product support JMS (Java Message Services)?	Yes	1
Does this product support SOAP over JMS?	No	0
Transaction management: This category concern about efficiency of managing transaction to handle several applications.		
Does this product support multiple step transaction?	No	0
Event management: This category shows capability of managing events. This category is used by users.		
Does this product have capability of defining events and add external events to process?	No	0
Enterprise service bus (ESB) Capabilities: this category concern about sophistication of ESB functionality. Is solution-standard ESB Standalone or Embedded		
Does this product have standalone solution-standard?	Yes	1
Web service standards: This category includes capability of products for supporting service oriented application.		

Does this product support WSDL?	Yes	1
Does this product support WS-Security?	No	0
Does this product support Web Services Distributed Management (WSDM)	No	0
Monitoring: This category concern about capability of tools for business monitoring.		
Does this product have ability to filter, aggregate, track, and sort process instances?	No	0
Total Grade:4		

3.5. Finding Tool

In this section, we try to juxtapose business management tools and measure their compatibility with our project needs. Regarding eight different introduced features groups in the chapter 3.2, business process management tools are compared.

1. Architecture

In the architecture part, JBPM have the best choice among candidate tools. Since, it fulfills all the necessary options for supporting our project needs. Powerful support of weblogic and Jboss application servers, database platforms, ad J2EE platform can be useful during project design. In this case, Activiti and Bonita must be next option because they support three features out of four but J2EE platform does not support by them. Intalio and Processmaker fulfill half of the necessary options, and they should be considered as last options in this case. We can strongly say, except JBPM rests of the productions are in a similar level because they cannot fulfill all the high priority factors.

2. Process modeling

Since Bonita and JBPM fulfill all the necessary project needs, we can consider them as suitable option in this case. Barely, next options among selected tools are ProcessMakers and Intalio. Activiti is the weakest option among them.

3. Protocols and adapters

In the supporting protocols issue, Bonita and JBPM convince us regarding our expectation and needs. Both productions support wide range of protocols and adaptors. Rest of the tools should not be considered as strong tools in this case because; they cannot meet high priority protocols for modeling.

4. Transaction management

 Except Intalio, rests of the tools support multiple transaction management.

5. Event management

Event management assists users to organize and handle projects in an optimize manner. Bonita, JBPM, and Intalio have capability of managing events. In this case, Processmaker and Activiti cannot support event management.

6. Enterprise service bus capability

Standalone solution-standard for service bus, is an important factor regarding our project needs. In this case Processmaker and Activiti are standalone tools. During the research we understood, Bonita and JBPM have capability of being either Embedded or Standalone solution-standard. Actually, mentioned tools fulfill our expectations and we can consider them as candidate in this field. Intalio is the only embedded solution-standard among tools.

7. Web-services standards

Bonita and JBPM can be the strongest option in this case. Mentioned tools support all the web-services standards which we expected from a tool. Processmaker and Intalio are the next tools in this case. These tools support three significant web-service standards and all of them can be considered as suitable option in this field. JBPM and Activiti are the weakest tools in this category since they support two standards out of four.

8. Monitoring

Regarding our research Bonita, JBPM, and Processmaker have the best monitoring process tools. They provide full capabilities of filter, aggregate, track, and sort which helps users to control and manage processes. In this case Activiti and Intalio are weaker option for monitoring process in comparison with others.

3.5. Recommendation

Table 9 shows, total grade of candidate tools. Following grades, show compatibility of each tool with project needs (Following grades do not show quality of tools). According table, JBPM has the best score among candidate tools.

Table 9.Tools Grade

Tools Name	Total Grade
JBPM	16
Bonita	14
Processmaker	8
Intalio	5
Activiti	4

In the previous section candidate tools are compared base on our evaluation framework. According high priority criteria and tools grade (Table 9), Bonita and JBPM are the first and second options for supporting our needs. Although, both of them support high priority criteria, JBPM is more suitable and quit compatible with criteria. Support high priority criteria include; application servers and databases is a noticeable preference of JBPM.

Chapter4. Updating model

This chapter focuses on the updating logical model of open e-PRIOR system. According business process management philosophy, business process management defines interactions between business and information technology departments. Following models, shows high level relations between open e-PRIOR and business process management systems. In the following models, process management defined as a standalone system which interacts with open e-PRIOR system. Business process management system acts as an autonomous system which, orchestrate services provided by open e-PRIOR.

Following open e-PRIOR logical views are updated:

- Component view: Shows structural relations between one or more system(s).

- Application view: Shows description of system functionalities.

- Deployment view: Shows systems deployed modules views.

- Data view: Shows data representation of system.

