ABSTRACT
In the last decades the management of ports has become ever more difficult. The goal of port management is to let ports evolve from logistic distribution centres into transport solution providers. Such evolution can be achieved through Business Process Reengineering (BPR), often jointly to the implementation of Information Technology (IT) solutions. Such approach does not always give the expected results. It is thus very important to use the most suitable tools. In this paper we propose an example of the path followed to study the processes related to four European ports (Taranto, Kavala, Thessaloniki, Igoumenitsa) and show the methodology for the first steps of BPR (as-is process representation and analysis). In our research we studied 10 processes and applied our methodology for their representation and analysis. As an example, focusing on one process, we show how to implement such methodology and how to use a simulation software for the as-is process analysis.

Keywords: Business Process Reengineering, Port, Simulation

1. INTRODUCTION
In the last decades we have assisted to a radical change in the way ports are considered. Indeed, the ports are evolving from logistics distribution centres (the so called third generation) into transport solution providers (namely the fourth generation), thus becoming ‘lean’ ports (UNCTAD 1999).

The challenge for a lean port is to quickly move cargo and smoothly deliver a service in alignment with the market demand while eliminating all types of waste in the physical and documentary/information processes (Marlow and Paixao 2003). This evolution is based on the concepts of leanness, flexibility, just-in-time and BPR techniques (Marlow and Paixao 2003).

Processes reengineering is a crucial issue to ensure that the port system is efficient. The drivers of port efficiency do not only consist of infrastructure variables, but also of management and/or policy variables. As stated by Clark et al. (2002), the greater the efficiency at the port level, the lower the transport costs, consequently the higher is the ship turnaround. Port efficiency is an important determinant of handling costs too. As a consequence, BPR is necessary for many ports that want to increase their competitiveness.

BPR is offered as an enabler of organizational transformation (Davidson 1993, Venkatraman 1994). Organizations usually adopt a BPR approach when they believe that a radical improvement can be achieved by marrying business processes, organizational structure, and IT change (Stoddard and Jarvenpaa 1995). In the past the use of BPR for organizational transformation in the public sector has largely been neglected. However the trend has changed in the last years and several studies on BPR in Public Administration have been published. For example, in a report entitled “Reengineering through Information Technology” (1993), the US government identified a strategy with several major initiatives to reengineer government services in order to meet the demand for better performance.

While lessons drawn from studies using private-sector organizations might be useful, these findings are not always applicable to public sector organizations since such organizations usually face different sets of issues, problems, and challenges (Swiss 1991).

According to this general approach, many ports have proceeded to reengineer their processes as a consequence of a joint IT introduction. The cases of Asian ports, such as Singapore and Hong Kong, which currently are the most competitive on a global context, are emblematic. The port of Singapore is a very large transhipment hub, serves everyday about 60 container vessels and moves about 45,000 containers (Port of Singapore Annual Report 2006). The key of its success is the rethinking of its processes focused on IT introduction. Such introduction allowed to fasten the information exchange not only inside the port, but also with customers, suppliers, etc. and to fully manage every issue related to administration and planning activities, and all the port operations (Gordon et al. 2005, Lee-Partridge et al. 2000, Tongzon 1995).

BPR does not always give the expected results. It is thus very important to use the most suitable tools. In this paper we propose an example of the path followed to
The main protagonists that are typically involved in a port community are:

- Administrative Institutions (namely Port Authority, Harbour Office, Maritime Health Office, Pilots, Towboats, Mooring Personnel);
- Police Institutions (namely Financial Police, Custom House);
- Traders (namely Ship-owners, Shipping companies, Receivers, Charterer);
- Intermediate (namely Port agents, Forwarding houses, Terminal);
- Financial institution (namely Banks, Chambers of Commerce).

The output of this phase is showed in Figure 1.

To collect data on the processes carried within the ports we conducted direct interviews with different port actors (Shipping Agency managers, Port Authorities directors and clerks). Two members of the research group went to Greece to interview the actors operating in the Greek ports involved in the project.

From the literature review and the direct interviews, we were able to report a list of the processes carried out within a port.

