COMBINED APPROACH FOR ENTERPRISE MODELLING: CIMOSA AND SOA AS DYNAMIC ARCHITECTURE IN MARITIME LOGISTICS

One of the main characteristics of logistics and supply chain management is the ability to cope with changes and challenges within an enterprise and among many companies as well as those coming from the external factors such as regulations and the need for compliances. This could be done effectively by the help of process modelling which enables the organisation more capability to analyse processes and minimise the costs and risks by process optimisation. So far the process modelling activity is mainly used in the area of classic manufacturing such as the discrete parts manufacturing industry like the automotive and mainly within a specific company and not quite discussed or implemented for the across-entity-business like logistics in the maritime goods transport environment where many actors rather than only suppliers or customers are involved.
The paper describes an approach followed in the European project EFFORTS (EF-Fective Operations in ports), which combines CIMOSA (CIM Open System Architecture) with SOA (Service Oriented Architecture) to achieve flexibility and transparency in the area of seaport operations and transport logistics.

Keywords: Logistics management, Process modelling, CIMOSA, Service-Oriented-Architecture (SOA), Process management, Enterprise Modelling

1 Introduction

Process modelling is actually not a new issue within the business environment anymore. However, it is still not implemented in many organisations due to the different management systems, background of business, knowledge of human resources, etc. and last but not least the many different concepts offered by vendors, which has a lead to a “Tower of Babel” type situation and a thereby to a confusion of potential users. These factors differentiate the advancement and development from the usage of process modelling in the real business world.

In the manufacturing industry especially in automotive, aircraft design and construction, the activity of process modelling is very significant for process management, quality control and process improvement. In the service industries such as bank, insurance, and other financial services, it plays also a crucial role for any re-structuring and re-engineering of the organisations. Nevertheless, there are other

industries where process modelling is still new and where it can help increase the efficiency and effectiveness for the business especially in industries where time is a decisive and costly factor like in logistics.

The main objective of this paper aims at introducing a combined approach of CIMOSA and SOA in order to achieve flexibility and dynamic concept for logistic industry where the demand of analysing processes is rising. The concept in this paper is a co-related work of a developed process modelling framework within an integrated project EFFORTS (EFFective Operations in poRTS) in the sixth Framework Programme funded by European Commission. Therefore the paper will emphasise handling the processes from seaport operations as a signification logistic node and related to transport logistics.

CIMOSA has been firstly introduced in the late 1980s by the ESPRIT Consortium AMICE as comprehensive open system architecture and was modified or adapted as basis for many other enterprise modelling approaches in later years such as Enterprise Modelling and Integration (IEM), Generalised Enterprise Reference Architecture and Methodology (GERAM) and many more. Many modelling languages developed for the usage of enterprise modelling world are known like Unified Enterprise Modelling Language (UEML), ICAM Definition Methodology (IDEF), etc.

However, the CIMOSA approach was always criticised by users and researchers that it is not really an easy-to-understand framework for practitioners due to its complicated detailed contents. On the other hand, CIMOSA covers all important aspects or views for process modelling within an enterprise. These views include information, organisation, function and resource. Moreover, it is a quite flexible approach which allows many opportunities of modification and combination with other architectural methods - like Service-Oriented-Architecture or SOA. The combination of CIMOSA and SOA will deliver a process modelling architecture and methodology for flexible and dynamic character of “ready-for-changes” in any circumstance.

The remaining of the paper is organised as follows: Chapter 2 includes definition of process management and process modelling, its importance of process modelling, the benefits for logistic processes as well as its general situation of process management and process modelling in the logistics industry. Chapter 3 provides the background of the project EFFORTS, its objectives and the role of process modelling within the development of work. Chapter 4 elaborates the methodology and frameworks used in EFFORTS: CIMOSA, SOA and its combination. Chapter 5 explains the benefits of the combined approach of CIMOSA and SOA and their importance to port processes. Chapter 6 provides information about expected project results. Lastly, chapter 7 is the summary and conclusion.

2 Process management and process modelling in logistics industry

This chapter aims at providing the fundamentals of process management and process modelling as well as the situations of these sciences in logistics.

2.1 Definitions

Process management is the ensemble of activities of planning and monitoring the performance of a process, especially in the sense of business process (Becker/Kugeler/Rosemann 2003) . According to Gadatsch (2005) in Grundkurs Geschäftsprozessmanagement, process management is one of the elements in business process- and workflow management (see figure 1) at the level of functional conception. Process management involves three main phases: 1) process scope; 2) process modelling; and 3) process steering (Gadatsch 2005).