4.1. Component view

In the Figure 11 shows component view of system. In the following system there are services provided by open e-PRIOR and following this business process management orchestrates them.
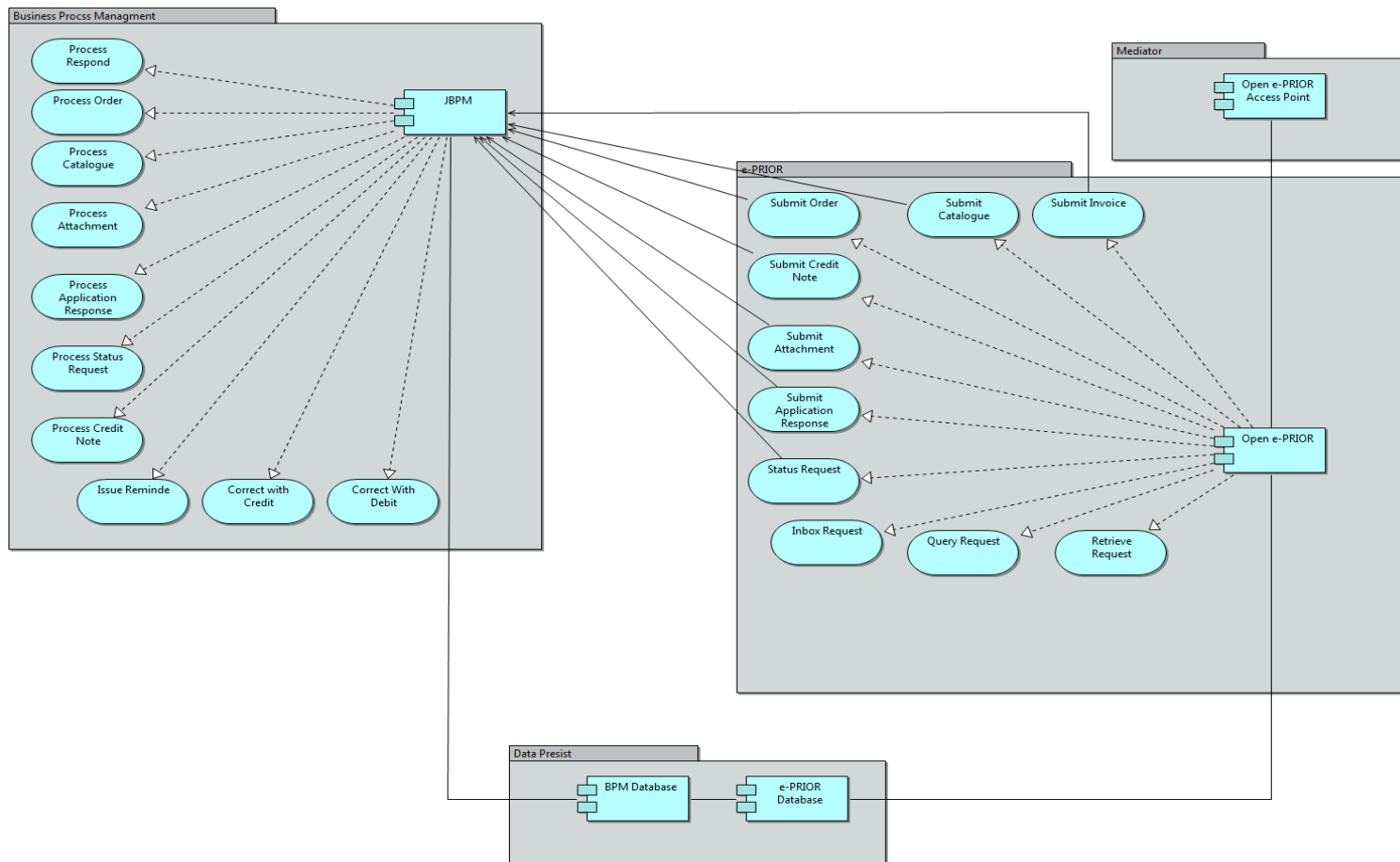
Figure 11.Component View

Open e-PRIOR exposes following services:

- Submit Order: Customers can submit orders via this service.

- Submit Invoice: Supplier delivers invoice via this service.

- Submit Catalogue: Catalogues delivers to customers via this service.

- Submit Credit Note: Commercial documents (credit note) delivers to customers via this service.

- Submit Attachment: Attachments delivers by customers/suppliers via this service.

- Submit Application Response: The response (approve/disapprove) send to customers by suppliers via this service.

- Inbox Request: Users can request their inbox information via this service.

- Query Request: Request for administrator to perform actions via this request.

- Retrieve Request: Users can recall a request via this service.

- Status Request: Status of document can be checked by users via these services.

Following services is designed by us for business process management system:

- Process Order: This service process customers order and make decision about them.

- Process Invoice: This service process invoices issued by suppliers and make decision about them.

- Process Catalogue: This service process suppliers catalogue and make decision about them.

- Process Credit Note: This service process credit notes issued by suppliers and make decision about them.

- Process Attachment: This service process attachment of customers/suppliers and make decision about them.

- Process Application Response: This service process customers' application response issued by suppliers and make decision about them.

- Process status Request: This service process customer's status requests and making decision about them.

- Correct with debit: This service provides capability of correcting rejected invoice by debit (customer).

- Correct with credit: This service provides capability of correcting rejected invoice by credit (Supplier).

- Issue reminder: This service provides reminding notification for debit (customer).

4.2. Application view

Figure 12 shows application views of our system. In the following model, open e-PRIOR performs features. Open e-PRIOR provides following features:

- Validation of business documents: This feature checks documents validity.

- Generation of a canonical model for business documents: this feature makes a decision about documents.

- Generation of human readable formats for business documents: This feature convert format of documents.

- Support of business statuses: This feature provides status for documents.

- Support of status request: This feature provides status request.

- Business notification: This feature provides notification for business documents.

- Support of interchange agreements: This feature provides the creation and storage of agreements between customers and suppliers.

- Support of party authorization: This feature provides authorization of accessing to documents.

- Collection and aggregation of logs: This feature manages logs files which provided by interactions.

