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IMPROVING COLLABORATION IN MARITIME OPERATIONS USING BUSINESS PROCESS MODELING NOTATION

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Abstract

In one of the highly globalized fields such as Marine Industry, shipping operations are hugely dependant on the quick and readily accessible information about the people, machinery and services available both at port and terminal levels. The e-collaboration tools often result in improving the potential to take advantage of the information across various dimensions such as nations, organizations and professions.

In the maritime transportation sector, collaboration is very much evident as intersection between various elements associated with it such as business processes (or service management), software tools (or technologies) and users. As a result, collaboration is crucial either to make good plans that are aligned with the different stakeholders or can be used as a tool for deviation management if such a thing occurs. Usually, the maritime shipping operations are carried out both on ship and also by various bodies affiliated with port and terminal services. However, establishing collaboration between operations and tools is often challenging as they are two very different disciplines. Therefore, the knowledge gathered via intersection of software engineering and processes involved holds the means for establishing the collaboration between the service providers and potential users. Normally the information is coming from sensors as well as traditional message based sources. These information sources can be used for identifying and capturing business processes which are part of maritime enterprise to achieve collaboration among various involved parties.

In this thesis, a method is proposed to overcome the problem of process management by establishing a collaboration medium between the service providers and participants in a maritime enterprise. This work is based on literature study, industry test cases and validation of test case models using process centric approach.

The process centric approach, which regards notion of developing enterprise based on process models and facilitating collaboration among participants of business process models, is the main result this work. The steps are to define goals, identify business processes and define collaboration in these. To support this we need the other contributions of the thesis; i.e. uncovering the collaboration space through intersection of entities, collaboration platform, collaboration-oriented architecture and collaboration matrix generation. BPMN (Business Process Modeling Notation) provided a means to model the industrial test case using the process-centric approach and study collaboration among tasks in business process. The analysis of test case BPMN model validates concepts of Marine Information Center (MIS) project at SINTEF and provides set of requirements for improving collaboration further.

Preface

This thesis is submitted to the Norwegian University of Science and Technology (NTNU) for partial fulfillment of the requirements for the Masters degree.

This thesis research has been performed at SINTEF and MARINTEK under the supervision of Adj. Prof. Parastoo Mohagheghi from NTNU as main supervisor and Kay Fjørtoft from SINTEF as co-supervisor.

Acknowledgements

Acronyms

BPMN	Business Process Modeling Notation
RH	Resource Hub
SW	Single Window
W3C	World Wide Web Consortium
XML	Extensible Markup Language
AIS	Automatic Identification System
CCS	Cargo Communication System
CP	Collaboration Platform
ENC	Electronic Navigational Chart
ETA	Estimated Time of Arrival
MTO	Integrated approach comprising (Man, Technology and Organizational)
PCS	Port Community System
PSC	Port State Control
RIS	River Information System
SENC	System Electronic Navigational Chart
VTM	Vessel Transport Monitoring
MIS	Maritime Information Centre
SCM	Supply Chain Management
UNEC	United Nations Economic Commission for Europe
OSS	One Stop Shop
URN	User Requirement Notation
GRL	Goal Oriented Requirements Language
BPM	Business Process Management
NSN	Nokia Siemens Networks
EA	Enterprise Architecture
MPA	Macro Process Analysis
PA	Process Analysis
BPEL	Business Process Execution Language
BPMI	Business Process Management Initiative

MEM   Maritime Enterprise Modeling

ME   Maritime Enterprise

CPM   Collaboration enabled Process Management

UTP   Users, Tools and Processes

AIS   Automated Information System

CP   Collaboration Platform

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Part I

SETTING

Chapter 1 - INTRODUCTION

This chapter gives an introduction to the project by presenting the motivation, problem statement and scope of the project. The outline of the report is presented in the last section.

1.1 Problem Outline

The maritime transport sector is one of the most environmentally friendly transport means, but will nevertheless have to face the common challenges of reducing green house gas emissions. One of the areas where there are significant operational gains to be made is in conjunction with port operations. This can reduce loading, discharge and waiting times for ships and, thus, allow the ships to use lower speed during transit and correspondingly less fuel. Presently, there has been an increased interest in areas related to new work processes, communication and collaboration based on the acknowledgement that successful implementation of information technology is closely interweaved with human and organizational conditions (the Man, Technology and Organizational perspective – MTO).

The transformation of business and flexibility to manage changes are two important drivers of the increasing interest in business modeling in recent years, apart from these two factors another important driver is *" The need to manage increasing complexity"* (David M.et.al, 2008). The complexity owing to the fact that majority of the work in business world depends on human collaboration as contributions of various factors in MTO are " *It's 80 percent about people, 15 percent about processes and 5 percent about technology"* (David Latin, 2009). So, improving operational efficiency is very much dependent on business process transformation by affording better communication and collaboration between the different parties and information technology.

Recent developments in process modeling have opened many new dimensions for the maritime field, which ranges from effective utilization of the resources in various processes to using the processes as means to gather the information.

A process can be described as set of one-to-many activities where either humans or information systems are involved. In maritime domain, the trade transactions and information exchanges between different parties can be considered as a business process such as loading and unloading of

ship. If all the prerequisites are met such as ETA (Estimated Time of Arrival), resource booking etc then process workflow proceeds as per predefined plan. However, if there are any discrepancies such as change in ETA or resources allocation, processes have to be dynamic and collaboration is must in order to handle deviation management and completely execute the processes.

In the maritime transportation sector, collaboration is evident as intersection between various elements associated with it such as business processes (or service management), software tools (or technologies) and potential users. As a result, collaboration is seeking as a routine to solve issues concerned with the process management and software tools are being developed in this regard to offer better collaboration resulting in efficient process management. This can be achieved in different ways, by incorporating common taxonomy to streamline message or processes within enterprise, by using common process diagrams with varying access levels to data contained in models, by supporting software tools between the stakeholders to be part of a CP (Collaboration Platform), by supporting tools to monitor and report status of process to regulate and handle exceptions.

The *Norsk Havneforening[1]* is the owner of the project "Maritime Information Centre" (MIS), which has been contributing to research and development in the area of port operations to increase the interaction and simplify report routines between parties in the maritime transport sector, and thus improving the efficiency and the competitiveness strength in the maritime transport sector. There has been emergence of some concepts in trade, transport and shipping sector such as Single Window (SW) which primarily focuses on the need for providing efficient electronic transactions between governmental and business entities (Kay Fjørtoft.et.al, Maritime Transport Single Windows).

Today's practice where all interaction links are one to one and reuse of data is limited, is leading to unnecessary time- and resource-demanding working days for everybody involved. There is a need to improve the collaborative processes for making the operations efficient. Therefore it is necessary to design a system where different processes can facilitate collaboration between actors and provide a means to information and resources available in the Resource Hub, (i.e. database where the list of the resources are available) developed by MIS.

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[1] *Norsk Havneforening* means Norsk Harbor Association (Havneforeningen).

1.2 Objectives of Study

The objective of the thesis project is to *"improve the collaboration among parties involved in maritime operations".* The problem statement of this research can be defined as follows:

> *How can collaboration be improved and maximized among the parties (i.e. people, operations etc.) involved in maritime operations?*

> *How BPMN can be used as a tool for process mapping by integrating RH (Resource Hub) as part of business process?*

> *How BPMN can dynamically support changes in business processes?*

> *Identify if a traditional process diagram can be made dynamically by use of BPMN and the Resource Hub developed in the Maritime Information Centre project (MIS).*

The following sections elaborate on the steps involved in the research process such as scope of project, research methods, research questions and deliverables. The principles and background on the problem are discussed more in detail in the next chapter.

1.3 Scope

This project is conducted to examine some of the aspects as proposed by the MIS project at SINTEF, Marintek. The MIS project implements the concept of Single Window and resource hub; these are explained in detail in next chapters. The work being performed in this thesis work is based primarily on these concepts and also necessity of collaboration is studied in order to improve the processes and efficiency.

Firstly, we will focus on understanding the maritime domain and the processes behind the functioning of the various operations in maritime field. The knowledge gained from the processes is transformed into business models respectively using the BPMN. The other important aspect of

the project will be to integrate the Resources (i.e. Ship Crew/Staff, Terminal operators, Transport provider's staff etc.), and Services available in the database with the processes.

As part of thesis work, I would be focusing more on implementing the concepts through some operations taking place in maritime transport operations as case of study. For instance, Loading and Unloading of goods on ship arrival to port. Hence, the case study is being implemented as business processes using BPMN. The flow of the business processes is determined by the relevant activities, decisions, events, documents (i.e. data). The BPMN events (for example, message events, Timer events, Error events etc.) are triggered based upon the decisions / activities taken place in the process flow. Therefore, monitoring the flow of the events will assist in understanding the flow of business processes and thereby realizing the business requirements with new business processes. The critical part of the project will be to use event handling, process monitoring jointly with the collaborative platform for improving the collaboration and objectives as defined in earlier section.

1.4 Research Questions

This research is mainly aimed to solve the issues concerned with the maritime operations such as collaboration and thereby improving the efficiency.

The main contribution of this thesis work is to address these following research questions:

How can collaboration be established between various elements associated with maritime operations?

How identifying and implementing business processes using BPMN (Business Process Modeling Notation) may provide support for establishing the collaboration?

What are the implications/ benefits of using BPMN in establishing collaboration?

To identify if a traditional process diagram can be made dynamically by use of BPMN and the Resource Hub (RH) developed in the Maritime Information Centre project (MIS)

1.5 Research Method

The research method is explained using the approach described by (Verschuren. et.al, 2000), where the rectangular boxes indicate the research objects helping to achieve the research goal and arrows act as navigation pathways between the objects. The following Fig.1.1, illustrates the research model being implemented for solving the research problem as defined in the earlier sections.

The research method can be broadly classified into three steps mainly (refer: Fig.1.1)

a) Literature Study:

  1) Understanding the field of the maritime operations. Brief study to be familiarized with the terms and concepts used in the domain and to understand the basic interaction processes.

  2) Gathering the requirements for the business models to be used in the case study: A high level description of the case study processes, based on data from the previous point.

  3) State of art relating to automation of services in maritime operations using BPMN.
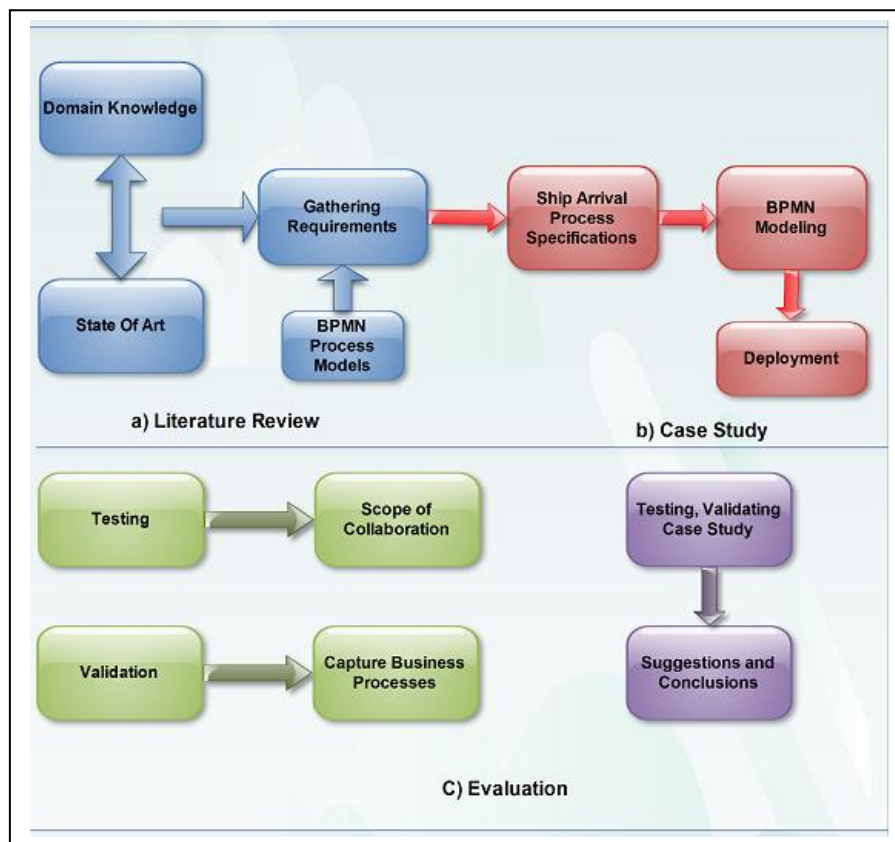
Fig.1.1 Research Model

b) Case Study:

1) Develop the specifications of collaboration process that the RH (Resource Hub) can supply to aid in cooperation with Ship Arrival Process. This is typically information exchanges and displays, synchronization of two or more processes, common resource reservations and release (this may be based on remote acknowledgements – e.g., for resources owned by other parties), notification services and event registration. The specification will be in the form of an "application profile" for BPMN that captures the use of the RH mechanisms in process collaboration. Some of these will be standard elements of BPMN (e.g., synchronization and information exchange), others may have to be based on special annotation techniques (e.g., resource management).

2) Business model design: Modeling the selected business cases using the developed application profile for BPMN and thereby understanding the mechanisms supported by the BPMN as well as getting a test case for further development.

3) Deploying the developed BPMN process models to server to provide access for different users and to monitor / handle process events.

c) Evaluation:

1) Configure the system and test, analysis and validate the concept. This is initially performed by testing case from MIS project and then evaluation based on people representing various sectors of Maritime Enterprise.

2) Summary and conclusions: Summary of experiences: What works, what does not work and where applicable, experience with how the users are able to relate to the BPMN description of their processes and finally suggestions for further improvements.

1.6 Research Activities and Contributions

The preliminary thoughts of this thesis work are based on the author's experience in Modeling and need for process optimization of industry such as SINTEF. As nature of this work is multi faceted, the amount of literature to be studied is very extensive. Due to the time limit of this thesis work,

scope and literature studies were mostly restricted to Maritime enterprise, Understanding maritime projects at SINTEF (i.e. Projects such as MIS and SiSas) , Process Modeling and Process Integration with Maritime Enterprise, and Improving Process Collaboration.

The groundwork studies of literature and research in maritime enterprise allowed to obtain some results, which includes mapping maritime enterprise goals for better process development, Intersection of various entities (i.e. Processes, Tools and Human participants) of enterprise forming collaboration space, collaboration platform for improving collaboration, collaboration oriented architecture for maritime enterprise. These concepts were suitable proposed using preliminary case studies and validating test case of SINTEF, MIS project.

A brief outline of the research activities and contributions are depicted in figure below. The major contributions from this thesis work can be described as follows:

1. **Goal Hierarchy:** It represents maritime goals and sub goals in a hierarchical manner such that larger goals can be decomposed into smaller sub goals. This will ensure that achieving the smaller goals will eventually lead to main goal of maritime enterprise.

2. **Intersection of Processes, Tools and Users:** In an integrated approach, interplay among elements UTP (Users, Technology, Business Processes) forms enterprise. The key to to improve operations and processes is by establishing collaboration space, which is nothing but intersection between these elements.

3. **Collaboration in Maritime Processes:** Collaboration enabled Process Management (CPM) within maritime enterprise can be established by using Layered Building Blocks, wherein each layer form building block for another layer.

4. **Enterprise formation lifecycle:** The formation of enterprise is mainly dependant on entities either functional or information oriented , where Functional entities are used for planning and managing tasks in the supply chain, and information entities are used to facilitate information and collaborative services within enterprise.

5. **Collaboration platform:** The collaboration and Integration platform facilitates collaboration and management of various activities governing maritime enterprise.

6. **Collaboration Oriented Architecture:** The architecture demonstrates a possible architectural solution for achieving collaboration between various services governing maritime enterprise.

7. **Collaboration Matrix Generation:** Collaboration matrix is a template to assist collaboration among various parties involved in enterprise at time of handling deviations.

A more detail explanation of research activities and contributions is provided in chapter 6.
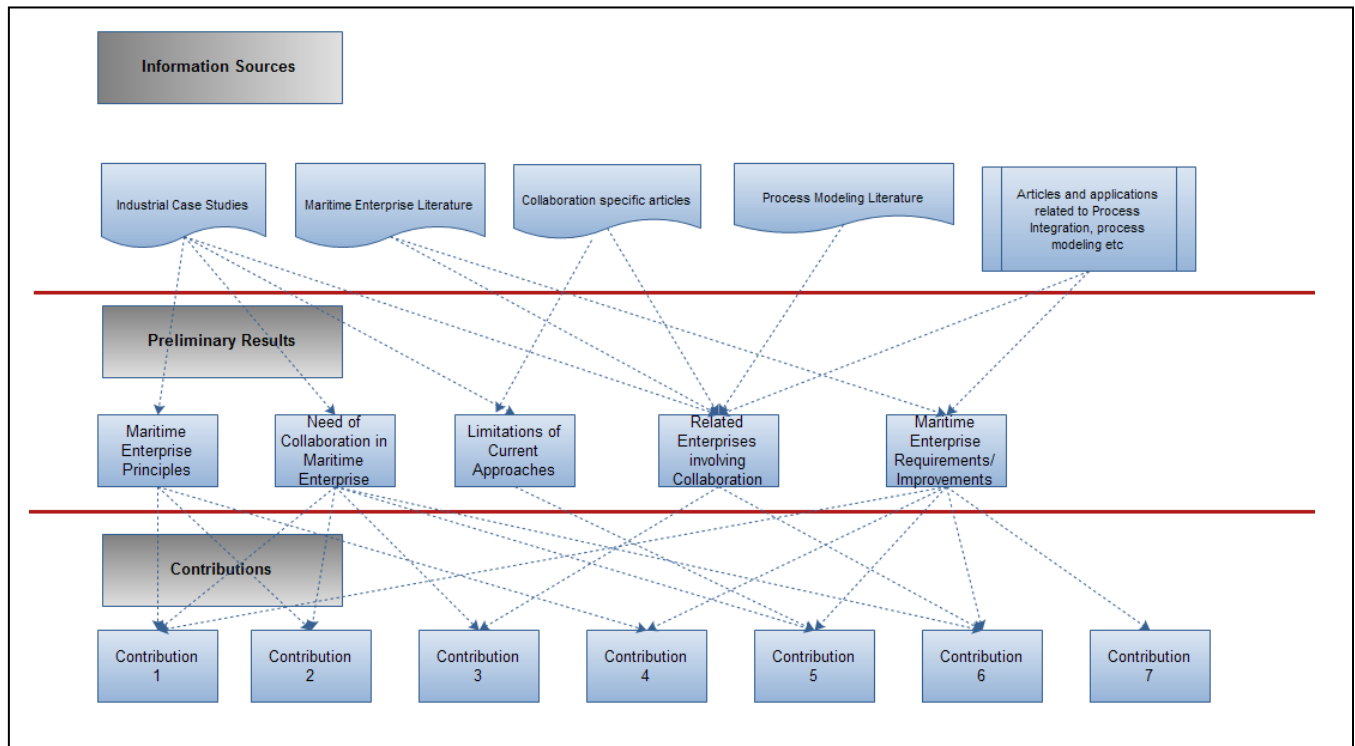
Fig.1.2 Research Activities and Contributions

1.7 Report Structure

This report consists of basic concepts pertaining to literature study, research over some aspects related to collaboration using BPMN, evaluation of results gathered using Test case. The overview of report structure is illustrated in Fig 1.3.

Chapter 2: Presents basic concepts which are needed to discuss key aspects of research.

Chapter 3: Outlines State of Art related to Maritime operations and presents business process modeling and its evolution. Then it focuses on achieving collaboration in maritime operations. In latter part of chapter, brief descriptions of projects at SINTEF and other related projects are presented and the lessons learned from these projects are used for modeling test case.

Chapter 4: Describes about process-centric modeling, It discusses mainly about process centric approach (PCA) and various phases in PCA such as discovery, implementation and maintenance.

Finally, it compares BPM (Business Process Management) with PCA and discusses about similarity among them.

Chapter 5: It discusses BPM in detail and then presents brief introduction to BPMN and its graphic elements.

Chapter 6: Presents the vital aspects of thesis, it gives an introduction to collaboration and then proposes intersection between various elements of maritime operations, collaboration platform to satisfy all collaborative needs within enterprise. Then it presents a collaboration oriented architecture model where BPM and CP (Collaboration Platform) are part of it. Finally, it presents dynamic matrix model i.e. Collaboration Matrix, which provides dynamic capability for better tracking and event handling.

Chapter 7: Presents the test case and is validated by BPMN models and results gathered with sample test data are analyzed further. In latter part of this chapter, it also focuses on monitoring and status reporting as they are basis for collaboration between different parties.

Chapters 8: This chapter evaluates work being performed in this thesis and presents major contributions from this thesis research work.

Chapters 9: This final chapter provides summary of work performed and key lessons learned and future directions from this work.
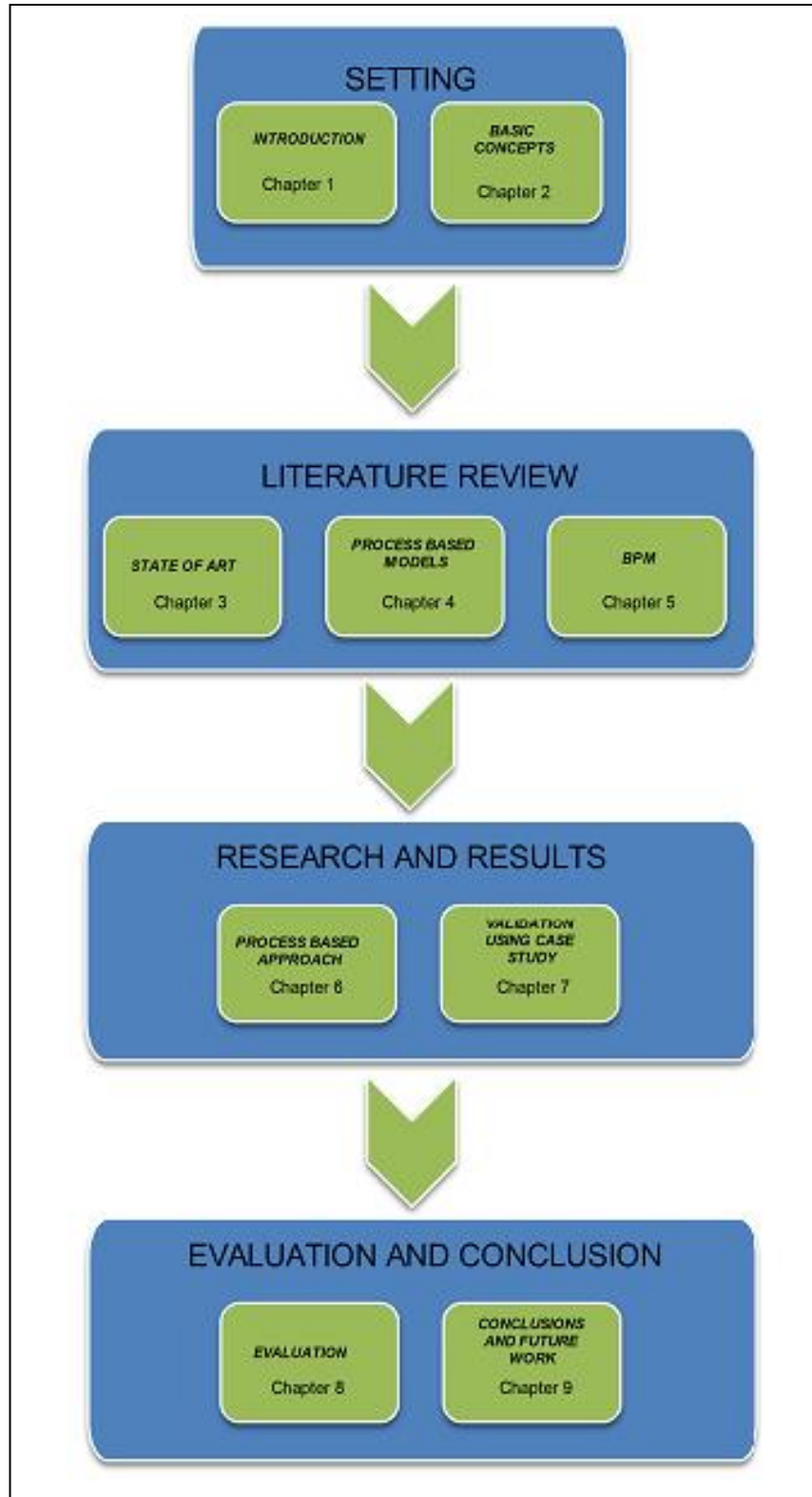
Fig.1.3. Thesis Outline

This chapter presents a brief overview of some of concepts, research fields being referred in this thesis. The aim of the chapter is to get familiarize with some of concepts specifically related to research.

2.1 Maritime Operations

These days, supply chain operations are vastly distributed inter-business activities frequently varying from countries and continents. Supply Chain Management (SCM) is a set of synchronized decisions and activities performed to integrate suppliers, manufacturers, warehouses, transporters, retailers, and customers such that right product is delivered at right time to right locations effectively and thus achieving customer's satisfaction [(Hau Lee.et.al, 2004),(Ling Li , SCM)].

The involved business partners often aim for optimizing the complexity of supply chains and maximizing the efficiency between supply chain operations by facilitating proper collaboration and at the same time flexibility, agility between operations (Christopher. M, (2000)). For example, in the case of Oil industry basic transportation medium is through marine shipping, as illustrated in Fig. 2.1
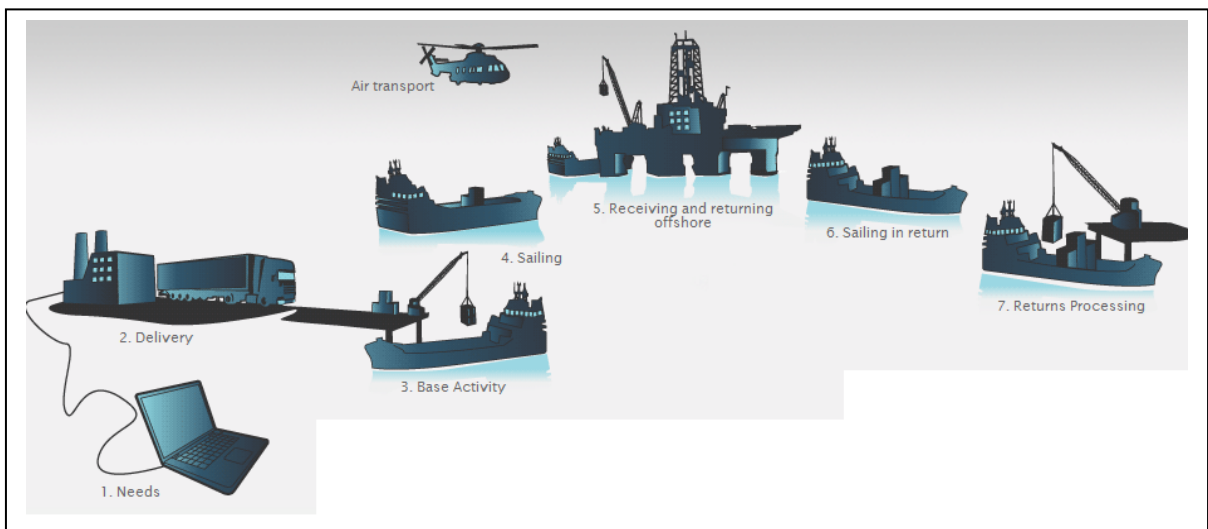
Fig.2.1 Maritime Operations in Oil Industry (Statoil Logistics Portal)

In Fig.2.1, the user places an order for the transportation of goods from one location to another. The ordered goods are shipped at terminal and ship sails to offshore oil platform. Upon arrival of ship at oil platform, loading and unloading of goods and/or containers takes place. After completion of operations at oil platform ship sails again to harbor.

As can be seen in above example, the various phases involved in maritime domain are Alignment & Marketing, Planning, Execution and Completion (Lone, B report).

Alignment & Marketing

The Alignment, Marketing and Sale processes are concerned with creating contact between the actors that have a need for transport or services and those who can offer transport and services that fulfill the demand; and the sale of the transport or service.

This phase consists of the publishing of needs or offered services, establishing contact between the parties, agreeing on the terms of the service and the sale of the service.

