Green EFFORTS

Green and Effective Operations at Terminals and in Ports

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LIST OF ABBREVIATIONS / GLOSSARY

ABC	Activity Based Costing
CIMOSA	An open source architecture for Computer Integrated Manufacturing
EFFORTS	Effective Operations in Ports, an EU funded research project under FP 6 Framework completed in 2009
ERP	Enterprise Resource Planning
KPIs	Key Performance Indicators
PTKL	Port and Terminal Knowledge Landscape
RTD	Research and Technology Development
RoRo	Roll on Roll off (wheeled cargo e.g. semi-trailer, trucks, automobiles, railroad cars)
Topology	an architectural system view showing areas of responsibility
UML	Unified Modeling Language
WP	Workpackage

Executive summary

The Green EFFORTS project main objective is to improve management of energy in the port and terminal, therefore understanding of relevant aspects of the port and terminal processes are essential. According to the heterogeneous port community, this project involves various parties having distinct knowledge, experiences and professional background. They all need to understand the problems and to agree on common methods, tools and solutions. Thus, this paper aims to identify the project topology, methodology and tools in order to provide a framework for further project works.

This paper will introduce the process methodology developed in the EFFORTS (Effective Operations in Ports) project, an EU funded research project under FP 6 Framework, which was completed in 2009. Overview of the EFFORTS process domains and methodology is provided, followed by identification of terminal domains. The EFFORTS process-oriented approach will be used as a reference mainly for identifying the terminal processes (WP 3), energy consumers of relevant processes (WP 4), for the process modeling (WP 5), energy supply opportunities (WP 6), and energy management strategies (WP7), among other WPs.

The added value of the deliverable D3.1 is:

- to allow education of the participating industry and the consortium about the EFFORTS process view as a development platform
- to elucidate the step from process view to the Terminal and Port Knowledge Landscape as an innovative information "space" to allow interactive and intuitive context building from distinct points of view and as the core dissemination tool.

Initially this paper deals with container terminals based on already available project work. After further investigation of RoRo- and inland navigation terminals these two terminal types will be included. Therefore, this document has the status of a living document which will be continuously updated following the course of research.

Throughout this deliverable the main problems and the motivation to develop the Port and Terminal Knowledge Landscape (PTKL) is introduced. This PTKL will allow

- Elucidation of processes and relevant contexts including the terminal-port-relationship
- Modeling of terminals to optimize energy management and optimum resource utilization
- Comprehensive understanding of all relevant aspects
- Tailor-made solutions for individual terminals
- Explanation and dissemination of project achievements
- Training.

The elaboration of the PTKL concept and its results will be reported by the Deliverable 3.5.

1 Introduction

With the EU policies and measures to achieve the 2020 energy goals and strategies in place, it presents a great challenge to reduce energy consumption by 20% before 2020. Current estimation shows that the EU is going to meet only about half of its target. To put this objective forward and get it back on track, the Commission proposed a new directive addressing energy efficiency applied to all sectors (e.g. public, household, services, energy supply, industry including transport sector) in 2011. This directive is going to propose new measures on potential energy savings, in addition to existing ones, and to encourage member states to more efficiently use energy by forcing legal obligations to establish energy savings measures (EU Commissions, 2011).

Economic growth has resulted in an increase of trade, transportation and traffic. In order to improve energy efficiency of the entire transport chain, for ports and terminals, serving as interfaces between the waterborne transport and the other modes of transportation, the Green EFFORTS project is going to investigate the potential to reduce energy consumption and to increase the use of "clean" energy. This will minimize their carbon footprint without affecting the productivity of operations.

The project will cover container-, RoRo and inland waterway terminals. Besides that, the role of seaports (depending on the organizational port model), responsible for the port infrastructure and facilitation of terminals, is part of the Green EFFORTS scope of research. Key research tasks of this project include the investigation of the potential for energy savings and reductions through improved operations, reduced consumption (e.g. by technical measures), optimum sourcing (e.g. by own energy production and mixture of renewable energy sources) and intelligent energy management. To achieve these tasks, however it must be based on detailed knowledge of terminal and port processes to not generate solutions for one area which later prove to be contra-productive in others.

Current terminal process management systems (e.g. terminal operating systems TOS for container terminals) do not allow for energy consumption management. Moreover, business process modeling is well established and there are various methodologies, conventions and tools available; however, in the port and terminal industry, the approaches are currently not common and do not include energy supply and consumption aspects. Before modification of a complex system all actors must understand the system and the potential impacts of modifications. Therefore, the main objective of this paper is to identify project topology, tools and methodology as a framework for further tasks.