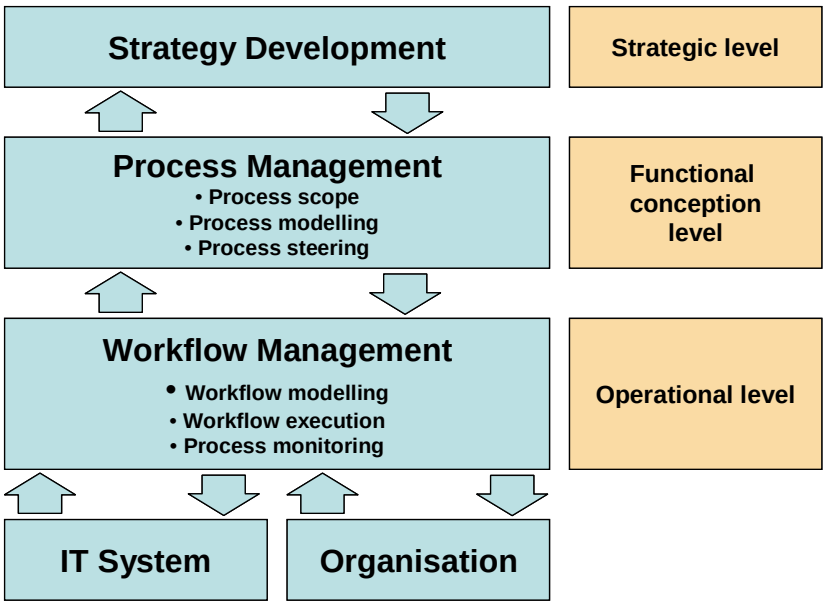

Fig. 1: Business process- and workflow management (Gadatsch 2004)

The definition of process modelling is mentioned by many authors. One of them which is likely to cover its role best is from P.R. White (1994). He defined “Process modelling” as an abstract representation of a process that excludes as many of the real world’s infinite details. The main purpose is to reduce the complexity of understanding by eliminating the details that does not influence its relevant behaviour (White 1994). The presentation of models can be done in mathematical or graphical and diagrammatical form. In the business world, a process diagram is likely to be implemented because the people working in an organisation are not technicians or model specialists. From this diagram, all objects and their attributes must be well-identified so that the programmer can encode them into the system and create the proper software application responding properly to the process ob-

jectives and users' needs as a final service or product for process analysis, optimisation as well as direct process monitoring and control.

Referring to the above definitions, process modelling is therefore an activity, which is a part of process management and means an activity trying to illustrate a reality of business activities according to the perspectives on its functional conception with the exclusion on some details to reduce complexity and ease the understanding to the process.

2.2 Benefits

Anyone who does not yet know process modelling might ask what benefits it delivers and why do they need it in their organisations. This chapter will elaborate the advantages of process modelling implementation as well as its importance and effects to the organisation.

There are two main advantages for an organisation to implement process modelling. It helps the organisation to:

- better understand the processes in their organisation
- identify means to run the processes in more efficient way such as better time management, improved process flow management, cost reduction, more effective process life cycle, etc.

Each modelling technique has different emphasises such as views of process, life cycle, level of process modelling (strategic, operation, data, etc.). Therefore the organisation should study them before implementing the techniques to achieve the most-benefits from modelling their processes.

2.3 General situation about process management in logistics

Before going to the concept proposed for the EFFORTS project, a brief description of the situation of process management in the logistics industry is provided. As logistic business covers a very wide scope that can be categorised - according to the main logistics activities - as procurement, inventory management, production, distribution, transport, disposal and supply chain management (Beckmann 2007). In each sector of logistics the depth of implementation of process management is different. The products can be classified into two types: tangible and intangible ones. The tangible products will include the classical products which are physically visible such as cars, machines, toys, etc. whereas the intangible products are equivalent to services like freight forwarding, door-to-door services, etc.

For the logistics dealing with tangible products, the process management – of course including process modelling – is playing a very significant role already for decades. Each manufacturer tries to optimise the processes to produces the products to be delivered in the requested timeframe.

On the contrary, for the logistic activities relating to services, the adaptation of process management is still in the early stage. The logistic services can be apparently seen in transport logistics which include all services relating to the shipping of a product from A to B. The organisations involved in this process include carriers in all transport modes (sea, air, road, and rail), freight forwarders, shipping agents, port authorities, logistics providers and integrators etc. Most of these companies were successful family-run businesses and that have grown organically into global players or government-owned entities. These kinds of organisations will sometimes remain in their way of doing business as done over the past decades. The new generation in the management level sometimes sees the need for changes on such as operation style, implementation of process management, etc. However, this is still the minority in the logistics industry. Therefore, a campaign to convince the industry is needed to help realise an evolution on using the process modelling science results in order to improve their businesses and to keep them survive in a sustainable way.