Planning

The provision of transport and services is planned and managed based on actual and foreseen demands, information about the Transportation Network infrastructure and traffic conditions. This is based on information provided by the Transportation Network Management domain. The planning includes decisions about routes, schedules, service types and use of resources.

Execution

The Execution phase begins when work processes are initiated in accordance with the execution plans and ends when the execution is either completed or cancelled. The execution of the operations includes movement of goods, cargo handling, document handling, monitoring and control of operations and goods. The latter may involve interactions with the On-board Support and Control domain. The domain's exchange of information with the Transport Demand domain shall support effective coordination and accomplishment of the whole transport chain, which is managed in the Transport Demand domain. This may include transport and terminal operations managed by several Transport Service Providers (transport companies, terminals, etc.).This phase also deals with detection and management of deviations.

Completion

The completion phase includes the agreed completion of the services (e.g. delivery of the transported goods at the destination), handling of payment and claims when the actual service has deviated from the agreed terms. Also, while the handling of payment for services may come at any time in the process (e.g. prepayment), it fits in the completion phase from a logical viewpoint.

As it is evident from above phases, the operations and processes involved in maritime domain are complex and hence the collaboration is needed to construct an aligned process flow and flexible transport plan.

In next section, we present the basic terms and concepts to get familiarized with problem statement and scope of the project as presented in earlier chapter.

2.2   Definition of Terms

This section gives an overview on some of the basic concepts which are being used in this thesis work to get familiar with some of the basic terminology.

2.2.1 The Single Window Concept:

The most commonly used and accepted process of a Single Window (SW) is derived from the recommendation of the United Nations Economic Commission for Europe (UNEC, rec33). Accordingly it states that

A single window is defined as a facility that allows parties involved in trade and transport to lodge standardized information and documents with a single entry point to fulfill all import, export, and transit related-related regulatory requirements (UNEC, rec33).

In our context, the Single Window acts as information exchange with the authorities, it is a means for collecting information required by the authorities. Single Window has its origin from the reporting in to customs, but has adopted messages to also cover the governmental reporting issues. Fig. 2.2(a) and 2.2(b) illustrate the As-Is and To-Be situation upon implementation of single window concept. In the As-Is situation, we can see one message is being sent to multiple users or existence of uncoordinated messaging. However, In the To-Be situation with implementation of Single Window principle, the messages are coordinated by sending the messages directly to Single

Window, where it acts as the central repository to gather all the data and all users can access the related data from the Single Window. Thus, SW perspective helps to integrate all the existing tools such as PCS or other tools and as well as reduces multiple message transfers.
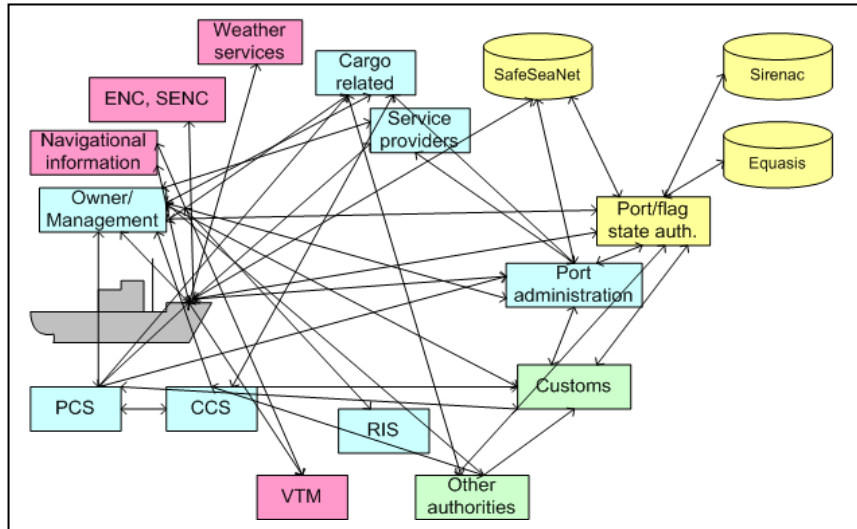
Fig.2.2 (a). As-Is Situation (without Single Window (VITSAR, D1.1))
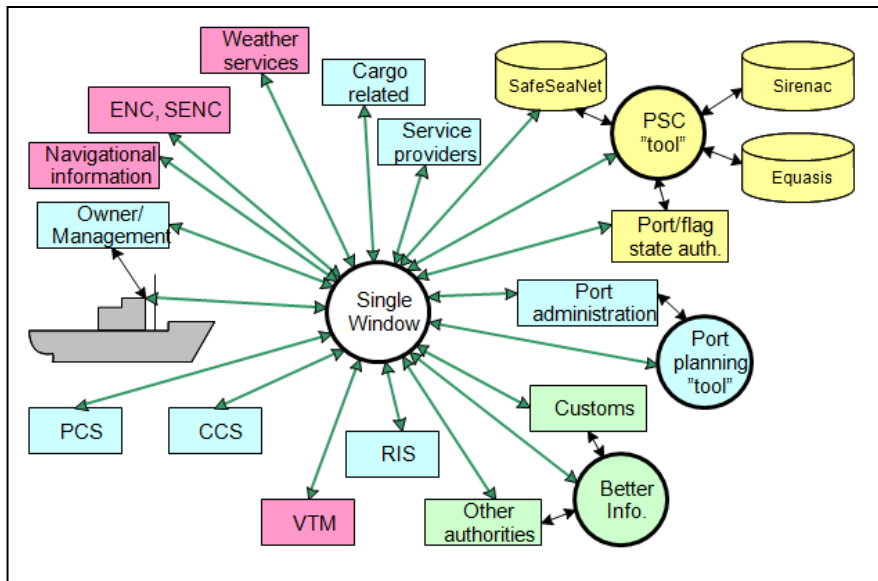
Fig.2.2 (b). To-Be Situation (With Single Window (VITSAR, D1.1))

2.2.2 Port Community System:

A Port Community System (PCS) supports the requirements of both governmental agencies as well as cargo interests, which includes providing Customs requirements and handling, other clearances which are concerned with handling ship and cargo services (Morgan.et.al, 2007).

The information required from the national authorities will be the same set of information, regardless of which port or terminal the transport mean is visiting. What will differ is the local information covering the port and its facilities. This local information includes the resources available in the port and services which can be availed at the port.

a) *One Stop Shop :*

The term One Stop Shop (OSS) is normally used when one single point of ordering, or reporting, to one site is the case. Single window can be part of an OSS in those cases that the SW solutions cover more than governmental mandatory reporting. OSS has its origin from the commercial marked where shopping of products and services can be done from one hub, but the term has got another meaning as this project is following:

One Stop Shop is a collection of services in a terminal. This means if you enter in to a "common" site, for example to port of Trondheim, you will get all services and information available about the port of Trondheim. This includes services offered from both the port itself and from those other companies related to port of Trondheim. In this sense this project considers that a system has to be developed to fully engage all agent or actor systems to utilize the OSS concept.

b) *Resource Management System (Resource Hub)*

Resource Hub is the system used to handle the activities concerned with the resources. RH contributes in the process by showing available resources at port/terminal on any date by using calendar function, supports scheduling of services, marketing/publishing of services and booking through the system (Lone, B report).

2.3 Process Modeling

Business largely comprises of complex processes having enormous and interlocking knowledge structure, It exists as a realm of its own having various facets of elements such as customers, development, marketing, inventory, complaints, profit, returns, and many other specialized events, objects, and relationships (Dorian, 2003). As Enterprise modeling is way of defining the large or small parts of the enterprise (Vernadat, 1996), so for defining an enterprise it is important to identify various processes taking place within enterprise.

For our work, we will model business process to explicitly define the enterprise, in our case it is maritime enterprise consisting of various elements such as ship owners, transport facilitators etc and expanding over various countries.

2.4 Enterprise Integration

Enterprise Integration is associated to providing information, effective control and communication across various organizations within enterprise (Vernadat, 1996). The Maritime Enterprise embraces large number of people with different roles working seamlessly in order to perform the various functions in the enterprise. Essentially, the main objectives for these functions can be any of these factors Product, Place, Price, Time, Quantity (P^3TQ) as illustrated in figure below (Dorian, 2003). The enterprise integration can be made possible by understanding and managing the intricacies and vagaries of P^3TQ and thus using the business processes to lay the foundation for smooth functioning of the enterprise.
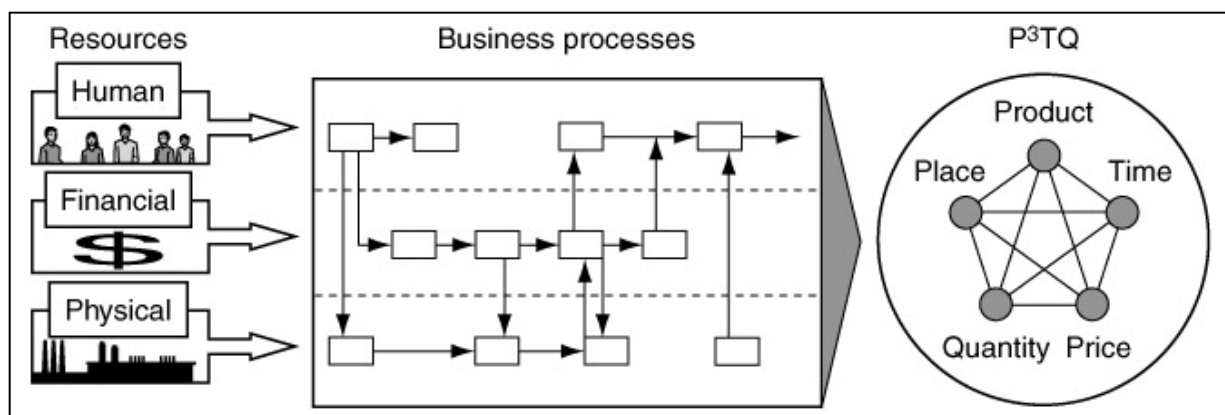
Fig.2.3 Mapping Business Processes and P^3TQ (Dorian, 2003)

Part II

LITERATURE REVIEW

Chapter 3 – STATE OF THE ART

This chapter provides the theoretical background on the aspects discussed in this thesis such as business process modeling, collaboration, and intersection between various factors contributing to collaboration; additionally, we will focus on the developments in these areas. The scope of the collaboration cannot be defined clearly as it differs from one field to another. In order to understand various factors influencing (or required) through the process of collaboration especially in maritime trade operations, basic processes involved in the ship-port operations are discussed. In the latter part of the chapter it focuses on the goals of the maritime enterprise; which forms the background for the next chapters.

3.1 Business Process Modeling

A process consists of a set of one-to-many activities where either humans or information systems are involved. In the business world the integration between organizations, humans and technology will be part of it. Ideally, the main objective in business process modeling phase is to develop process models which can define the process flow in detailed manner (Kapil Pant, 2008). The flow of the processes in models provides the transparency for various stakeholders such as business analysts, customers to understand the processes in detail. On the other hand this can also assist in evaluating the efficiency and quality of the system/ processes.

3.2 Evolution of Business Modeling

There has been development of large number of process modeling notations mainly adding control-flow aspects to Petri Nets model as shown in figure below, wherein most notations were able to combine transformational and behavioral aspects with Petri Nets perspectives (John Krogstie, 2009).
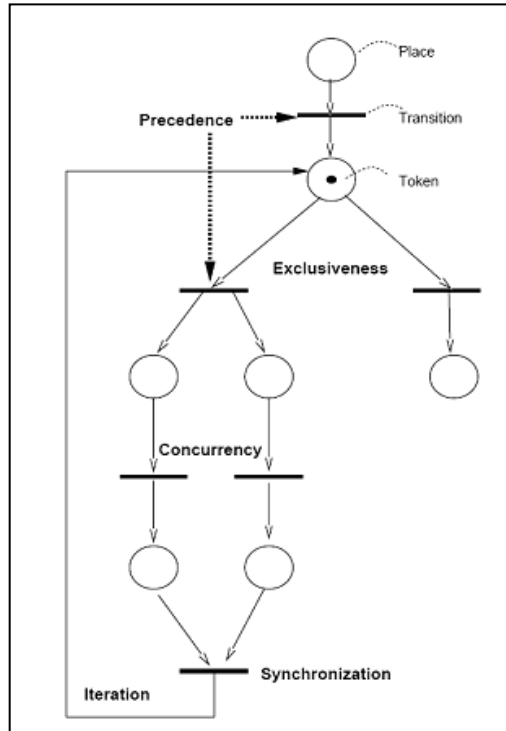
Fig.3.1 Dynamic Expressiveness of Petri Nets (John Krogstie, 2009)

In this context, a notation named URN (User Requirements Notation) was developed to support in a semi-formal and lightweight manner, modeling aspects and user requirements in form of goals and scenarios (Weiss.et.al, 2007).
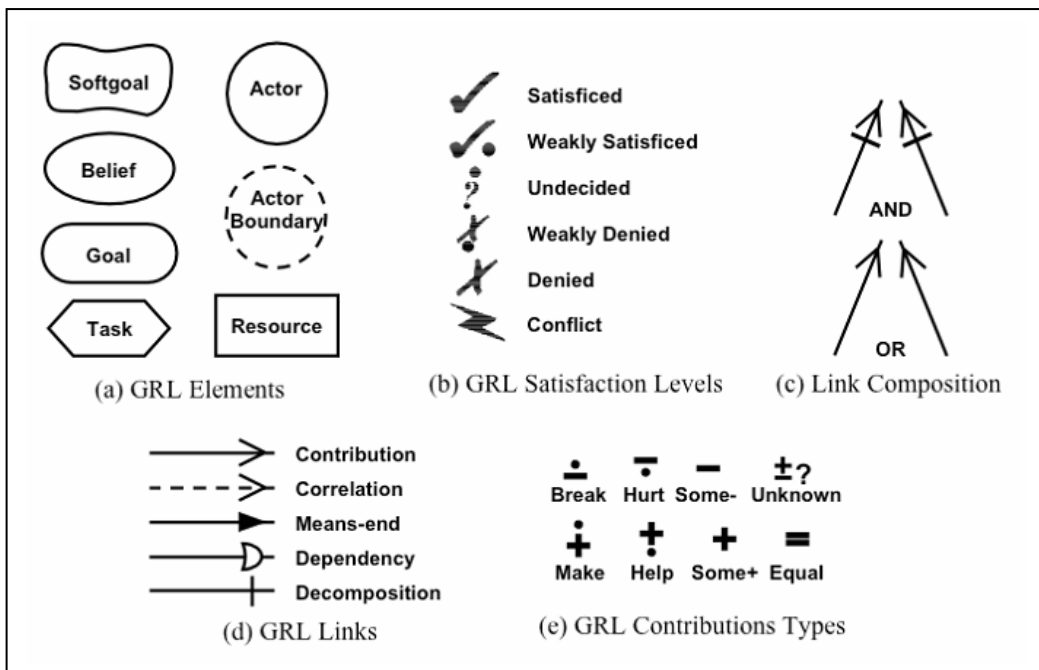
Fig.3.2 Elements of Goal Oriented Requirements Language (URN, 2003)

The URN covers wide range of concepts which are very significant in business process modeling such as behavior, structure, goals, and non-functional requirements (Weiss.et.al, 2007). URN is combination of two corresponding notations that is Goal-Oriented Requirements Language (GRL) as shown in Fig 3.2 and Non Functional Requirements (NFR). The notation is especially good for the modeling of non-functional requirements.

Other most prominent example in this category is BPMN, Business Process Modeling Notation (BPMN) was introduced as standard business process modeling notation in 2004 (Stephen, 2004) and since then on it has been widely adopted as standard of Business Process Management (BPM). BPMN is formulated based on methodologies such as UML's Activity Diagrams, EDOC Business Processes, IDEF, ebXML, BPSS, Activity-Decision Flow (ADF) Diagram, Rosetta Net, LOVeM and Event-Process Chains (John Krogstie, 2009). The main objective behind developing BPMN was to provide a notation which can be easily understood by all business users. Another key development of BPMN was to provide support to execution languages such as BPEL (John Krogstie, 2009).
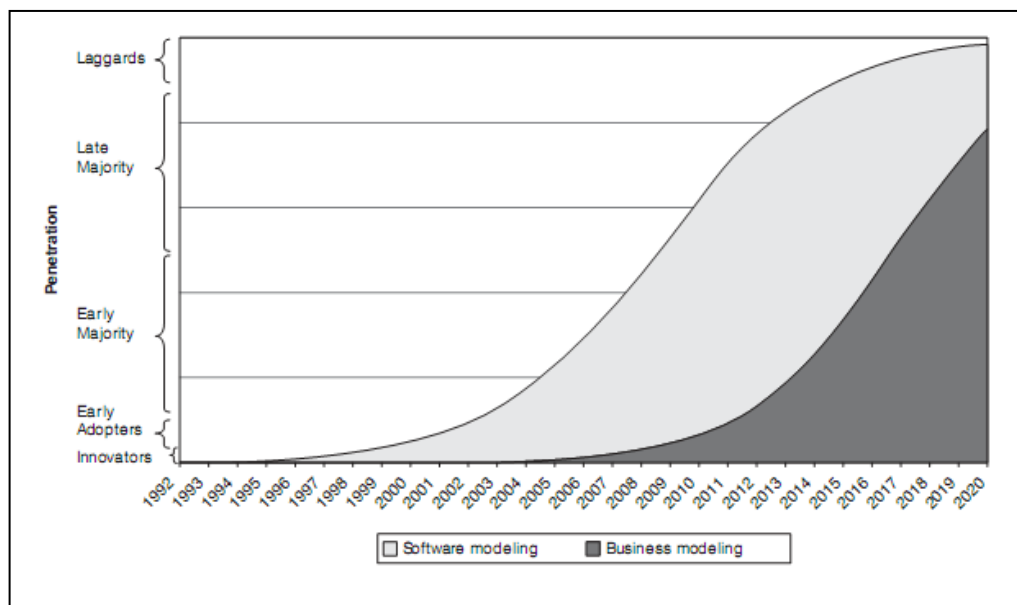
Fig.3.3 Rise of Software and Business Modeling (David M.et.al, 2008)

The rise in popularity of business modeling can be explained using technology adoption lifecycle as explained by Geoffrey Moore (Moore.et.al, 1991), which is framework for depicting progress of technologies from their inception to wide acceptance and usage. It mainly works on criteria that

initially technology can be promising yet it has to sustain for certain amount of time before being matured enough to be accepted by large number of users (David M.et.al, 2008).

As shown in above figure, software modeling has penetrated to a great extent in market now whereas Business modeling is still in early days and will rapidly rise as mainstream activity. The main drivers behind rise of business modeling as mainstream technology is decline of information technology (IT) budgets and growing needs of organizations to align IT initiatives with business needs (David M.et.al, 2008).

3.3 Ship Port Operations:

Ship Port operations include the basic processes both at open sea and terminal operations at port. We can classify Ship Port operations into following stages from a ship perspective; *Open Sea*, *Approaching port*, *In port* and finally *Departure*. This is because of the reporting stages i.e. the 24 hours rule to report to the cargo to be loaded to a ship, as well as border crossing. The following figure illustrates these major processes: where Arrival stage includes both open sea and approaching port stages.
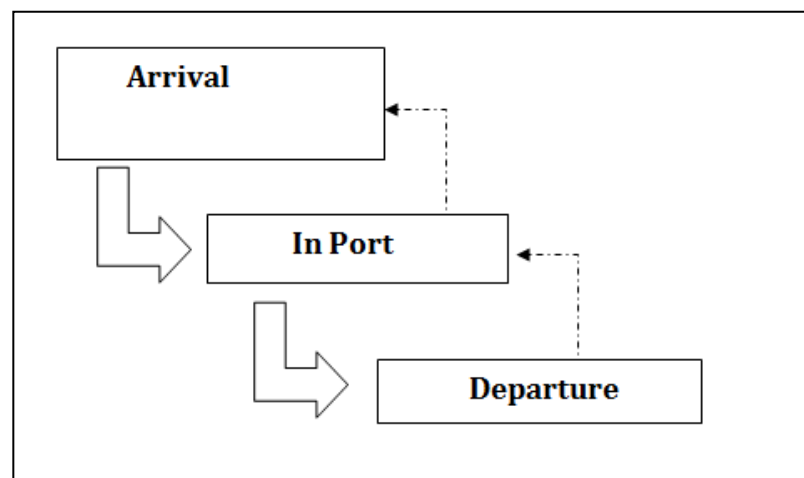
Fig.3.4 Ship Operations

Ship Arrival: The ship arrival process includes all the operations prior to the arrival of the ship to the port. The main Actors involved in the process are Regulators (Authorities such as customs etc.), services at the Port and Terminal level such as pilot, providing warehouse, loading,

unloading and so on. In addition, the transport users are also involved as they have to collect the information about the status of the goods and clearance notification from the authorities.

The Regulators are authoritative body responsible for performing the inspections and customs clearance. They need the information about the cargo, the ship, the crew and passengers, as well about the voyage. The major activities at the Port and Terminal includes cargo operations (loading, unloading, transit, clearance) , storing the goods, ensuring safety and security activities (especially in case of dangerous / fragile goods), monitoring and status reporting of the goods; this is especially important as cargo location at terminal helps in planning processes of loading a ship. The MIS using the Single window concept reduces the complexity in the information sharing as the single repository is maintained where the concerned parties have access to their information. For instance, the customs clearance and regulators can directly connect to the single window and notification of the clearance can be made available to the transport providers and transport users for necessary action upon arrival of the ship.

Ship In Port: The ship In Port process includes all the operations after arrival of the ship to the port. The main Actors involved in the process are services at the Port and Terminal level, information about the ship.

The most important activities at the port level are to make sure that *cargo handling and terminal services* are arranged upon the arrival of the ship to the port. In addition, the resources are allocated for these services.

The necessary information about the clearance and cargo, people responsible for the unloading or loading of the goods are made available through the single window of central data repository in MIS.

Ship Departure: The ship departure process includes all the operations after the departure of the ship from the port. The main Actors involved in the process are Regulators (Authorities such as customs etc.), transport services and infrastructure providers at the Port and Terminal level.

The most important activities in this phase are the *pre departure and departure notice* to the authorities, service providers at the port and terminal. This information is also made available to traffic monitoring and regulators.

The incorporation of the Single window in the MIS, all the necessary information is made available to the authorities, thereby inspections, clearance can be planned according to the schedule of the departure of the ship.

3.4 Need for Collaboration

Collaboration is a process in which different entities share information, resources and responsibilities to jointly plan, implement, and evaluate a program of activities to achieve a common goal (Camarinha-Matos.et.al, 2006).

In general, Collaboration always takes place when any group/ people from different fields are working together for their common goals. In business world, collaboration takes place via exchange of information from various sources of information such as databases, online chats etc. For instance, in our case of maritime operations; different operations and resources are required to perform the activities in ship, port and terminal level. There are different concepts interlinked with collaboration. As illustrated in below Fig 3.5, the concepts such as network, coordination and cooperation constitute the building blocks for the collaboration (Camarinha-Matos.et.al, 2006).
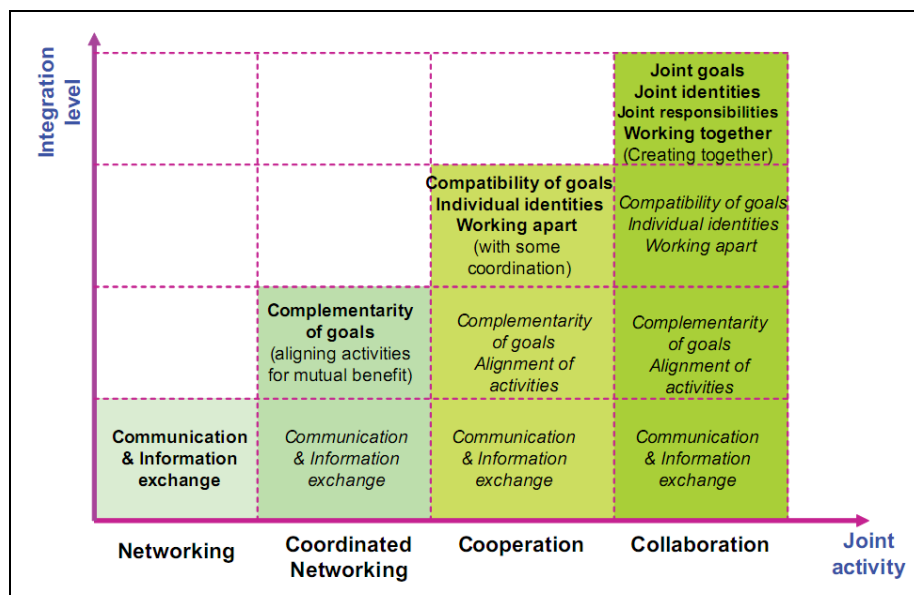
Fig.3.5. Levels of Joint Endeavour (Camarinha-Matos.et.al, 2006)

3.5 State of Practice

Among the benefits of BPM are the formalization of current processes and the occasion for reengineering, greater efficiency, increased productivity and decreased head count, the ability to add people to a process to resolve hard problems, and the traceability of compliance processes (Havey,2005).

In the earlier sections, we have presented numerous concepts associated with thesis and the state of the art corresponding to these concepts; now in this section we focus on the state of practice of these concepts. As part of this thesis work, we have considered several inter disciplinary projects consisting various entities such as people, tools and operations. These entities work mutually for completing goals of enterprise. In this context, we have considered some projects such as DSME in Korea, NSM at UAE and so on.

These projects are compliant to our test case, wherein we have considered all these factors working together in maritime enterprise. These projects enabled to gain knowledge and awareness in multidisciplinary projects. The following is brief description of these projects, which focuses on BPM in order to solve their problems pertaining to collaboration and optimizing processes for achieving business goals.

SINTEF Projects:

1. SiSas

The main purpose of the SiSaS (SINTEF Software as a Service) project is to develop a platform such that it works with services over internet and being based on a Service Oriented Architecture (SOA). Requirements to the SiSaS platform are described using the COMET methodology, which is based on the requirements modeling in order to address the following needs (SiSas, SINTEF):

- Identify system requirements, functional, non-functional, constraints
- Use cases and scenario descriptions
- System Boundary Model, Use case scenario model, prototypes, non-functional requirements

2. MIS

The main goal of MIS is to specify a set of cooperating systems offering information services that improve the effectiveness of maritime transport. Tools for improving the information flow in reporting, ship and cargo clearance, port services, loading and unloading of cargo, as well as other information flows between actors involved in cargo transport is among the services that MIS aims to provide (MIS, SINTEF).

The SiSaS pilot focuses on a part of MIS called "Resource Hub", a software system for providing and booking services based on port resources. The system functions as a tool for generating services based on resources and services from diverse providers at the port, for booking and reserving the services, as well as handling exceptions (e.g. late arrival to port) in an effective manner. It is believed that the use of the system will lead to a more effective utilization of the resources in port, as well as making maritime transport more attractive (MIS, SINTEF).

3. FInest

The FInest project addresses international transport and logistics as a use case for the Future Internet. International transport and logistics operations are concerned with the planning and execution of the world-wide shipment of goods and people. International transport and logistics enterprises operate as global businesses and their activities constitutes the backbone of the European economy. Operating in a highly competitive, distributed, and agile industry, global transport and logistics service providers require novel ICT solutions for enhancing their inter-organizational collaboration capabilities in cooperative business networks.

The planned services of Future Internet technologies are meant to facilitate radical improvements in the business efficiency of this industry as well as contribute to positive socio-economic and ecological side effects.

Other Projects:

Ship Building and Design in Republic of Korea

The republic of Korea has been one of the leading producers of ship building designs. One of the leading yards in Korea such as Daewoo Ship Building and Marine Engineering Ltd. (DSME)

needed to solution to improve workflow mechanism for supporting daily routine work of engineers. Hence, Brix foundation project was developed by DNV software to serve needs of DSME. The main features of the software are document services, flexibility, learning and collaboration (DSME, 2006).

Nokia Siemens Networks, UAE

Nokia Siemens Networks (NSN) is one of the leading players in network communications, which consists of over 60,000 employees across world and has sales of more than €15 billion per annum. The Consulting and Systems Integration (CSI) division of NSN is an organization of 4,000 staff, with turnover of €500 million per annum. As CSI's business focuses on combination of consulting projects and value-added services, therefore CSI resorted to BPM technology to tackle challenges such as fast and effective decision-making to drive the business (Layna, 2010).