2 Project Topology

Within the port and terminal industry expertise is organized vertically in depth, but horizontally very narrow. This means that special knowledge is restricted to only a few experts. Research and development aiming at improved energy management of terminals and ports, however, is a multi-disciplinary issue requiring the cooperation of a very wide scope of experts and involving all levels of users from top management to helpers, in order to not overlook any aspect of relevance. Thus some of the parties to be involved do not know much about terminal and port operations, but need to understand it in context of the contributions required from them. Examples are ICT- or energy-experts. The experts taking part in the scientific activities must be able to understand each other and to communicate to practitioners in order to produce coherent research results.

As introduced in EFFORTS (2008), the problems of mutual understanding and communication become even more severe when work has to be conducted within international project consortia. Teams are confronted with

- Language barriers
- Diverse semantics of similar terms
- Same terms for distinct objects
- Distinct mental models of system operation and associated roles
- Differences in education, competences, experience and associated social and cultural environments
- Variety of attitudes of problem solving.

These also applies to port and terminal communities, having different background, knowledge and experience but need to agree on all project issues and comprehensively understand its impacts.

Successful cooperation of heterogeneous experts requires a conceptualization of the complex port and terminal world to allow for

- Common understanding
- Cooperative and concurrent development
- A common taxonomy to relate e.g. to activity costing, resource utilization, risk management or training
- Matching individual ERP tools with the port cluster
- Application of balanced score card tools
- etc.

Experience has shown that these problems to a far extent can become overcome by basing communication and work performance on a transparent and understandable architecture of the target systems depicted by relevant processes (Froese, 2007).

2.1 EFFORTS Port Process Domains Map

Depending on the size and nature, a port, which mainly comprises berth operations, may facilitate all kinds of logistics services but also production facilities, forms a kind of complex industrial city, which must become logically fragmented before considering the processes. This can be achieved by defining domains to represent coherent application areas (Froese, 2009). Figures 2-1 and 2-2 show Port Process Domains developed within the EFFORTS project to provide a understanding of different functions and links between port actors. As shown in the figure 2-2, terminal operations processes are part of the port domain “Logistics”, which links all processes in relation to the operation taking place at a terminal (EFFORTS, 2008). Usually a domain consists of so many processes, depending on the level of detail considered, that a hierarchical process organisation by meta-processes and process clusters fosters understanding

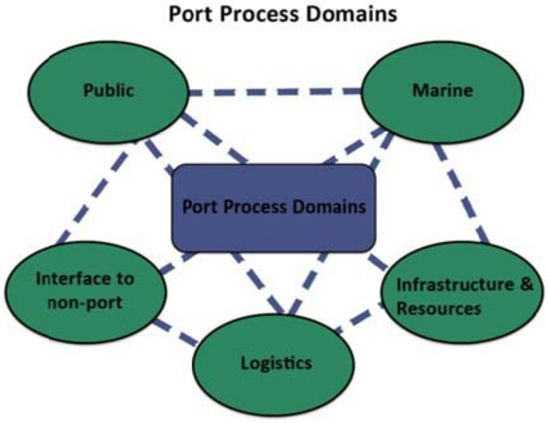

Figure 2-1 Port Process Domains (Froese 2009)