We also defined a questionnaire to be submitted to the Port Authorities involved in the project in order to identify the critical processes carried out in their own ports. The questionnaire reported a list of the main processes carried out within a port and the main activities carried out within the mentioned processes. When submitted to the interviewed persons, the questionnaire was used as a reference during the interview. Once the critical processes were identified by using the questionnaire, the interview was focused on the collection of data about such processes. The questionnaire was not submitted only to the interviewed persons but was also submitted to the main actors in the ports involved in the project.

By the analysis of the interviews and the responses to the questionnaire submitted to different ports actors, we were able to identify the critical processes for each port involved in the project. The list of the critical processes is reported in

Table 1.

After the identification of the critical processes we represented and analyzed them. For the representation we created, for each process:

- the root definition (i.e. the identification of CATWOE, namely Customers, Actors, Transformation, Worldview, Owner, Environment);
- the tree diagram;
- a tabular representation (for each activity we identified inputs, outputs, resources, and duration); and
- the reticular representation.

Table 1: Critical Processes
Then with the support of a specific software (namely Simprocess®) we simulated and analyzed such processes. One of the problems in the process analysis has been the data gathering; indeed not ever the needed data were available or exhaustive. When we found a lack of data for a process, this process was simulated making reasonable hypotheses about the lacking data. Nevertheless we checked with the interviewed people that such data were coherent with the reality.

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Next we represent, simulate and analyze only one process as an example, namely the Management of the Bill of Lading. The remainder of the paper is articulated as follows: first we describe the process, then we represent it, and finally we simulate it and analyze the results.

3. PROCESS ANALYSIS AND REPRESENTATION
The ‘Management of the Bill of Lading’ process starts when the Shipper has to make a cargo shipment and needs the Bill of Lading. The process stops when the Bill of Lading is delivered to the Receiver that forwards it and receives the shipment.

The process customer is the Receiver that, by delivering the received Bill of Lading, qualifies as such and receives the shipment. The process actors are: Shipper, Ship’s Master, Port Agent, Receiver, Chamber of Commerce, and Bank. The process transformation is:

\[ \text{Bill of Lading} \rightarrow \text{Bill of Lading in Receiver’s hands} \]
The process worldview is to let the Receiver qualify as such and pick up the cargo arrived at the destination port.

The process environments are the ship delays in arriving at the destination port.

The tree diagram (Figure 2) uses blocks to represent all the activities identified for the process, starting from an initial macro-block, i.e. the process itself, and then dividing it into the macro-activities that constitute the process. The decomposition of the activities is repeated until arriving to the single activities that constitute the process as it was characterized. Each activity represented within the diagram has a code that allows understanding to what macro-block the activity belongs. In the case of a two-way specialization (a situation in which two alternative routes are feasible), e.g. under the 1.2 block, the codes of the two lower level blocks are 1.2.a and 1.2.b.

The tabular representation (Table 2) summarizes each activity, with its code and its characteristics, i.e. description, inputs, outputs, actors, duration, costs, and technical and material resources. In the Duration column we highlighted in red the duration that has been hypothesized for the lack of data. Indeed, not ever it has been possible to gather accurate data from the actors. As stated above we verified with the actors that all the data hypothesized were coherent with reality.