3 Project EFFORTS – EFFective Operation in ports

EFFORTS is an integrated project in the sixth European Framework Program, starting on May 01st, 2007 and lasting to October 31st, 2009, co-funded by European Commission. The project aims at improving the competitiveness of European port operations, the quality of the ports labour conditions and better market positions of ports. The consortium consists of 37 expert partner entities from over 13 European countries. Due to the distance and language constraints, a comprehensive and unambiguous communication between project partners is seen very necessary for efficient project work.

One of the main research areas of the project is about “Port Organisation and Infrastructure” where firstly a system analysis will provide a comprehensive picture of related port processes and architectures in order to appropriately allocate project activities, to elucidate interdependencies, to provide a common understanding on a European level and to allow identification of potential synergies (EFFORTS 2007). The activities relating to this research area co-relate in essence with the port and maritime logistics. To realise these tasks, a common methodology and ontology as well as a process modelling framework must be defined so that project partners can communicate on the same basis of terminology and method. Then, the process modelling can help analyse the existing key processes of European ports and find a way to improve their effectiveness and efficiency in a consistent way.

In port and maritime logistics, as in any other industries, two typical and equally important process types exist: business process and technology process. Business processes are a logical sequence of business activities carried out by individuals or teams in a business to achieve some business goals (Gehring 1998). Technology or technical processes are a logical sequence of technical activities fol-

lowed carried out by individuals or team during the operation of a business to achieve the operational goals or industry standards, for example regulations in maritime industry from International Maritime Organisation (IMO). In other words, in the case of EFFORTS, business processes involve how a port can generate revenues and its technology process defines how the port operations can be efficient (Froese 2007). These two worlds of processes must be optimised so that the port can achieve the strategic business goals with efficient operations at optimum time and costs. The differences of business and technology process can be seen easily with an example of a typical port process, dredging, as follows:

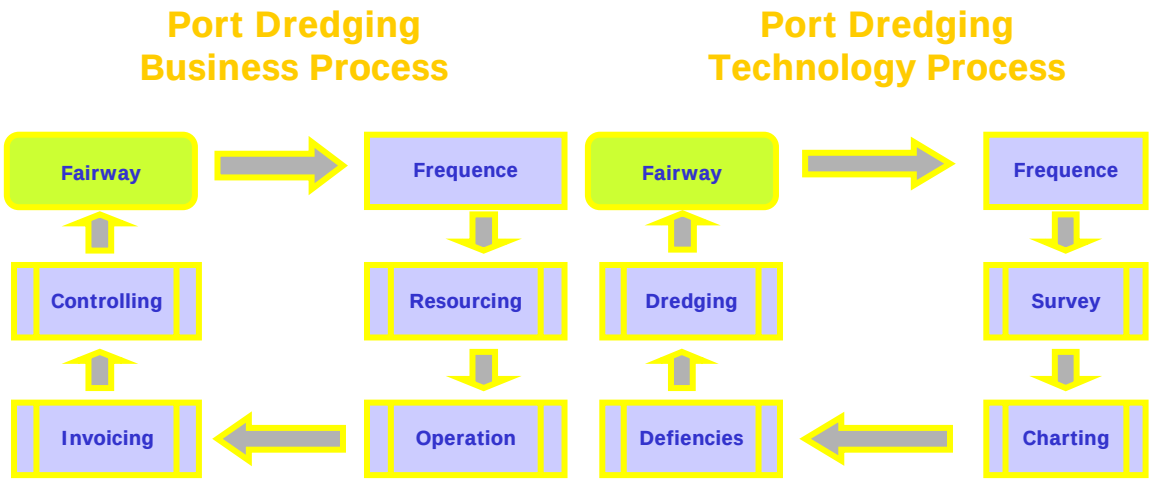

Fig. 2: Business Process versus Technology Process for Port Dredging (Froese 2007)

This figure shows that the beginning points of both process flows are the same until the third activity which make the business and technology process dissimilar. The distinction between this two types of process occurs because their different objectives. For example, the business process of port dredging aims at collecting the dredging fee at the due date from customer on time, whereas its technology process aims to achieve the smooth operations on dredging within the timeframe defined by the customers and to make the waterway passable for the vessels calling at the port. Due to these differences, it is important for the port to capture both process types to know where exactly the improvement for the port should be made.

One important characteristic to highlight here is that, in maritime logistics, ports and relevant organisations mainly are performed in networks. Even different ports themselves work together and help each other improve the standard of work which must be in line with related regulations. Therefore, it is essential that a coordination platform for exchanges of information and knowledge should exist for the network of ports. This became one of the main targets to be achieved in the EFFORTS project.

4 EFFORTS Ontology: Modelling Framework and Architecture

In order to accomplish the objectives to improve the effectiveness and efficiency of port operations, a common concept in process modelling, in other words a "modelling ontology", must be defined in EFFORTS. The author has developed such ontology for use in the project as shown in Figure 3.