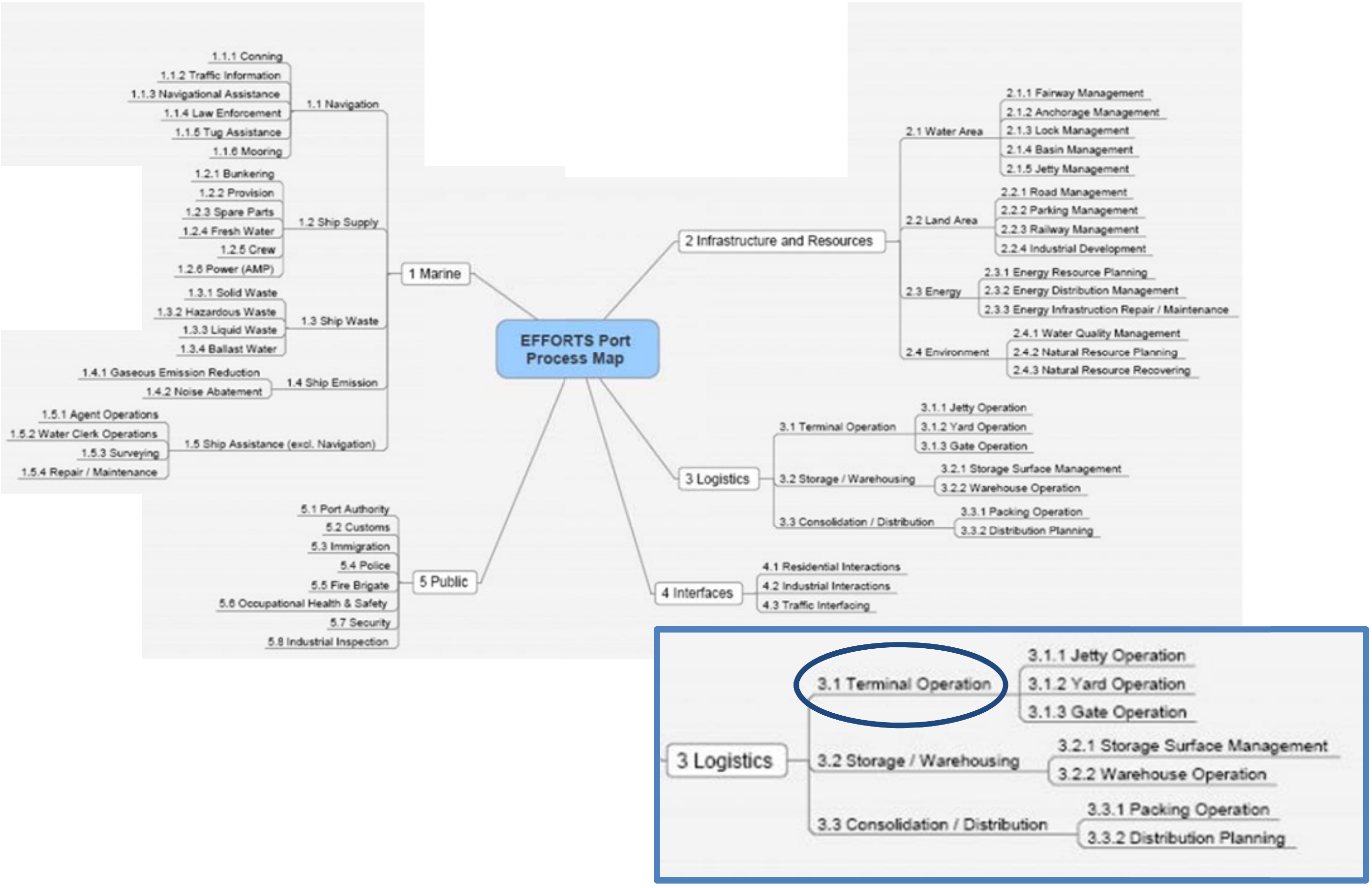

Figure 2-2 EFFORTS Port Process Domains and Meta Processes (Froese 2009)

2.2 Green EFFORTS Container Terminal Domains

Initially this paper deals with container terminals based on already available project work. After further investigation of RoRo- and inland navigation terminals these two terminal types will be included.

The terminal operation systems are considered to be complex due to the highly dynamic interactions between different factors and often unpredictable future events, because of transshipment processes not being defined in advance and in detail (Kim & Guenther, 2007). In the case of a container terminal, various factors influencing the terminal systems including the handling systems, transport modalities and types of containers, as well as different operational conditions (e.g. weather condition, local particularities).It certainly is true that every container terminal is unique and varies in size, functions, and layout, however principally the operational processes are the same (Steenken et. al., 2004). Therefore, to understand a terminal's energy consumption pattern and to identify potential energy efficiency measures, it is essential to comprehend the terminal operation processes. For research purposes generic reference terminals are specified to meet a maximum of real-world conditions of various terminals. Following considerations aim at container terminals, RoRo- and inland navigation terminals will follow.

As above explained for ports, also the container terminal processes are organised in domains. The relevant container terminal domains (figure 2-3) are:

1. **Berth Operations**
   The berth domain associates to processes related to ships while they are berthed (water side).
2. **Quay Operations**
   The quay domain comprises processes also involving the ships but related to the land side.
3. **Marshalling**
   The marshalling domain comprises processes linked to work and circulation areas (occasionally called “apron areas” as in airports).
4. **Stacking**
   Container stacking encompasses processes occurring during stacking of containers (e.g. including pre-stowing and shuffling of containers and any processes required by different types of containers).
5. **Interchange Operations**
   The interchange domain links to processes in relation to handling of containers for hinterland transport modes.
6. **Gate**
   The gate domain includes processes to dispatch containers from/to hinterland (interface between container terminal and hinterland).
7. **Equipment Maintenance**
   The equipment maintenance domain includes processes related to support handling equipment functionality and availability.
8. **Administration**
   The administration domain includes processes to manage the whole terminal and all client processes.
9. **Staff Service**
   The staff service domain associates to all processes for staff.
10. **Off-terminal Storage**
    The off-terminal storage domain includes processes to move and store containers outside the terminal operation area (e.g. empties, to-be-repaired containers).

11. Special services

The special service domain include all service processes which are not part of the terminal operation, however can be offered by terminals as additional value-added services to their client. For example: container repair, container leasing, labeling, packing, stuffing, stripping, and cross docking.