As can be seen from above projects, either in maritime transportation sector or other projects involving numerous participants, roles and services depends on collaboration. Collaboration is apparent as business activities are interdependent, it can be usage of common human participants, tools or processes. As a result, collaboration is seeking as a routine to solve issues concerned with the process management and software tools are being developed in this regard to offer better collaboration resulting in efficient process management. This can be achieved by using common process diagrams with varying access levels to data contained in models, by supporting software tools between the stakeholders, by supporting tools to monitor and report status of process to regulate and handle exceptions.

Chapter 4 – PROCESS-CENTRIC MODELS

This chapter presents an introduction to process-centric modeling and brief overview on business process modeling, especially PCA and discusses how BPM is interrelated with BPM principles.

4.1 Introduction:

Competitive advantage is critical for the success of any business strategy. What are decisions an organization has to made to take advantage over competitors, what strengths they possess to attract customers to do business with them – these are some of the critical drivers for business decisions taken by an organization. There are various methods to model these business decisions; For example, In goal and actor-oriented approach an organization is essentially composed of actors with strategic dependencies among each other , where these dependencies can be goals, soft goals, tasks, and resource and these dependencies describe the agreement between the actors [(Yu, 1993),(Fuxman.et.al, 2001)]. The Customers are also in need of quicker solutions to their businesses within short duration, for example, FedEx and Dell computers are known for their leading products and services at reasonable prices, as technology was no longer the competitive advantage, these companies were forced to justify their existence based upon their ability to provide value to their customers (Modus21, PCA). So ability to successfully execute its business processes and process alignment has been the key of success for many leading organizations.

4.2 Process Centric Approach

The advantage of any organization lies in business processes and technology together to execute business decisions taken by organization involving actors with strategic dependencies among each other; however the approach of organizations is more "Process Centric" than "Technology Centric". The Technology existing today allows organizations to build up rules, roles, and workflows depending upon requirements and need of flexibility, rather than previous notion of having focus on concrete programming logic alone (Modus21, PCA). This approach of being more concerned with process instead of technology alone will provide great advantages to organizations such as better control on execution of business processes, better capture of

knowledge needed by organization and efficient usage of existing resources within organization, In addition to gain corporate value, aligning business and IT strategy (Modus21, PCA).

A Process Centric approach can be mainly divided into three phases, namely *Discovery, Implementation, and Maintenance*. These phases are vital for successful execution of overall business directives set by any organization and in case of not meeting these requirements may lead to failure of organization's success.

4.2.1 Discovery

According to Gartner Research Inc., *"more than 40% of the entire project effort takes place in the discovery phase."* (Modus21, PCA). This phase is essential for identifying business requirements and setting up goals and successful completion criteria by organizations. Majority of organizations fail in this phase as they are unable to identify goals either due to lack of technological development at that time or lack of foreseen future prospects, developments. The discovery phase will depend upon the nature of the organizations and its goals. It can occur mainly either at domain level of organization i.e. *Macro Process Analysis* or at larger scale at Enterprise level i.e. *Enterprise Architecture Analysis.*

a)   Macro Process Analysis (MPA)

Macro Process Analysis mainly is to identify processes within domain of an organization rather than processes covering entire organization. Generally, it comprises details of each process, relationships between those processes, and aids in optimizing and automation of processes (Modus21, PCA).

b)   Enterprise Architecture Analysis

Enterprise Architecture (EA) is a model representation of various components of enterprise with focus on mainly four viewpoints: strategy, business, systems, and technology into an organized EA plan that become accustomed to needs of enterprise over time (Modus21, PCA). The Enterprise Architecture analysis provides models representing the goals, business processes, rules and

relationships among them and also useful for analyzing *how changes would affect the enterprise*? *What are changes required for improving operations and process flow across enterprise?*

4.2.2 Implementation

Consistency is critical for implementation of business processes in Business Process Management (BPM), consistency can be achieved by using Process Centric approach by process analysis, usage of right technology / tools, implementing the required tools, and thereby establishing appropriate solution for needs of business. However, these steps are independent and needs to be addressed individually (Modus21, PCA).

a) Process Analysis (PA)

Process Analysis is a short phase of any project where process discovery and analysis are performed for a particular process within the organization. The analyses are usually conducted by numerous interviews, process model reviews and requirements from the clients to thoroughly identify the scope of the existing processes (Modus21, PCA).

b) Implementation

Implementation of BPM, SOA and Enterprise architecture requires proper tools deployment. Apart from providing BPMS (Business Process Management System), tools are vital for implementing business architecture in order to get maximum utilization of resources. This is mainly done by means of identifying and making use of needed or accessible web services, as well as potentially deploying an Enterprise Service Bus to serve the needs of enterprise.

c) Solution Implementation

An efficient tactic to implement BPMS should include mainly five stages namely, planning, analysis, prototyping, quality assurance, deployment. Along with these stages MPA and PA are also carried out (Modus21, PCA).

4.2.3 Maintenance

The last phase of the process centric approach is maintenance of the desired results of organization. This is mainly achieved by aligning IT and business operations, applying optimization techniques and monitoring processes continuously to be in agreement with the desired results. A successful business often demands change, which forces organizations to concentrate on integrating their processes management within their infrastructure and thereby making process owners to be able to support collaborative effort between executive level, business owners, and IT (Modus21, PCA).

Presently, most of BPMS provides ability to cope with rapid changes in requirements by changing business process, However Process centric approach gives addition advantage by making process owners to be aware of changes made with processes will effect whole business management and at same time it would improve in planning of changes to suit to business needs.

4.3   BPM as Solution to Process Centric Approach

Gartner Research Inc. states that,

> "*Organizations that had the most-successful BPM initiatives spent more than 40 percent of the initial project time on process discovery. Establish core team responsibilities, select the right tools and use an iterative method to create a process model that supports ever-changing business conditions.*" (Michael James, 2005)

These views are in agreement with "Process Centric approach". It is very likely that organizations seek for advantage by following certain process plan or by adopting some particular tools to achieve what they think right for them at that moment rather than achieving long term business goals. This methodology is sure to letdown and will result in process failure. However, implementation of Process Centric strategy will allow an organization to have an edge over

tackling problems within processes steadily. This approach ensures that all problems are tackled before implementation or while monitoring processes continuously over time.

As an organizational viewpoint, the primary task is to identify process and thereby apply Process Centric approach, scrutinize the results and finally establish appropriateness of process. In case of in existent process, then best way is to initiate with known business problem and extending it further. It's always preferable to illustrate proof of concepts via pilot project to the decision-making management and hence applying it to whole organization upon successful results.

For any organization, it is essential to implement good process flow for gaining competitive edge and most importantly it all starts by *Process Centric approach.*

Chapter 5 – BUSINESS PROCESS MANAGEMENT

This chapter presents an introduction to BPM and thereby discusses various services provided in it. Further it gives a brief overview on BPMN notation and its graphical elements .which form basis for modeling test case which will be discussed in chapter 7.

5.1 BPM Services

Every organization needs proper execution of processes in order to achieve their organizational goals and thereby it helps in following best practices to ensure that it covers most of the business needs. The following figure illustrates the BPM services.
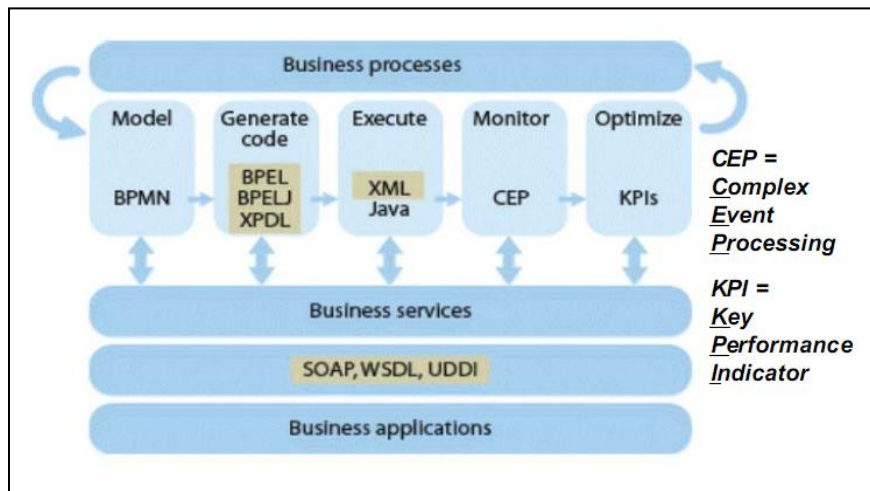
Fig.5.1 BPM Services Stack (Hallvard, 2009)

As can be seen in above figure, Identifying business process is first step in BPM. The central part of the system depends on the runtime engine, which executes BPMN (Business Process Modeling Notation) processes into BPEL (Business Process Execution Language). The Business requirements are designed by analysts or stakeholders using graphical editor which is basically supported by BPMN. Presently, the editor's such as Eclipse with appropriate plug-ins can directly export BPMN diagrams to required BPEL XML code.

The interactions between Actors and computer are primarily responsible for process execution in the BPM engine; the people participating in the process can connect to the runtime engine through a programmatic *worklist interface*[2] (Havey, 2005). These interactions can be categorized into either internal or external applications. The internal applications, which are typically external to organizations network can be accessed via integration technologies such as web services, J2EE, or COM, XML messaging, or for internal interactions, lightweight code snippets can be written using programming languages such as Java, C# (Havey,2005).

The External interactions are typically web service-based communications, managing choreographies and B2B (business-to-business) collaborations, integrating with the business processes of other organizations (Havey, 2005). The stakeholders can monitor their executed business processes using monitoring console and also it helps in tracking changes with respect to business processes. This is mainly done by providing interface to runtime engine and thereby understanding status of process by accessing database or through any ad hoc process queries. Monitoring console will also permit stakeholders to optimize processes by removing identified bottlenecks in processes and thereby focus more on KPI (Key Performance Indicators).

BPMI (Business Process Management Initiative) has been standardizing business processes distributed across various applications and is primarily responsible for developing BPMN standards, asserts that BPMN and BPEL can be represented into hourglass model as demonstrated in below figure, where each one focuses on Modeling and Execution respectively (BPMI).
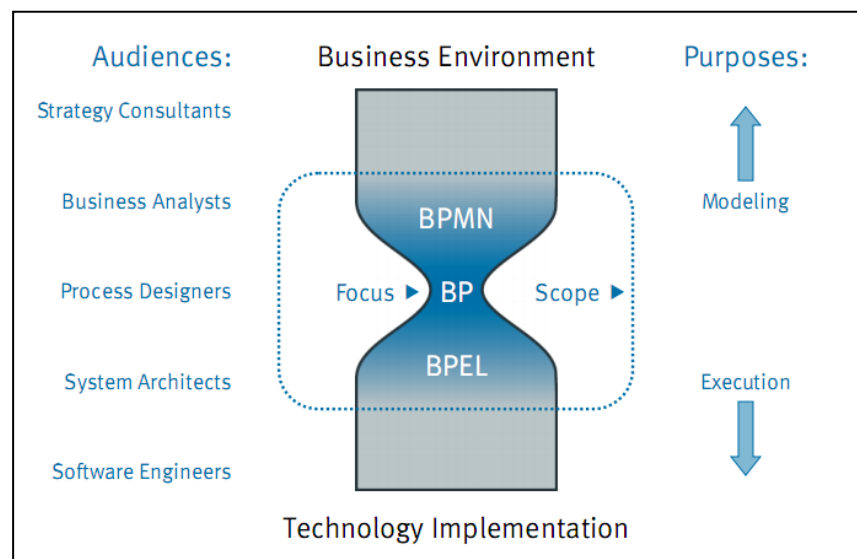

Fig.5.2 BPMI.org Hourglass (Hallvard, 2009)

[2] *Worklist* user *interfaces* (UI) enable end users to interact with running business processes (Using the Worklist, Oracle)

BPMI.org Hourglass Metaphor addresses different stakeholders where key areas of modeling and execution of processes are being carried out by BPMN, BPEL while being following process centric approach where strong foundation is laid using BPMN and eventually extending to areas of maximum added value (BPMI phase 2).

5.2 BPMN

BPMN is a flow-chart based representation to define Business Processes (Stephen, 2006). BPMI states that it was developed mainly to provide *"Businesses with the capability of defining and understanding their internal and external business procedures through a Business Process Diagram, which will give organizations the ability to communicate these procedures in a standard manner. BPMN will also be supported with an internal model that will enable the generation of executable BPEL4WS"* (Stephen, 2004). The following is sample illustration of usage of BPMN for handling insurance claims.
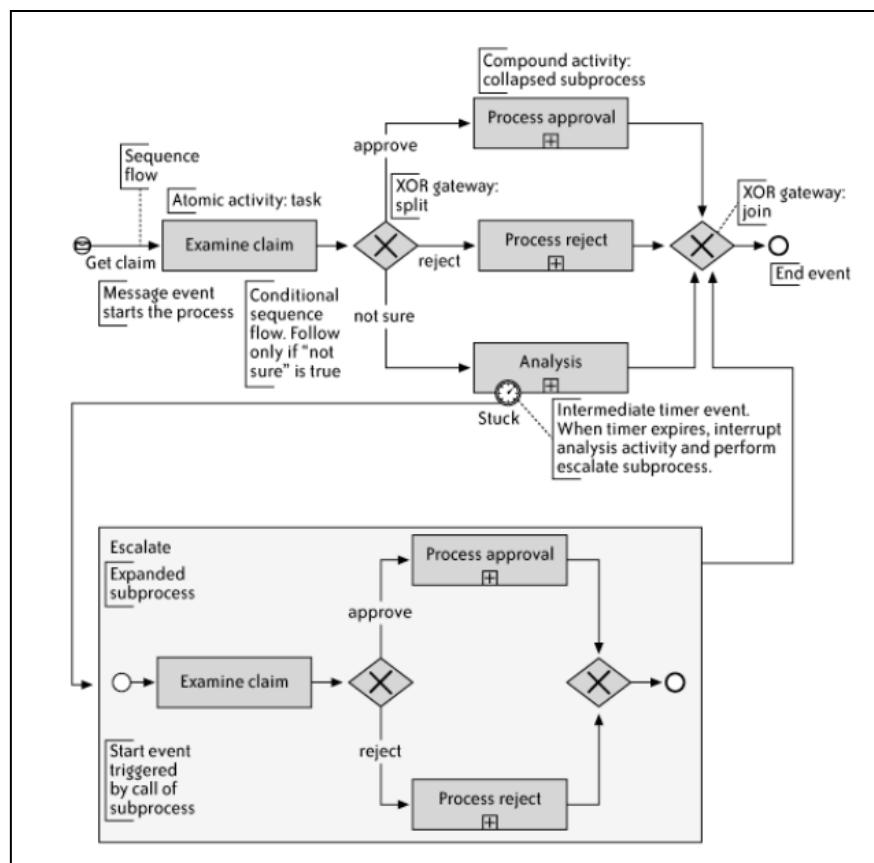

Fig.5.3 BPMN usage for Insurance Claims (Havey,2005)

As can be seen in above figure, BPMN is composed of certain graphical notations to handle processes. It majorly consists of six basic graphical diagram elements namely Activities, Events, Gateways, Connections, Artifacts and Swimlanes. The descriptions of these elements are provided in next section.
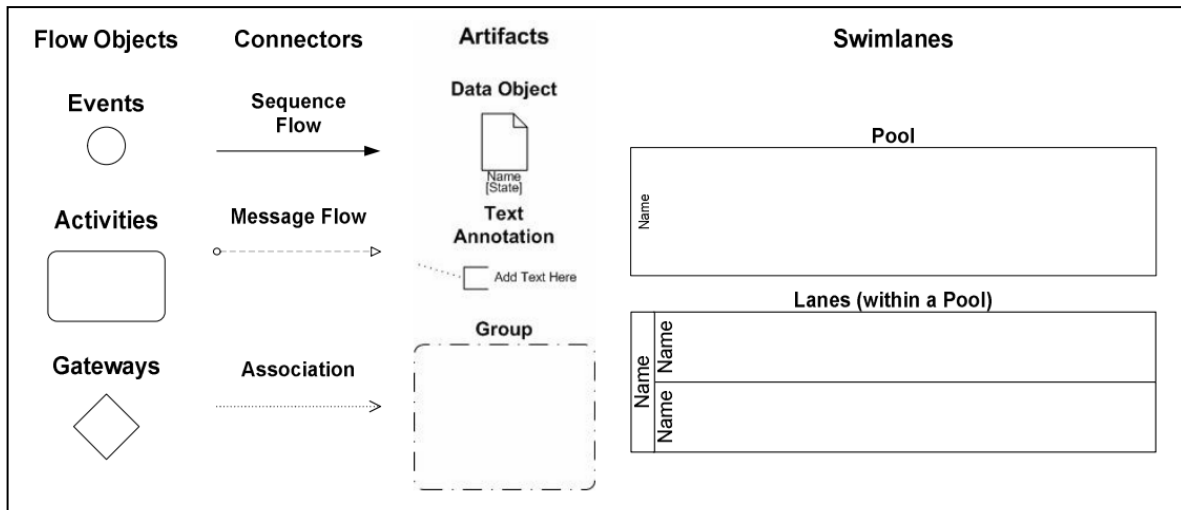
Fig.5.4 BPMN Diagram Elements (Stephen, 2006)

5.3 BPMN Notation Graphics

This section presents the basic description of the diagram elements available in BPMN and also this section will help to get familiar with various design elements and concepts being used for test case in chapter 7.

a) Activities

An activity is can be any task element which is performed in a business process. It can be either atomic or non-atomic (compound). The various categories of activities within Process Model are: Sub-Process, and Task. The activities are represented by rounded rectangles and they can have internally defined loops as well. The Sub-Process is a compound activity which is part of a Process and can be drilled down for finer granularity. The following figure illustrates graphical notation used for Activities.
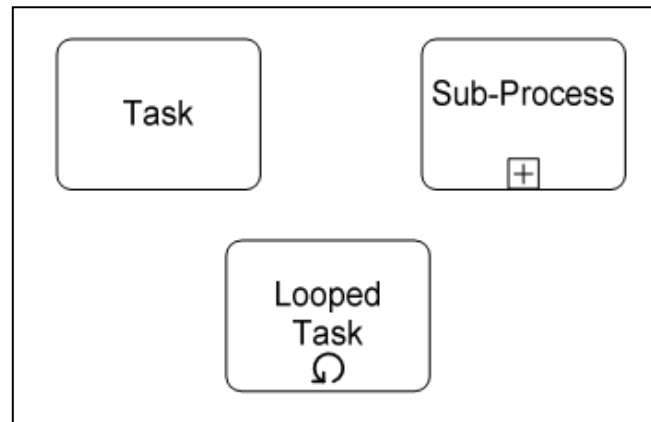
Fig.5.5 BPMN- Activities (Stephen, 2006)

b) Events

An Event is something that takes place during course of business process (Stephen, 2006). Events have usually Result or Trigger which effects business process, which allows process to have either start, interrupt or end the flow (Stephen, 2006). The following figure illustrates various design elements provided by BPMN for different needs.
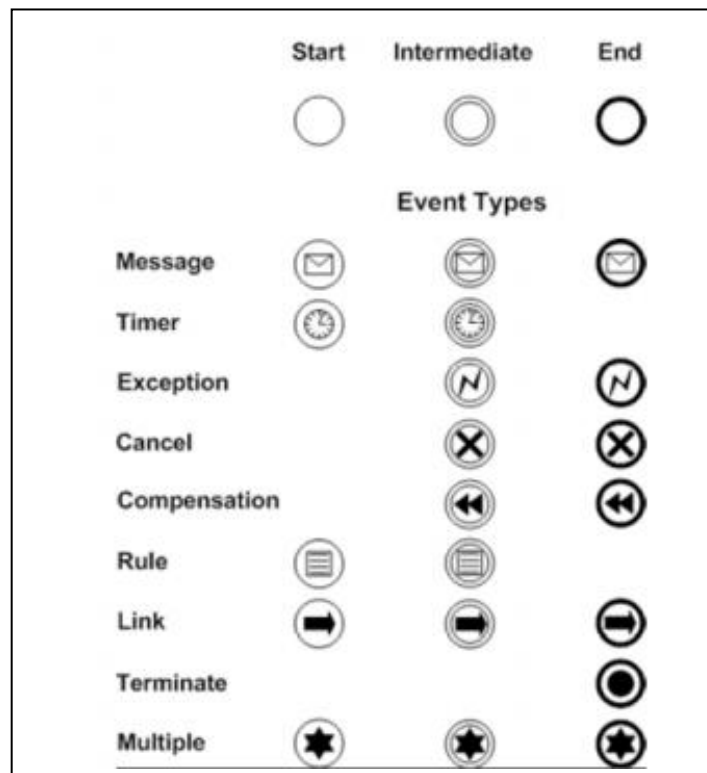
Fig.5.6 BPMN- Events (Stephen, 2006)

c) Gateways

Gateways are modeling elements which are used for controlling sequential flows upon converging or diverging within a Process (Stephen, 2006). Thus, they are mainly used where control of flow is needed and Gateways can be used either to split or merge (Stephen, 2006).
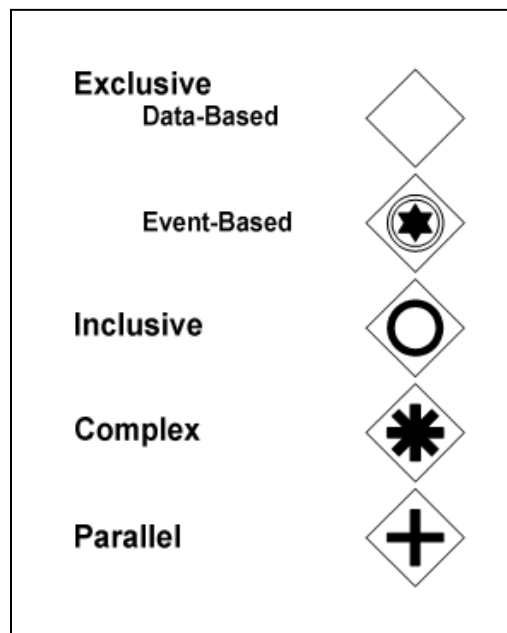
Fig.5.7 BPMN- Gateways (Stephen, 2006)

d) Connections

The connections can be mainly of three types Sequence Flow, Message Flow and Association, as illustrated in below figure. The Sequence Flow is used when activities are executed in sequential order (Stephen, 2006). The message flow is used to represent flow of messages between two entities, which are prepared to either send or receive a message (Stephen, 2006). An Association connection is being used for associating either data, information or artifacts with flow objects (Stephen, 2006).
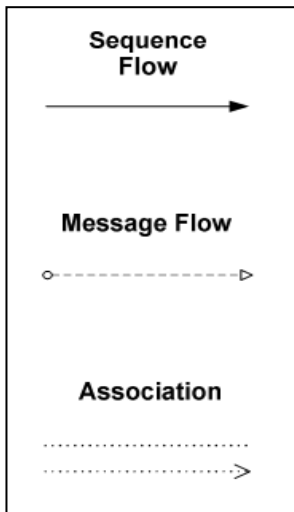
Fig.5.8 BPMN- Connectors (Stephen, 2006)   Fig.5.9. BPMN- Swimlanes (Top figure represents-
Pool and Bottom figure represents Lane) (Stephen, 2006)
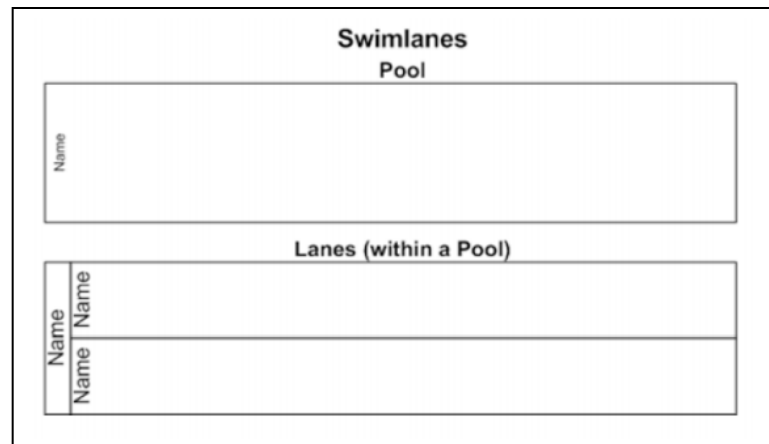
e) Swimlanes

BPMN provides a facility to use known as "swimlanes", which helps partition and/organize activities (Stephen, 2006). There are different approaches of using swimlanes namely Pools and Lanes (As illustrated in above figure), where former is used for representing participants in an interrelated Business Process Diagram and latter is used for sub partitioning objects within a Pool (Stephen, 2006).

f) Artifacts

Artifacts offer additional capability to explain information further than basic process flow as represented in process diagram. BPMN currently supports three modes of Artifacts namely, Data Objects, Groups, and Annotations. However, modeler or tools can also be used for extending artifacts via defining new Artifacts (Stephen, 2006).

This section is used primarily to cover design elements which are being used for modeling test case in next chapter. However, to have further knowledge and basics on BPMN, readers can refer OMG BPMN Tutorial (Stephen, 2006)

Part III

Research and Results

Chapter 6 – THE PROCESS-CENTRIC APPROACH

6.1   Introduction

This chapter presents the process-centric approach and addresses all research questions as presented in chapter 1, section 1.4. However, Q3 and Q4 are dealt partially in this chapter and continued in next chapter with test case implementation. Fig 6.1 provides a brief overview of research and results, where in each research question forms a building block in entire research plan. As can be seen in Fig 6.1, the block named "BPMN Models based Approach" is explained in depth in this chapter.

The business activities taking place within organizations can be portrayed in form of business processes. While, integrating enterprises and defining goals, each and individual entities constituting business processes are critical for success of organizations within enterprise. The development of these business processes is supported by decision support mechanism in order to specify the processes as per actual needs. The development of the business processes is one of phases in the lifecycle of the Maritime Enterprise Modeling (MEM). The lifecycle of MEM can be explained based on viewpoints from Enterprise Modeling and Enterprise Reference Architectures (Kazi.et.al, 2002), as illustrated in figure 6.5. As can be seen in fig 6.5, MEM is formed based on concepts, goals of organizations defined within enterprise apart from following rules and guidelines of maritime. The needs of customers act as instigator for running business processes and set goals for participants in business models to serve needs of customers. During the preliminary stage of forming an ME (Maritime Enterprise) formation, the individual entities collaborate with each other to accomplish task of serving needs of customers.
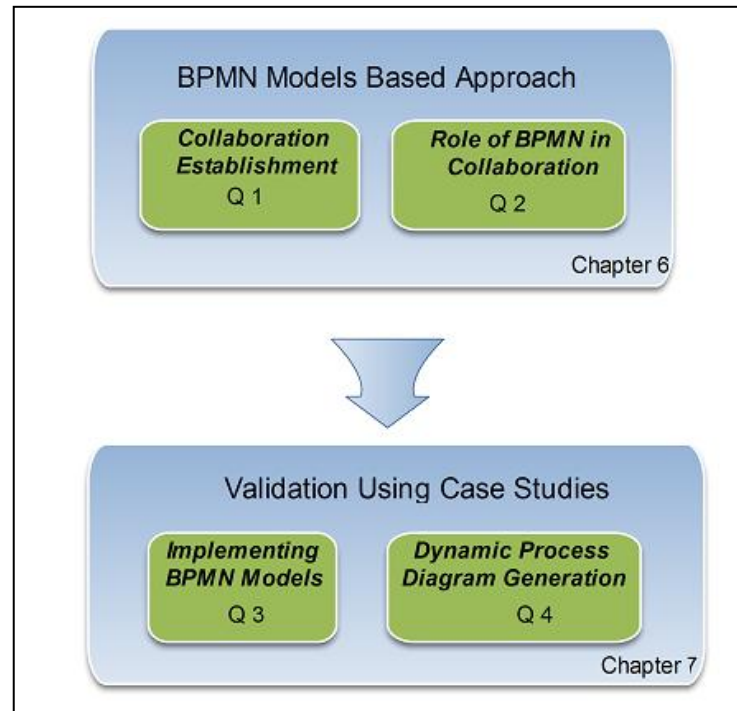
Fig.6.1 Overview of Research & Results

6.2 Goal Map

The maritime operations can be portrayed into business case with the needs of the business. The needs of the business have to be aligned with business goals for providing a compelling reason to achieve those (Dorian, 2003). The larger goals can often be decomposed into smaller sub goals, this will ensure that by achieving the smaller goals it will eventually complete the desired larger goal, this results in an hierarchy of goals as can be seen in figure 6.4 (David M.et.al, 2008).