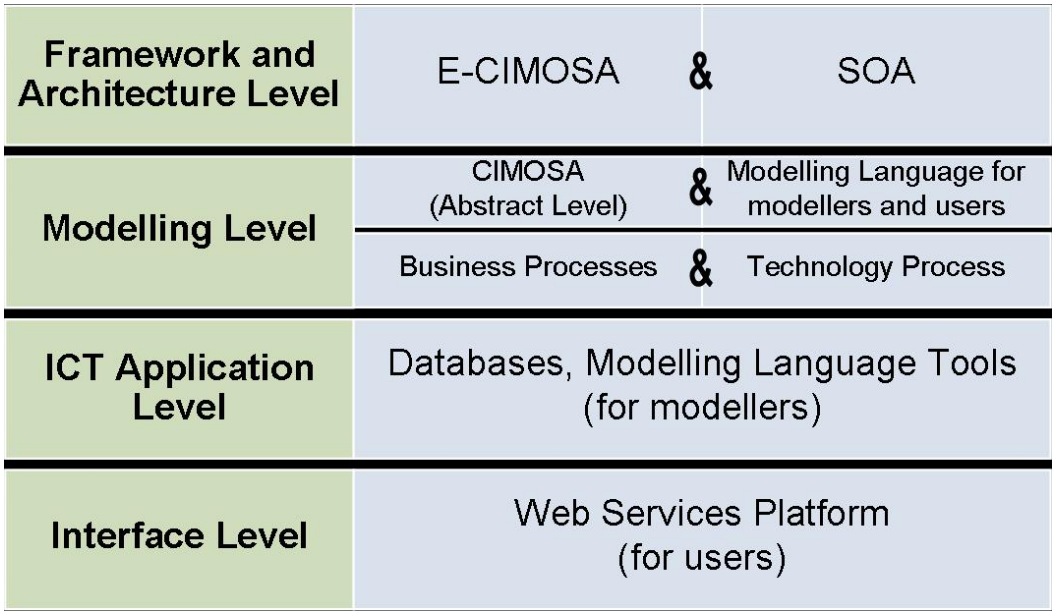

Fig. 3: EFFORTS ontology

The above figure shows the different levels of the ontology employed in the EFFORTS project. The main part to be elaborated here is **Framework and architecture level** where the combination of E-CIMOSA and SOA has been agreed on.

4.1 E-CIMOSA

E-CIMOSA or EFFORTS-CIMOSA is a modified framework of the CIMOSA or The Computer Integrated Manufacturing Open System Architecture. CIMOSA is a pre-normative development efforts aimed at guiding and supporting users and vendors in enterprise integration as well as in the development of complying products, which will ease enterprise integration (ESPRIT Consortium AMICE 1993). It has been one of the main contributors to the related enterprise modelling standards developed by both the European (CEN) and international standardisation organisations (ISO) such as ISO 15704/CEN-ISO 19439 and 19440. The CIMOSA modelling framework provides the necessary guidance to enable parties involved in modelling the enterprise and its processes in a coherent way (ESPRIT Consortium AMICE 1993).

When modelling an enterprise or a process there are many aspects, hierarchies and view points to be examined that cannot be structured in a one dimensional frame-

work (ESPRIT Consortium AMICE 1993). The CIMOSA concept is illustrated as below (Figure 4):

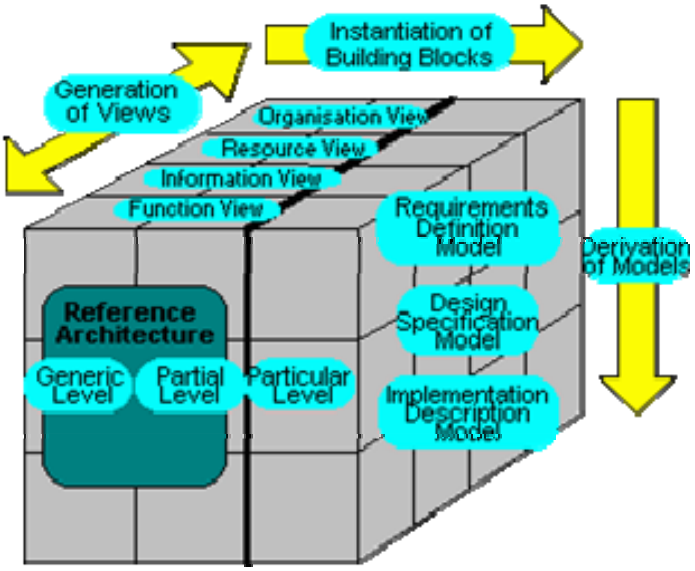

Fig. 4: The CIMOSA modelling approach (Kosanke 1995)