- Archiving of documents: This feature provide an archive from exchanges documents.
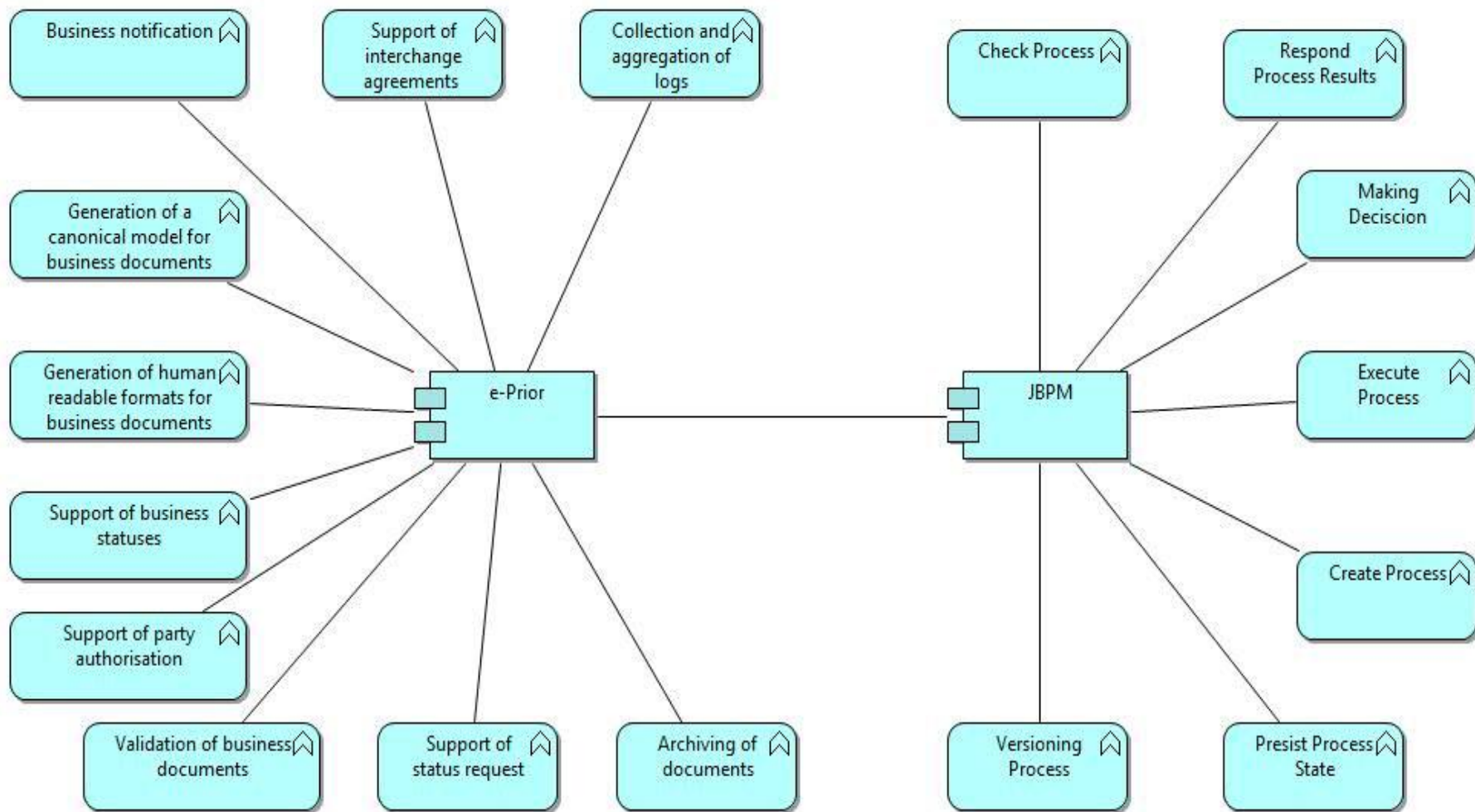
Figure 12.Application view

Following this business process management system offers features to support process requests of open e-PRIOR system. Business process management system features are listed above:

- Check process: This feature helps to check the process, validity of documents, and categorize it before making decision about it.

- Responding process result: This feature reflects process results.

- Making decision: This feature make decision about processing documents and route them in a right direction.

- Execute process: This feature provides capability of executing process.

- Create process: This feature provides capability of creating a process.

- Persist process state: This feature record information about each process.

- Versioning process: This feature provides version for each process.

4.3. Deployment View

Figure 13 shows deployment view of our system. As picture shows Jboss application servers deployed on the open e-PRIOR system. And HSQL database is allocated for following model as a database platform. To have better integrity between systems, business process management system must have quit similar requirements, we allocated same application serve and database platform in this case.
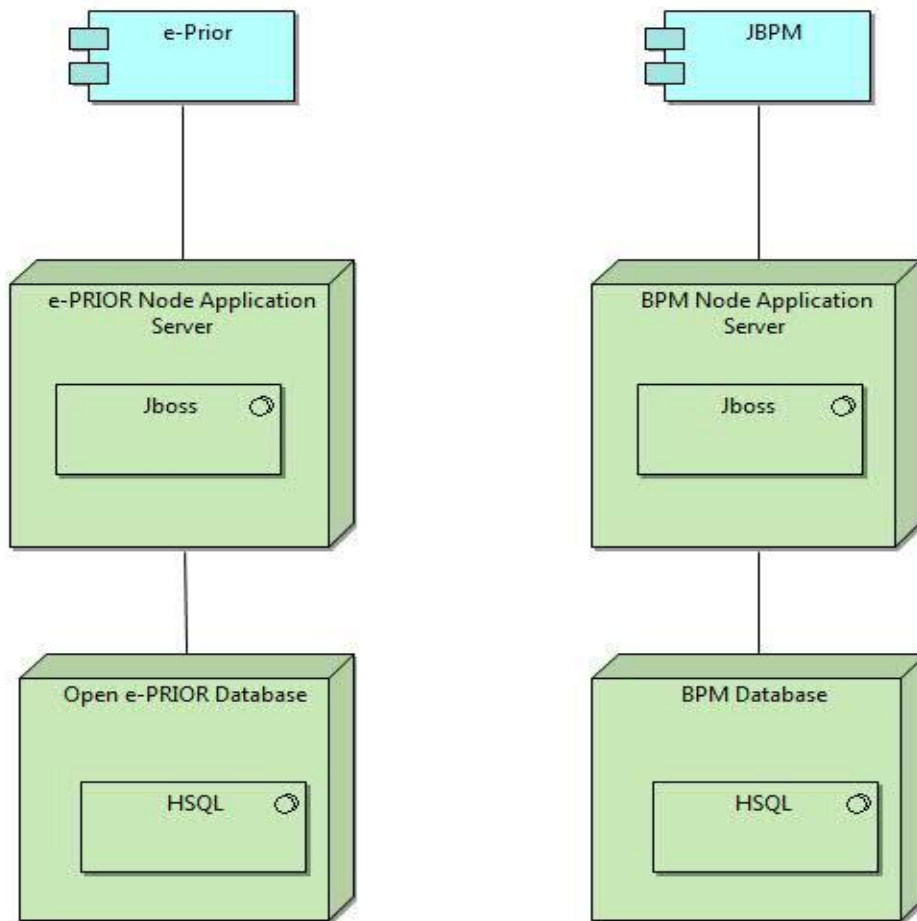
Figure 13.Deployment view