The below figure illustrates the goal map with five goal levels, it illustrates the generic and less complete objectives, the more in depth on the goals are provided in the next chapters. The top-level goal represents the major objectives that the project should support; to model these goals is complicated as so many variants are involved in reaching those goals. The sub goals at level 5, provides description of *process variables* which can be measured and captured (Dorian, 2003). These process variables are essential to describe the states and interactions to be modeled, which are discussed in next chapters.
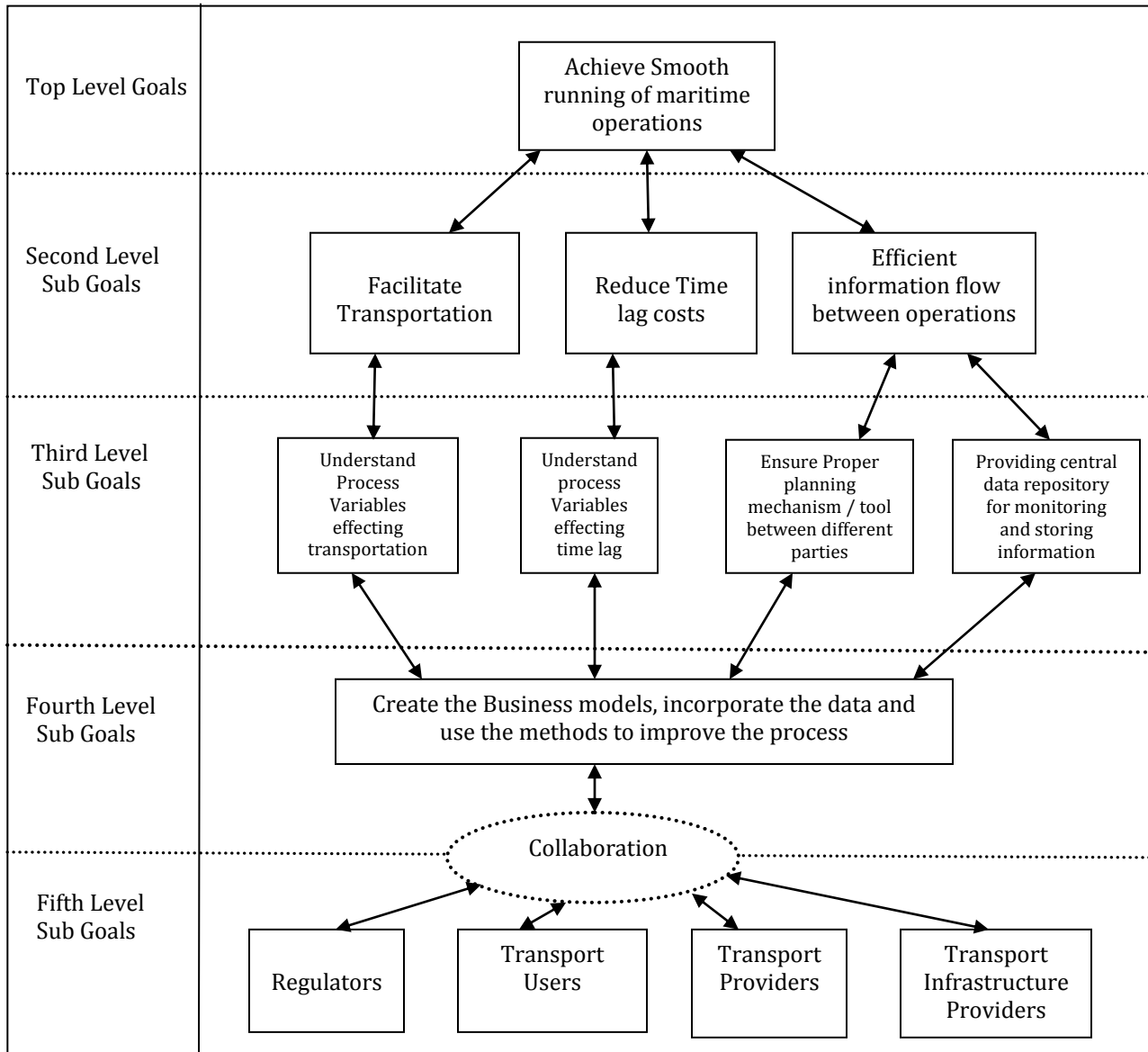
Fig.6.2 Goals Hierarchy

6.3 Intersection of Processes, Tools and Users

One of the highly globalized fields such as Marine Industry, shipping operations is hugely dependant on the quick and readily accessible information about the people, machinery and services available both at port and terminal levels. The e-collaboration tools often results in improving the potential to capitalize the information across various dimensions such as nations,

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organizations and professions. In the maritime transportation sector, collaboration is very much evident as intersection takes place between various elements such as business processes (or service management), software tools (or technologies) and users for common goal as illustrated in following figure. As a result, collaboration is crucial to either to make good plans that are aligned with the different stakeholders or can be used as a tool for deviation management if such a think occurs

Presently, "Integrated practice" has been increasing largely in maritime sector which means that different roles/ organizations and their operations are more integrated and coordinated through improved interaction and information exchange facilitated by MIS. In Oil and Gas industry, they developed an integrated approach known as "MTO (Man, Technology, Organisation)" where Human factors, supporting Technology and organizations have to work closely to achieve their goals and maritime activities are central for their goals acheivement (Lone , B report). In the same way, In Maritime sector, we identified three coinciding factors namely "UTP (Users, Technology, Business Processes)" to improve operations and processes due to increased opportunities for collaborating, sharing and integrating information across professional, organizational and geographical boundaries.
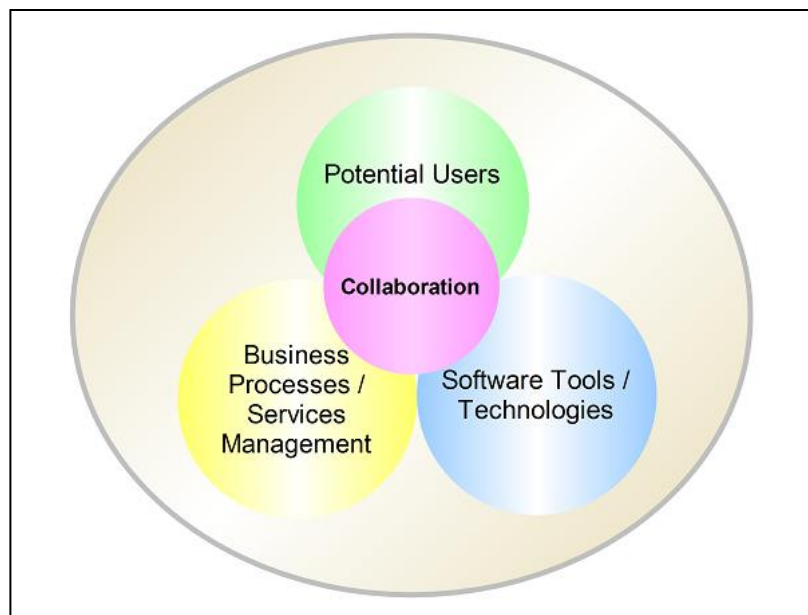

Fig.6.3 Intersection of Processes, Tools and Users

6.3.1 Processes

In business world, a process is primarily composed of one-to-many activities where either humans or information systems are involved. These set of activities combine together to achieve their business/ organizational goals. In general, these activities can be captured as sequence of business activities supporting information and can be represented using BPMN (Stephen, BPMN).

6.3.2 Software Tools / Technologies

The Software Tools and Technologies are referred in general to the various forms of tools which aid in the process of collaborations. The most general form of tools which aid in collaboration are online video chat, shared documents / spreadsheets, portals where tracking and monitoring of work is possible. The usage of tools may vary from person to person or within organizations but still they serve their purpose of providing collaboration and aligning the business processes.

6.3.3 Users

The users can be any stakeholder such as business analyst or customer, who are using various tools and technologies to either monitor flow of processes or aligning the processes to work in systematic way to achieve the business goals.

6.4 Collaboration in Maritime Processes

Collaboration is a difficult process as it depends on different requirements and should serve the purpose of joint goal involving multiple parties rather than individual goals. The process of Collaboration requires a "collaboration space", which is an environment to enable and facilitate the collaboration process (Winkler, 2002). Establishing notion of Collaboration enabled Process Management (CPM) will jointly support both workflow and collaboration support systems within the same process framework (DSME, 2006).

CPM framework will provide some aid to the knowledge worker and exceptions can be resolved by means of collaboration (DSME, 2006). The figure shown below, illustrates the Layered Building Blocks for implementations of Business Solutions such as Single Window, MIS, Resource Hub; which is essentially the primary focus of research of this thesis work.
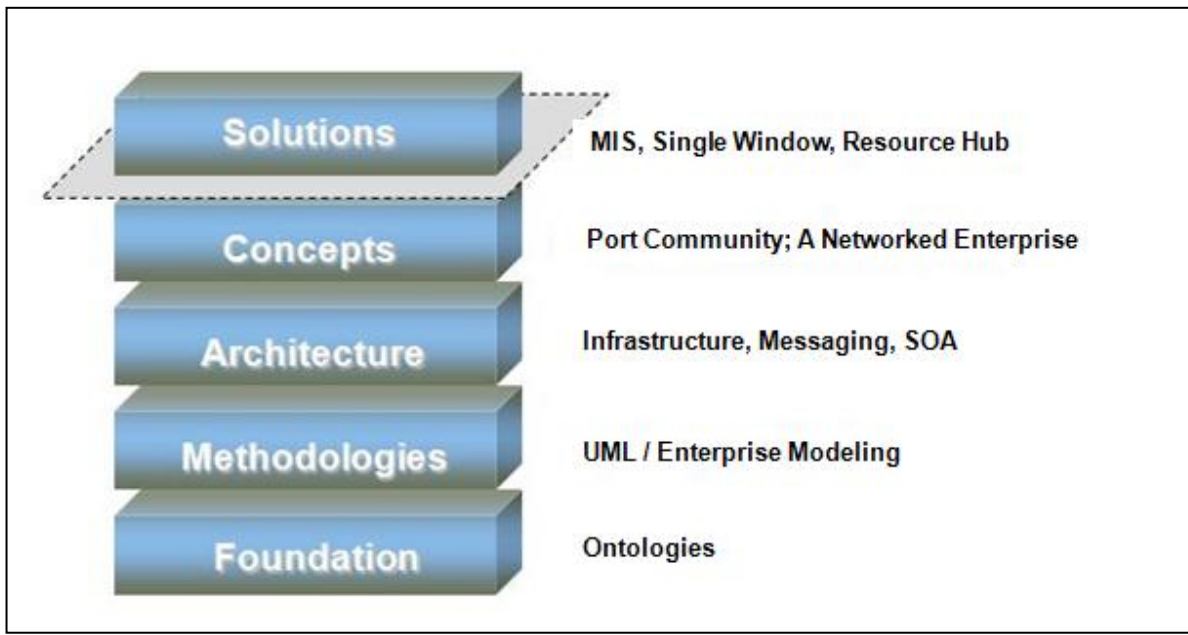
Fig.6.4 Layered Building Blocks of Business Solutions (MIS, SINTEF)

Business solutions such as Single Window, MIS, and Resource Hub can be realized using the suite as can be seen in above figure, the various phases in development of business solutions are Foundation, Methodologies, Architecture, Concepts and Solutions integration.

At base level of Suite, Ontologies are used to define knowledge from set of concepts contained in domain; this is mainly used as it helps in describing entities pertaining to domain. The next phase is methodologies, wherein enterprise is modeled either using UML or other related methodologies such as BPMN, I *, goal modeling, use cases and so on, which are based upon entities defined through ontologies in previous phase. After defining modeling aspects and methodologies, Enterprise Architecture can be successfully developed using appropriate tools. The tools often support in automating either part of enterprise (i.e. domain) or entire enterprise and aids in speeding up overall development activities such as applying SOA principles, messaging within enterprise. The concepts can be applied to architecture to address needs of users i.e. in our context integrating with port community or other related enterprises. The businesses solutions such as integrating MIS, Single Window and Resource Hub can also be related with these concepts in order improve collaboration among participants and thereby making processes efficient.

When collaboration is part of the process framework, then process engine can be set for maintaining event log for each collaborative event triggered by the users (DSME, 2006). These log details can serve as valuable source of information to perform systematic analysis for enriching

process definitions. Eventually, it augments enterprise's capability to learn from past performance and rapidly improve business processes while maintaining competitive gain in today's business environment.

6.5   BPM- Process-centric Model

This section mainly deals with the research question Q2 (*How identifying and implementing business processes using BPMN (Business Process Modeling Notation) will provide the collaboration*). The process-centric model can be compared with agent based modeling where various agents participate to form virtual enterprise (Fox.et.al, 1996). Fig.6.5, illustrates lifecycle of enterprise, which is based on principles of TOVE [(Fox.et.al, 1996), (sobah, 2007)].
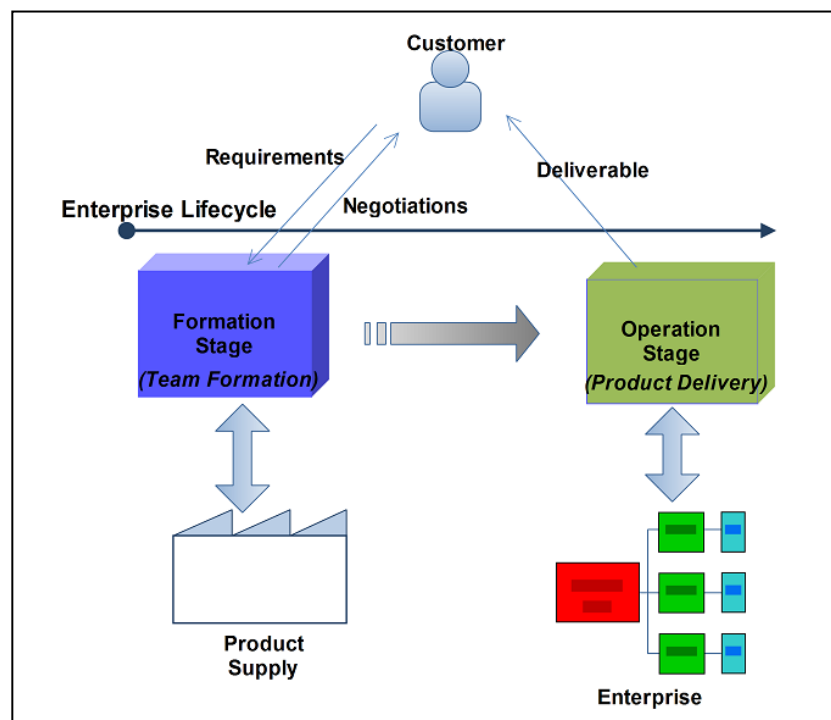

Fig.6.5 Enterprise formation Lifecycle [(Fox.et.al, 1996), (sobah, 2007)]

In the TOVE model, entities (i.e. in-formation agent) are introduced as components within information structure facilitating collaborative services (or virtual) within enterprise. These entities are used as set of collaborative agents to model enterprise [(Fox.et.al, 1996), (Fox.et.al, 1994)].

The entities can be either functional or information oriented , where Functional entities are used for planning and managing tasks in the supply chain, while information entities are used to facilitate information and collaborative services within enterprise.

In accordance to concepts as explained in chapter 3, the entities such as Users, Tools and Processes (UTP) collaborate mutually for achieving organizational goals. These goals are achieved based upon tasks performed as part of collaboration between various entities. The functional tasks such as IDEF modeling, requires resources in order to carry out the actions. These tasks are highly dependent upon the requirements to be satisfied by the entities participating in the enterprise. The perceptions of role have to be specified for achieving requirements, which will be satisfied by allocating roles to the actors participating in enterprise (Kendall, 1998). This aspect of describing models using metamodels such as METIS Generic Enterprise Model (METIS, 2003); Enterprise Architect model (Enterprise Architect) is evident in enterprise modeling. The entities expressed in models are described using attributes and relations between entities that govern rules and regulations of the modeling language such as BPMN.

6.5.1 Roles within Process Models

Business process models comprising the Enterprise play a vital role in the process-centric approach and acts as a source to form multi agent (i.e. Multiple Actor) oriented architecture. The process is initiated from needs of customers, who are associated with enterprise. These roles of customers form preliminary phase for defining processes (i.e. requirements, design phases) during lifecycle of an Enterprise. Apart from customers, there can be various agents playing various roles such as suppliers, operators, and transport facilitators etc, which enclose whole enterprise. Fig.6.6, illustrates roles of participants which differ from one agent to another based upon requirements, however they have same objective to achieve enterprise goals.

During designing phase, roles of various participants depending upon set of requirements and tasks performed to achieve them are portrayed in process models. The goals, roles and the requirements for every participant in enterprise are presented in process models during formation phase of the enterprise. Upon completion of enterprise formation, models can be updated with available resources (i.e. agents / actors participating in enterprise) to perform the assigned tasks in order to achieve goals and perform activities within enterprise. At operating phase, contributions from all resources are assembled as set of activities to deliver products to customers. In our context of

maritime enterprise, resources can be participants with roles such as ship owners, operators at terminal/ ship, transport facilitators, regulators and so on, wherein each contribute by performing their set of activities within enterprise.
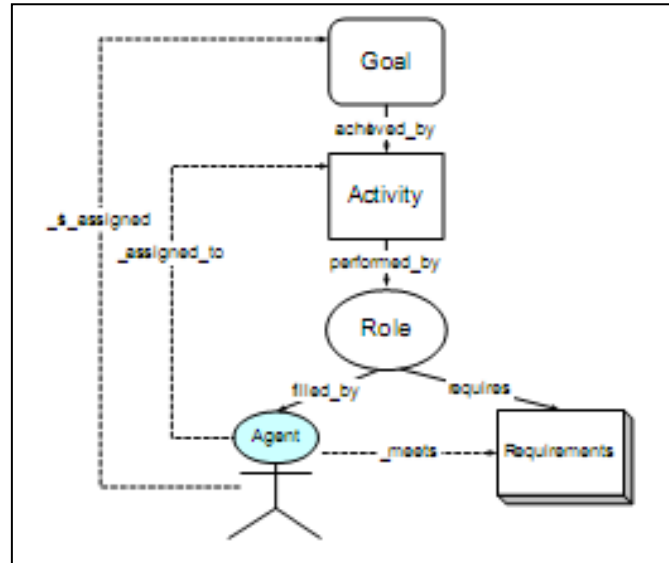
Fig.6.6 Role of Agent in Enterprise (sobah, 2007)

Therefore, considering this way of defining roles of various participants in terms of their goals, roles and requirements of enterprise helps in identifying key processes and actors associated with those set of activities. Subsequently, BPMN can be used for modeling those identified key processes. Thus it solves one of the constraints of Q2 (*How identifying and implementing business processes using BPMN (Business Process Modeling Notation)* i.e. identifying business processes which can be modeled using BPMN.

6.6   Collaboration Platform

This section mainly deals with the research question RQ1 (*How can collaboration be established between various elements associated with maritime operations such as business processes (or service management), software tools (or technologies) and potential users?*). The importance of collaboration in integrated approach are already discussed in chapter 3 and also we identified phenomenon of intersection between various elements Users, Technology, Business Processes (UTP) to improve operations and processes due to increased opportunities for collaborating,

sharing and integrating   information across professional, organizational and geographical boundaries (refer: section 3.5). In order to realize this integrated approach one should identify means to integrate inter-organizational systems and collaboration among them (Franklin, 2010). The figure below, illustrates the collaboration and Integration platform for facilitating management of various activities governing maritime enterprise
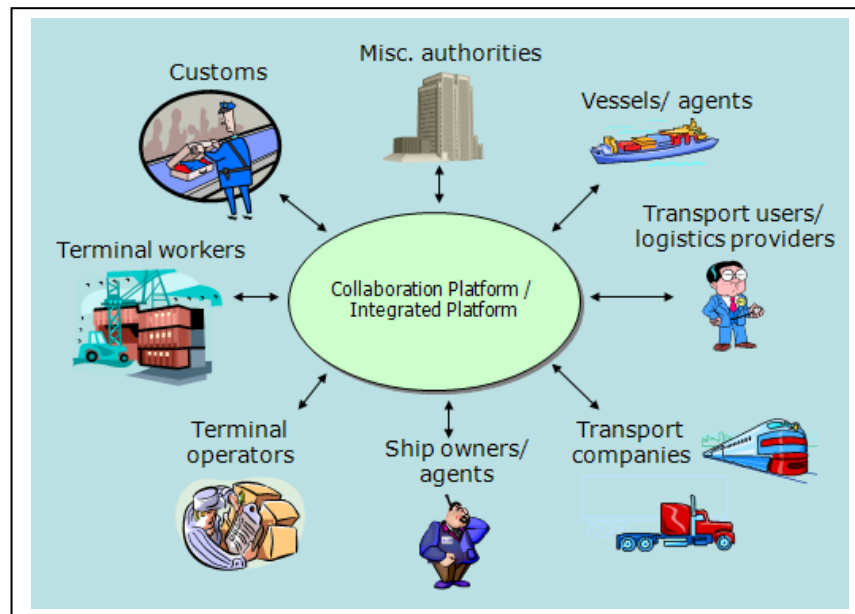
Fig.6.7 Collaboration / Integration Platform (VITSAR, D1.1).

As can be seen in Fig 6.7, the collaboration platform will provide facility to integrate all related services either used or provided by participants in maritime enterprise such as ship owners, agents, terminal workers, transport companies, vessel agents, terminal operators, logistic providers, customs and so on. The seamless of all these services will add additional advantages such as interoperability, scalability, adaptability, availability, predictability within enterprise operations and thereby substantially increase process optimization and business efficiency [15, 46].

This collaboration platform can be realized on the same lines as mentioned in FI PPP (Franklin , 2010), where building blocks can be aligned with most desirable domain-specific capabilities and inter-organizational process coordination, transport monitoring and tracking, event-driven re-planning, and security and privacy management. The following are four major activities needed in order to implement collaboration platform and attain collaboration among various services (Franklin, 2010).

(1) Domain Analysis: This phase is to understand the know-how about the processes taking place in the domain and identify key processes, requirements of stakeholders and investigating new business prospects.

(2) Design and Implementation: This phase deals with integration of collaboration platform with core design platform and critical business components.

(3) Monitoring: The monitoring is one of the important phases wherein the status of process is identified. This gives great advantage as in case of any deviation or errors within processes can be easily solved by collaboration between parties associated with those effected processes and thereby maintain proper functioning of processes.

(4) Enhancements: This phase is to improve the capabilities of existing collaboration platform by providing addition facilities or adding additional users.

6.7   Collaboration Oriented Architecture

As seen in previous section 6.6, collaboration platform is most crucial part of enterprise architecture for facilitating collaboration among various services encompassing enterprise especially transport and logistics services. The following figure illustrates collaboration oriented architecture, which is based on approaches as described in (Kapil Pant, 2008) and (Franklin, 2010). In our preliminary studies, we have identified that in process centric approach; business processes play an important role in defining enterprise and its operational goals, wherein processes can be modeled using BPMN graphical notation. So, the working principle of collaboration oriented architecture is based on process centric approach and collaboration platform.

The collaboration oriented architecture is developed by building collaboration platform on top of the core functionalities, which facilitates business oriented features such as ubiquitous access and availability, service-based information and system integration, and transport monitoring and tracking on the basis of sensor networks (Franklin, 2010).
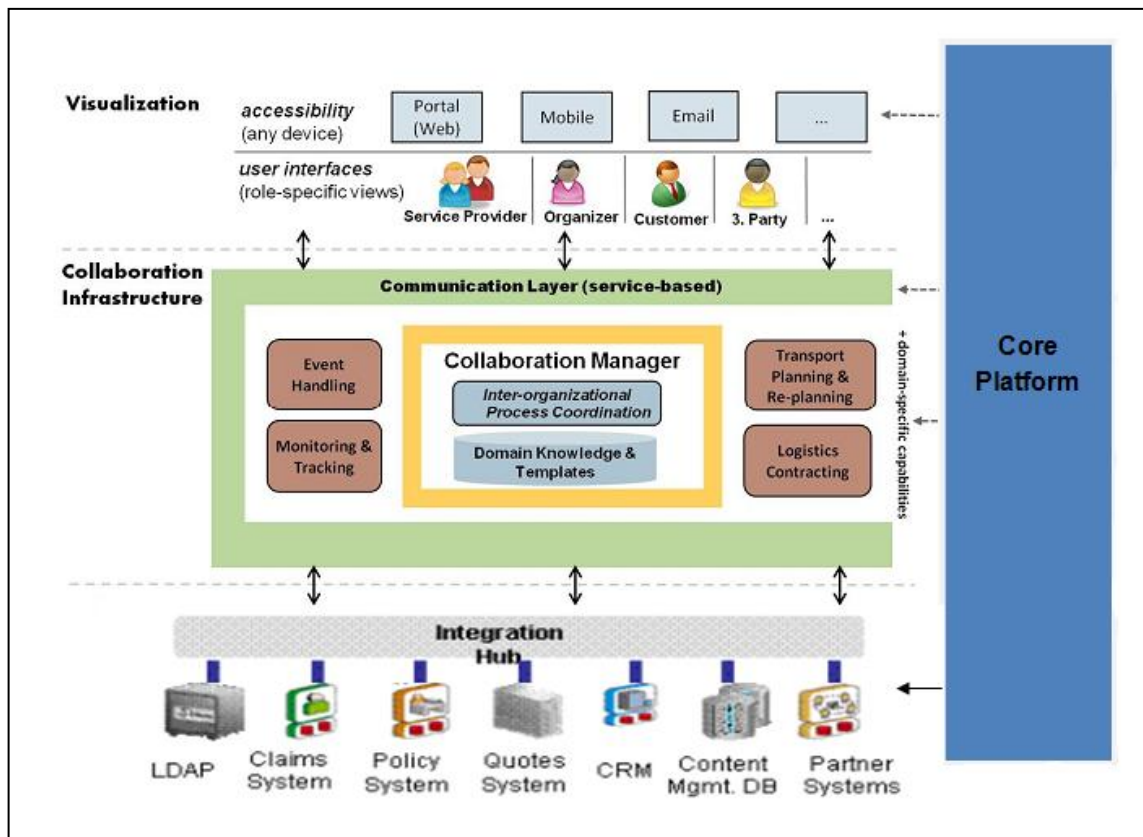
Fig.6.8 Collaboration Oriented Architecture [(Kapil Pant, 2008), (Franklin, 2010)]

The architecture demonstrates possible architectural solution for achieving collaboration between various services governing maritime enterprise. In bottom, we can see integration hub providing access to various systems such as some lightweight access protocols, activities claiming system, regulatory and rules governing system (i.e. policy system), related databases and third party systems providing data pertaining to weather, AIS (i.e. sensor information for finding location of ship vessel) etc. The middle layer encompasses the domain-specific capabilities that provide business-relevant functionalities and will be developed on top of distinct facilities provided by the Core Platform (Franklin, 2010). The main envisioned platform services are the collaboration manager that is concerned with coordinating the planning and execution of international goods transportation processes among the involved business entities, transport monitoring and tracking and end-to-end visibility for customers enabled by real-world integration techniques along with pro-active event handling for allowing efficient treatment of delays and other unforeseen events, the integration of IT systems for enabling efficient transport planning and re-planning, and (semi-) automated support for contracting within logistics business networks (Franklin , 2010).
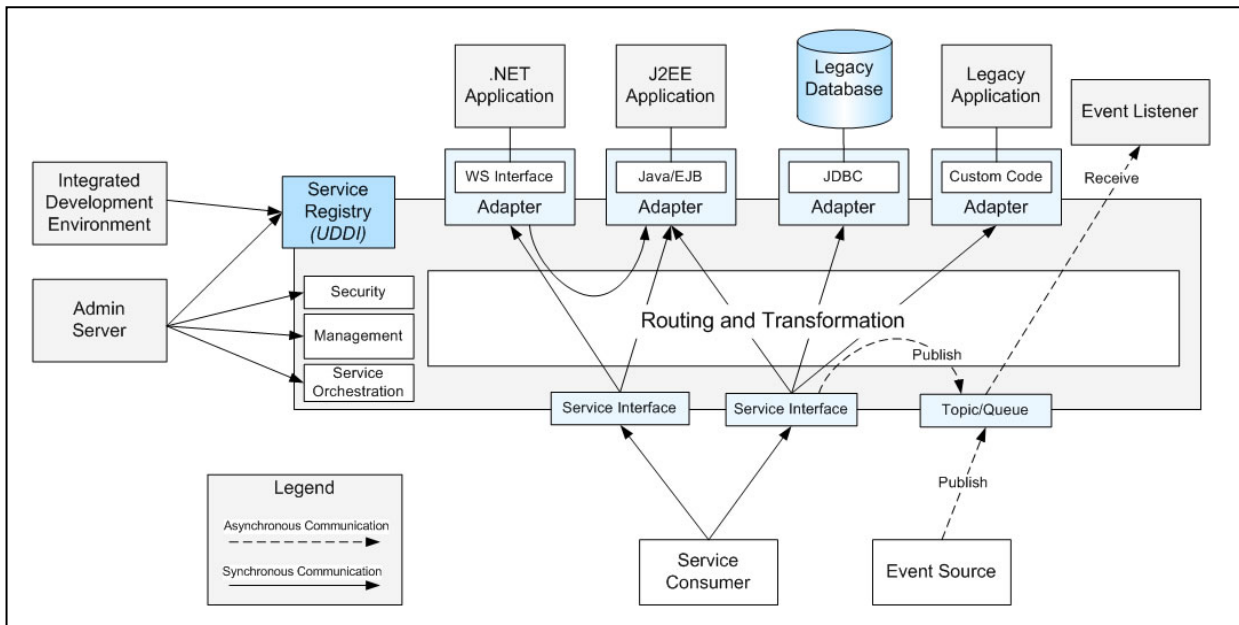
Fig.6.9 Generic Implementation of ESB (Enterprise Service Bus) [ESB pattern, NIH]

On the top layer, end-user interfaces with sophisticated visualization concepts for role-specific views in order to ensure information privacy as well as ubiquitous accessibility via various end-user devices are provided. The communication among all components thoroughly shall apply the service-based concept, thereby facilitating interoperability via standardized interfaces, along with integrated security and privacy management techniques for ensuring exchange of confidential and business-critical information in a secure and reliable manner, which are mainly provided by core Platform (Franklin, 2010).