From Figure 4, three dimensions of the framework encompass (ESPRIT Consortium AMICE 1993):

- The genericity dimension – so-called Instantiation of Building Blocks - is concerned with the degree of particularisation. This dimension differentiates between Reference Architecture and Particular Architecture.
  1) Reference Architecture resembles a catalogue of reusable building blocks which contains generic and partial building blocks applicable to specific needs.
  2) Particular Architecture serves the use of a specific case in process modelling which is not intended to be reusable for other models.
- The modelling dimension – so-called Derivation of Models - provides the modelling support for the system or work life cycle starting from requirements to implementation. At this point, EFFORTS will only include Requirements and Design Phase into consideration. The Implementation Phase is not in the scope of the project. However, as the demonstration of tools developed in EFFORTS should take place, the Implementation Level will be complemented by a Validation Level as an extra level to check the complete functionality of the tools.
- The view dimension – so-called Generation of Views – offers the users to work with partial-models representing different aspects of the enterprises: function, information, resource and organisation with the option for other views to be defined as needed.

In E-CIMOSA which is implemented in the EFFORTS project, the CIMOSA modelling approach is modified to explicitly show the clear steps of the use of this framework. To this point it can be elaborated as follows (Zuesongdham 2006):

- Above all before process modelling activities can begin is the task of Domain Identification. This mean to define which area of the port and its objectives and which processes fulfilling those objectives are is to be modelled. Following must be the concept definition of the domain so that it is clear what process aims for. Both steps are defined and described in detail in the CEN and ISO standards mentioned above.
- In the Derivation of model dimension, Validation Model is added after "Design Specification Model" to have the clear cut between the validation of the IT System which will be tested before implementation and the implementation phase itself. In other words, its functions serve as a test bed for the design specification model done in the previous level so that the feedback – both positive and negative – will be considered and the requirements defined in the first level will be changed correspondingly.
- Quality assurance is a very significant topic in any process analysis. This means during and after implementation, process monitoring and control must be done permanently and consecutively. These activities help recognise problem areas in the processes which were not discovered by the process analysis, Therefore, another modelling level – so-called Monitoring and Control Model - is added to this E-CIMOSA Model. And since this is a permanent activity, the graphic shows its circle as a loop which can be reverted to each derivation of model to enable modification to the process global objectives.
- Moreover, to make the terminology more comprehensive among the project partners and practitioners, the terms used in original CIMOSA have been renamed as following:
  - Generation of Views or View dimension – now Architecture Views
  - Information view – now Communication view which include data, messages, and all items relating to communication aspects.
  - Instantiation of Building Block – now Instantiation (Object-oriented Approach). This will help the understanding that this architecture is strongly related to an object-oriented approach which is the significant reason for selection of any object-oriented modelling language.
  - Relating to the previous point, the generic / partial / and particular level are also renamed to Meta-Model / Class / and Object level in order to link the relationship to an object-oriented approach. However, the meanings of these terms remain unchanged.

The modified model can be illustrated as below.

