Maintenance and Spare Parts Management: The Case of Thessaloniki’s Port Authority Container Terminal

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Abstract
The main supporting activities for the efficient operation of a Container Terminal (CT) are those of maintenance management and spare parts inventory management. Thessaloniki’s Port Authority (ThPA) CT has significantly expanded through the last two decades. However, the two relevant supporting systems did not manage to keep up with this development rate, thus today their re-engineering is of critical importance. Furthermore, an organization’s development in the competitive environment of Port Industry, presumes no resources waste (human, economic, equipment). Therefore, improving the operation of these systems on a technical-economic and scientific basis, while neglecting the current empirical policies plays a key-role in increasing port’s productivity and equipment’s availability (mainly for cranes and straddle carriers), as also its cost-effectiveness.

The purpose of this research work is to map the current status of ThPA CT and address few pivotal issues regarding the maintenance and spare parts management system, respectively, while providing the necessary input for the ThPA managers to decide on developing the appropriate re-engineering processes. The empirical, myopic and non-optimal policies currently followed by ThPA should be replaced by more robust and efficient optimization policies that are able to ensure a significantly improved performance.

Keywords: container terminal, maintenance management, spare parts management.

1. Introduction
The main supporting activities for the efficient operation of a Container Terminal (CT) are those of critical equipment maintenance and spare parts inventory management. Thessaloniki’s Port Authority (ThPA) CT has significantly expanded through the last two decades. However, the two relevant supporting departments did not manage to keep up with
this development rate, thus today re-engineering of these departments is of critical importance.

Furthermore, acting in the competitive environment of Port Industry, waste of resources (human (Vagianis (2007), economic, equipment) is prohibited. Improving the operation of these departments on a technical-economic and scientific basis, while neglecting the current empirical policies plays a key-role in saving valuable economic resources and increasing port’s productivity and equipment’s availability.

In 1970, port management was assigned to the Thessaloniki Port Authority. In 1999, the Thessaloniki Port Authority was incorporated into a public limited company named "Thessaloniki Port Authority S.A." (ThPA S.A.), and it was listed on the Athens Stock Market in 2001.

The main profitable economic activity is the CT operation (containers handling and transport activities) with an increasing revenues share of 55%. The CT’s containers handling, storing and stowing equipment includes: four cranes, which are used for container loading and unloading services (2 post panamax), one transtainer of 50 tones lifting capacity, twenty-one straddle carriers (SC), four tractors, five front lifts, twenty trailers, six forklifts, etc.

The equipment of critical importance is mainly cranes, since a crane’s failure causes the disruption of the containers’ flow (production process).

2. Maintenance Department

2.1. Maintenance Department’s Current Operational Status

The Maintenance Department (Md) includes a central building and few support buildings, while its personnel consist of managerial staff, SCs’ and cranes’ operators, and technical staff (mechanical and electrical technicians). Md is open for 361 days per year, 11 hours daily (from 07:00 to 18:00) with 8 hours of regular employment and 3 hours of overtime. The Md reaches its maximum capacity for about 72% of its total operational time, while for the rest 28% of the time the capacity is at 75% of its maximum value.

The primary policy currently applied by the Md is repair maintenance (run to failure policy) with the partial employment of preventive and failures-finding maintenance. As regards the cranes, preventive maintenance planning is based on real time (e.g. every week), while the planning regarding SCs is based on their total time of operation.

The communication between Md and operators is wire-less, conducted via a VH Frequency. When a failure causes the vehicle immobilization, a group of technicians moves at the point
of occurrence and repairs it, while in any other case the vehicle visits the Md’s repair shop. A failure’s search and detection process is usually performed by the operator of a vehicle or the Md staff (visual or electronic check). The common cause for failures is regular deterioration due to the equipment use (e.g. spreaders, gear-boxes, drag-lines, etc.).

The failures that occur while the Md is closed (13 hours per day) are repaired the next day. Moreover, Md’s planning and decision-making procedures are often performed by the employees. The repair priority is assigned to equipment according to whether or not its operation is of critical importance (e.g. BCs have the absolute repair priority), which practically means that the criterion that defines the equipment’s priority is whether or not the equipment failure causes the disruption of the production process (flow of containers). Moreover, a secondary rule, regarding priority assignment, is fixing failures according to the required-time for a failure to be repaired (shortest process next).