The collaboration oriented architecture is similar to industry standards of providing functionalities of ESB (Enterprise Service Bus) as illustrated in Fig. 6.9. The ESB facilitates key services for successfully implementing Service-Oriented Architecture (SOA) which includes management and monitoring, security, service orchestration, support for both asynchronous messaging and request-reply, and adapters for a variety of packaged applications and technology platforms [ESB pattern, NIH]. Therefore, the architecture proposed to facilitate collaboration using "Collaboration Oriented Architecture" is likely to handle all issues concerned with SOA such as monitoring, service orchestrations, messaging and enables to apply core functionalities, which facilitates business oriented features such as ubiquitous access and availability, service-based information and system integration, and transport monitoring and tracking on the basis of sensor networks.

6.8   Collaboration Matrix Generation

Collaboration matrix is a tool for storing information contained in business processes and resource hub at various levels of granularity. As discussed in previous section, the middle layer of collaboration oriented architecture consists of collaboration manager to facilitate coordination between services and capability to handle delays, unforeseen events by providing efficient re-planning and collaborative mechanism. This can be achieved by using collaboration matrix, which helps in collaboration by providing information about various people associated with process and means to contact them.   In Fig 6.10, sample illustration of the dynamic matrix generation is provided, which is automatically updated from the information contained by each business process.   The actual dynamic matrix portraying entire maritime operations is presented in Appendix-A. As can be seen in figure below, the services called "C" is mapped with company "123 company" and there upon other related services are mapped under various phases of maritime business processes (i.e. planning, execution, completion as explained in chapter 2, section 2.1). Also the contact details of the persons associated with those processes are also mapped respectively. This method aids in gathering all the relevant information concerned with business process i.e. how one participant is associated with other participant and contact details of each participant. The information gathered using this approach can give support to collaboration mechanism at the time of handling deviations. The circumstances in which collaboration matrix can be useful is explained below using sample test scenario described in VITSAR project (VITSAR, D1.1).

| Services	Company / Authority	Planning	Execution	Completion			Contact Details	
		Plan port and terminal Service operation	Port and Terminal service operation	Monitor goods transport	Invoice and Payment	Deviations and Claims		
A	abc company	Inbound Logistics	Monitoring	Cargo Handling and Monitoring		Defining Marketing Activities	Name 1	Name 2
B	123 company	Outbound Logistics	Reporting	Report Delivery Progress		Service Scheduling	Email 1	Email 2
C		Resource Allocation	Safety Activities	Handle Deviation		Publish Transport Service	Phone 1	Phone 2

Fig.6.10 Dynamic Matrix Generation
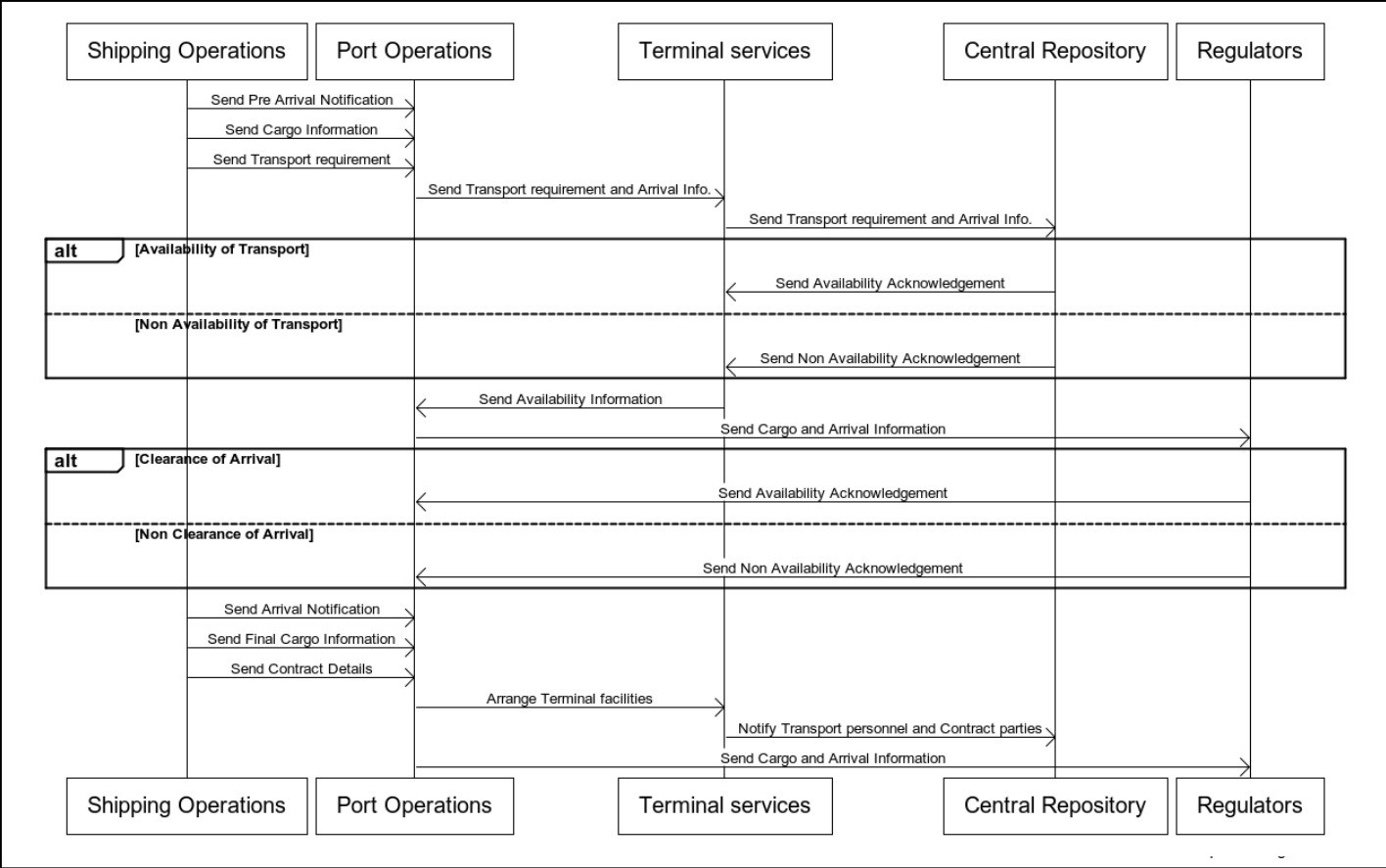
Fig 6.11 Ship Arrival Interaction Diagram

Scenario:

A ship arrives to Trondheim port from Rotterdam port carrying some containers of vegetables. Upon arrival of ship, it has to unload those containers. A ship agent let say "X" is responsible for reporting and allocating resources to handle services needed by ship agents. In this case, let's consider that ship arrives on time and services are arranged as per agreement (i.e. in accordance with pre arrival notification).

*(Ship **S** departs from Rotterdam port)* → *(Ship sails in sea)* → *(Ship arrives at from Trondheim Port)* →*(Ship agent **X** arranges services for **S**)*

................(Case 1)

Now, let's consider that ship S, notifies Trondheim Port about time of arrival. Since bad weather is encountered in the North-Sea pool, ship gets delayed by few hours. As weather is bad, ship agent X expects ship delay and plans to reschedule services. Now, X will contacts all available resources and allocates available resources as per new expected arrival schedule and notified to S that if the delay will be more than 6 hours it is likely to drop Trondheim on the schedule.

*(Ship **S** departs from Rotterdam port)* → *(Ship **S** gives pre arrival notice to X)$_1$*

(X plans resource allocation) → *(Gets Bad weather information)*→ *(Plans to contact available resources, in case of reschedule)*→*(Arranges new resources)$_2$*

(X notifies S about reschedule and notifies maximum of 6 hrs delay is allowed) →*(Ship **S** receives message and plans accordingly)$_3$*

...................................(Case 2)

As it is evident in case 2 that contact information of available resources, participants in process i.e. ship agents, ship owners and other related participants are necessary to handle any deviations. This can be managed easily using dynamic matrix collaboration tool. The dynamic collaboration matrix is generated based upon information stored in RH (i.e. information about resources) and activities/ tasks involved in business processes. The following figure illustrates collaboration matrix formation.
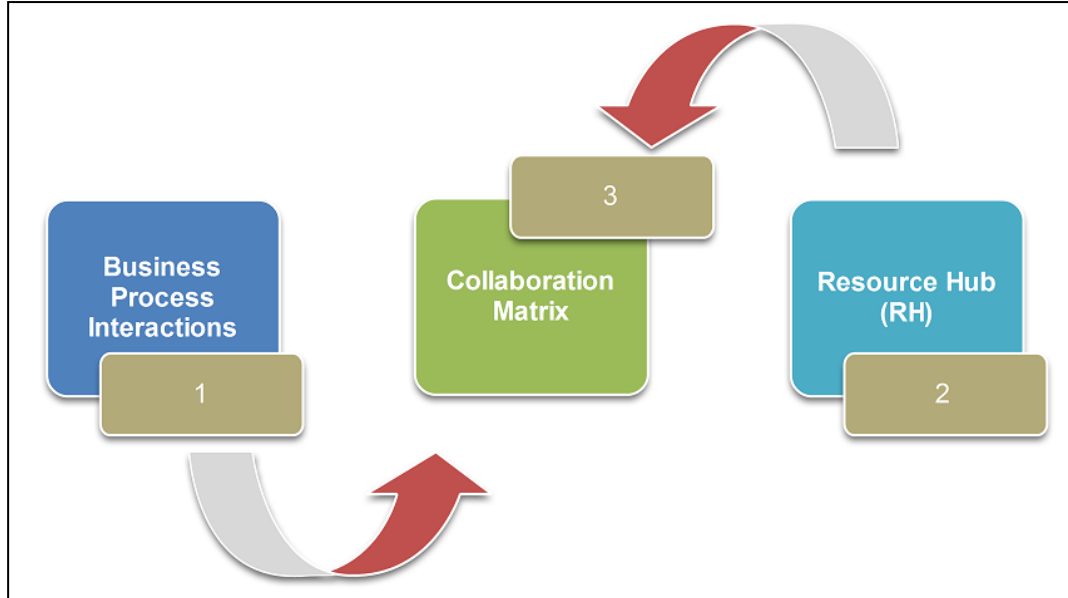
Fig 6.12 Collaboration Matrix Formation

The collaboration matrix is formed by mapping the process interactions (As illustrated in Fig 6.10) with related data from resource hub. Thus generated collaboration matrix holds all information about the running processes. Based upon the interactions data within collaboration matrix can be changed dynamically. As mentioned above in case 2 of sample scenario, the information gathered within collaboration matrix can be used for initiating collaboration approach and hence, finding appropriate solutions which cannot be handled by processes directly.

Chapter 7 – VALIDATION USING CASE STUDIES

7.1 Introduction

The process of validating concepts and research is complex in Enterprise Modeling. The validation for the process-centric approach for defining enterprise can be done in two possible methods: 1. Implementation of Concepts: The first phase will be to understand the concepts related to enterprise. The concepts are portrayed into process-centric models involving all participants associated with those processes.

2. Testing and Validation with case studies: The second phase will be to test those implemented process-centric models with case studies from industries. However, gathering information for use case testing is often difficult as there can be huge number of processes involved in larger enterprise.

In this chapter, the concepts related to "The Process-centric Approach" as discussed in chapter 6, will be validated using case studies from SINTEF, MIS project (MIS, SINTEF). This chapter deals with the research question RQ4 (*Identify if a traditional process diagram can be made dynamically by use of BPMN and the Resource Hub developed in the Maritime Information Centre project (MIS)*). The main endeavor behind validation of process models is to understand role of processes in defining enterprise goals, which will also enable to understand strengths and weaknesses of BPMN and thereby answer RQ5 (*What are the implications/ benefits of using BPMN in establishing collaboration?*). The case considered in this chapter, will comprise of basic operations related to arrival process. The various parties (i.e. organizations or individuals) involved with processes will act as users in process models.

7.2 Case Description

This section gives a brief overview on test case. Initially, it presents background of MIS project and relevance of test case with MIS. Then, it presents case description.

7.2.1 MIS Project

The main goal of MIS is to specify a set of cooperating systems offering information services that improve the effectiveness of maritime transport. Tools for improving the information flow in reporting, ship and cargo clearance, port services, loading and unloading of cargo, as well as other information flows between actors involved in cargo transport is among the services that MIS aims to provide (Kay Fjørtoft, Pilot 1 report).

The SiSaS pilot will focus on a part of MIS called "Resource Hub", a software system for providing and booking services based on port resources. The system will function as a tool for generating services based on resources and services from diverse providers at the port, for booking and reserving the services, as well as handling exceptions (e.g. late arrival to port) in an effective manner. It is believed that the use of the system will lead to a more effective utilization of the resources in port, as well as making maritime transport more attractive (Kay Fjørtoft, Pilot1 report).

7.2.2 Test Case Description

In Maritime Enterprise, operations usually consist of many processes interacting at same time. MIS is integral project of SINTEF, which focuses mainly to facilitate collaboration and reduce operations costs. These are fulfilled by using some notions such as resource hub and Port Community Systems and Single Window, as illustrated in Fig. 7.1. So the test case is formulated based on these above mentioned notions.
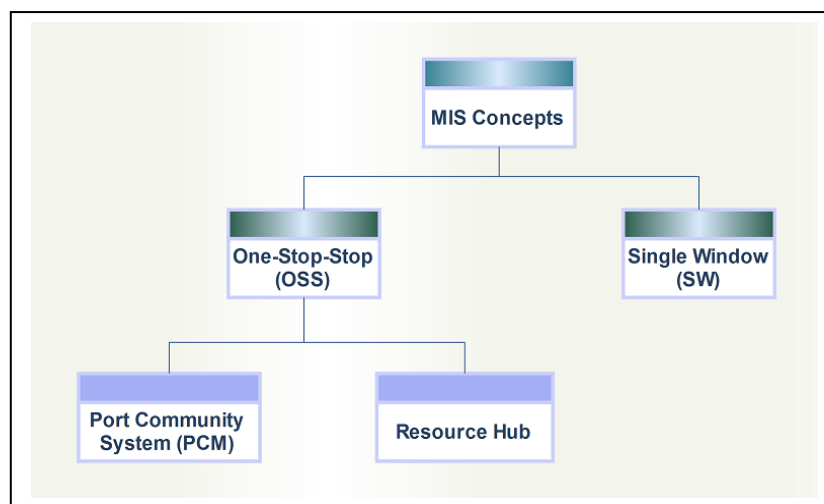

Fig. 7.1 Structure of MIS concepts (MIS, SINTEF)

In our case study, we have considered ship arrival process. The use case scenario depicting interactions and information exchanges in ship arrival process is illustrated in below Fig. 7.2 In ship arrival process, ship enters harbor and requires different resources and facilities both at terminal. Apart from this, it needs proper collaboration among people involved with these operations at port and terminal.

The basic processes involved in ship arrival are the communication between various resources such as vessel agent, port authority, terminal operators, pilot booking and regulators.

The process is initiated by the ship vessel agent wherein he enquires the facilities, Terms and Conditions at port and subsequently verifies port checklist. After analyzing and fulfilling proper requirements information as per the guidelines mentioned in the port checklist , Pre Arrival message is sent to the port authority in As-Is situation, however, we are using concepts proposed by the MIS such as resource hub and marine data center , wherein communication is streamlined and coordinated (i.e. reduces multiple message passing).

So in our case, Pre arrival notice will be sent to the Resource Hub (RH). RH provides notifications to concerned people associated with processes such as service providers such as pilot booking, regulators for inspection and completing other related formalities. The services, people concerned with these activities are consulted and upon agreement, ship arrival is planned. Thereafter, the port authorities will be responsible for monitoring the location of the ship by observing the coordinates and tracks path of the ship, whether it is in course as per planned. In case of any discrepancy the ship vessel agents are informed about the plans and possibilities of services.

As soon as ship is arrived, depending upon the ship requirements and already planned pilot is arranged. Mooring and other loading and unloading operations are arranged at the terminal end.

This case is taken so as to include basic operations at ship arrival, it can be extended to entire domain comprise all actors and individuals involved with these operations.

7.2.3   Process, actor and interaction:

Port, terminal, ship and regulators are the main actors in this process. Activities including interaction and/or information exchange between the actor groups are:

1. *Receive pre-arrival notice:* Regulators, ports and terminals receive pre arrival notices from vessels. Ports and terminals need information about vessels arrival to plan/prepare terminal/port services according to contract. The ship managers are responsible for the reporting (notice), but this activity is often delegated to agents. The pre arrival notice includes information about: arrival time, dangerous goods, waste, ballast water, bulk and what to load/unload. The regulators require pre arrival notifications for information about arrival time, cargo and crew.

2. *Receive arrival notice:* The arrival notice constitute a confirmation of the pre arrival notice and any corrections/ changes that must be taken into account by port and terminal actors when planning/executing services.

3. *Terminal and port services:* This activity includes navigation services, berth services and mooring which are performed by different actors, both public and private companies.

7.2.4   Contributions of MIS to the process

MIS reduces the needs for distributing messages since; data registered in MIS are available for port, terminal and regulators. The needs for registering data are reduced because data about vessel and cargo are available in MIS (V*essel information and Cargo information).*

- **Cargo information:** information about cargo registered earlier in the transport chain are available, which imply reduced needs for data registering

- **Single Window:** All messages (pre arrival, arrival notice) can be registered through Single Window which are linked to different external databases (e.g. *Vessel information database,* an existing international database) and provide MIS with data and information about ships/vessels.

- **AIS:** is important for receiving notifications on positions to MIS to get updates on arrival times

7.2.5   **Information/messages included in the process are:** Pre arrival and arrival notification
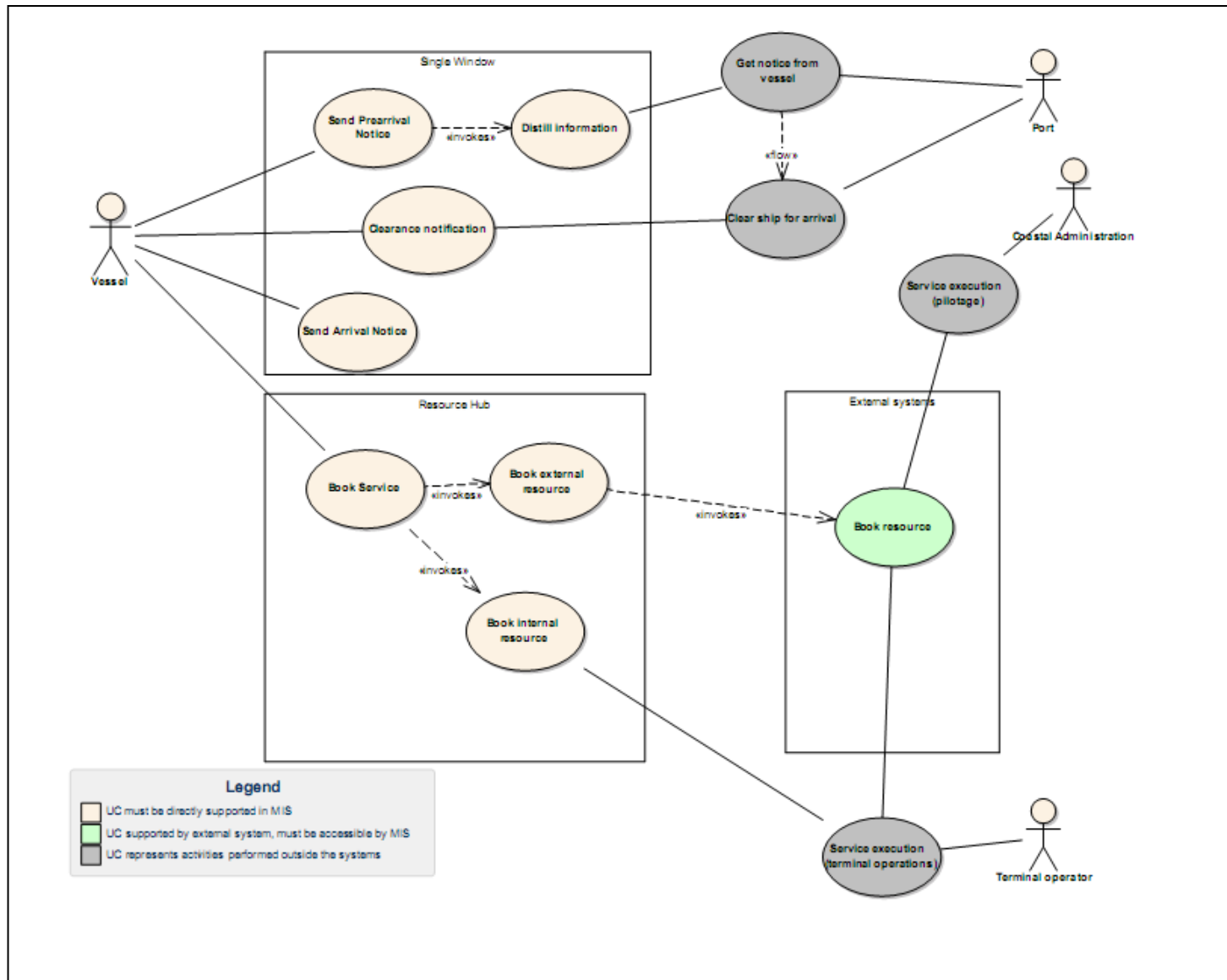
Fig. 7.2 Use Case Scenario of Ship Arrival Process

7.3 Case Studies Analysis

This section presents modeling of the test case and summarizes the analysis results performed on the test case.

7.3.1 Dependencies for Modeling the Case

The model is created based on test case description as defined in section 7.2, The test case includes several people participating in model and held responsible for various different roles as illustrated in Fig. 7.3, Vessel agents, port authority, terminal operators, pilot service personnel and regulators actively participating in models, however each one has their own goals and tasks to complete , for example vessel agents may need to work in collaborate with pilot service and Port authorities for completing their tasks. Similarly, port authorities have to work in collaboration with Vessel Agents, Port Authorities, Terminal Operators, Pilot Service Providers and Regulators in order to complete their tasks. A brief overview of task dependency and collaboration is illustrated in below Fig. 7.3.
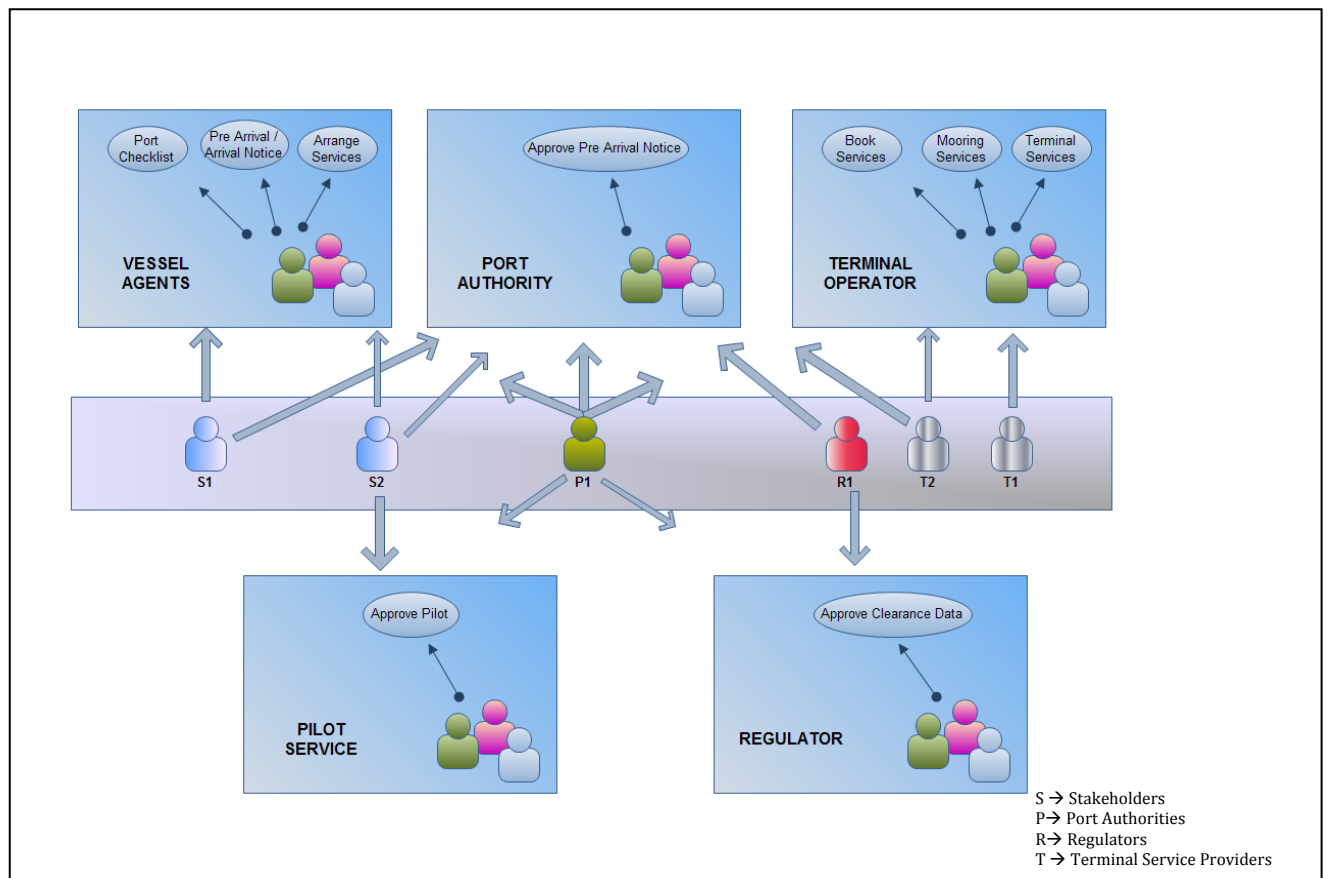

Fig. 7.3 Overview of task dependencies and Collaboration

7.3.2 Test Case Process Diagram

The swim lane diagram shown in Fig 7.4, illustrates interactions between tasks connected with Test Case Model. The process is initiated, when the ship is reporting to port by fulfilling port checklist. The request of services and pre arrival notice is sent to single window, wherein resources and services are reserved for ship. When necessarily resources have been ordered and confirmed the reporting process to the OSS system can be done. It is also possible to report to the OSS before reserving resources. Then the OSS will receive the port call information and send information to subscribed receivers. When all information has been received by the agent the information can be sent back to the vessel.