Very useful for the software implementation is the reticular representation (Figure 3) that graphically describes the activities so the entire path of the process from the initial event to the final event can be identified, along with the interdependencies among the activities. To identify the interdependencies, the inputs and outputs of each activity, as defined in the tabular representation, can be useful.
<table>
<thead>
<tr>
<th>Activity ID</th>
<th>Description</th>
<th>Actors</th>
<th>Input</th>
<th>Output</th>
<th>Optimistic</th>
<th>Mean</th>
<th>Pessimistic</th>
<th>Communication tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Forwarding the instruction about drawing up the Bill of Lading</td>
<td>Shipper to Port Agent</td>
<td>Shipping of the goods</td>
<td>Instruction list</td>
<td>15 minutes</td>
<td>30 minutes</td>
<td>12 hours</td>
<td>Fax, E-mail</td>
</tr>
<tr>
<td>1.2</td>
<td>Forwarding the draft of the Bill of Lading</td>
<td>Port Agent to Shipper</td>
<td>Instruction list</td>
<td>Draft of the Bill of Lading</td>
<td>15 minutes</td>
<td>30 minutes</td>
<td>12 hours</td>
<td>Fax, E-mail</td>
</tr>
<tr>
<td>1.3</td>
<td>Acceptance of the Bill of Lading</td>
<td>Shipper to Port Agent</td>
<td>Bill of Lad- ing draft</td>
<td>The latest version of the Bill of Lading</td>
<td>Immediate</td>
<td>Fax, E-mail</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4</td>
<td>Forwarding the final version of the Bill of Lading</td>
<td>Port Agent to Master</td>
<td>The latest version of the Bill of Lading</td>
<td>The latest version of the Bill of Lading</td>
<td>10 minutes</td>
<td>Face to face</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td>Signing and forwarding the Bill of Lading</td>
<td>Master to Port Agent</td>
<td>The latest version of the Bill of Lading</td>
<td>Bill of Lading signed</td>
<td>10 minutes</td>
<td>Face to face</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.6</td>
<td>Delivering the Bill of Lading</td>
<td>Port Agent to Shipper</td>
<td>Bill of Lad- ing signed</td>
<td>Bill of Lading signed</td>
<td>10 minutes</td>
<td>Face to face</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>Requesting the certification</td>
<td>Shipper to Chamber of Commerce</td>
<td>Bill of Lad- ing signed</td>
<td>Forwarding of the request</td>
<td>1 hour</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.2</td>
<td>Forwarding the certification</td>
<td>Chamber of Commerce to Shipper</td>
<td>Bill of Lad- ing signed</td>
<td>Certification</td>
<td>30 minutes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.0.a</td>
<td>Forwarding the certification and the Bill of Lading</td>
<td>Shipper to Receiver</td>
<td>Bill of Lad- ing signed and certifi- cation</td>
<td>Certification and Bill of Lading signed</td>
<td>30 minutes</td>
<td></td>
<td>Courier</td>
<td></td>
</tr>
<tr>
<td>3.0.b.1</td>
<td>Forwarding the possible certification and the Bill of Lading</td>
<td>Shipper to Bank</td>
<td>Bill of Lad- ing signed and certifi- cation</td>
<td>Bill of Lading signed and certification</td>
<td>30 minutes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.0.b.2</td>
<td>Delivering the Bill of Lading and the possible certification</td>
<td>Bank to Receiver</td>
<td>Bill of Lad- ing signed and certifi- cation</td>
<td>Bill of Lading signed and certification</td>
<td>30 minutes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1</td>
<td>Delivering the Bill of Lading</td>
<td>Receiver to Port of destination Agent</td>
<td>Bill of Lad- ing signed</td>
<td>Bill of Lading signed</td>
<td>2 hour</td>
<td>Face to face</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.2</td>
<td>Forwarding the Bill of Lading</td>
<td>Port of destination Agent to Master</td>
<td>Bill of Lad- ing signed</td>
<td>Bill of Lading signed</td>
<td>Immediate</td>
<td>Face to face</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.3</td>
<td>Delivering cargo</td>
<td>Port of destination Agent to Receiver</td>
<td>Bill of Lad- ing signed</td>
<td>Picking up of goods</td>
<td>Immediate</td>
<td>Face to face</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4. PROCESS SIMULATION
Following we simulate the as-is model of the Managing the Bill of Lading. The simulation is the last step of ‘diagnose’ as defined by Kettinger et al. (1997). Indeed, with such step we can measure, thorough several indicators, the performance of the process. To carry out this task we utilize a specific software, namely Simprocess®. Simprocess® is an object-oriented process modelling and analysis tool that integrates process mapping, object-oriented simulation, and activity-based costing (ABC) into a single tool. Simprocess® allows representation of processes, people, and technology in a dynamic computer model. A model, when simulated, mimics the operations of the business. Because simulation software keeps track of statistics about model elements, performance metrics can be evaluated by analyzing the model output data (as in Figure 9).