4.4. Date Model

Figure 14 shows our data models. Following model includes open e-PRIOR and business process management systems. Each system includes some entities.
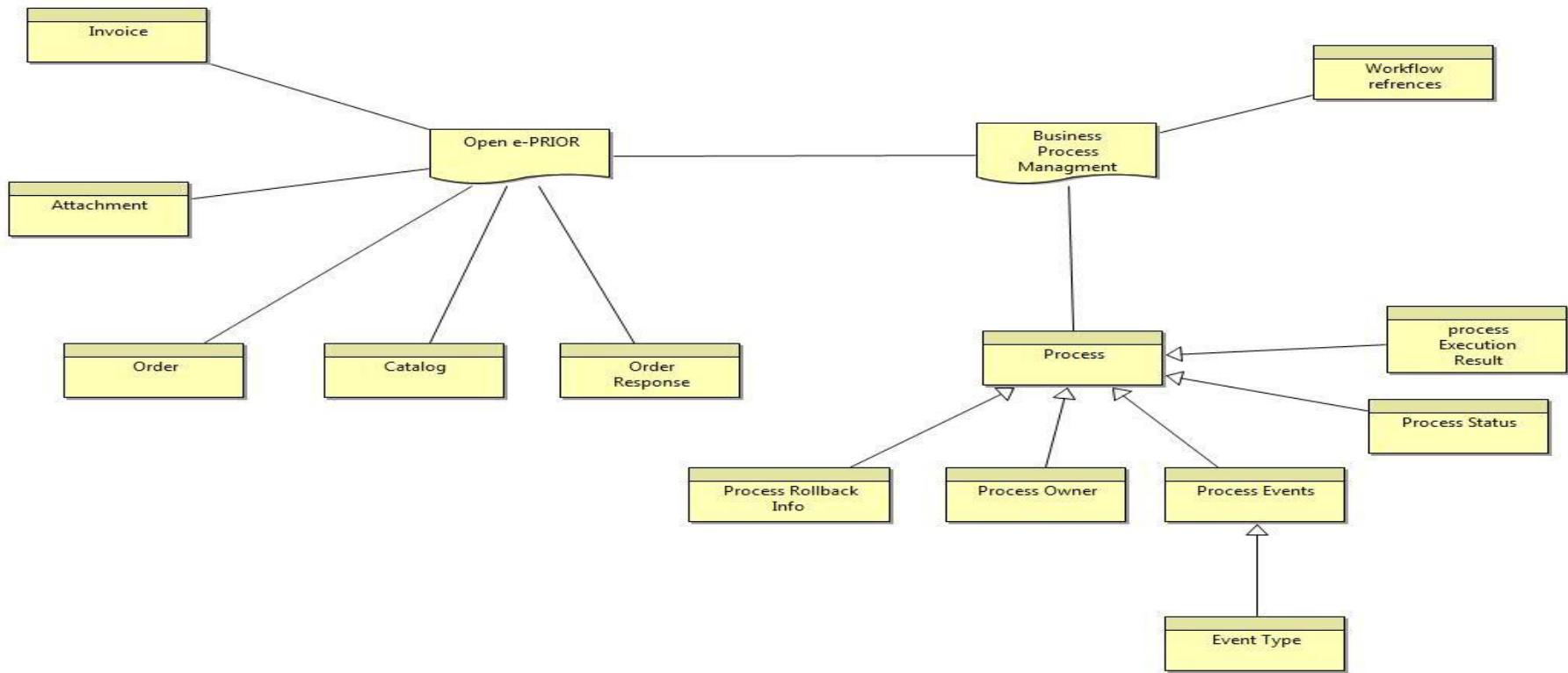
Figure 14.Data view

Open e-PRIOR includes following entities:

- Invoice

- Attachment

- Order

- Catalogue

- Order response

Following entities are designed for business process management system:

- Workflow references: Assign a unique reference number to each workflow.

- Process

  - Process Rollback Info: Includes information of unsuccessful or cancelled process.

  - Process Owner: Includes customer/supplier identification and organization. It helps us to have better coordination.

  - Process Event: Includes type of process.

  - Event type: Includes steps of event (name of step).

  - Process status: Includes state of each process.

  - Process Execution Result: Includes status of each task after process execution.

Chapter5. Implementation

Business interoperability interface for public procurement in Europe enables interoperability between different organizations of European commission. To standardize electronic commerce, several business groups are defined. Each group includes several profiles, which orchestrate business actions between different organizations. Implementation of a business process management profile by using selected tool (JBPM) is the main objective of this chapter. There is a list of business interoperability business interface group below:

- Publication

- Tendering

- Ordering and billing

- Source

- Support

Since, procurement is an important profile in the open e-PRIOR document process system; we select this group for implementing by JBPM. This group includes following profiles:

- Submit Order

- Submit Invoice

- Billing

- Billing with dispute and reminder

- Advance procurement
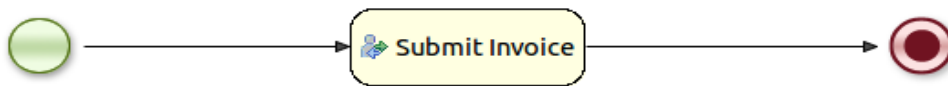
5.1. Submit Order

This profile describes a simple process of submitting order by customer.