There are not any standard methods or standard times regarding the performance of maintenance tasks. The main applied repair policy is rather empirical, while sometimes technicians use the manufacturer’s manuals or come in direct communication with the manufacturer. Repair time has a range of 1 day to 1 month. Operators’ and technicians’ opinions are considered by the manufacturers and are incorporated into the production process in order to obtain more efficient and user-friendly equipment.

Md records include: the daily maintenance book, the technical specifications and standards record, the history record, etc. The Md’s information system consists of two computers, one electronic failures detection system, and software.

Md is supplied with spare parts and materials by the SPIMd’s primary warehouse (repair maintenance) or the CT’s secondary one (preventive maintenance). Spare parts often differ to the ones recommended by the equipment manufacturer.

There are few general empirical observations for the maintenance procedures costs such as that the older vehicles have a higher maintenance cost, etc.

### 2.2. Maintenance Department’s Disorders

The number of the available technical staff has been subjected to a significant reduction during the last decade, meanwhile the active equipment increased by 2 cranes, 6 SCs, e.t.c., extending the task load of the department (preventive and repair maintenance).

Furthermore, the SCs’ operators prefer the new vehicles, thus, their non-stop operation for 22.5 hours daily, in contrast to the manufacturer guidelines allowing for a 16 hours operation, leads to more failures.
The absence of an adequate building infrastructure raises few critical limitations to the Md’s unimpeded performance, especially during winter time (low temperature). Furthermore, the absence of critical technical equipment plays a key-role in the safety of the employees.

The Md is open for 13 hours per day, thus the intermediate time between two openings is 11 hours. Meanwhile, the equipment is in full operation, which means that there is no real-time technical support for approximately 45% of its operational time with the sequential delay in failures repairing, the accumulation of pending tasks, e.t.c. The low number of employees, which has reached to a turning-point, results in a periodical reduction of the Md capacity (25%) – for about three months per year, during the holidays – that is stepped-up when the only electrician is absent. The technicians have not taken any specific training and the tasks are not allocated according to the technicians’ particular capabilities.

The role of the Md chief and the CT managers in organizing and programming the Md operation is limited. The task programming takes place on an empirical, non-scientific basis, while some of the decision-making processes have been transferred to lower levels of hierarchy. The lack of an adequate control procedure results in low-quality performance. Moreover, the lack of standards concerning the execution method and time for every task has negative effects on Md programming.

There is no central organized, scientific maintenance system. The technical department staff executes few preventive maintenance procedures and a limited failures-finding maintenance. The consequent equipment’s availability reduction and the irregular presence of failures due to the insufficient maintenance procedures results, finally, in a task overload for the technical department itself.

When a vehicle has a failure at a particular day and this day is close to the preventive maintenance date (according to the equipment’s maintenance program), the Md does not execute the maintenance tasks, so the vehicle has to re-visit the repair-shop, which means that there is no scale-economies.

There is not any specific programming pertaining to the required materials, spare parts or general technical equipment. Moreover, the records’ update is often deficient, and there is no type of statistical analysis conducted in order to utilize the collected data.

There are no significant financial limitations regarding the operational total cost of the MD.

2.3. Maintenance Department’s Re-engineering

Initially, the Md has to reach an acceptable level of operation before further improvements regarding its planning, programming and operational processes take place.
The buildings have to be reformed and some critical equipment should be obtained. The preventive maintenance should be established as the main policy of the Md. Repair maintenance and occasional and failures-finding maintenance should be performed supplementary to the main policy. At a later stage, when the collection and statistical analysis of the available data is done, the predictive maintenance should be added to the overall policy in order to efficiently control this stochastic system.

The ThPA should expand the current personnel with the addition of a mechanical technician and an electrician to ensure the required human resource capacity, which is necessary, mainly, for the preventive maintenance performance. Furthermore, a shift reshuffling (operation in 2 shifts per day/ 16 hours) is of critical importance. When demand peaks occur, the proposed policy is over-time labor thus it is more efficient than outsourcing, due to the specific characteristics of the equipment and the lack of specialized personnel in the area of Thessaloniki.