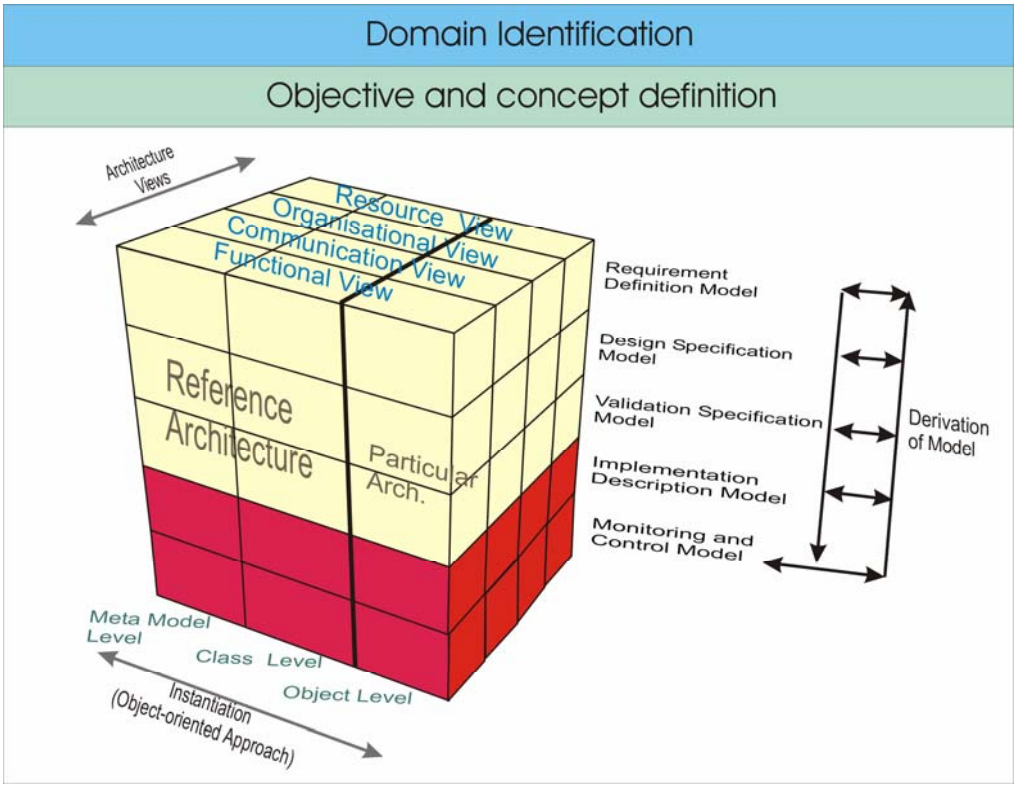

Fig. 5: E-CIMOSA modelling framework

4.2 Service-Oriented-Architecture (SOA)

Service-Oriented-Architecture or SOA has become well-known in the past few years regarding the IT infrastructure architecture. It turned into a new paradigm for IT industry to define services as focal points for the construction of systems.

SOA is an architectural strategy that helps achieve tighter business-IT alignment by taking a three-dimensional-perspective of the enterprise, namely technology, people and processes. The key aspect of SOA is to make business functionality available as a set of well-governed, standard-based, loosely coupled services and processes, defined in a flexible and agile manner. The concept of SOA can be compared with the LEGO children's toy. Each building block refers to a service (DiMare/IBM Corp. 2006). Therefore, a company can put different building blocks to create new services, which are matched to business objectives or even create a new business strategy. The services can perform also as stand-alone application if one needs only simple services and reuse the services to create other services.

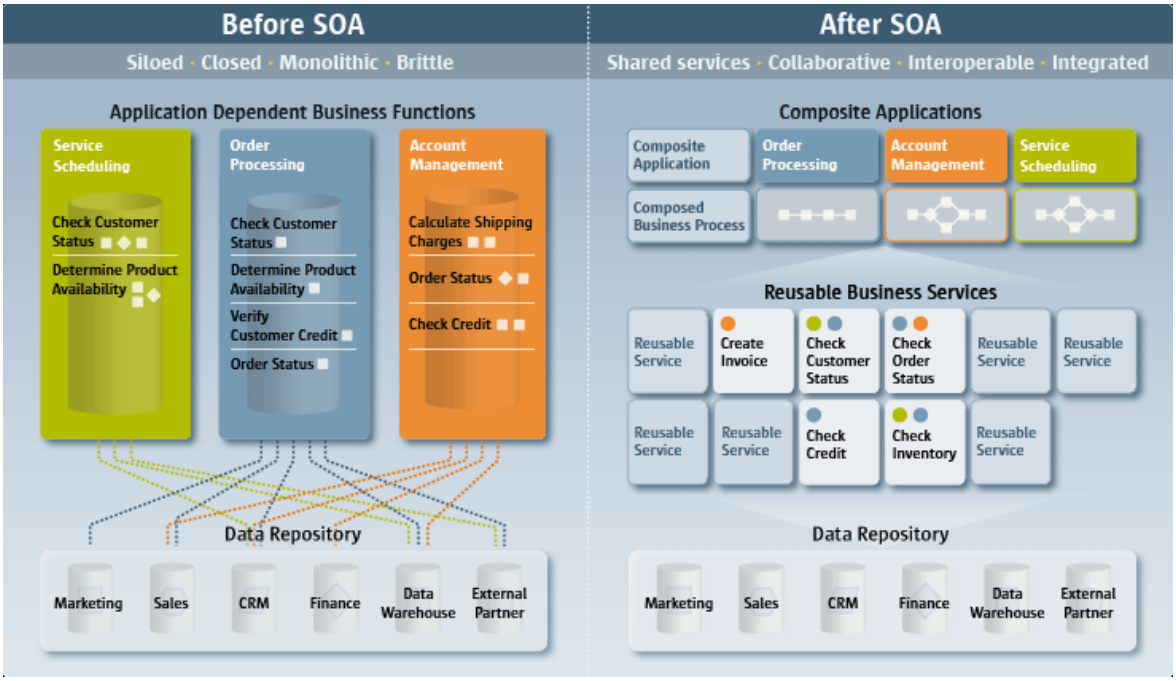

Fig. 6: System architecture of an enterprise: Before and After SOA (Sun Microsystem 2007)

Figure 6 illustrates very well how the system architecture of an enterprise can look like comparing the designs before and after the implementation of SOA. In traditional IT architecture, business process activities, data and application are locked into independent, often-incompatible “silos”, which highly require intensive maintenance and coordination to keep the system function smoothly (Sun Microsystem 2007). Its consequence is therefore the need of a large portion of the enterprise budget.