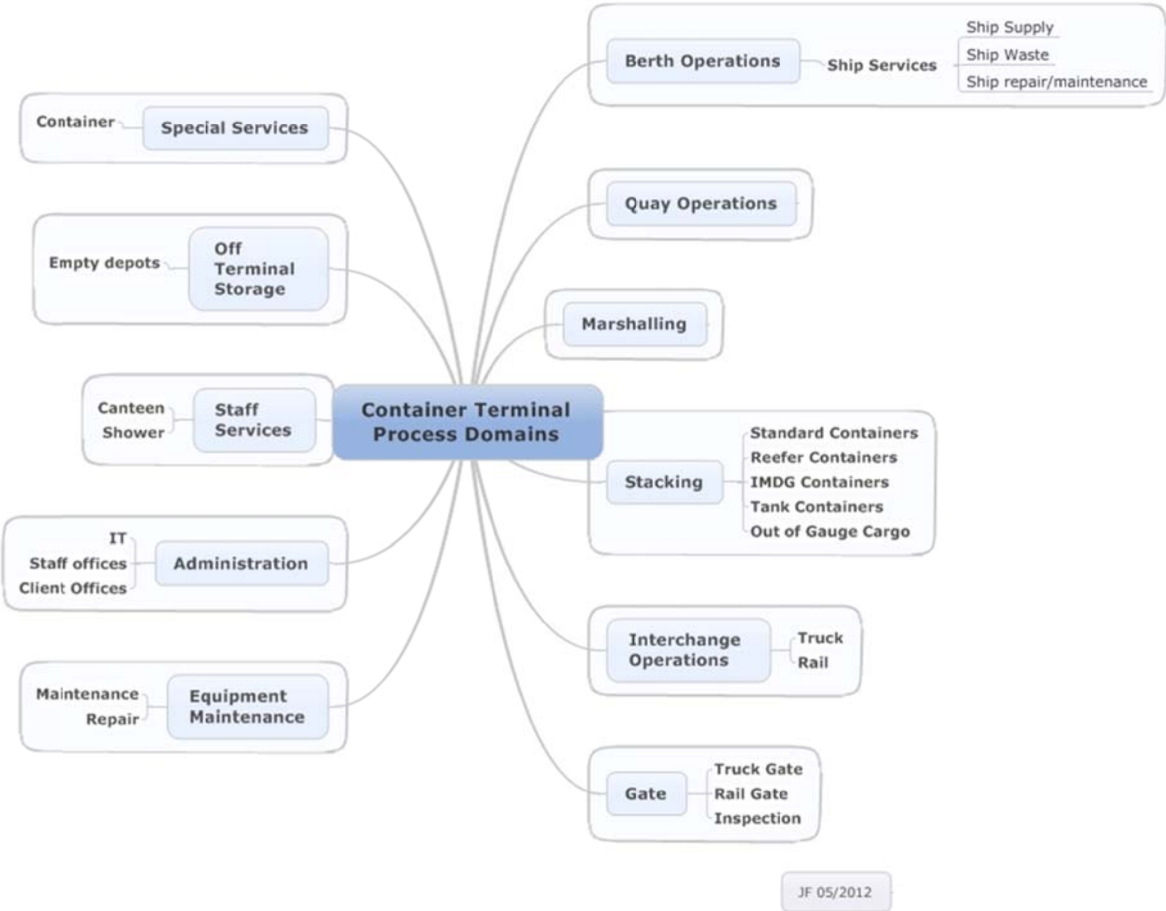

Figure 2-3 Green EFFORTS Container Terminal Process Domains and Meta-Processes

The details of container terminal processes will be discussed in details in the Deliverable 3.2, using the mentioned above domains.

3 Methodology and Tools

The following sub-chapters introduce and describe the methodology developed in the EFFORTS project.

3.1 Process Mapping Approach

A process is understood as a workflow with specified begin and termination covering a phase of a production. Providing a service here is also treated as production. Usually there is a sequence of sequential and parallel processes (process chain). Processes can depend on other processes or be independent. The cumbersome work of capturing processes commonly follows a specified objective, e.g. reduction of costs, time or in this project case, energy consumption and CO2 footprint.

Processes can be described on abstract and generic levels and in a very detailed way. For a coherent "map" of processes as a tool to successful manage technical research projects the objectives can be manifold and might be defined at a later stage, so a common approach on a lower level of detail (low model resolution) is required. However, the process map must allow a higher degree of detail and extensions whenever required at any later stage. Because the volume of data for a research project is not as big as for operational management, where usually huge masses of data must be administered, no expensive process management tools are required. Even a spreadsheet tool may serve the purpose assumed it allows for distinct data types and hyperlinks.

For understanding the contexts of individual processes with a common cluster or meta-process goal, a simple process map is sufficient, explaining

- process objective(s)
- main operations and its sequence
- operational site(s)
- time-dependency
- resources
- responsible parties.

However, it must be clear that specific process improvement measures require a more detailed process view.