The proposed division of the Md into a SCs’ department and a cranes’ department (currently applied to Piraeus CT) is rather premature due to lack of critical mass of equipment. The partition of the processes would reduce the overall system’s flexibility, the number of available capabilities for each department, and the utilization of human resources. Comparing Thessaloniki’s CT to Piraeus CT, we should note that the latter holds 173 equipment units (cranes, SCs, etc.), while the former supports just 53 equipment units.

The Md should establish and operate a new maintenance system, reconsidering records, reports, quality control processes, maintenance costs, spare parts supplying processes, etc. The determination of the following three fundamental maintenance elements is necessary (Vlachos, 2005): (i) the tasks’ contents, (ii) the standard method for performing each task, and (iii) the standard performance time.

The basic cost elements concerning the Md’s activities should be estimated and the Md should be supplied with an appropriate specialized software (Computerized Maintenance Management System – CMMS).

Finally, a more optimistic solution is to address the overall system’s processes on an holistic basis (Pachis, 2005). By adding a new wi-fi GPS system and sensors to the current existing systems (data record system and wireless communication system) we are able to create a new one, providing real-time data and information. This system could integrate few segmental procedures (production, maintenance, and inventory management) into a unique, more efficient operational entity/ system.
3. Spare Part Inventory Management Department

The CT’s facilities include two warehouses: a primary warehouse (at the Spare Parts Inventory Department), where most of the Stock Keeping Units (skus) are stocked, and a secondary one (at the CT’s Maintenance Department), where skus of low cost and high demand are stocked, as well as fuels and lubricants.

3.1. Spare Parts Inventory Management Department’s Current Operational Status

The warehouse of critical importance is the primary one, which includes the manager’s office, the secretariat, and few personnel offices, while its personnel is constituted of a manager and 6 employees. The warehouse is open from 07:00 to 15:00 daily.

The total skus are approximately 6,200, with 1,173 (mechanical and electrical material) of them concerning the CT. Spare parts are divided into the following categories:

- skus with no stock/skus with stock.
- “active” skus, for which demand occurs, and “under withdrawal” skus, which includes obsolescent and useless materials.
- repairable/non-repairable.

As regards the selection of the suppliers, the basic criteria are to:

- ensure that spare parts conform to the required technical specifications and quality standards,
- minimize lead-times, and
- achieve procurements at low prices (or discounts).

Generally, the CT’s managers select suppliers from the local market (Thessaloniki), whenever this is feasible, because in some specific cases, the import of the parts is required. Additionally, we should note that there are no contracts between the CT and a specific supplier.

A supplier selection process takes place in one of the following three ways, according to the order value (Chandolia and Chotzidou, 2005):

- for orders up to €1,500, the general financial director’s approval is required,
- for orders between €1,500 and €15,000, the chief executive officer’s approval is required, while a committee performs the relevant market research, and
- for orders over €15,000, an open contest (lower bid) takes place.

When a demand for a spare part occurs, the Md is informed through the information system, if there is enough stock for this part or not. A request card is invoiced and dispatched to the
SPIMd, where a second “availability-check” is performed. If there is enough stock to cover the demand, the relevant materials are forwarded to the Md. When a shortage occurs, a purchase card is edited.

Materials are transported to the CT by trucks or by ships. Following their arrival and record of the relevant data, spare parts and materials are stocked into the warehouse. Materials that need specific handling and storage conditions are stocked in an appropriate place. Demand forecasting and the current inventory management policy are performed by the manager on an empirical basis. Taking into account data pertaining to last year’s demand, the warehouse manager makes a prediction about the upcoming year, and determines a lower (reorder point) and an upper allowable limit for the inventory level. Practically, inventory inspection is continuous and when the inventory level reaches the lower limit an order is placed, which is equal to the difference of the upper limit minus the lower one.

Lead times are spread within the range of:
- 1 to 2 hours, if the available stock is adequate,
- 1 day to 1 month, if an order is required, or
- up to 1 year, if the construction of a spare part is inevitable.

There are not any significant cost limitations pertaining to spare parts ordering and stock keeping policies, while the basic suppliers usually provide discounts.

The CT uses SCO-UNIX warehouse management information system by Delta Singular S.A., since 2003.