Figure 15.Submit Order

5.2. Submit Invoice

This profile includes a simple process of submitting invoice by supplier after receiving order.

Figure 16.Submit invoice

5.3. Billing

This profile includes sending an electronic invoice and possible responses. The invoice is a document with financial and commercial request. The supplier as a creditor sends an electronic invoice to customer as a debtor.
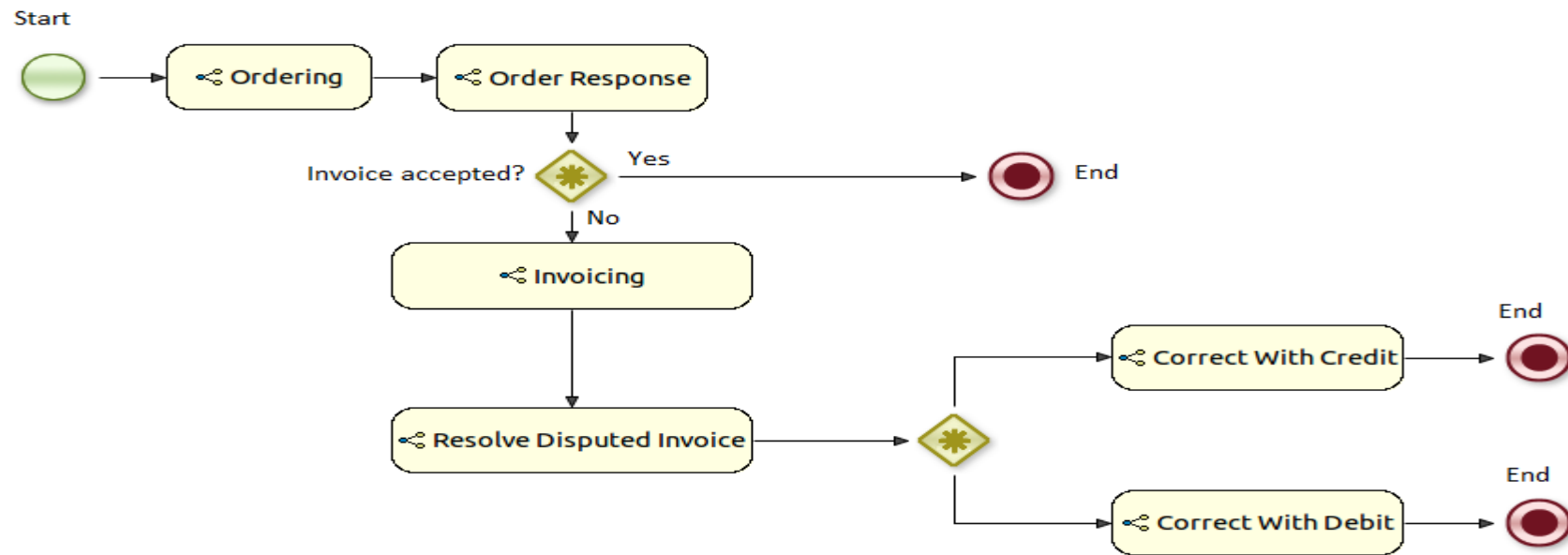

Figure 17.Billing

Following process are done by this profile:

- Invoicing: Submit invoice for processing.

- Invoice Accepted: Accept order by debtor after processing.

- Invoice Disputed: Reject Order by debtor after processing.

- Resolve Disputed Invoice: Rejected invoice must be processed for correction. Rejected invoice can be corrected by creditor or debtor.

- Correct with creditor: Reject invoice details can be corrected by creditor.

- Correct with debtor: rejected invoice details can be corrected by debtor.