7.3.3 Comparison of Various Characteristics

While analyzing test case model, various phenomena between concepts and their importance were identified. These are as demonstrated in figure below, These characteristics are very much evident as can be seen in models developed for test case, based upon modeling of test case and running of models , the values were represented qualitative such as high, medium , low rather than qualitative parameters.

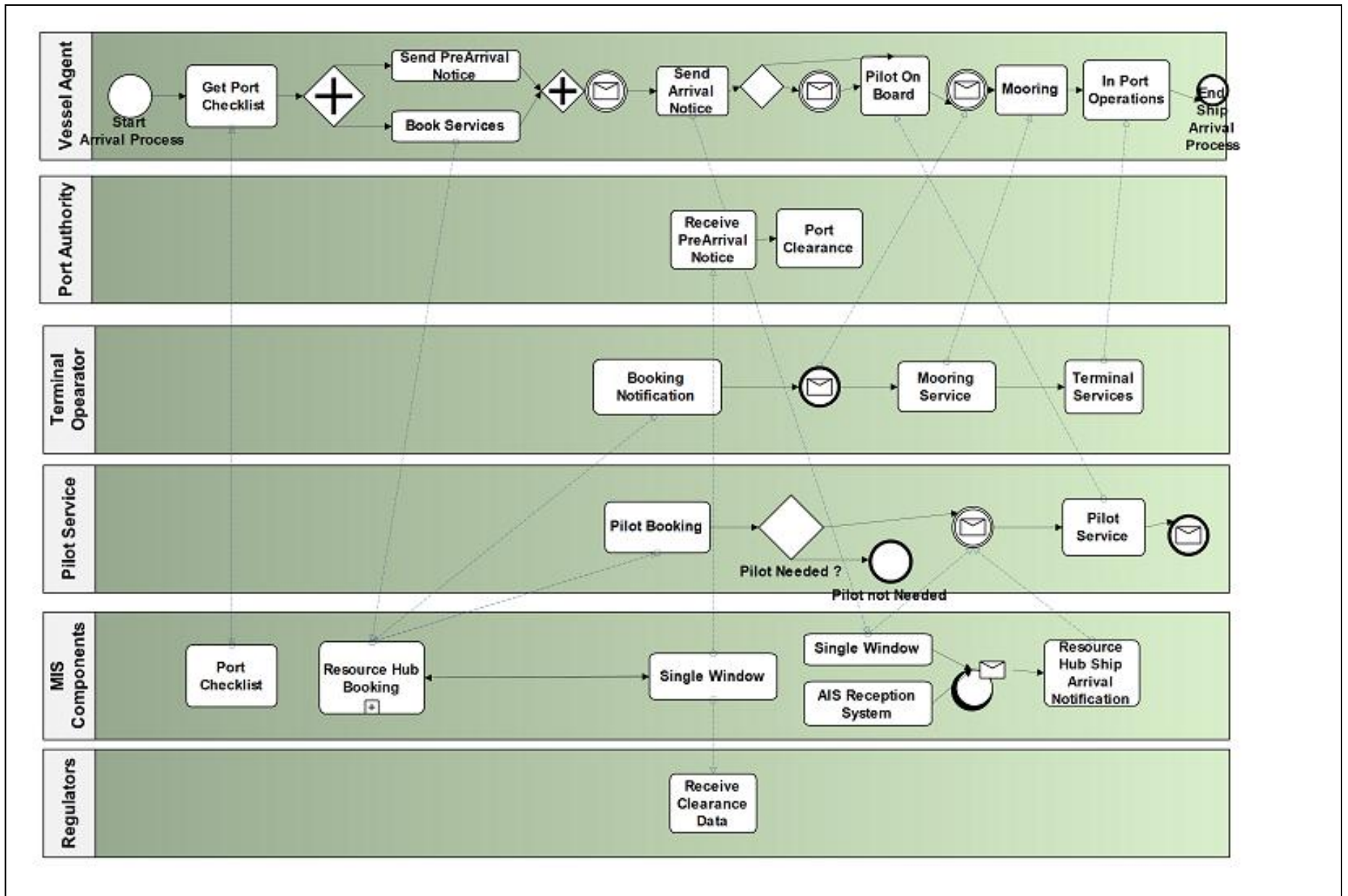| Characteristics	Importance
Collaboration	High
Skills required for completing processes	Low
Detail representation of representation	High
Complexity of enterprise	Medium
Dynamic data retrieval	High

Table 1. Comparison of Characteristics

Fig. 7.4 Test Case Process Model

7.4 Discussion

The main conclusions from the analysis of the case studies are discussed in the following subsections.

7.4.1 Applicability of the Process-centric Approach

Fig. 7.5 demonstrates usage of the process-centric approach with respect to layered representation as defined in section 6.2 as can be seen, the process-centric approach can be useful to define various aspects enveloping whole maritime enterprise such as Technical and Logical aspects. The Technical aspects are responsible for communication between various applications whether internal or external. Whereas Logical aspects are responsible for covering some of the critical aspects of domain such as defining functions, defining behavior of components and conceptual aspects , this includes business process involving different participants of enterprise, role of these various participants, how best these people can collaborate together to achieve fruitful results and as well as achieve enterprise goals.
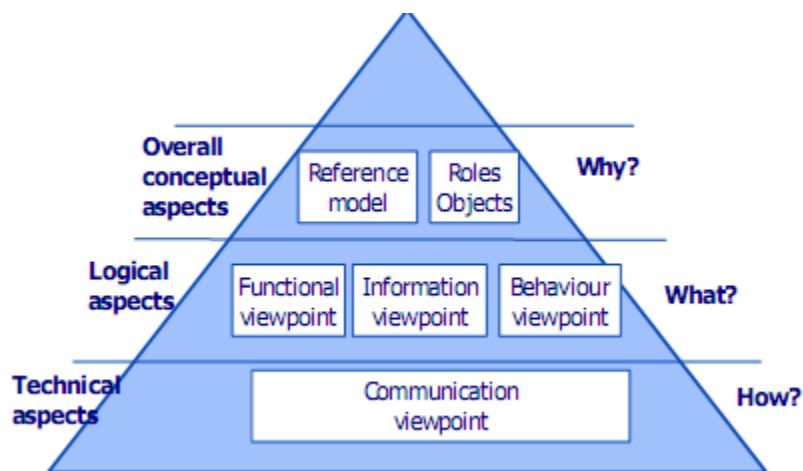

Fig. 7.5 Aspects of Maritime Enterprise (ARKTRANS, 2008)

As can be seen from above figure these aspects are very much dependant on processes and incorporating collaboration among several members of enterprise. This process-centric approach is more suitable in case of following:

(a) If enterprise is large and depends of collaboration between various people involved within enterprise

(b) If number of stakeholders are more

(c) Processes are complex and needs decisive management, i.e. manual input and sometimes decision has to be taken by the human.

(d) If the business is spread across global level, then it depends certainly on managing processes governing them.

Based on modeling results, (as presented in Fig 7.5) the process-centric approach enabled to define relationship between various entities such as participants (i.e. people concerned with Ship Arrival process), processes (i.e. tasks concerned with Ship Arrival process) and external information sources (i.e. databases). Thereby collaboration was effectively established. In the test case, the services and resource allocation were based upon MIS components such as RH, PCM, and SW (refer: section 7.2.3). The information from one user is broadcasted to other user and upon approval or some work performed by other user, the process is completed. The model developed provides strong collaboration mechanism between various people involved within enterprise. Also the model has scope to extend for more online collaborative methods by incorporating some features such as Chats, Google wave etc. This helps to reduce operation time and plan effectively, when deviation is caused.

7.4.2 Testing with Sample Data

The purpose of test case was to validate various aspects pertaining to maritime enterprise such as collaboration between processes, process alignment and so on. As discussed in (Gruninger, 1995), competency questions such as maritime enterprise formation, skills necessary to perform tasks in process, goals being affected by lack of performing task are necessary to evaluate maritime enterprise and they can be solved by methods prescribed in (Petersen, 2003). However, we would be ignoring those aspects and focusing more on the process completion and collaboration among various tasks in process.

As identified various characteristics of model in 7.3.3, the test case model have to satisfy three major characteristics, they are

a. Process Interactions

b. Dynamic retrieval of data

c. Collaboration mechanism

The above mentioned three aspects are tested by considering small sections of the Test Case Model, wherein successful realization of these models will automatically prove the completion of entire test case model as presented in Fig 7.4.

Process Interactions: The test case is complex as it involves various participants such as Vessel Agents, Port Operators, Terminal Operators and Regulators. The interaction among these participants is complex and it involves lot of decision making. So, testing this complex nature is difficult. However, we can test basic interactions and flow of information between those processes. The following figure illustrates interaction between processes and decision making depending upon input received from users.
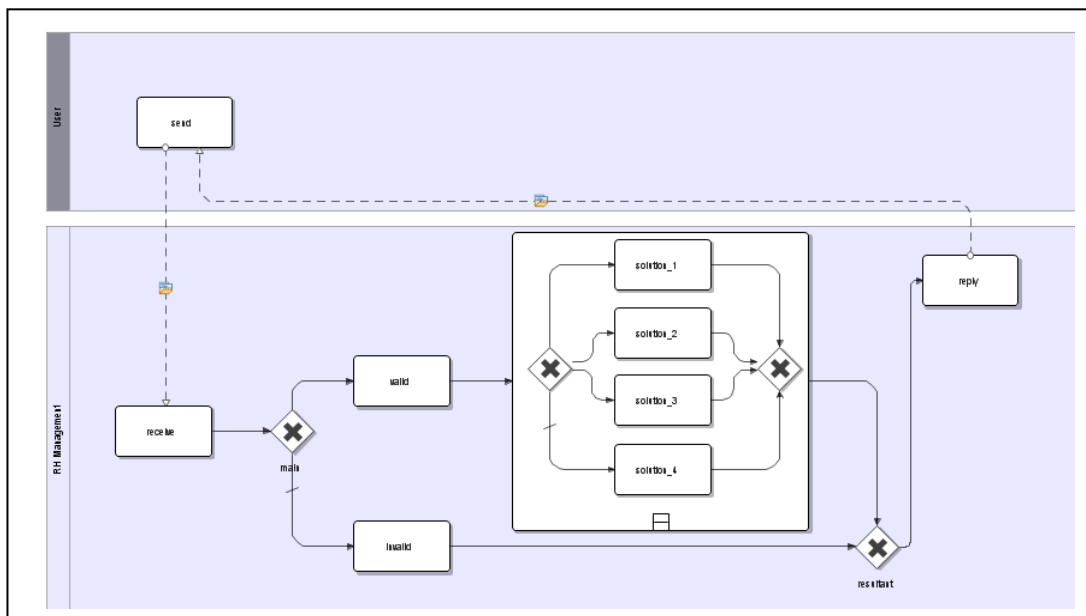

Fig 7.6 Process Model for Testing Process Interactions

The deployment of this process will automatically prompt the user to provide the input for fields, as illustrated in Fig 7.6. Depending upon the input provided by the user the response varies.
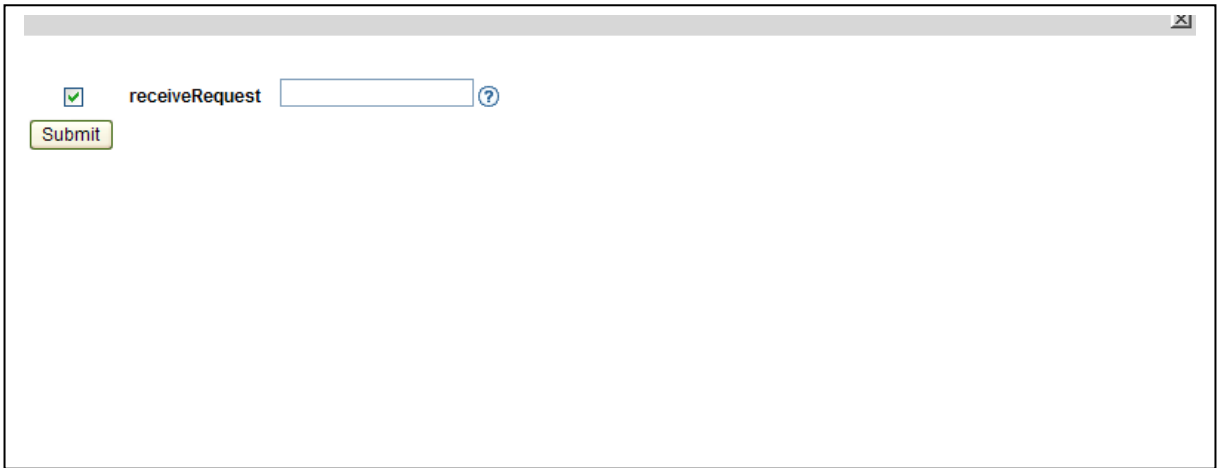
Fig 7.7 Deployment of Process Model for Testing Process Interactions

The results are displayed as shown below in Fig 7.7 based on mapping as defined while modeling process.
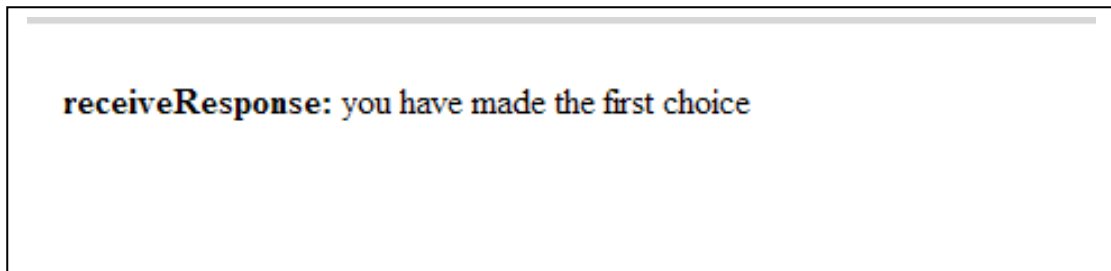

receiveResponse: you have made the first choice

Fig 7.8 Deployment of Process Model for Testing Process Interactions
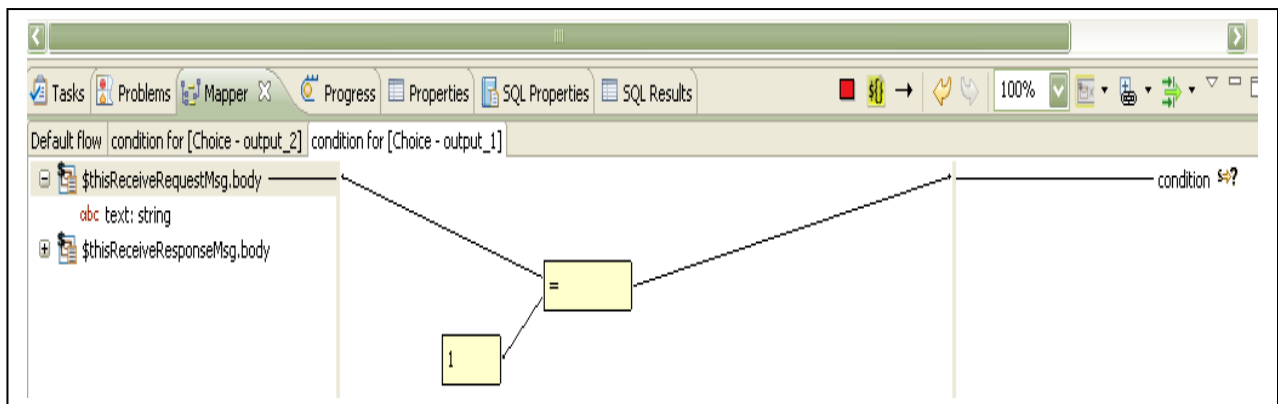

Fig 7.9 Process Mapping of Model

Dynamic Retrieval of Data:

In the Test Case as presented in Fig 7.4, the processes are connected to MIS component data sources such as RH, Marine Information Centre. In order to test the ship arrival test case it is essential to fetch data from database.

In this context, we are implementing a case in which a user requests for resources available in the RH, description of which is maintained in the database. The request is accepted if any resource is available in RH database. In addition, there is also a provision to insert a new item (i.e. resource to database). In this case, the user wants to view list of resources available in database. The process can allow the user to view list of all the resources present in the stock and thereafter can book the resource.

The process also computes the total charge for availing the ordered resources. There is also an option of adding a new entry to the existing reserve of resources. The following figure illustrates dynamic retrieval of data and price computation of resources allocated.
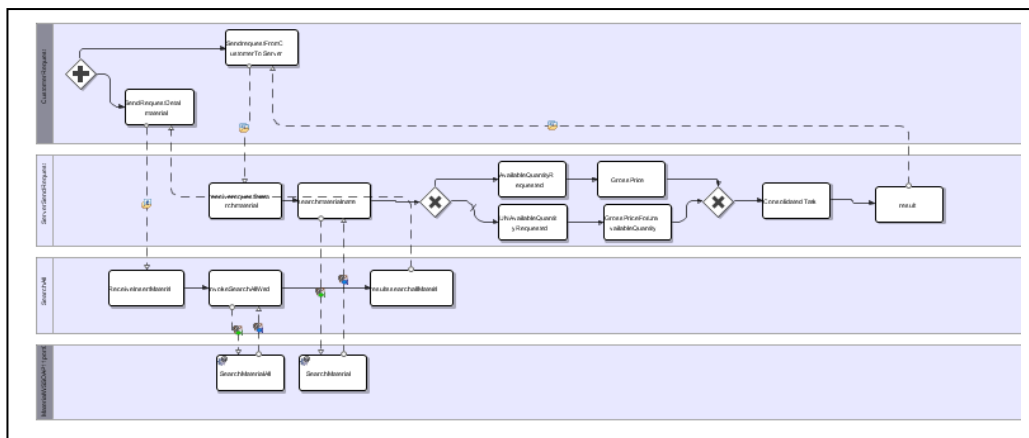

Fig 7.10 Process illustrating Dynamic Data Retrieval

The execution of process provides the user a form as illustrated in Fig 7.10, which prompts the user to enter details of employee such as name, phone and email. The duration for which resource is used and type of resource required (i.e. piloting, mooring etc.) and number of hours required are also filled by user. The requirements filled by the user are notified to concerned authorities for approving and allocating desired resources. The resources are assigned as per their availability and information stored in resource hub (i.e. in our case MySql database).

Fig 7.11 Generated Form on Process Execution

Collaboration Mechanism:

Collaboration is a process in which different entities share information, resources and responsibilities to jointly plan, implement, and evaluate a program of activities to achieve a common goal. This is one of the vital aspects concerning Test Case. In general, collaboration can exist either directly or indirectly. In direct approach, participants collaborate together at the same time unlike in indirect approach where collaboration takes place in offline mode.
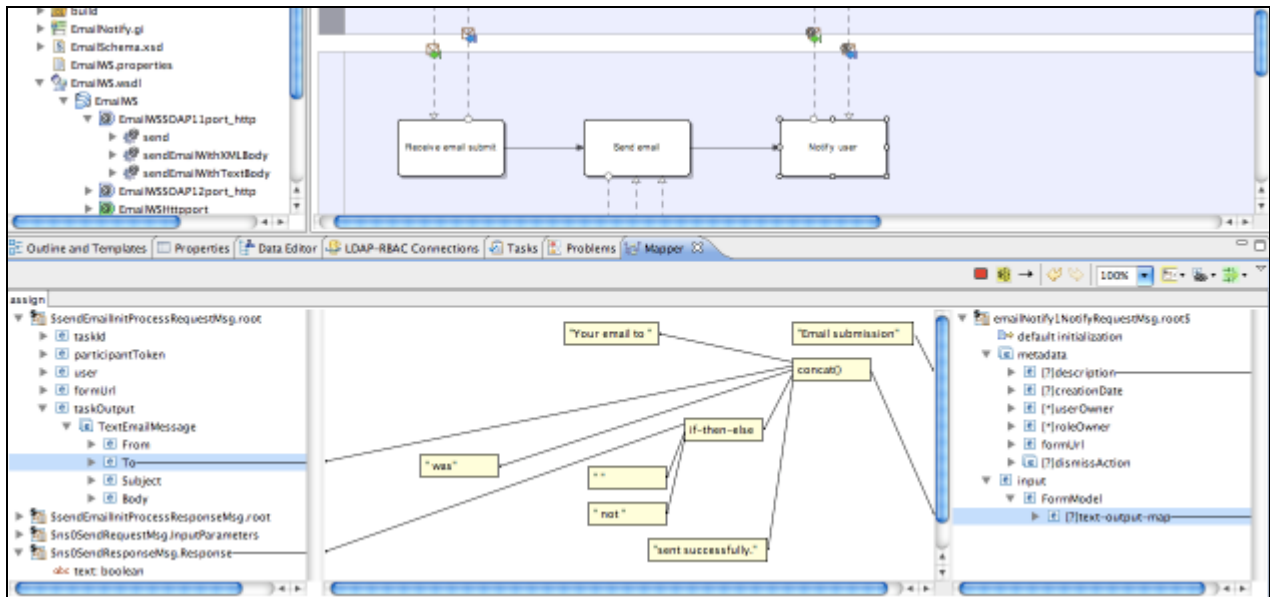
Fig 7.12 Process Mapping of Dynamic Data Retrieval Model

The model as illustrated above facilitates sending mails through Intalio business process web services. The form for sending e-mails is created using AJAX form having fields such as "To:", "From:", "Subject:", and "Body:" The following figure illustrates the SMTP server email configuration needed in order to send mails.


```
# Email Service Configuration
contentType=text/html;charset=utf-8
returnAddress=
joe@gmail.com
# JavaMail-specific property
mail.transport.protocol=smtp
mail.host=smtp.gmail.com
mail.smtp.port=465
mail.smtp.auth=true
mail.smtp.socketFactory.port=465
mail.smtp.socketFactory.class=javax.net.ssl.SSLSocketFactory
mail.smtp.socketFactory.fallback=false
mail.smtp.starttls.enable=true
mail.smtp.quitwait=false
authUsername=
joe@gmail.com
authPassword=joespassword
```

Fig. 7.13 Email Configuration

7.4.3 Monitoring and Status Reporting

Monitoring plays a key role to find bottlenecks and check status about processes. In case of process being stopped or hindered by lack of any information, using monitoring console we can set up any collaboration platform or notification mechanism for completing tasks within process and allow flow of information between tasks.

The following figure demonstrates usage of monitoring console, as can be seen in figure, the indication (green colored forward arrow) illustrates that process is halted and requires input from other user in order to complete the whole workflow. This information is vital as it aids in finding people involved with those tasks and set up some collaboration for it.
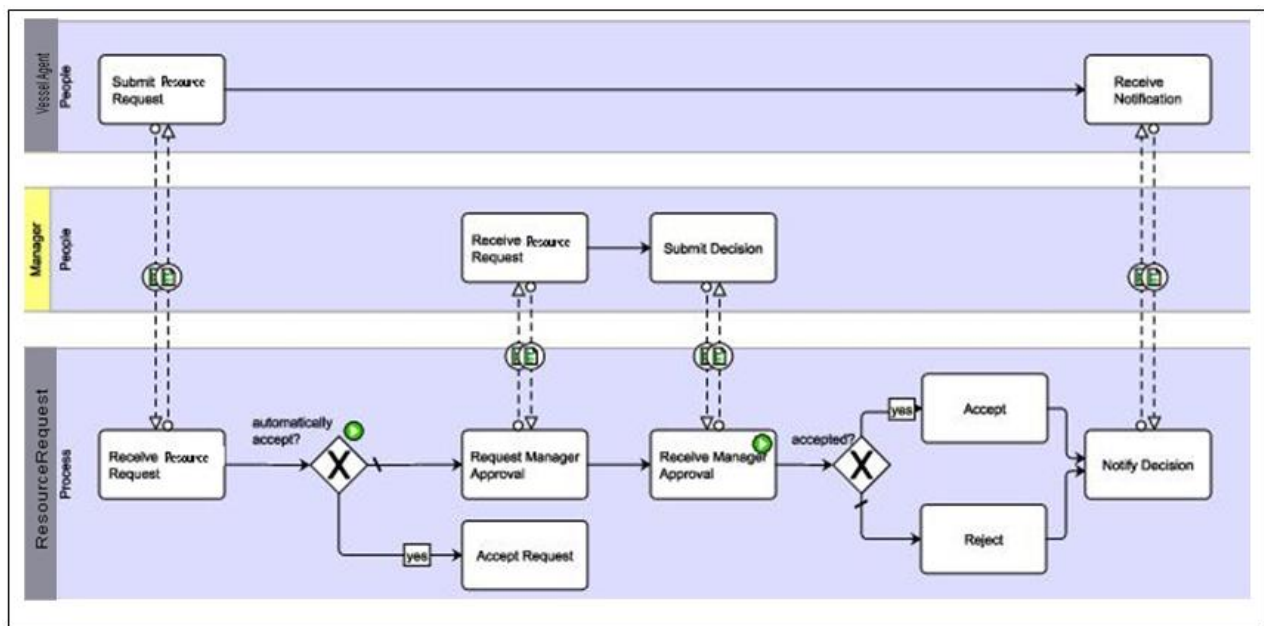

Fig. 7.14 Status of Process Execution

If in case processes are interrupted because of errors in executing or completing the process workflow, then execution failure notification (red color with "!" mark) is indicated. The symbol is shown on respective process element (i.e. process task, gateway etc.) such that place where the process acquired error can be easily identified. Fig. 7.13 illustrates the process diagram generated after executing the email process, which was developed as part of improving collaboration mechanism. Fig 7.13 clearly shows the error obtained for task which was supposed to send email.
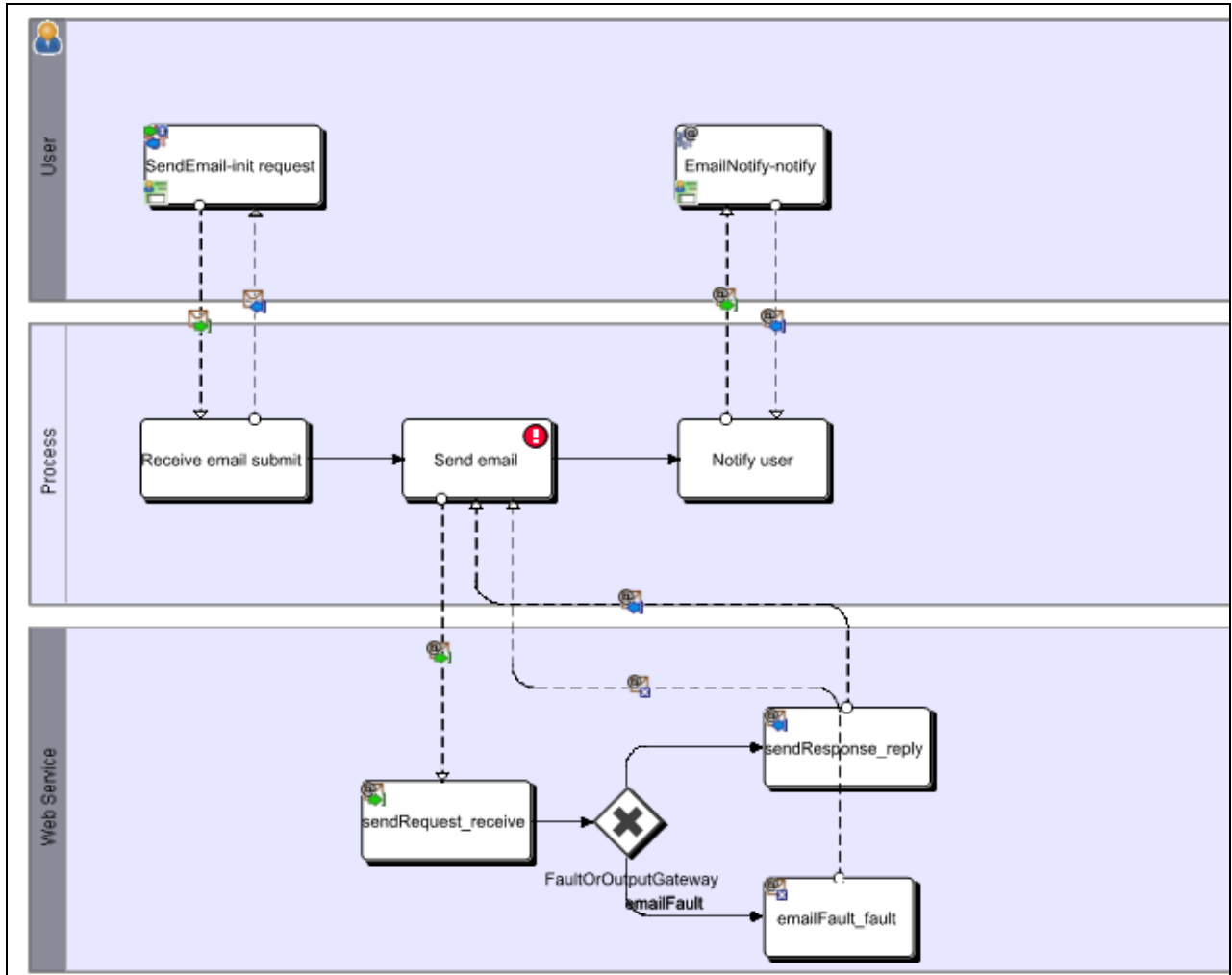
Fig. 7.15 Error Reporting for Email Process

Part IV

Evaluation and Conclusions

CHAPTER 8 - EVALUATION AND ANSWERS TO RESEARCH QUESTIONS

This chapter provides the evaluation of concepts and results presented in previous chapters. The first section gives an overview of evaluation of contributions achieved in this work. In later sections, we present confinements of the process-centric approach, evaluation of research methodology, questionnaire used for analysis. Then based upon these evaluations of contributions and results from questionnaires, the research questions of this thesis work are answered. Finally, choice of case studies and key lessons learned in this work are presented.