3.2. Spare Parts Inventory Management Department’s disorders

The last two decades were characterized by order quantities considerably higher than the required ones, resulted in the increase of useless and worthless inventory. SPIMd is currently in a transient phase, trying to discard from this stock and move to a new more efficient operational performance level. The crucial delay of the decision-making process on the subject of handling (recycle or destroy) obsolescent and useless spare parts (estimated to be 38.5% of the total skus) leads in a low flexibility, space-consuming, cost-intensive, and complicated inventory management system.

The major drawbacks concerning the primary-warehouse operation involve:
- invalid coding and
- erroneous recording for the stock-keeping materials/ units,
since there are sometimes more than one codes corresponding to the same sku or materials/
units with no code etc. Additionally:

- for 33.2% of the skus, the allowed lowest and highest inventory levels are equal.
- for 12.8% of the total skus, there is no indication for their reorder points.
- for 19% of the skus, the maximum stock-level of these values are zero.
- for 23% of the skus, the current inventory level is higher than the decided one.

The utilization of the warehouse management software is low, thus the company lacks
essential capabilities that it has paid for. The exact time that a demand occurs and the time
that a demand is satisfied are not recorded; therefore demand seems always to be satisfied and
critical information regarding shortages, backorders, lead-times and delays are lost. The
overall system is not supported by appropriate inventory management software (optimal
reorder point, optimal order quantity etc.).

Furthermore, the CT employees often procure greater quantity for a sku than the required one
in order to carry out the maintenance tasks, resulting to a false demand input.

The decision-making process regarding the selection of the appropriate supplier (cost of order
lower than €15,000) is carried out by the relevant committee. However, the criteria that are
settled by this committee are ambiguous, since sometimes it is the specifications or unit cost
that matters while other times it is lead time. In case of orders with cost higher than €15,000,
an open contest (lower bid) takes place.

The applied inventory management policy is rather insufficient since decision-making on
critical issues is empirical. Specifically, there are no scientific methods/models employed
cconcerning the decision making on stocking or not a particular sku, the determination of the
reorder point and the order quantity, demand forecasting etc. Furthermore, there is no logistics
monitoring for the secondary warehouse, which means that there is ignorance for its stock
level and potential shortages.

Finally, the primary warehouse is open for 40 hours per week while the Md is open for 77
hours per week; therefore there is a substantial schedule gap between the working-hours of
these departments. Practically, this mismatch implies that it is impossible for the Md to be
supplied with spare parts approximately for 48% of its operational time.

3.3. Spare Parts Inventory Management Department’s Re-engineering

The role of the secondary warehouse, which is settled into the physical area of the CT, should
be upgraded in order to facilitate the entire order-and-receipt processes and decrease the total
inventory management levels. Although in the past managers addressed the inventory
management issue on a holistic basis, using a central inventory management system to
support the entire company’s supply needs, we believe that the CT should be autonomous and
operate independently.

The count of the total number of skus, the record of the current inventory level for each one of
them, and the disposal of the useless and obsolescent units are just few of the required steps in
order to reengineer the SPIMd. It is estimated that the entire system should dispose of
approximately 30-40% of the total skus to obtain a higher level of flexibility and ease of
managing.

SPIMd employees should take few training courses involving application of inventory
management practices and use of the software. Furthermore, critical data should be gathered
and statistical analyzed to feed (raw data) the appropriate scientific models. The current
inventory management software has to be extended with the addition of more specialized
capabilities.

The primary warehouse schedule should be extended to 16 hours of operation per day
(Monday to Friday), while one more shift (8 hours) should be added on Saturday. According
to this reconsideration, technical equipment would be supported for 70% of its operational
time in contrast to 29% currently.

Demand forecasting should be performed through the use of time-series analysis.

ABC-analysis outcomings show that

- 20% of the skus corresponds to 86% of the inventory value,
- 30% corresponds to 12% of the inventory value, and
- 50% of the total skus corresponds to 2% of the total inventory value.