5.4. Billing with Dispute and Reminder

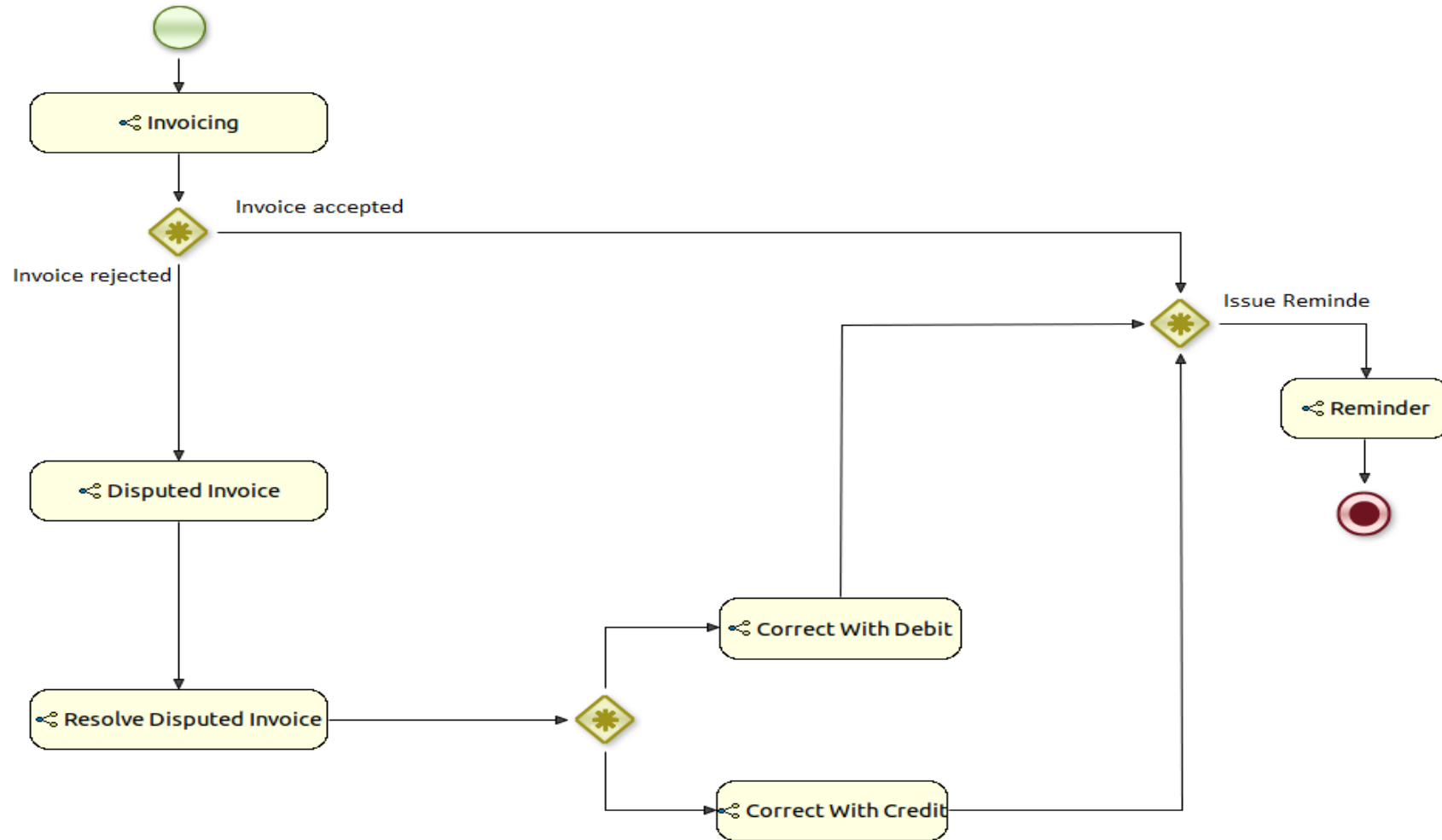Creditor in the role issues an invoice to be processed and send it to customer as a debtor.

Figure 18. Billing with dispute and reminder

Following process are done by this profile:

- Invoicing: Submit invoice for processing.

- Invoice Accepted: Accept order by debtor after processing.

- Invoice Disputed: Reject Order by debtor after processing.

- Resolve Disputed Invoice: Rejected invoice must be processed for correction. Rejected invoice can be corrected by creditor or debtor.

- Correct with creditor: Reject invoice details can be corrected by creditor.

- Correct with debtor: rejected invoice details can be corrected by debtor.

- Reminder: Remind debtor to have an action on invoice.

5.5. Advance Procurement

Procurement is a process of sending an order by customers to suppliers.
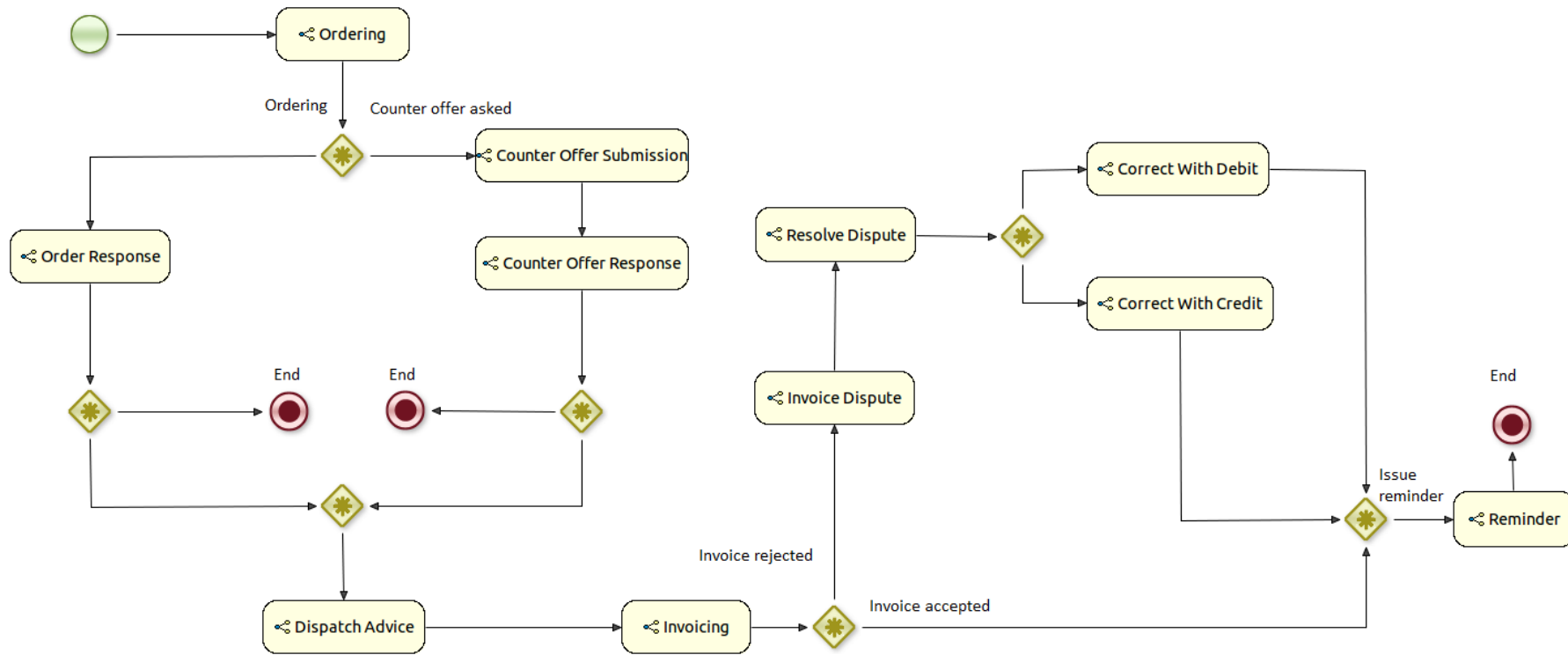

Figure 19.Advance procurement

Following process are done by this profile:

- Ordering: Process an order.