8.1 Evaluation of Contributions

The contributions from this thesis work are concerned with maritime enterprise and especially the test case of Ship Arrival process and MIS project at SINTEF. However, these contributions can be extended to any enterprise as collaboration is part and parcel of every business process. The following are brief description of contributions from this thesis work:

Goal Hierarchy: As discussed in section 3.6, the representation of maritime goals and sub goals in hierarchical manner such that larger goals can often be decomposed into smaller sub goals, will ensure that achieving the smaller goals will eventually lead to achieving the main goal of maritime enterprise. The hierarchy can be considered as a contribution to maritime enterprise and the role of contribution is highlighted in the goal diagram. It can also be extended to other enterprise/ organizations with small changes to structure.

Intersection of Processes, Tools and Users: As explained in section 3.5, in an integrated approach interplay among elements UTP (Users, Technology, Business Processes) forms the enterprise. The key to to improve operations and processes is by establishing collaboration space, which is nothing but intersection between these elements. This can be considered as a contribution to maritime enterprise for establishing collaboration and can also be applied in general to other fields as well where there is integrated approach between various elements.

Collaboration in Maritime Processes: As discussed in section 3.4.1, Collaboration enabled Process Management (CPM) within maritime enterprise can be established by using Layered Building Blocks, wherein each layer form building block for another layer. This can be considered as a contribution for maritime enterprise for defining and understanding correlation between different layers.

Enterprise formation lifecycle: As presented in section 6.2, the formation of enterprise is mainly dependant on entities either functional or information oriented , where Functional entities are used for planning and managing tasks in the supply chain, while information entities are used to facilitate information and collaborative services within enterprise. This can be considered as a contribution for maritime enterprise, however can be applied to any enterprise with supply chain mechanism.

Collaboration platform: As explained in section 6.3, the collaboration and Integration platform facilitates collaboration and management of various activities governing maritime enterprise. This can be considered as contribution for maritime enterprise. This design permits collaboration platform to be combined with other applications as well. The design is at the level of architecture while there are several tools that may be used to implement it.

Collaboration-Oriented Architecture: As explained in section 6.4, this architecture demonstrates possible architectural solution for achieving collaboration between various services governing maritime enterprise. This can be considered as contribution for maritime enterprise, however can be applied to any enterprise with small modifications.

Collaboration Matrix Generation: As presented in section 6.6, Collaboration matrix is a template to assist collaboration between various parties involved in enterprise at time of handling deviations. This can be considered as a contribution for maritime enterprise, however can be applied to any enterprise wherein there is a need to handle deviations via collaborative approach.

These contributions are developed for solving research questions as explained in chapter 1, section 1.4. In order to validate these contributions and their role in solving the research questions, the questionnaires research method was used, wherein opinions from various people in maritime enterprise was gathered. The detail evaluation and results of these questionnaires method is presented in section 8.5 of this chapter.

8.2   Confinements of the Process-centric Approach

The analysis of the process-centric approach using test case of arrival process revealed some of the restrictions, those confinements are as follows:

- Message passing: The messaging between tasks was only one to one, however in real-time operations are complex and decision making depends on multiple messaging between different tasks.
- Multiple access roles: The processes or tasks within processes can be handled by multiple users/ stakeholders. However, we have considered task/ process controlled by single user.
- Granularity: The models were lacking granularity and can be represented in a more detailed manner by defining attributes properly.

8.3   Evaluation of Research Methodology

The maritime enterprise comprises of huge number of process and parties involved with those processes. So, multi-discipline roles/ parties affiliated with maritime enterprise are difficult to consider in our test case. Therefore, simple case of ship arrival is taken involving few operations, process-centric modeling and facilitating collaboration was measured as the core concrete background for this thesis work.

The research methodology was based on both case studies and thereafter practical implementation of case studies. This approach proved beneficial as it gives broad perception over problem domain and also provided an overview on troubles encountered by business organization. The case studies aided to understand whole domain and conceptually build solutions to minimize drawbacks faced in domain. However, providing solution by modeling all processes taking place in enterprise is outside the scope of this thesis work.

8.4 Evaluation using a Questionnaire

The research method questionnaire is an efficient way of collecting the data from broad range of people for performing research or analyzing test results (Oates, 2006). The questions have to be constructed appropriately for analyzing desired research questions. The questions used for

questionnaire are based on research questions defined in this thesis work and can be categorized into three parts namely: Need for collaboration in maritime operations, analyzing contributions of this thesis work (refer: section 8.2), usage of BPMN in supporting collaboration and improving operational efficiency.

8.4.1 Participants of Questionnaire

Background: The maritime enterprise comprises of complex operations and processes taking place through collaboration, sharing and integrating information across professional, organizational and geographical boundaries. The best possible way to evaluate and analyze the work was to conduct questionnaire with people representing various sector's of maritime enterprise.

Questionnaire Setting: The questionnaire was carried out on 14th June, 2011 at Marintek, SINTEF during MIS project meeting. The meeting was aimed to discuss on current challenges faced in maritime industry and opportunities for providing better collaboration. As can be seen in Fig. 8.1, In total there were 8 members representing various sectors of maritime industry such as Cargo Owners, Ship Agents, Terminal Owners, Port Authorities, Terminal Operators, Coastal Administrators, Port Authorities and members of MIS project.

Fig. 8.1 Participants of Questionnaire

The template used for Questionnaire can be seen in Appendix B, the template provided various questions pertaining to achieving collaboration mechanism in maritime enterprise and validate contributions proposed in this thesis work. The results from these questionnaire were also used for answering research questions.

8.4.2 Results

The results obtained by using questionnaire method are used for evaluating the three major objectives i.e. understanding the need for collaboration in maritime operations, analyzing contributions of this thesis work (refer: section 8.2), usage of BPMN in supporting collaboration and improving operational efficiency. The results acquired for these objectives will also solve the research questions as defined for this thesis work. The structure and layout used for questionnaire can be seen in Appendix B.

a) Need for collaboration in maritime operations:

In the maritime transportation sector, collaboration is very much evident as intersection between various elements associated with it such as business processes (or service management), software tools (or technologies) and users. As a result, collaboration is crucial either to make good plans that are aligned with the different stakeholders or can be used as a tool for deviation management if such a thing occurs. In order to test these results
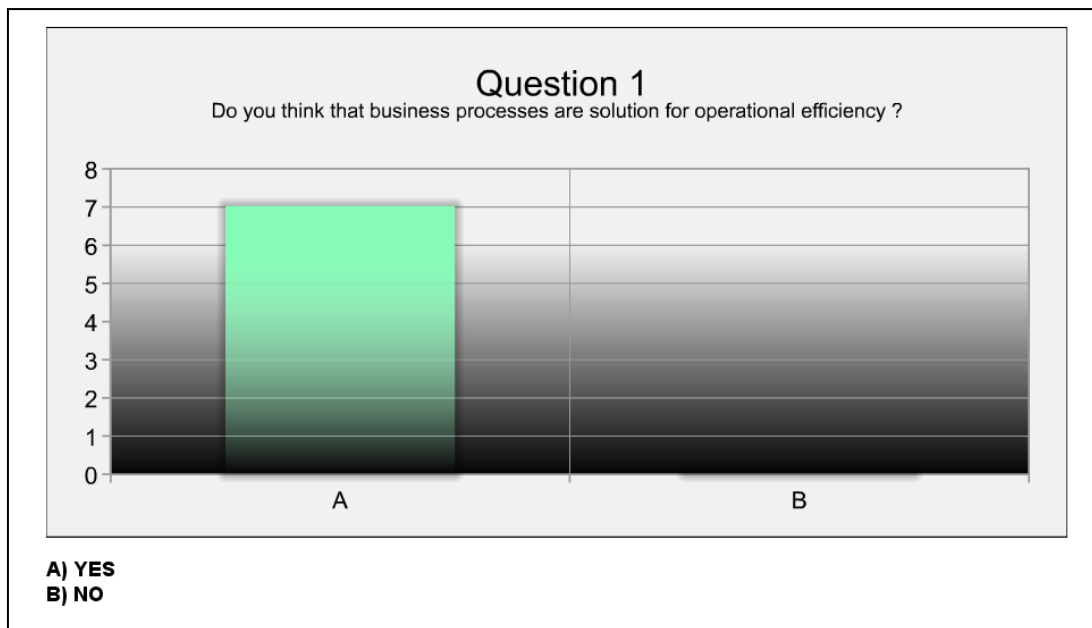

Fig 8.2 Response to the importance of business processes in improving operational efficiency

Fig 8.2 illustrates the response of participants for importance of business processes for improving operational efficiency, the results are completely one sided. Every participant feels that business processes are key solution for achieving operational efficiency.

The response obtained for the second question of questionnaire i.e. *how can collaboration be improved and maximized among parties involved in maritime operations?* Is illustrated in Fig 8.3.
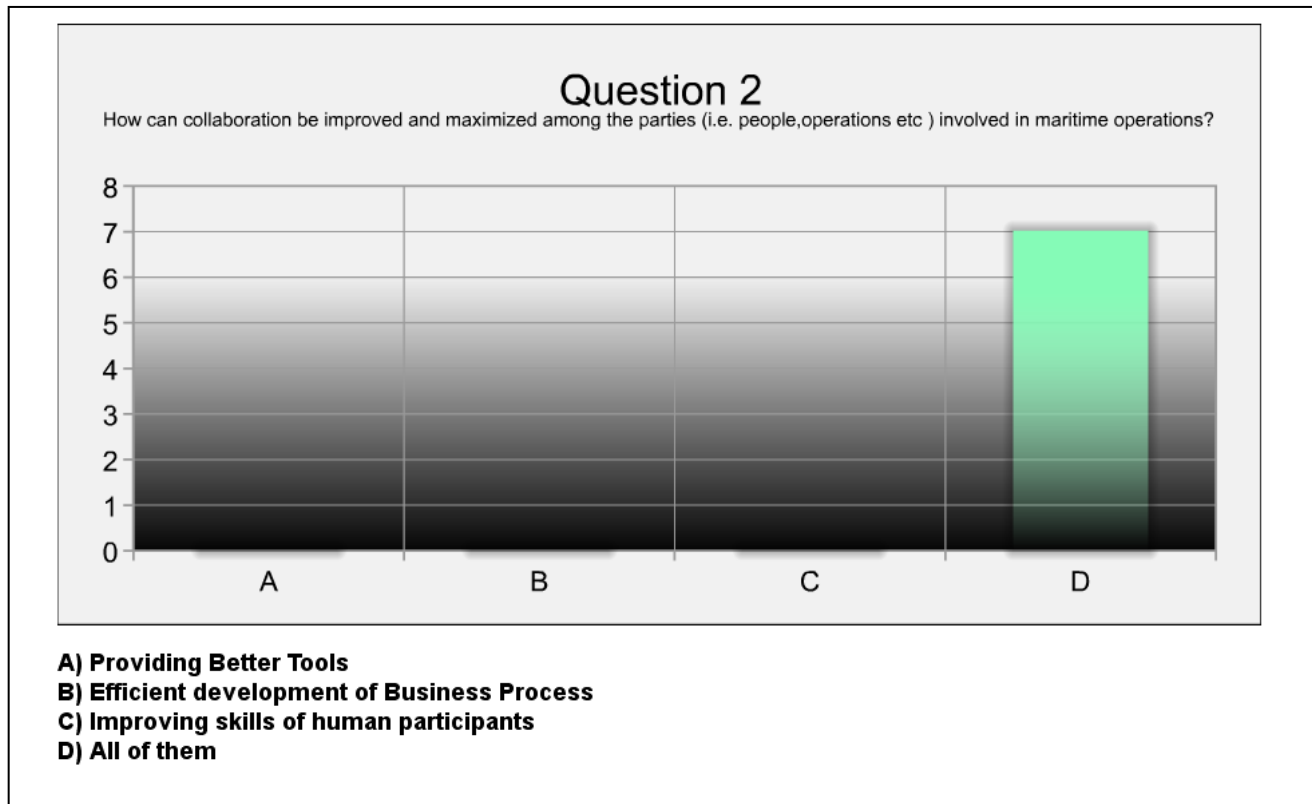

Fig 8.3 Response to factors contributing for improving collaboration

As can be seen in Fig 8.3, all the participants agree that providing better tools, efficient development of business process and improving skills of human participants are all essential for improving and maximizing for collaboration among parties involved in maritime operations.

b) Analyzing contributions of this thesis work:

The contributions developed in this thesis work (refer: section 8.2) in order to solve the research questions were also evaluated using questionnaire. The participant's response on these contributions can be seen in Fig. 8.4

As can be seen in Fig 8.4, the participants were given different degrees of agreement i.e. strongly disagree, somewhat disagree, somewhat agree, neutral and strongly agree. The responses demonstrate that majority of participants strongly agree with contributions for improving collaboration and developing enterprise. Also, it can be seen that participants are also neutral and somewhat agree with the contribution in shaping contributions and developing maritime enterprise. The responses are encouraging as none of participants were disagreeing with the contributions developed for solving research questions.

For contribution B (i.e. Intersection of Processes, Tools and Users), 5 members were in somewhat agreement with their importance in collaboration and developing maritime enterprise. Whereas for contributions A (i.e. Goal Hierarchy) and D (i.e. Collaboration Platform), 4 members were in strong agreement.
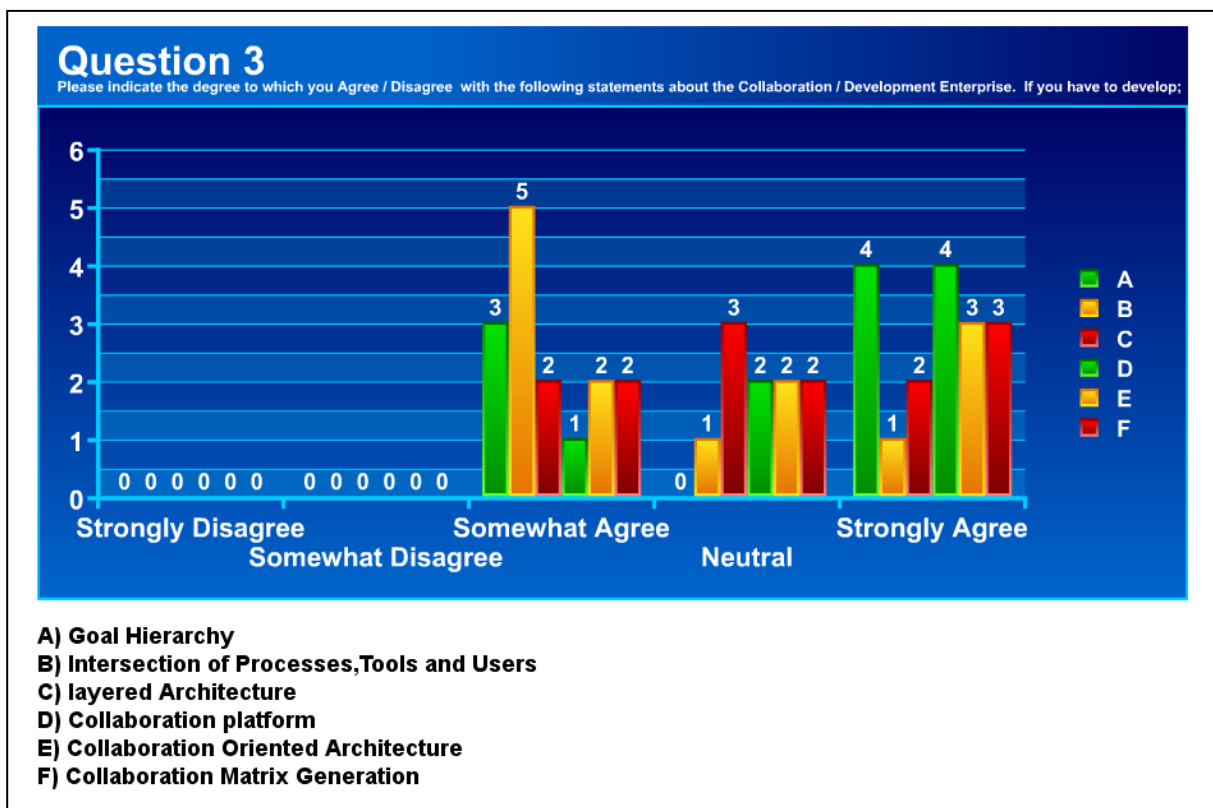

Fig 8.4 Response to role of contributions for improving collaboration/ developing maritime enterprise

c) BPMN in supporting collaboration and improving operational efficiency:

BPMN was majorly used for developing the business processes and developing test case. Therefore, the role of BPMN plays a key role for representing the business activities taking place in maritime operations into business processes. In order to get the good results, the participants were demonstrated with test case (i.e. execution and deployment of business processes) developed in this thesis work. The response for evaluating and understanding the capabilities of BPMN can be seen in following figures.

The responses obtained for role of BPMN in supporting basic interactions among various parties involved in maritime enterprise and representing them in business processes can be seen in Fig. 8.5
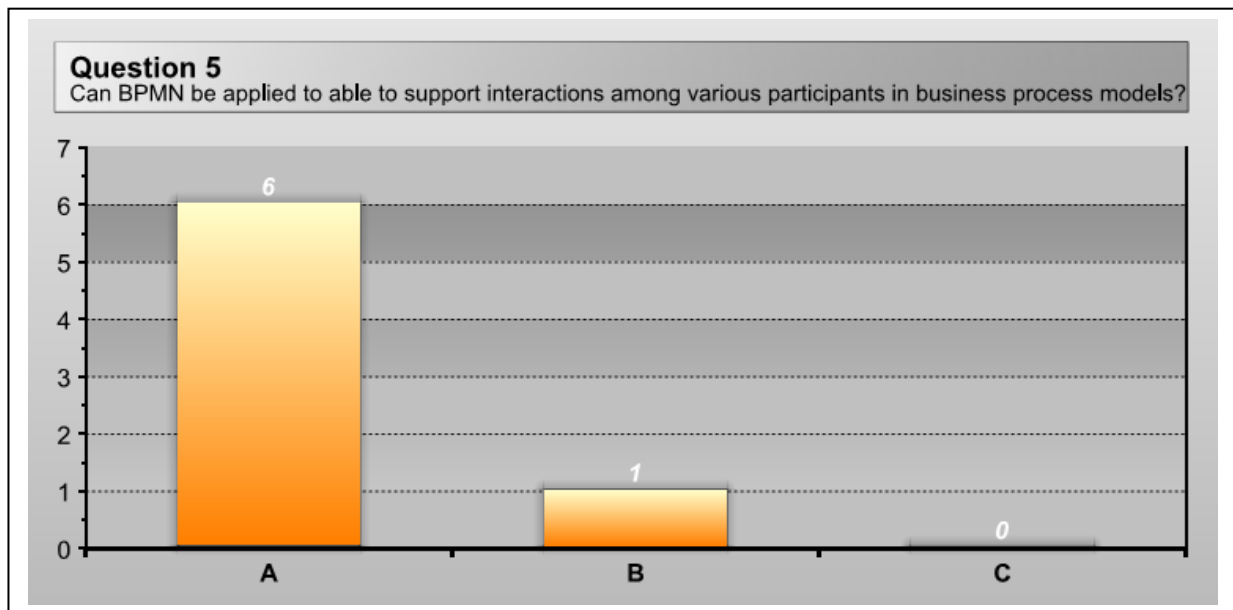

Fig. 8.5 Response to role of BPMN in supporting interactions

The participants were provided with three options A (i.e. Yes), B (i.e. To Some Extent) and C (i.e. No) for evaluating capability of BPMN for providing interactions. As can be seen in Fig. 8.5, majority of participants (6 participants) agree with BPMN supporting interactions. One participant agrees partially in support with BPMN.

The responses obtained for role of BPMN in supporting dynamic changes in business processes can be seen in Fig. 8.6. The participants were provided with three options A (i.e. Yes), B (i.e. To

Some Extent) and C (i.e. No) for evaluating capability of BPMN for providing dynamic behavior. As can be seen in Fig. 8.6, majority of participants nearly 72 percent agree with BPMN in supporting dynamic behavior nature of business processes. Other participants i.e. 28 percent partially agrees on role of BPMN in supporting dynamic capabilities.
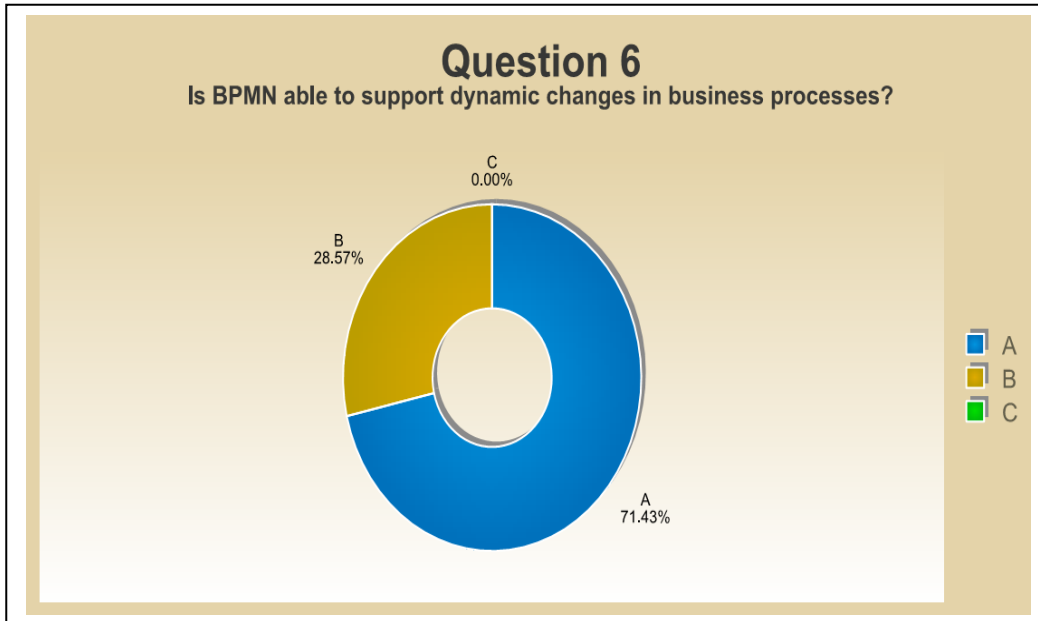

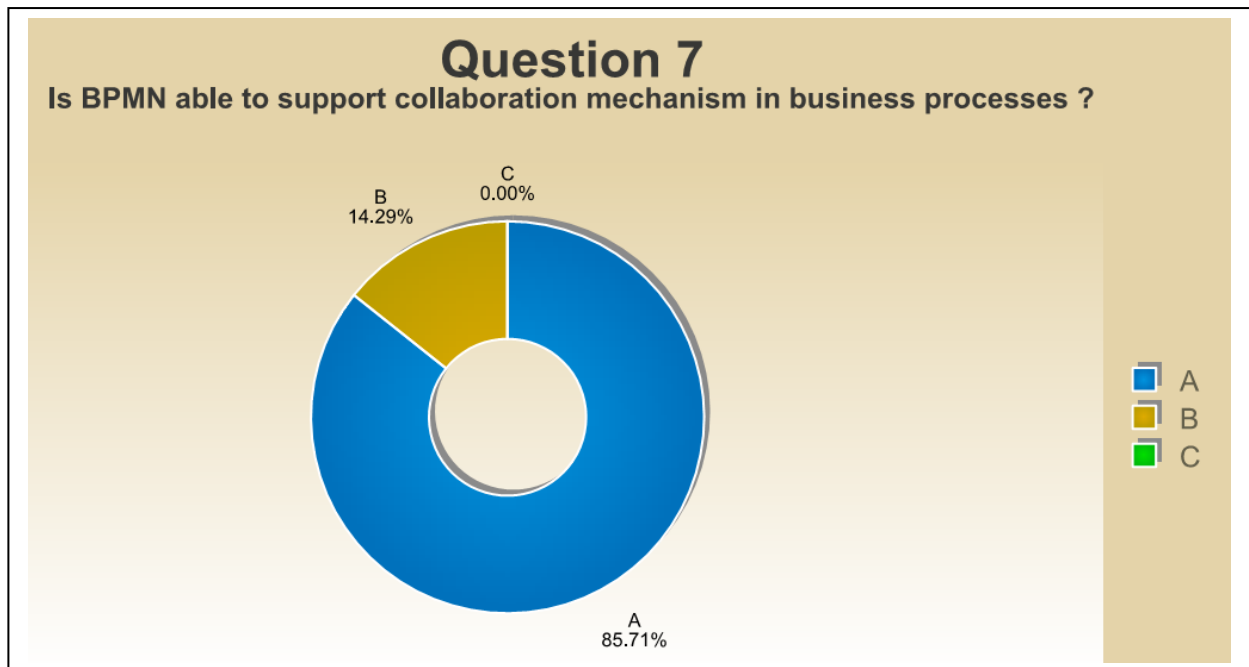Fig. 8.6 Response to role of BPMN in supporting Dynamic Behavior

Fig. 8.7 Response to role of BPMN in supporting collaboration mechanism

The responses obtained for role of BPMN in supporting collaborative mechanism governing business processes can be seen in Fig. 8.7, wherein the participants were provided with three options A (i.e. Yes), B (i.e. To Some Extent) and C (i.e. No) for evaluating capability of BPMN for providing collaboration mechanism. As can be seen in Fig. 8.7, majority of participants nearly 86 percent agrees with BPMN in facilitating collaborative mechanism. Other participants i.e. 14 percent partially agrees on role of BPMN in supporting collaboration and none of the participants are in contrary with BPMN in supporting collaboration.

8.5   Answers to the Research Questions

The main goal of this thesis work has been:

To *"improve collaboration among parties involved in maritime operations"*

This central goal of this thesis work has been answered by suggesting the process-centric approach for defining activities (i.e. information exchange) taking place in enterprise. This approach was studied using test case from SINTEF and the results were compared with requirements (such as collaboration, task completion etc) for fulfilling goals of enterprise, as discussed in chapter 6 (refer: section 6.4). In addition, the goal hierarchy combined with the process-centric approach provided a new methodology to validate process centric approach and at same time increase efficiency, collaboration among processes.

This main goal of thesis work was mainly segregated into four main research questions, as discussed in chapter 1 (refer: section 1.4). The answers of these four research questions support achieving the main goal (i.e. *improving the collaboration among parties involved in maritime operations)* at different levels of granularity.

 Q1. How can collaboration be established between various elements associated with maritime operations such as business processes (or service management), software tools (or technologies) and potential users?