The proposed inventory management models for spare parts that are used for preventive
maintenance and thus they have known and deterministic demand, include the employment of
simple Economic Order Quantities models (EOQ models), which co-evaluate lead times, and
All Units/Incremental Discount EOQ models, when discounts are available (Iakovou, 2005).
Moreover, (s-1, s) policies, allowing for unsatisfied demand, should be applied in order to
manage the inventory of spare parts (stochastic demand), either holistically or individually
(Muckstadt, 2005; Silver, Pyke, and Peterson, 1998). Finally, a point of interest is the
management of high cost, high significance and low demand (s-1, s policies) units which can
be repaired (“as good as new”) (Sherbrooke, 2004).
4. Numerical Analysis

In this section, a numerical analysis is presented for a specific category of SKUs (repairable spare parts) in order to illustrate the application of the proposed inventory management methods.

In general, the SKUs under study correspond to repairable spare parts of:
- high cost,
- low demand,
- and high significance.

Actually, these items are systems of parts that are addressed as an integrated entity. Practically, they could be further analyzed into their component parts or echelons of parts (first indenture items, second indenture items, etc), on a bill-of-materials basis. As concerns the ThPA CT, such SKUs are SCs’ engines, cranes engines and reduction gears, etc.

A model developed by Sherbroke (2004) on the computation of an optimal curve relating investment cost to expected system backorders is employed to find the optimal inventory management policy. Sherbroke, using a derivation by Smith, Fisher, and Heller (1972), shown that the maximization of the availability of the equipment is obtained by the minimization of the system’s backorders. Thus, the optimal curve for investment cost versus expected backorders can be transformed immediately into an optimal curve for investment cost versus expected system availability.

The model employs the Palm’s Theorem (1938) in order to enable us to determine the steady-state probability distribution of the number of units in repair from the probability distribution of the demand process and the mean of the repair time distribution.

The model inputs include:
- mean annual demand (m) in units,
- mean repair time (T) in years, and
- cost per unit (c) in Euros.

The model output includes:
- a discrete function between the mean total backorders and the investment cost.
- a discrete function between the mean equipment’s availability and the investment cost.

The mathematical statement for three items is:

\[
\min (s_1, s_2, s_3) \quad EBO(s_1) + EBO(s_2) + EBO(s_3)
\]

subject to \[c_1s_1 + c_2s_2 + c_3s_3 \leq C, \text{ for a series of total system cost targets } C,\]
where, \( EBO(s_i) \) denotes the expected number of backorders for item \( i \) when \( s_i \) units are stocked, \( c_i \) denotes the cost of item \( i \), and \( C \) denotes the total cost of inventory investment for items 1, 2, and 3.

The target is the determination of the optimal inventory management policy or equivalently, the determination of the base stock level for each item. Thus, the decision variables are the spare parts’ stock levels \( (s_i) \). The two competitive criteria, affecting this decision-making process, are:

- the maximization of the equipment’s availability or equivalently, the minimization of the average total backorders, and
- the minimization of the equipment investment (cost).

The algorithm addresses the set of items under study on a holistic basis, defining the considered stock-levels simultaneously, on the same run (not applied separately on each item). The ordering policy implies that when a demand for a particular item occurs, we should place an one unit order \( (s-1, s \text{ policy}) \). Two potential options are available for a manager to decide on, namely:

- for a given equipment investment (inventories), the algorithm determines the optimal policy that maximize the equipment’s availability.
- for a given equipment’s availability, the algorithm determines the optimal policy that minimize the equipment investment (inventories).

The algorithm is applied on three SKUs of cranes’ engines (E100, E105, and E120). The input data is summarized in table 1 and was obtained through the relevant statistical analysis.

**Table 1: Algorithm’s input data**

<table>
<thead>
<tr>
<th>SKU</th>
<th>E100</th>
<th>E105</th>
<th>E120</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average annual demand (units) ([m])</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Average repair time (years) ([T])</td>
<td>0.167</td>
<td>0.334</td>
<td>0.083</td>
</tr>
<tr>
<td>Average number of units under repair (units) ([mT])</td>
<td>0.167</td>
<td>0.334</td>
<td>0.083</td>
</tr>
<tr>
<td>Cost per unit ((.000 \text{ €})) ([c])</td>
<td>4.3</td>
<td>2.765</td>
<td>1.87</td>
</tr>
</tbody>
</table>

The algorithm was implemented using OptQuest, a decision-making tool of the Oracle Crystal Ball package (for predictive modeling, forecasting, simulation, and optimization). The results are presented in table 2.
### Table 2: The discrete function between availability and total cost