In such model, in the first macro-activity, namely ‘Drawing up the Bill of Lading’, there is a deep information exchange among Shipper, Port Agent, and Ship’s Master. All these actors interact to produce the Bill of Lading. On the basis of the information gathered through the interviews and considering the lacking of some data, we made the following assumptions for the simulation:

- The request of shipping the goods occurs once a day at 09:00 and for ten days, so we analyzed ten process occurrences;
- For all the simulation, the following actors are available: 20 Shippers, 20 Masters, 20 Receivers, 20 Banks, one Port Agent, and one Chamber of Commerce (the choice to insert a number of 20 actors for each role is aimed at not causing queues due to interferences between different process occurrences in the process simulation);
- The probability to request the possible certification is equal to 30%;
- The Shipper takes one hour to request the certification;
- The Chamber of Commerce takes half an hour to send the requested certification;
- The probability that sending the Bill of Lading and the possible certification to the Receiver happens in an indirect way is equal to 40%;
- The activity of sending the Bill of Lading and the possible certification to the Bank takes at least one hour, on average two hours and at most three hours;
- The delivery of the Bill of Lading from the Bank to the Receiver takes at least one hour, on average two hours and at most four hours;
- The delivery of the Bill of Lading to the Port agent takes two hours;
- The forwarding of the Bill of Lading to the Ship’s master and the delivery of goods to the Receiver occur only after the ship is arrived at the port, on average after another day since the Bill of Lading is delivered to the Port Agent;
- After forwarding the Bill of Lading to the Ship’s Master, it takes one hour before delivering the goods;
- The actors involved are available all the week days in the following hours:
  - Shipper and Chamber of Commerce: from 08:00 to 13:00 and from 15:00 to 20:00;
  - Port agent and Bank: from 08:00 to 13:00 and from 15:00 to 19:00;
  - Master and Receiver: from 08:00 to 20:00;

Some displays of the model created with the software are reported in the next Figures (4-8). Figure 4 shows the overall process, whereas Figures 5-8 show the activities included in the four blocks, namely ‘Drawing up the Bill of Lading’, ‘Possible request of Certification’, ‘Eventual sending to the Bank’ ‘Cargo in port’.

![Figure 4: Bill of Lading: As-is Model (General View)](image-url)
Figure 5: Drawing up the Bill of Lading (Macro-activity 1.0)

Figure 6: Possible Request of Certification (Macro-activity 2.0)

Figure 7: Eventual Sending to the Bank (Macro-activity 3.0)

Figure 8: Cargo in Port (Macro-activity 4.0)
As emerging from the report generated by the software (Figure 9), during the whole simulation 184 requests of shipping goods were generated (one per day), but only 182 of them were completely processed, i.e. for these process occurrences the goods were shipped by the Port Agent. The remaining two requests did not complete their path because the simulation process was terminated. Moreover, 56 request of shipping with certifications are generated. The path followed by a shipping request to the final event interfered with the paths followed by the other shipping requests. At the most 5 shipping requests and 3 certifications were simultaneously processed. There were waiting times before performing activities because some actors were unavailable at that moment, since they were not working, due to the assumed working hours and the actors involved in performing other activities. The process lasts 68 hours on average for the simple request and 69 hours for requests with certification. 12.5 hours are for performing activities related to simple requests and 14 hours for requests with certification; almost 18 hours are for waiting due to the unavailability of the actors that perform the activities. The actors that work more within the process are the Shipper and the Port Agent. The activities that caused the entities to wait for being processed are:

- the sending of the certification by the Chamber of Commerce;
- the forwarding of the Bill of Lading by the Port Agent to the Master;
- the delivery of goods by the Port Agent;
- the sending of the draft of the Bill of Lading by the Port Agent; and
- the sending of the final version of the Bill of Lading by the Port Agent.

By analyzing the data by macro-activity, we noted that the entities (i.e. the Bills of Lading) spent almost 35.5 hours in ‘Cargo in port’ (4.0) almost 25.5 hours in ‘Drawing up the Bill of Lading’ (1.0), almost 0.5 hour in ‘Possible request of Certification’ (2.0) and almost 2.5 hours in ‘Eventual sending to the Bank’ (3.0). Considering that for ‘Cargo in port’, 24 hours are solely dedicated for physical operation (i.e. unloading goods, docking etc.), the real time spent for the administrative process is 11.5 hours on average. Consequently, the real bottleneck of the entire process is the ‘Drawing up the Bill of Lading’ macro-activity. In this macro-activity there is a heavy and redundant exchange of data that cause a great waste of time.