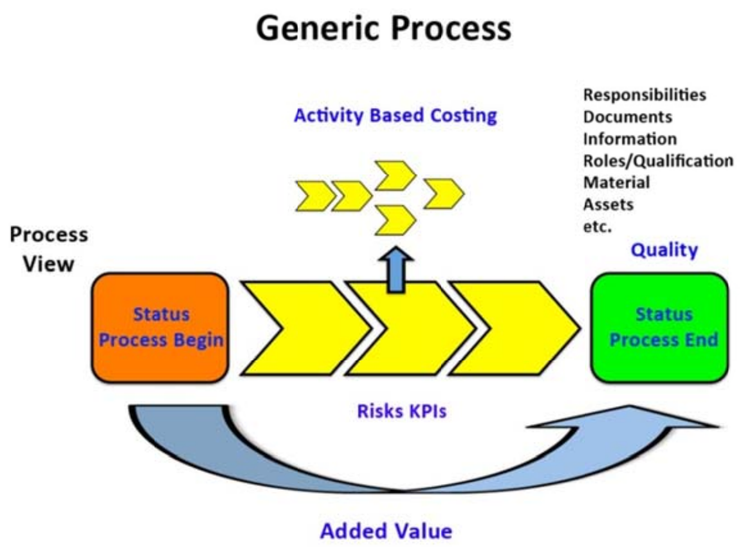

Figure 3-1 Generic Process (Froese 2009)

Moreover, the level of process detail should be kept as generic as possible, since in most cases the operational objectives are similar or comparable on this level (as shown in the figure 3-1). This is also beneficial to avoid too much fragmentation, which might lead to loss of transparency and comparability. Some important aspects to be associated to the terminal operation process such as:

- Related organization(s)
- Responsibilities
- Roles/qualifications
- Information flow
- Required documents
- Equipment
- Scheduling
- Resources
- Other relevant facts

As figure 3-1 also shows that managerial processes, such as benchmarking by key performance indicators (KPIs), activity-based costing (ABC), quality assurance, training and risk assessment and management, can be linked.

3.1.1 Capturing of Processes: *Identification of Relevant Processes*

It was found that practitioners are mostly “task-oriented”, which means they are trained for a defined task to perform in the best possible way without questioning the final objective of this task or the process it contributes to. In the attempt to improve operations they then tend to improve the task performance instead of searching for the optimum way to achieve the task goal, which can include to even drop a whole task because there are better ways to achieve specified objectives. Therefore, when capturing processes, the first and most important question always needs to address the process objective(s) to measure the system according to required results and not according to the tasks performed, which might be quite misleading. All "added values" of a process, its related tasks, involved process stakeholders and further details should be then matched to the process objective(s). A simplified architectural view on a system to identify process is shown in figure 3-2.

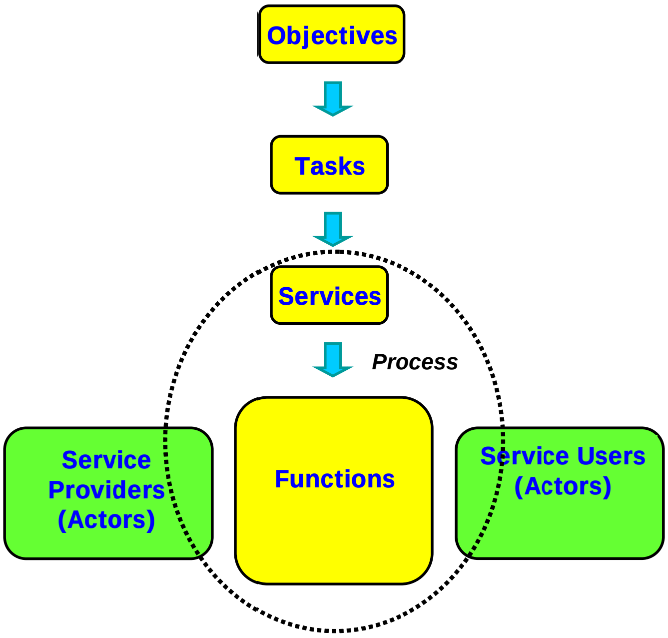

Figure 3-2 Simplified Architectural View on a System to Identify Processes (Froese 2008)

3.1.2 System Architecture for Process Modeling

The process modeling must be based on a system architecture, which can well serve to understand complex technical systems, even by non-technicians (Froese, 2007). A general problem of process modeling is that it requires involvement of numerous actors with different background. Sources of reliable process information are operators (dealing with the tactical aspects) and managers (responsible for strategic issues). Therefore capturing of process information requires and unambiguous and easy-to-understand language. In the EFFORTS project, the port process modeling architecture was developed according to CIMOSA, Computer Integrated Manufacturing Open Source Architecture and hence ISO/CEN 19439 and 19440. This architecture is based on system life cycle concept also allowing to capture dynamic aspects of processes (EFFORTS, 2007).