- Order response: The decision of supplier about Order.

- Counter offer submission: Counter offer submit by customer.

- Counter offer respond: Supplier makes decision about counter offer which submitted by customer.

- Dispatch advice: process content of physical goods described by customer for supplier.

- Invoicing: Submit invoice for processing.

- Resolve Disputed Invoice: Rejected invoice must be processed for correction. Rejected invoice can be corrected by creditor or debtor.

- Correct with creditor: Reject invoice details can be corrected by creditor.

- Correct with debtor: rejected invoice details can be corrected by debtor.

- Reminder: Remind debtor to have an action on invoice.

Chapter 6.Discussion

Generally, this project contains information about developing business process management on open e-PRIOR system. Projects information, help us to learn following concepts:

1. Applicability and effect of business process management system on open e-PRIOR (Chapter 2).

2. Mechanism of business process management tools (Chapter 3).

3. Implement a business process management system on our current logical model (Chapter 4 and 5).

This project supposed to prepare a background for integrating business process management system on open e-PRIOR. We could accomplish project goals include, updating logical model of open e-PRIOR and selecting suitable business process management. By accomplishing mentioned tasks, we could approach projects targets.

Identify Business process needs

The outcome of this section (Chapter 2.4) includes open e-PRIOR needs for integrating BPM. Although, outcome of this section looks tiny, noticeable amount of time was spent to explore open e-PRIOR documents for reaching a conclusion about it. Following this we try to explain about number of significant identified needs and describe reason of their selection:

- Jboss and Weblogic application servers: application servers provide services for software application. There are several available application servers. Since open e-PRIOR system is based on the weblogic and Jboss , we need to consider them as business process needs.

- Databases: HSQL, Oracle, and MySQL are the number of famous databases platforms in the world. Open e-PRIOR system is integrated with these database platforms. Hence, we needed to consider all of them as project needs.

- TCP/IP communication protocol: TCP/IP is the main transport protocol for communicating in open e-PRIOR system. So; we need to consider it for integrating issue.

These results are outcome of our research about open e-PRIOR business process requirements. But we can face with two important questions:

- Is it possible to change these requirements (business needs)?

- What will be happened if we do it?

Our answer to above questions is positive. We can use different platforms, databases, or protocols for integrating BPM and open e-PRIOR. But, in this case we need to change foundation and architecture of open e-PRIOR system if want to integrate it with BPM. We can barely say, it is not impossible to do it but, open e-PRIOR is a wide system and any change might be costly. It is quite wise to integrate BPM with open e-PRIOR instead of changing open e-PRIOR system.

Identify candidate business process management tools

The five candidate tools (Chapter 3.3) are selected based on the comprehensive explore in this case. Developer experience and strong support of features were significant factors for selecting them as candidate tools. We can strongly acclaim, there are several BMP tools that could be selected as candidate tools, but according our projects scope we supposed to have a comparison among limit number of tools.

Define evaluation framework and tools selection

BPM tools provide capabilities of implementing and integrating BPM system, hence Tools selection formed important part of our research. Since, we needed to reach a scientific conclusion in this case; this chapter was the most challenging part of the project. To reach a logical result we needed to define a strategy (Chapter 1.3) by respecting project time limitations. In this case we needed to find a common solution between business process management and open e-PRIOR systems. Although, selected tool (JBPM) strongly matches with our project needs (Chapter 2.4), we cannot strongly acclaim selected tool (JBPM) is the only available option for implementing business process management on open e-PRIOR. Due to time limitations, we could not test all the available options in the business process management market. In the beginning of this project, we tried to follow a subtle strategy to reach a reasonable conclusion in a specific time instead of comprehensive research in this case.

Each business process management tool supports plenty of features and protocols. Barely, in this project we needed to use specific groups of them to evaluate, compare, and find a suitable BPM tool. Hence, our project needs (chapter 2.4) formed foundation of our evaluation framework and leaded us to look for a specific target.

Two different strategies applied to evaluate BPM tools. First, according tool compatibility with our criteria, we assigned a total grade for each tool. Total grade shows; how compatible is a tools with our criteria (project needs).In this case JBPM had the best grade by 16 point.

Assign a weight (low/normal/high) to our criteria was another strategy for evaluating tools. As mentioned above Project needs (chapter 2.4) are formed our criteria for evaluating and comparing tools. Regarding their applicability, each criterion has a weight. For example, having a MySQL database is more important than event management so; database category and event management have high and low priority respectively. Although, JBPM fulfilled our requirements and prevail over others for running this project, this weight could be useful for selecting a tool if we had reached similar conclusion (same grade) about one or more tools. In this case each tool that supports high priority criteria can be selected as a suitable tool.

Of course, applied method for selecting tools is not the only optimize and subtle choice. Test and monitor performance of several tools is a strong method and it could approach us to a trusty decision in this case. But we could face two serious problems in such an experiment. First, testing business process management tools is a long term process and it can be a risky method regarding time limitations. Second, there is no guarantee to reach a reasonable point after a long term experiment.

Update current open e-PRIOR system

Update open e-PRIOR system was done in a high-level architecture. In this section we tried to define business process management services (chapter 4.1) and features (chapter 4.2), in a manner to orchestrate open e-PRIOR activities. Regarding project management decision, we were not able to modify open e-PRIOR services, functions, and architecture. So; we looked for a solution to implement and orchestrate business process management system activities with current open e-PRIOR mechanism.