The implementation of SOA totally changed the way of the structure within the system. Services become dependent of the process and are reusable at any time for different business units and applications.

A study (DiMare/IBM Corp. 2006), according to reports of different SOA projects collected by IBM Global Services, concluded that SOA deliver many benefits to enterprises some of which are:

- Improvement on flexibility
- Cost reduction
- Risk mitigation
- Increase on revenue
- New products / services

Therefore, SOA is becoming popular and a new solution to the enterprise or the network where the changes of business circumstance occur regularly and SOA’s benefits are the main requirements for the business like in the logistics industry to survive.

4.3 Combination of E-CIMOSA and SOA: idea and benefits

The attractiveness to the combination between E-CIMOSA and SOA mainly lies on the fact that these two approaches can complement each other very well and enable the possibility to deliver a complete service solution for seaport networks.

Whereas the E-CIMOSA can help seaports and relating organisations define and describe clearly their inter-organisational processes, both business and technology ones, in the form of models at different level and with different views within the consistent framework, SOA facilitates constructing system architecture for reusable services provided by ports in a flexible way to provide access to the data repository. Moreover, the possibility of web-services, an important element of SOA, enables the better interoperability between the different users, in this case the port operators and their related entities.

The elements that the EFFORTS project can adopt for the development of the work from E-CIMOSA and SOA are following:

E-CIMOSA	SOA
• Fundamental modelling framework • Modelling Ontology • Glossary for common understanding on terms and definitions • Constructs and modelling language for business and technology processes	• Ability of system integration • ICT structure / architecture • Reusable services • Web services

Tab. 1: Elements of E-CIMOSA and SOA selected for the combination

In sum, the combination of E-CIMOSA and SOA helps multiply the benefits of both approaches in terms of flexibility, clarity on process descriptions, possibility for network building and will improve the efficiency in planning and operations.

5 Expected results

Regarding the objectives of work in the project EFFORTS, it should enhance the improvement, the efficiency and effectiveness in seaports through a better understanding of port operations. To achieve this, a common platform to help improve communication between ports must be established. The system of this platform should function as process library for the ports to have access for the exchange of information and to identify standardised information of processes and their relevant objects which will be stored in databases (DB); such as organisations, resources, etc.; involved in port operations. The concerns on external environment such as standards, regulations, and other external factors as well as need for compliance should also be included in the system or process library as well. These will help guidelines for creation of new objects in the system and keep it updated for recognising changes occurring in the future, which is not avoidable.

The figure 7 illustrates the possible use of the expected result.