In general, a system architecture should be able to provide a rational process classification scheme, be compatible with different architecture systems, not depend on a dedicated capturing tool, allow a fragmentary record open for later amendments. It should be developed according to an appropriate information and data model, in order to avoid being drawn into irrelevant and unlimited data production. Adoption of an architecture design approach, therefore, should meet following requirements:

- interoperability to other dedicated data models for e.g. logistics
- strict entity-relationship-model allowing to capture relevant objects (entities) jointly with their attributes and relationships organized by classes (entity families) and instances (specific individual entities)
- redundant-free register (data bank) not carrying any other information for e.g. visualization than those required to describe entity classes and instances
- easy linkage to application-oriented processes to use the model content for e.g. visualization or as input to other tools.

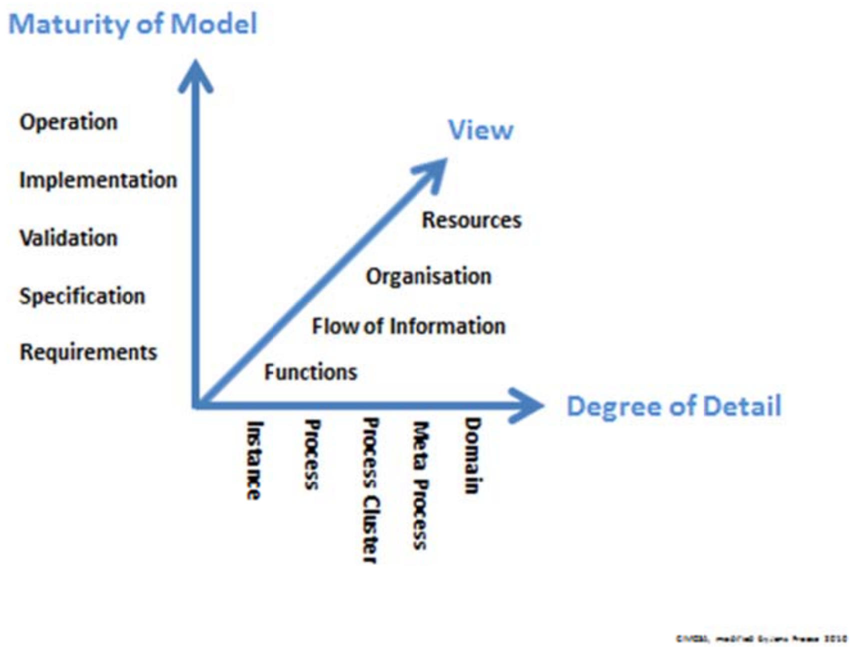

Figure 3-3: CIMOSA Architecture for System Development

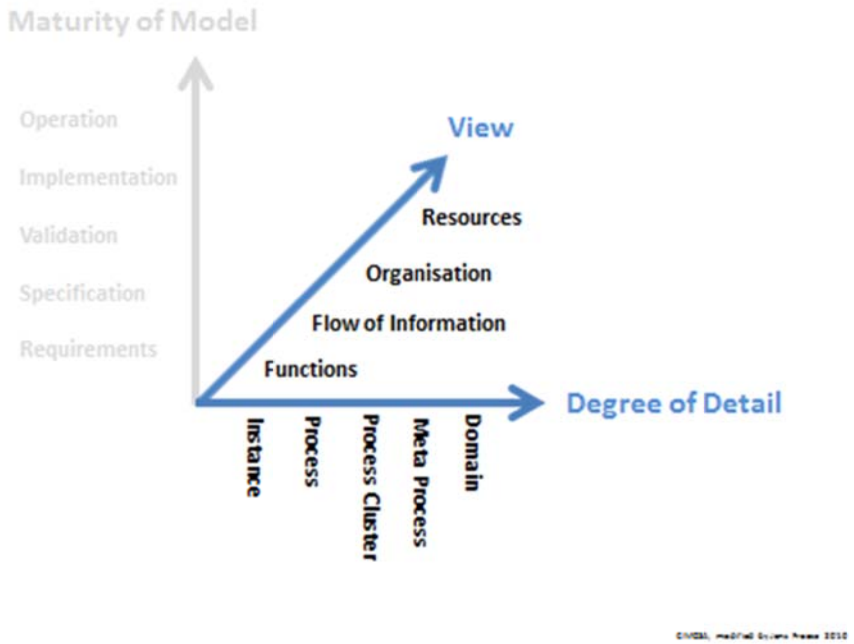

Figure 3-4: Simplified CIMOSA Architecture for a System in Operation

3.1.3 Entity Relationship Approach

The entity relationship approach will be referred to describe process objects, attributes, and relations/links, which will easily allow import of results to process management tools. It is a database modeling technique to document the entity, its attributes and relationships to other entities. This approach is used to produce a type of conceptual data model, containing semantic information and adds it to a data structure.

Annex A shows an example of EFFORTS graphical notation based on the Unified Modeling Language (UML), an object-oriented-approach, to show relationships between entities.