Answer to Q1: Maritime enterprise comprises of a large number of processes concerned with various organizations, individuals or any third party tools , which are collaborating together to

achieve goals of enterprise. These elements are in a way interlinked in formation of enterprise. As can be seen in section 6.3, "Integrated practice" which is predominant in maritime sector, consists of many different roles/ organizations interacting together for improving information exchange. In Maritime sector, factors namely "UTP (Users, Technology, Business Processes) are overlappling in nature. We identified that intersection between these factors is due to collaboration. This intersection region is key for improving operations and processes by increasing opportunities for collaborating, sharing and integrating information across professional, organizational and geographical boundaries.

The collaborative nature can be achieved through networked enterprise, SOA and semantic interoperability [Pål.et.al, Efforts]. This is also supported by [Vernadat, 2007] that

"Interoperable enterprise systems are essential components to build agile organizations using a mixed service and the process-centric approach. Modern organizations, be they considered from the intra or inter-organizational point of view, need to be made interoperable both in terms of their business processes, their applications or IT systems, and even their human resources to face current business challenges" [Vernadat, 2007].

This proves that collaboration can be realized using the process-centric approach. The very essential elements for defining collaborative processes in integrated practice are UTP (Users, Technology, Business Processes).

The responses obtained from section 8.5.2, under part (a)- Need for collaboration in maritime operations demonstrates that participants representing different sectors of maritime enetrprise consider that providing better tools, efficient development of business processes, and improving skills of human participants is vital for efficiency of maritime operations. This is also in agreement with our contribution of finding the intersection between users, tools and business processes as explained in section 6.3 - Intersection of Processes, Tools and Users.

Q2. How identifying and implementing business processes using BPMN (Business Process Modeling Notation) will provide the collaboration?

Answer to Q2: Every business is composed of large number of complex processes having enormous and interlocking knowledge structure, It exists as a realm of its own having various

facets of elements such as customers, development, marketing, inventory, complaints, profit, returns, and many other specialized events, objects, and relationships (Dorian, 2003). In our test case of ship arrival process in maritime enterprise, we have tried to identify some of key processes and actors associated with those set of activities. As discussed in the previous chapter, we have used BPMN for modeling tasks within process, in which tasks are dependent on various users/ stakeholders associated with those set of tasks. The collaboration between those users/ stakeholders is the means for successful execution of the process. The testing of model as discussed in 7.4.2 is based on this collaborative approach. The input from each user/ stakeholder is necessary for completion of process. These execution steps can also be monitored in console by system/ process administrator, as can be seen in section 7.4.3. The approach showed to be feasible and since Marintek is interested in using BPMN, this approach is easy to integrate and does not add any overhead.

The responses obtained from participants of questionnaire for the question *"Is BPMN able to support collaboration mechanism in business processes?"* illustrates (refer: Fig. 8.7) that participants are in agreement with BPMN supporting collaboration mechanism. This explains that identifying and implementing business processes using BPMN (Business Process Modeling Notation) was able to facilitate collaboration.

Q3. What are the implications/ benefits of using BPMN in establishing collaboration?

Answer to Q3: The answer to Q3 is not straightforward as the answer deals with "How suitable is the BPMN tool for incorporating collaboration into processes". In reality, the usage of tool depends upon the experience of the person using tool and case which is being modeled. In our thesis work, we have used Intalio tool for process modeling using BPMN for ship arrival process. We have tested the tool by modeling processes based on specifications or requirements of ship arrival process. Some of the advantages of using Intalio BPMN tool are ensuring consistency, completeness and compliance with BPM standards, interactivity, reduction in development time facilitates monitoring.

The responses obtained from questionnaire about BPMN as illustrated in Fig. 8.5, Fig 8.6, Fig 8.7 also suggests that participants are in agreement with BPMN supporting process interactions, dynamic behavior and collaboration mechanism. However, there are some implications which Intalio BPMN are imposed such as lack of hosting and other versioning systems such as SVN, CVS or other related versioning systems, wherein modeler can verify code changes with respect to

every change performed on model. The tool is open source tool, however for additional features support such as cloud deployment, versioning systems one has to purchase licensed version of tool. However, the real test of tool can be done by addressing needs of entire maritime enterprise processes.

BPMN in general is evaluated as useful in the case and adding collaboration will just enhance and extend the role of business process modeling in the organization.

Q4: Identify if a traditional process diagram can be made dynamically by use of BPMN and the Resource Hub (RH) developed in the Maritime Information Centre project (MIS)

Answer to Q4: In real-time, business processes are dynamic in nature. A process consists of a set of one-to-many activities where either humans or information systems are involved. Presently, most of BPMS (Business Process Management System) provides ability to cope with rapid changes in requirements by changing business process; however using the Process-Centric approach gives edge towards monitoring processes and its effect on business whole business management. As discussed in the previous chapter, we have developed BPMN test model with integrating MySql database. The testing of model illustrates that deployed process models were able to fetch data from database automatically. In case of testing RH, we have used only messaging between different tasks associated with RH component. However, testing can also be done upon integrating web services of RH such as booker with database in order to check dynamic retrieval of the data using web services as well.

The responses obtained for role of BPMN in supporting dynamic changes in business processes as illustrated in Fig. 8.6, also supports the capability of BPMN providing dynamic behavior.

8.6   Choice of Test Case

The test case was primarily preferred to correspond to various needs of maritime enterprise such as ability to handle dynamic data, resource hub integration with web services. The test case was focusing on one of maritime process namely "Ship Arrival Process"; the main idea behind this test case was to facilitate capture of data from MIS components such as Single window and Resource

hub. Apart from these components, processes were also integrated with databases such that data can be automatically fetched from databases; this adds dynamic capability to business processes.

The contributions such as goal hierarchy, finding intersection between three elements processes, users, tools was primarily based on understanding the ship arrival process test case. However, these contributions are general in nature and can be suitably modified to fit to other test cases as well.

8.7   Lessons Learned

The testing and validation was performed on Ship Arrival Process test case in maritime enterprise, from ship owner perspective. However, in real life situation test case varies. This is due to the complex nature of enterprise where same person can participate in multiple processes, for instance, regulator who does verification and inspection checks of vessel may not need any tool, this is contrary to our concept of integrated approach wherein users, tools and processes are interlinked.

The models were built based on MySql database and some basic processes, However it can be further extended with other databases and related technologies as well. The multi-discipline roles/ parties affiliated with maritime enterprise are difficult to consider in single process, but multiple processes can be constructed using same person such that execution of one process depends upon decision taken for other process.

The tool used for process modeling was Intalio provided BPMN. The designer provided various graphic elements for representing all types of business elements. However, there were some problems encountered upon multiple messages or sequences using Link, Task elements supported by BPMN. However, these can be represented in other ways by facilitating lanes, pools. One of the advantages of using BPMN is automatic generation of BPEL code for executing and deploying business processes. The tool supports to model business processes using various design elements. However, the support of BPMN for representing complex nature of processes in maritime enterprise can only be tested upon implementation to integrate information across professional, organizational and geographical boundaries.

Chapter 9 – CONCLUSIONS AND FUTURE WORK

This chapter presents conclusions and future scope of this thesis work. The first section gives an overview on summary of results and contributions. The second section presents challenges encountered during thesis work and finally last section describes about possibilities of further work.

9.1   Summary of Results and Contributions

The process-centric approach for constructing and integrating activities in enterprise is mainly dealt in this thesis. The central notion behind this approach has been to identify activities and roles played by various parties involved in maritime enterprise. The information exchange between these parties influences formation of maritime enterprise. The efficient business processes enveloping these information exchanges with various parties can provide quick and easy access to information, thus it saves most of operating costs and assists in handling deviations as well. The building blocks for process centric approach as discussed in chapter 4 are *Discovery, Implementation and Maintenance.* Based on contributions and studies performed in earlier chapters, the best possible solution for providing collaboration in maritime enterprise is as follows:

- Identifying goals of enterprise and thereafter mapping goals with collaboration using goal hierarchy as discussed in section 3.6
- Business Processes are mapped with goals associated with each individual and as well entire maritime enterprise
- The identified business processes are integrated with collaboration platform, core platform, visualization and integration hub to comply with overall architecture as discussed in section 6.4. This architecture resolves most of collaboration needs of enterprise and provides ability to handle deviations as well.
- Collaboration matrix can be generated based upon data from process models associated with various parties as discussed in section 6.5. This generated matrix provides key information to handle deviations, for example change in ETA, resource allocation etc.

The process centric approach using BPM (Business Process Modeling) is vital for identifying processes and map interactions among them. This approach provides basis for establishing collaboration and thereby form overall architecture. The process centric approach is tested using industrial case study (i.e. MIS project at SINTEF) on Ship Arrival process. The investigation proved that information between various parties can be shared and at the same time collaboration can be initiated by sending message to concerned parties associated with processes. In order to improve communication mechanism, the notification was improved from normal message services to email messaging.

9.2   Challenges

The main difficulties encountered during routine of this work were many facets of parties associated with processes. For instance, a ship can be owned by multiple owners and at same time an owner can act as vessel agent as well. This representation of single actor with multiple roles is often difficult to map as one process is completely different from another process. However, actor can access various business processes and can take course of action individually.

Another important issue is handling processes with various business model participants that processes will be stopped due to lack or delay of information flow from any participant. This can be avoided by monitoring processes as discussed in section 7.4.3, and switching to collaboration mechanism for speeding up processing time and thereby improves communication.

There were also some challenges faced during validation of use case test model developed using BPMN. Firstly, models were tested using principles of resource hub and other MIS components; however, web services within resource hub are not integrated with models such as Booker service research. So, the only decisive factor used for validating processes was verifying requirements met by process interactions. Secondly, basic version of Intalio tool was used for modeling, which holds back usage of some additional features to models such as versioning repository (eg. SVN, CVS, GIT, Assembla etc.) And cloud services.

Moreover, there can be difficulties in order to validate models as there can be so many factors affecting information exchange between processes, for instance weather conditions, sensor data from ships, lack of proper communication means such as internet etc. These factors are difficult to manage; however, some of the factors can be resolved using collaboration approach.

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9.3   Directions for Future Work

The process models developed using BPMN on the test case can be studied comprehensively to evaluate the process-centric approach and realize requirements and roles played by participants in maritime enterprise.

The models have to be extended with web services in order to comply with services provided by RH.   In the same way, the collaboration can be improved by providing more collaborative approaches such as online chats, facilitating services like Google wave, versioning system like SVN. The Google wave facilities both capabilities of email's and sms, wherein user can send a wave (i.e. message trigger) for initiate a new collaborative session.   In case of versioning systems, users can work synchronously. This is achieved by maintaining same repository or code base from server and changes are automatically reflected in each user repository / code base. Thus, the business process models can be improved to have proper processes and resource alignment and at same time provides ability to handle any deviations encountered while exchanging information.

Further work can be carried out to extend the models comprising various parties, roles and enclose entire maritime enterprise and thereby realizing overall architecture as discussed in section 6.4.

Appendices

Overall Collaboration Matrix

	Role Groups	Service Groups	Services	Company / Authority	Marketing, Sale and Alignment		Planning	
					Port and Terminal Alignment, Marketing and Sale	Ship alignment, Marketing and Sale	Plan port and terminal Service operation	Plan ship operation
1	Role Groups	Service Groups	Services	Company / Authority				
2					Marketing, Sale and Alignment		Planning	
3					Port and Terminal Alignment, Marketing and Sale	Ship alignment, Marketing and Sale	Plan port and terminal Service operation	Plan ship operation
4								
5	Transport Service Providers				Defining Marketing Acti	Get Handling Instr	Inbound Logistics	
6					Publish Port information	Get Cargo Details	Outbound Logistics	
7					Define Terminal Service	Booking	Resource Allocation	
8					Sell Terminal Services	Equipment Manag	Booking	
9					Contract	Collection Plan		
10						Delivery Plan		
11								
12		Port Services			Service Scheduling			
13					Get Information on Port Services		Booking	
14					Define Terminal Services			
15								
16								
17								
18								
19		Terminal Services						
20								
21					Define Port Service Needs			
22		Shipping Services			Buy Terminal Services			
23								
24	Transport Users					Provide Handling	Handling Instructio	Prepare Customs / Othe
25		Cargo Owner				Provide Cargo Details		Prepare Special Handlir
26						Booking		Safety Requirements
27		Transport organiser				Transport Chain Planning		Environmental Require
28								Security Requirements
29		Consignee						Insurance
30								
31		Consignor						

Appendix B - Questionnaires

General Information:

Name:

Role:

Research Project / Group:

Organization:

Project Related Questions:

Do you think business processes are solution for operational efficiency?

- ☐ Yes
- ☐ No

How can collaboration be improved and maximized among the parties (i.e. people, operations etc.) involved in maritime operations?

- ☐ Providing Better Tools
- ☐ Efficient development of Business Process
- ☐ Improving Skills of Human Participants
- ☐ All of Them

Please indicate the degree to which you agree/disagree with the following statements about the Collaboration / Developing Enterprise, if you have to develop.

Category	Strongly Disagree	Some what Disagree	Somewhat Agree	Neutral	Strongly Agree
Goal Hierarchy					
Intersection of Processes, Tools and Users					
Layered Architecture					
Collaboration platform					
Collaboration Oriented Architecture					
Collaboration Matrix Generation					

Are there any addition features which can be incorporated into this work?

Can BPMN be applied to able to support interactions among various participants in business process models?

☐ Yes
☐ To Some Extent
☐ No

Is BPMN able to support dynamic changes in business processes?

☐ Yes
☐ To Somewhat Extent
☐ No

Is BPMN able to support collaboration mechanism in business processes?

☐ Yes
☐ To Somewhat Extent
☐ No

Please provide additional comments for improving collaboration / handling complexity among maritime operations, if any?

Appendix C – WSDL Source Code

Source Code: *ResourceRequest.WSDL*

```xml
<?xml version="1.0" encoding="UTF-8"?>
<wsdl:definitions
 targetNamespace="http://www.intalio.com/workflow/forms/ResourceRequest/ResourceRequest"
 xmlns="http://schemas.xmlsoap.org/wsdl/"
 xmlns:ar="http://www.intalio.com/workflow/forms/ResourceRequest/ResourceRequest"
 xmlns:soap="http://schemas.xmlsoap.org/wsdl/soap/"
 xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/" xmlns:xsd="http://www.w3.org/2001/XMLSchema">
 <wsdl:types>
  <xsd:schema elementFormDefault="qualified"
targetNamespace="http://www.intalio.com/workflow/forms/ResourceRequest/ResourceRequest">
   <xsd:include schemaLocation="ResourceApproval.xform.complete.xsd"/>
  </xsd:schema>
 </wsdl:types>
 <!-- Messages -->
 <wsdl:message name="notifyTaskCompletionRequest">
  <wsdl:part element="ar:notifyTaskCompletionRequest" name="root"/>
 </wsdl:message>
 <wsdl:message name="notifyTaskCompletionResponse">
  <wsdl:part element="ar:response" name="root"/>
 </wsdl:message>
 <!-- Port Types -->
 <wsdl:portType name="userProcessPortType">
  <wsdl:operation name="notifyTaskCompletion">
   <wsdl:input message="ar:notifyTaskCompletionRequest" name="notifyTaskCompletionRequest"/>
   <wsdl:output message="ar:notifyTaskCompletionResponse" name="notifyTaskCompletionResponse"/>

  </wsdl:operation>
 </wsdl:portType>
 <!-- SOAP Bindings -->
 <wsdl:binding name="userProcessSoapBinding" type="ar:userProcessPortType">
  <soap:binding style="document" transport="http://schemas.xmlsoap.org/soap/http"/>
   <wsdl:operation name="notifyTaskCompletion">
    <soap:operation soapAction="notifyTaskCompletion" style="document"/>
    <wsdl:input>
     <soap:body
      namespace="http://www.intalio.com/workflow/forms/ResourceRequest/ResourceRequest"
use="literal"/>
```

```xml
      </wsdl:input>
      <wsdl:output>
       <soap:body
        namespace="http://www.intalio.com/workflow/forms/ResourceRequest/ResourceRequest"
use="literal"/>
      </wsdl:output>
    </wsdl:operation>
  </wsdl:binding>
  <!-- Services -->
  <wsdl:service name="notifyTaskCompletionService">
    <wsdl:port binding="ar:userProcessSoapBinding" name="userProcessPort">
     <soap:address location="http://localhost:8080/ui-fw/tasks.htm"/>
    </wsdl:port>
  </wsdl:service>
</wsdl:definitions>
```

Appendix D – XSD Source Code

Source Code: *ResourceRequest.XSD*

```xml
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema elementFormDefault="qualified"
  targetNamespace="http://www.intalio.com/workflow/forms/ResourceRequest/ResourceRequest"
  xmlns:ar="http://www.intalio.com/workflow/forms/ResourceRequest/ResourceRequest"
  xmlns:fe="http://www.intalio.com/workflow/forms/ResourceRequest/ResourceRequest"
 xmlns:xs="http://www.w3.org/2001/XMLSchema">
 <xs:element name="input">
  <xs:complexType>
   <xs:sequence>
    <xs:element name="employee" type="fe:contact"/>
    <xs:element name="details">
     <xs:complexType>
      <xs:sequence>
       <xs:element maxOccurs="unbounded" name="request">
        <xs:complexType>
         <xs:sequence>
          <xs:element name="from" type="xs:date"/>
          <xs:element name="to" type="xs:date"/>
          <xs:element name="type" type="xs:string"/>
          <xs:element name="hours" type="xs:integer"/>
         </xs:sequence>
        </xs:complexType>
       </xs:element>
      </xs:sequence>
     </xs:complexType>
    </xs:element>
    <xs:element minOccurs="0" name="contactWhileAway" type="fe:contact"/>
    <xs:element minOccurs="0" name="notes" type="xs:string"/>
   </xs:sequence>
  </xs:complexType>
 </xs:element>
 <xs:element name="output">
  <xs:complexType>
   <xs:sequence>
    <xs:element name="approved" type="xs:boolean"/>
    <xs:element minOccurs="0" name="comment" type="xs:string"/>
    <xs:element minOccurs="0" name="contactWhileAway" type="fe:contact"/>
   </xs:sequence>
   <xs:attribute name="taskId" type="xs:string"/>
   <xs:attribute name="participantToken" type="xs:string"/>
```

```xml
     </xs:complexType>
    </xs:element>
   <xs:complexType name="contact">
    <xs:sequence>
     <xs:element name="name" type="xs:string"/>
     <xs:element name="phone" type="xs:string"/>
     <xs:element name="email">
      <xs:simpleType>
       <xs:restriction base="xs:string">
        <xs:pattern value="[^@]+@[^\.]+\..+"/>
       </xs:restriction>
      </xs:simpleType>
     </xs:element>
    </xs:sequence>
   </xs:complexType>
   <xs:element name="notifyRequest">
    <xs:complexType>
     <xs:sequence>
      <xs:element name="metadata">
       <xs:complexType>
        <xs:sequence>
         <xs:element maxOccurs="1" minOccurs="0" name="description" type="xs:string"/>
         <xs:element maxOccurs="1" minOccurs="0"
          name="creationDate" type="xs:dateTime"/>
         <xs:element maxOccurs="unbounded" minOccurs="0"
          name="userOwner" type="xs:string"/>
         <xs:element maxOccurs="unbounded" minOccurs="0"
          name="roleOwner" type="xs:string"/>
         <xs:element maxOccurs="1" minOccurs="1" name="formUrl" type="xs:anyURI"/>
        </xs:sequence>
       </xs:complexType>
      </xs:element>
      <xs:element name="input">
       <xs:complexType>
        <xs:sequence>
         <xs:element ref="ar:input"/>
        </xs:sequence>
       </xs:complexType>
      </xs:element>
     </xs:sequence>
    </xs:complexType>
   </xs:element>
   <xs:element name="notifyResponse">
    <xs:complexType>
     <xs:sequence>
      <xs:element maxOccurs="1" minOccurs="1" name="status" type="xs:string"/>
      <xs:element maxOccurs="1" minOccurs="0" name="errorCode" type="xs:string"/>
      <xs:element maxOccurs="1" minOccurs="0" name="errorReason" type="xs:string"/>
     </xs:sequence>
    </xs:complexType>
   </xs:element>
  </xs:schema>
```

Appendix E – Screenshots

a) Monitoring Console showing status of processes
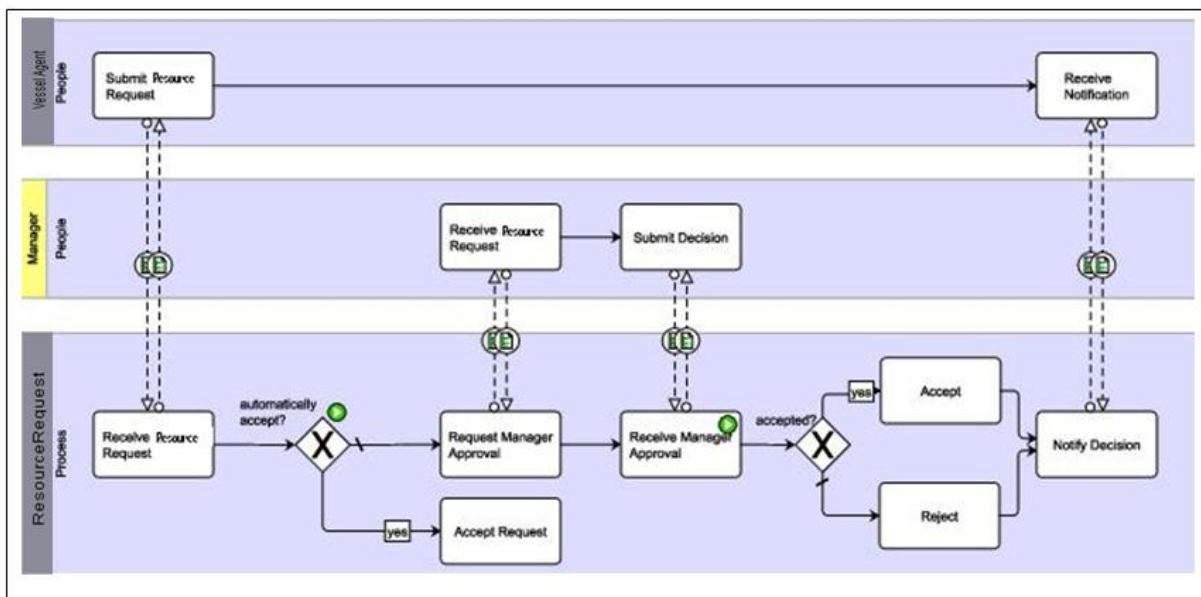
b) Monitoring Console showing status of Resource Management Process

c) The form generated for email process

d) The details filled in form for sending mails

e) Notification of Email Process (1)

f) Notification of Email Process (2)

g) Notification of Email Process (3)
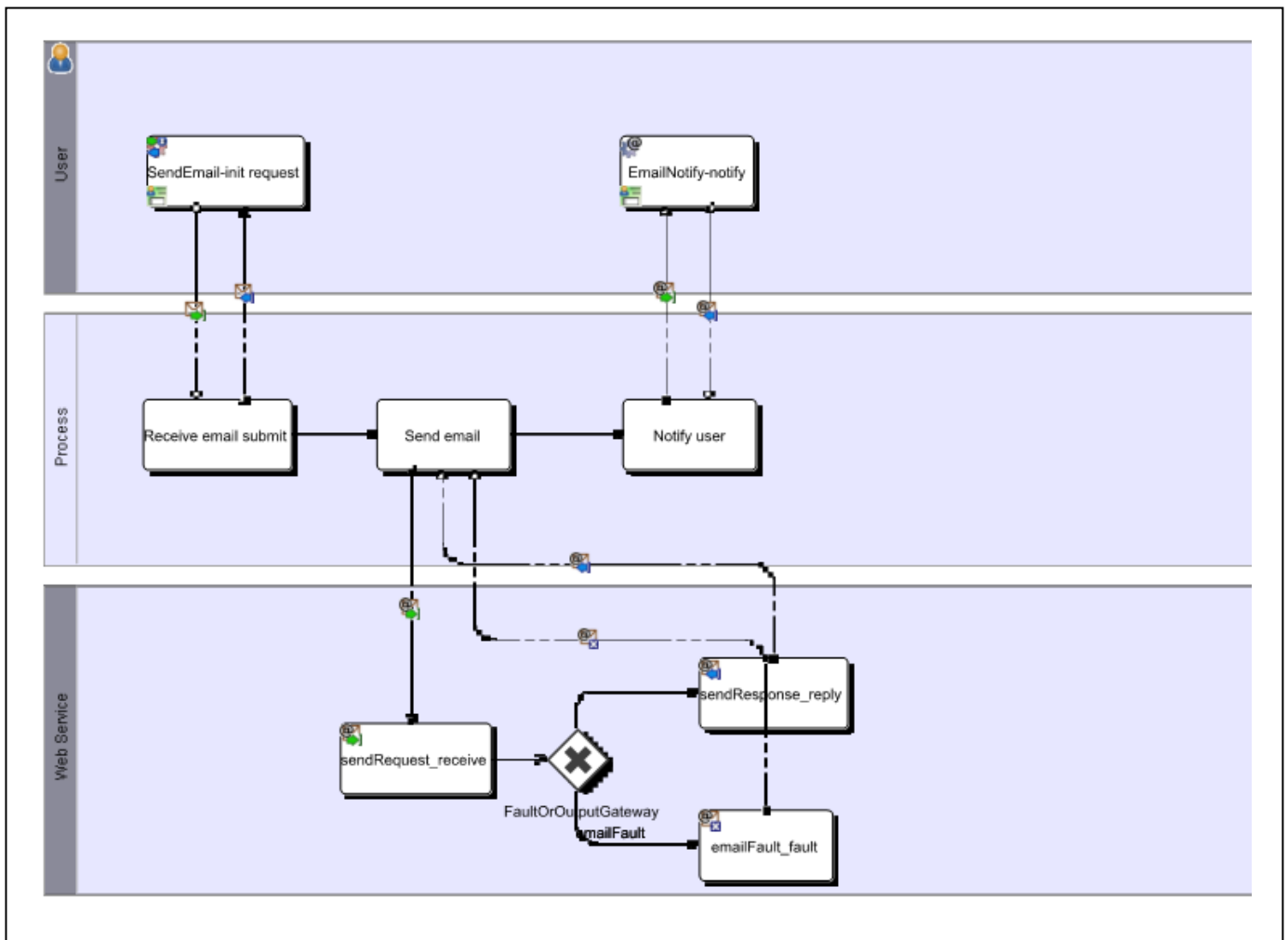
h) Monitoring Console: Status of Email Process

i) Variables involved in Email Process

j) Resources Involved in Email Process

k) Events occurred in executing Email Process

Glossary

Resource Hub: Resource Hub is the system used to handle the activities concerned with the resources

Process: A process consists of a set of one-to-many activities where either humans or information systems are involved

Single Window: A single window is defined as a facility that allows parties involved in trade and transport to lodge standardized information and documents with a single entry point to fulfill all import, export, and transit related-related regulatory requirements

BPMN: BPMN is flow-chart based notation for defining Business Processes

SOA: SOA stands for Service-oriented architecture; this architecture is based on principles of supporting interoperable services.

Collaboration: The Collaboration is a process in which different entities share information, resources and responsibilities to jointly plan, implement, and evaluate a program of activities to achieve a common goal

Dynamic processes: The processes which are dynamic in nature. Practically, business processes are dependent on information exchange between various people involved in the processes. These sources of information can be based on databases, which can change owing to transactions between those people. This makes processes to have dynamic nature.

MTO/P: In an integrated approach, wherein Man, Tools and Organizations work together. The perspective of integrated approach comprising these elements is called MTO/P.

Infrastructure Providers: The unit responsible for arranging the infrastructural needs of the users at port/ Terminal end.

Safe Sea Net: It is Norwegian Coastal Administration (NCA)'s ship reporting, where it is obligatory for every ship arriving or departing Norwegian ports should report. [Safe Sea Net, def].

ENC: ENC stands for electronic navigational chart, which is primarily used for Electronic Chart Display and Information System (ECDIS) [ENC, wiki].

SENC: System Electronic Navigation Chart

PSC tool: The tool of Port State Control for monitoring foreign ships in other national ports by PSC officers (inspectors). This is used to make sure that ship is complying with international conventions such as SOLAS, MARPOL, STCW, etc. [PSC, wiki]

Equasis: It is a non commercial tool for providing safety related information on ships (Equasis, website)

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