<table>
<thead>
<tr>
<th>Policy</th>
<th>Base Stock $(S_1)$</th>
<th>Base Stock $(S_1)$</th>
<th>Base Stock $(S_1)$</th>
<th>Expected Backorders $(EBO)$</th>
<th>Availability $(A)$ [%]</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Policy 1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.5833</td>
<td>86.20</td>
<td>0,000</td>
</tr>
<tr>
<td>Policy 2</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0.5034</td>
<td>87.77</td>
<td>1,870</td>
</tr>
<tr>
<td>Policy 3</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0.2999</td>
<td>92.67</td>
<td>2,765</td>
</tr>
<tr>
<td>Policy 4</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0.2199</td>
<td>94.56</td>
<td>4,635</td>
</tr>
<tr>
<td>Policy 5</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0.2166</td>
<td>94.56</td>
<td>6,505</td>
</tr>
<tr>
<td>Policy 6</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.1463</td>
<td>96.38</td>
<td>7,065</td>
</tr>
<tr>
<td>Policy 7</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>0.0664</td>
<td>98.35</td>
<td>8,935</td>
</tr>
<tr>
<td>Policy 8</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.0631</td>
<td>98.43</td>
<td>10,805</td>
</tr>
<tr>
<td>Policy 9</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>0.0218</td>
<td>99.46</td>
<td>11,700</td>
</tr>
<tr>
<td>Policy 10</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>0.0185</td>
<td>99.54</td>
<td>13,700</td>
</tr>
<tr>
<td>Policy 11</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>0.0169</td>
<td>99.58</td>
<td>14,465</td>
</tr>
<tr>
<td>Policy 12</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>0.0093</td>
<td>99.77</td>
<td>16,000</td>
</tr>
<tr>
<td>Policy 13</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>0.0060</td>
<td>99.85</td>
<td>17,870</td>
</tr>
<tr>
<td>Policy 14</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>0.0045</td>
<td>99.89</td>
<td>18,765</td>
</tr>
<tr>
<td>Policy 15</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>0.0012</td>
<td>99.97</td>
<td>20,635</td>
</tr>
</tbody>
</table>

The decision maker has the option to set either the equipment’s availability or the investment cost at the desired level, and then determine using the algorithm the other one. For example:

- setting the target value of the equipment's availability to an over 95% level, the ThPA should follow policy 6, and invest an amount of €7,065 for the procurement of $s_1=1$ [unit] of E100, and $s_2=1$ [unit] of E105 (figure 1).
- setting the target value of the total investment cost to a lower than €10,000, the ThPA should follow policy 7, stocking $s_1=1$ [unit] of E100, $s_2=1$ [unit] of E105, and $s_3=1$ [unit] of E120 (figure 1).

We should note that implementing policy 6, there is no base stock that should be kept for the E120 item. This solution is in line with the holistic nature of the algorithm, allowing for the total investment cost minimization.
5. Conclusions and Discussion

The optimization of the MS and SPIMS is crucial for the profitability and the efficient operation of every container terminal. The empirical, myopic and non-optimal policies currently followed by ThPA should be replaced by more robust and efficient optimization policies that may ensure a significantly improved performance (i.e. cost-efficiency, increased productivity, rational utilization of the available resources, flawless operation, increased equipment availability, etc.). To this effect, this diploma thesis proposes a holistic hierarchic decision-making methodological framework for ThPA’s CT. In particular, the main goal of this work is to re-engineer container terminal’s spare parts delivery and receipt operations, as well as the maintenance processes of the container terminal’s equipment.

References

1. Chandolia, B., and Chotzidou, M., (2005), Organizing Thessaloniki’s Port Authority S.A. Inventory Management System. Diploma Thesis. Aristotle University of Thessaloniki, Faculty of Engineering, Department of Mechanical Engineering, Industrial Management Division.
2. Iakovou, E., (2005), Notes on Logistics and Supply Chain Management. Aristotle University of Thessaloniki, Faculty of Engineering, Department of Mechanical Engineering, Industrial Management Division.
9. Vlachos, D., (2005), Notes on Maintenance and Reliability Theory. Aristotle University of Thessaloniki, Faculty of Engineering, Department of Mechanical Engineering, Industrial Management Division.