3.2 Process Management and Visualization Tools

Described process capturing techniques will allow to model terminals to allow easy perception of relevant aspects. This, however, is only a first step. As the objective of the Green EFFORTS project is to improve management of energy, i.e. sourcing and consumption, these aspects needs to be brought into context to the terminal and port processes. Each distinct “view” on a terminal results in a distinct model. To avoid the generation of too many models, again disturbing the transparency gained by the process maps describe above, the Port and Terminal Knowledge Landscape (PTKL) is introduced.

3.2.1 Port and Terminal Knowledge Landscape (PTKL)

The term “knowledge” has many meanings depending on the individual and his or her social context. To avoid the traps of epistemology, knowledge here means any facts, skills or expertise which has the potential to serve the purpose of the research. The dilemma is that distinct views on the same system require distinct knowledge depending on the terms of reference of the research. Knowledge required to optimum support port and terminal research and investigation comprises a very wide scope at distinct levels of itemization. Certainly this can be listed in a kind of a knowledge catalogue; however, searching for details will be very cumbersome especially when not knowing the appropriate key words. Therefore an organizational system is required to support digging for information also for non-experts and there will be no experts for all related fields.

The term “Landscape” indicates that this information system is based on a three-dimensional depiction of the Green EFFORTS project environment. The PTKL shall provide distinct generic levels and degrees of detail and must be interactive to allow users to enter on an overview level and by mouse clicks go to the more detailed levels without losing the overall context. Figures 3-5 and 3-6 show an exemplary depiction of the same terminal as a realistic presentation and as generic one. The realistic depiction allows easier orientation of a user not familiar with terminals whereas the generic one requires already terminal knowledge. The PTKL can be described as a visualised knowledge presentation system based on advanced content management and visualisation technologies. Further research will show if it is possible to allow users to edit the system, i.e. adding and deleting own information of distinct data types, without thorough software skills. This would allow adapting the PTKL to individual terminals and ports and using it for strategic planning and decision-making. The PTKL also shall serve as a training tool for terminal and port staff.