5. RESULTS OF THE ANALYSIS

Following the same methodologies utilized for the above example (root definition, tree diagram, reticular representation, tabular representation, and software simulation) we have analyzed all the processes indicated in

Figure 9: Simulation Report (Partial View)
For the Management of the Health Practice at the port of Taranto there are no significant criticalities, since the overall duration of the activities aimed at releasing the Health Practice to the Ship’s Master is much less than the time that is potentially available to release it. The ship thus has not to wait due to delays, once it is arrived.

As to the Bunkering management at the port of Kavala, there are no significant criticalities. Potential problems should be searched within the activities of communicating dates and hours of the ship arrival between the Port Agent and the Gas-oil company selected for bunkering. As emerging from the information gathered, the Port Agent, after an early communication concerning the ship arrival, does not get in touch with the selected company, although it would be important that the two actors involved in the process remain in contact.

As to the Management of containers in equipped areas at the port of Kavala, there were multiple requests of checking containers that interfered among them. A potential problem could thus be caused by the limited capacity of the container area in that port, which is still under construction. This area, since it does not allow to simultaneously work on a high number of containers, can cause delays in accepting requests.

As to the Management of works at the port of Thessaloniki, there was a work overload for the planning office.

As to the Management of Landing Communication at the port of Thessaloniki, the overall duration of the activities is much less than the waiting times for activities performed in parallel to be completed. This is an evidence of a complex process, which is open to enhancements through BPR techniques.

As to the Integration between Port and Railway at the port of Thessaloniki, there was a considerable difference between the overall time to perform the activities and the time needed to the train to arrive at the port. This confirms what emerged from the face to face interviews, i.e. the need to modernize the railway structure linked to the port of Thessaloniki.

During the literature review and the processes analysis we found that the processes can be divided into two categories: ‘documental processes’ and ‘operational processes’. The former are characterized by heavy document flows (e.g. Releasing the Health Practice, Management of the Documentation for Waste Disposal, Management of the International code for the Security of Ports and Ships, Management of the Bill of Lading); as a consequence, the main criticalities derive from the management of the documental flow. In the latter (e.g. Integration between Port and Railway, Management of works, Management of containers in equipped areas, Management of ship failures, Management of the cargo loading, Bunkering management) there is a predominant operative part. As a consequence, the main criticalities are influenced by the availability of facilities (e.g. docks, terminals), as well as of instruments and tools (e.g. cranes, trucks, ships). Consequently the ‘documental processes’ can be strongly influenced by BPR because the performance of such processes is mainly based on activity flow improvements, IT solutions, or bottleneck elimination. In the ‘operational processes’ the improvement of the performance should be obtained not only by BPR but mainly by increasing the resources (human or not) and the facilities. So the BPR effort must be mainly oriented toward the ‘documental processes’ to have real improvement.

6. CONCLUSIONS
In this paper we first highlighted the need for the ports to adapt their processes to the new global context through the BPR. Then we proposed a methodology based on graphic representation, tabular representation, and software simulation for the first step of BPR (i.e. ‘diagnose’). As showed by the literature analysis and empirical evidence, even more the ports need a rethinking of their processes. Very significant is the case of the port of Singapore. The BPR can be helpful to redesign the general operations of a port. The result of this effort is a radical improvement of the port performance. However the implementation of BPR is not simple, there are many ways of implementing it and many tools available. So it is very important to select the right path to follow.

In this paper we proposed the path followed to deal with BPR. The type of representation used for the process analysis (namely root definition, tree diagram, reticular representation, and tabular representation) was suitable for the next step, i.e. the implementation of the simulation software. Through the simulation support we highlighted the bottlenecks, the main workloads, and the inefficient activity flows.

Nevertheless it has to be noted that the main problem of the BPR implementation was the availability of relevant data. In this paper it is evident how the lack of some data reduces the precision of the analysis.

Finally, with this research we have started to create a repository of the most critical processes within the ports. Such repository could be very useful for all the actors involved in port activity. Indeed, not ever the actors know well who their partners in port processes are. Moreover such repository is useful for research and consulting scope; indeed the possibility to compare the same processes implemented by different ports can allow finding best practices.

Further research could be focused on gathering more available data to redesign the processes and simulate the to-be processes, in order to compare the as-is and to-be process performance, and to enhance the number of processes analyzed.
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BIOGRAPHIES

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