Impalement an open e-PRIOR business process management

 Implement BPM on the open e-PRIOR system was a pioneer idea for European commission. Since, we had not sufficient information among organizations documents to form background of our work, exploring other researches (designs) in the BPM field helped us to create a view of our architecture. Based on the other researches information, in each system BPM has an independent and exclusive design. Referring this, we needed to show creativity to design BPM. Business process management must be designed by respecting central system (open e-PRIOR) architecture.

As mentioned in chapter 5, open e-PRIOR includes several profiles. In the 5th chapter, we tried to implement a procurement prototype to evaluate selected tool (JBPM) performance (Chapter 3) and designed architecture (Chapter 4). Procurement a profile contains significant services which prone us to select it as a sample prototype to examine our results.

Recommendation

 We would strongly suggest to companies and organizations with high work load to follow the idea of implementing and integrating business process management system in their initial architecture. Following policy helps them to face with fewer difficulties for finding suitable tools and integrate business process management system.

 Developer teams might encounter with following problems if they do not consider BPM in their architecture initially:

- They might have lots of difficulties to find a suitable BPM tool.

- They might modify their system foundation to integrate it with alternative BPM tools (If they do not find suitable tool). For example, changing communication protocols or application servers that are not an easy task for wide systems.

- They might have lots of difficulties for integrating central and BPM systems. For example, they might face with lack of some protocols supports in a BPM tool.

Chapter 7.Conclusion

Business process management is an autonomous system that provides feasibility of control and monitor workflows in organizations. Implementing business process management system depends on organizations workflow loads. Hence, this system must be developed and implemented regarding organizations needs and policy. Business process management must be considered as a solution for optimizing system performance to manage workloads.

In general this project proposed a solution to implement business process management on the open e-PRIOR. As we mentioned above we tried to implement business process management as an autonomous system on open e-prior to coordinate workflows.

Select a proper BPM tool formed an important part of our project research. We tried to find a suitable BPM tool that support open e-PRIOR system. In fact, we needed to prove a reasonability of our selection. So; we decided to find and introduce set of tools (candidate tools), compare them in a common evaluation framework and select one of them. Evaluation framework includes our tools features and criteria. By using evaluation framework a table created to evaluate tools features and measure their compatibility with our system. Finally, most compatible tool (JBPM) was selected to be used for implementing and integrating BPM on open e-PRIOR.

To follow a scenario for implementing business process management system, open e-PRIOR logical view is updated by attaching business process management to high-level architecture of it. In this architecture, necessary services and feature are defined, regarding open e-PRIOR requirements and business process management system responsibility for coordinating workflows.

In the last step, a sample prototype is implemented base on the designed architecture and by using selected business process management tool (JBPM). The implemented prototype is outcome of this research.

Future work

Selected tool and designed models are sufficient to provide a background for integrating open e-PRIOR and business process management systems. Definitely, integrating open e-PRIOR and BPM system is the next step for continuing this project that is applicable by using this project results. Setup business management system helps open e-PRIOR users to manage their workflow automatically and organization will be able to save resources. High workload of open e-PRIOR system may increase demands for having new services and functions. So; regular update of current architecture is a significant task for European commission to support this system after integration and setup.

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Appendix A

JBPM tool installation instruction for Linux and Windows

Install Prerequisites

Following patches are required for installing JBPM:

- Java JDK 1.5 or above versions (Download address: http://java.sun.com/javase/downloads/index.jsp).

- Ant 1.7 or above versions (Download address : http://ant.apache.org/bindownload.cgi)

Install Ant

Generally Linux users are not faced with any problem for installing Ant. But windows users have lots of difficulties in this case. Hence we provide brief and quick instruction of installing Ant on windows:

1) Download Ant.

2) Unzip and rename it(We advise to rename it to Ant)

3) There are two ways to set environmental variables JAVA_HOME to your Java environment (Installed patch), ANT_HOME to the unzipped directory.
   Following commands are used for setting Java environment via command prompt (Assume Ant is unzipped in : "E:\ant\")

   - set ANT_HOME=E:\ant
   - set JAVA_HOME=D:\Program Files\Java\jdk1.6.0_03
   - set PATH=%PATH%;%ANT_HOME%\bin

   In windows 7, we need to follow this instruction:
   - Go to control Panel\All Control Panel Items\System
   - Choose Advanced Tab
   - Click on environment variables button
   - Click on new button in the system variables.
   - Give the variable name: ANT_HOME
   - Give the value: C:\ant
   - Click OK
   - Then, we add new ANT_HOME path,
   - Give the variable Name:path
   - Give the value D:\Program Files\Java\jdk1.6.0_03\bin;%ANT_HOME%\bin
   - Click OK

   4. Check Ant installation.
   We need to type following command in the command prompt:
   ant –version

Download the installer

In the first step we need to download JBPM installer. There are several versions of JBPM installer.
Generally, recent versions include newest updates (Download address:
http://sourceforge.net/projects/jbpm/files/jBPM%205/)

Demo setup

To run demo setup of JBPM we need to follow a simple way. We can follow instruction below:

1) Open CMD (for windows) or Terminal (for Linux).

2) Go into the folder of JBPM.

3) Run following command:

```
ant install.demo
```

Following patches will be downloaded and installed(It is possible to follow download and installation from console):

- Download JBoss AS

- Download Eclipse

- Install Drools Guvnor into JBoss AS

- Install jBPM Designer into JBoss AS

- Install the jBPM console into JBoss AS

- Install the jBPM Eclipse plugin

- Install the Drools Eclipse plugin

When demo setup finished successfully, we can start to use JBPM. We only need to run following command from console:

```
ant start.demo
```

Following tasks will be performed to run JBPM:

- Start the H2 database
- Start the JBoss AS
- Start Eclipse
- Start the Human Task Service