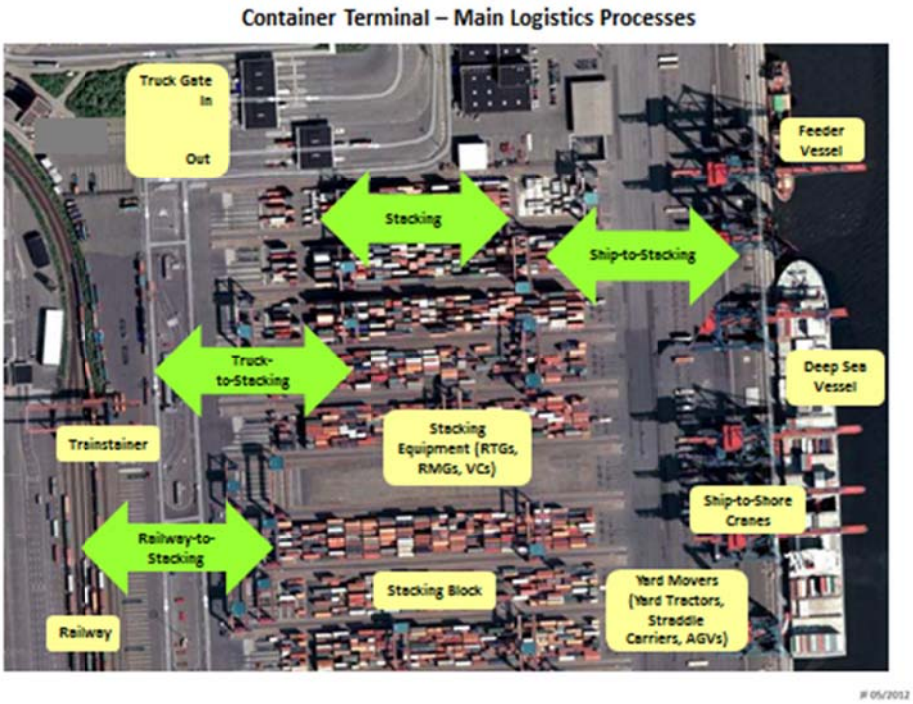

Figure 3-5: Container Terminal – Main Logistics Processes

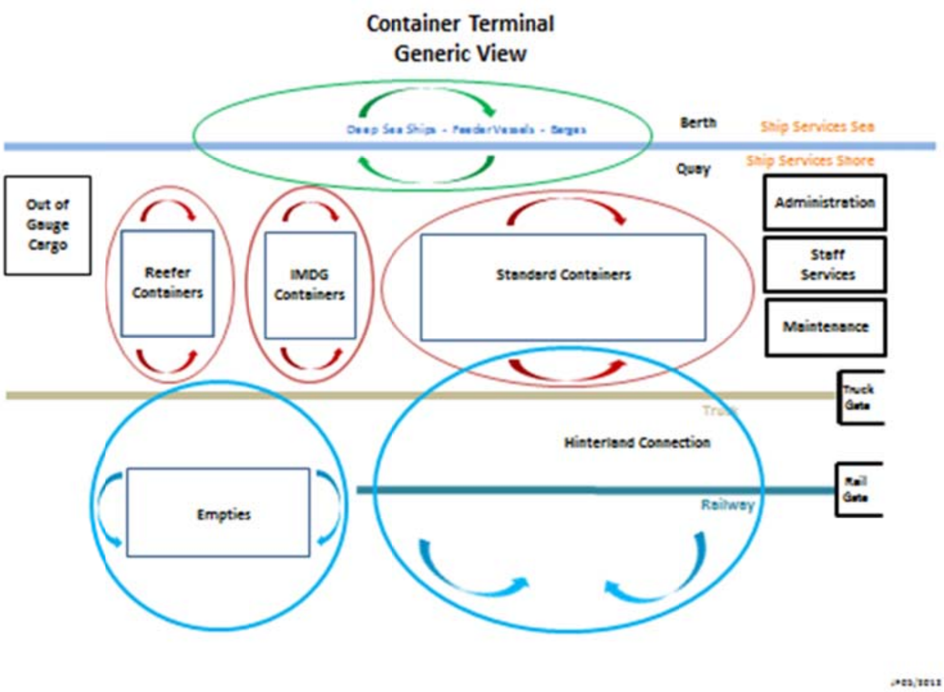

Figure 3-6: Generic View of a Container Terminal – Main Logistics Processes

Both figures 3-5 and 3-6 are restricted to the logistics processes of a container terminal. In a next step these processes and related process entities (e.g. equipment and infrastructure) must be amended by the energy-related entities and processes to allow investigation of energy consumption and sourcing and estimate potential impacts of results (see figure 3-7). The term “energy management” here covers aspects of consumption based on equipment and operation, sourcing of energy from available sources and usage of energy to minimize carbon footprint and other emissions and at the same time costs without deteriorating productivity.

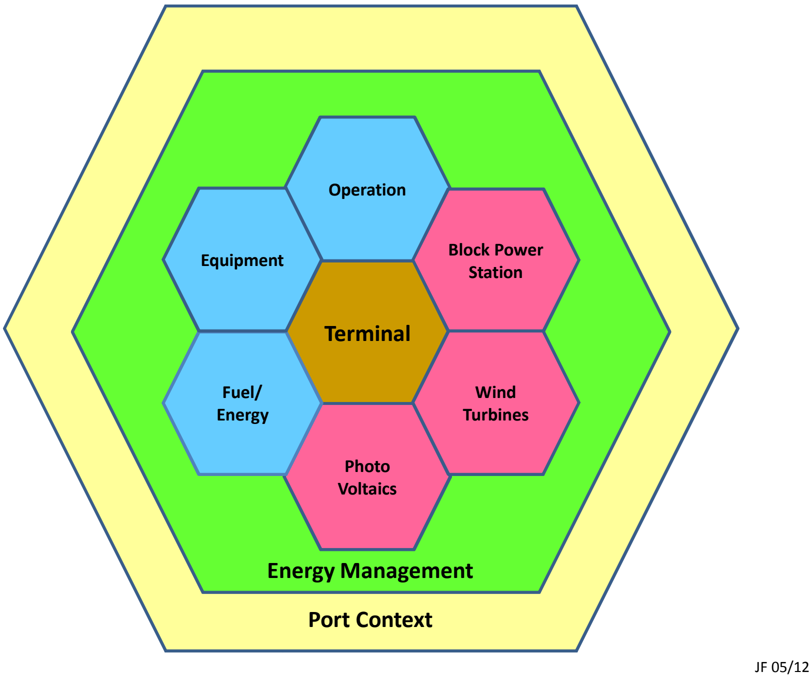

Figure 3-7: Generic Research Environment to investigate Energy Management at Terminals

(Example, content not exhaustive)

4 Conclusion

To conclude, the main results of this deliverable is the identification of terminal domains and a concept to develop the PTKL map, a process map organized into domains (areas of responsibilities), showing influencing factors and relationships between the processes and energy consumption. The EFFORTS domains and process map approach is adopted since it fosters transparency of complex systems and operations, allows to specify necessary relations (process input, output, equipment and other resources, responsibilities, etc.), to model processes and to simulate logical process chains.

This paper, providing the concept to create process model (WP3), will be used to develop a baseline model for benchmarking between terminals, known as the **Green EFFORTS terminal reference model**, which will facilitate quantification of energy consumption (WP 4) of terminal operation processes and simulation of relevant processes (WP5). The PTKL map will serve as a basis mainly for the WP 3 “Process Map”, WP4 “Energy Consumption”, WP 5 “Modeling of Energy Consumption”, WP 6 “Energy Supply”, WP 7 “Energy Management” and also to the other work packages.

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ANNEX A UML NOTATION OVERVIEW FOR EFFORTS