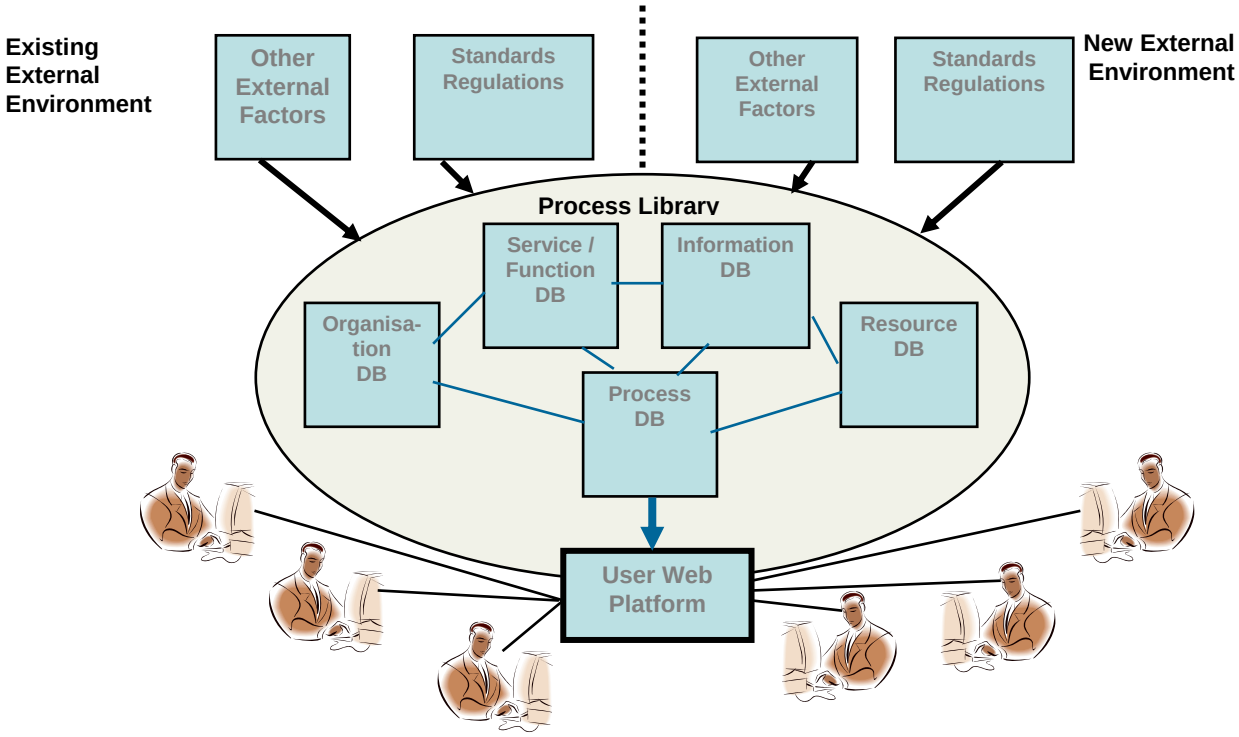

Fig. 7: The expected EFFORTS web platform

Moreover, the user should have the possibility to exchange information in and between different organisational Unit (OU) and organisational levels, so that employees from the same organisational position but from different ports can discuss the issues related to their level across organisations and at the same time the adoption of objectives from the strategic level can be transferred to both the management and the operational level within the organisation itself as illustrated in Figure 8.

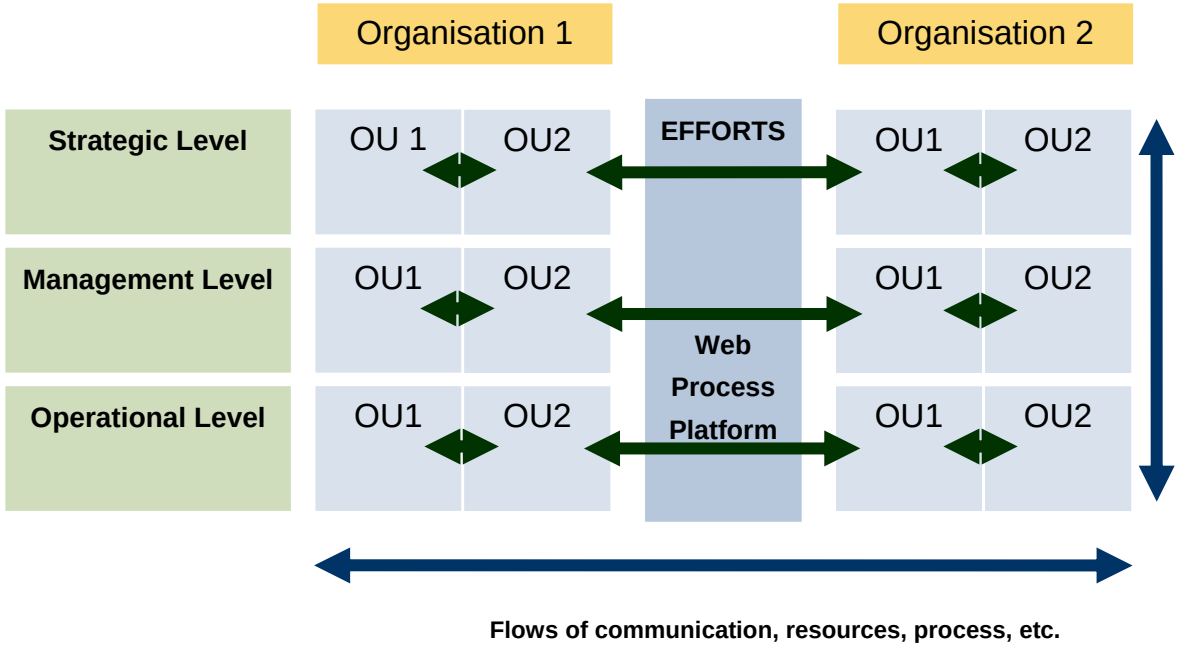

Fig. 8: Organisational model for communication through EFFORTS web service

6 Conclusion

Due to the permanent changing circumstances in the maritime logistics industry, seaports as main players should be able to analyse their operations in an effective and efficient way to identify the opportunity for improvement. A better understanding on port processes is needed, not only for the business processes but also the technology ones, so that the ports can achieve its goals in term of business strategy and effective operation at the same time. This will increase competitiveness for ports as the end result. To achieve this, understanding on the processes and dynamic actions or flexibility are very crucial requirements for any approach to be implemented in the industry. In regards to the benefits and possibilities, which both E-CIMOSA and SOA can deliver, make this approach valuable and helpful in the complex maritime industry.

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