This work studies the operations of loading and unloading in container terminals using indicators of productivity, efficiency and costs. Before that it is necessary applying queueing theory to study the movements of ships.

Container terminals can be conceived as a system composed by other four subsystems: the zone destined to load and unload ships, the warehouse of containers, the zone to delivery and receive the exterior transport and the one that is oriented to interconnect the rest of the subsystems. The capacity of all terminal is the minimum of the capacities of the subsystems. This work is focused in the first subsystem.

The operations to load and unload containers of the ships can be analysed using queueing theory. Using an idea of Daganzo, instead of working with ships as a unit of our study, ships can be divided in holds. A hold only admits one crane. This implies that we have a system with bulk arrivals. Also, the ships’ arrivals have a Poisson distribution, the time used by the cranes to serve ships has an exponential distribution and the discipline of the queue is FIFO. According to these characteristics, the most important aspects that define the queueing process can be obtained. To do analytically resolution it is necessary assuming that the quantity of holds that the several ships have is a geometric distribution.

After studying analytically the operations of loading and unloading ships, three indicators are defined. The first of these is an indicator of productivity, denoted by P, and is defined as the number of movements to load and unload one ships per unit of mean time that ships is in the harbour. Another indicator is about costs, ICB, and indicates the cost per unit of movement used by ships in its operations. The last indicator is about the efficiency of the operations in the terminal. To do this the Evolved Analysis Data (DEA) is used in a particular way. Instead of considering a real case as a reference of efficiency, a theoretical case is used and compared with the situation of the container terminal. The mean time that a ship stays in the harbour is used. All of these indicators can be viewed as a several ways to study the operations of ships in container terminals.

On another hand, the optimal quantity of the several variables involved in the indicators can be obtained using an heuristic algorithm. Because of complexity of the expressions of the indicators, it is impossible to use a software to achieve the optimal solution. To make this algorithm two principles are used: to do a simple way to estimate the optimal solution, because the exact solution is not needed, and using the most information as possible from the container terminal.

In order to have a global vision of the problems of container terminals, the role of harbour authority is considered. This institution has to fix the several tariffs that ships has to pay when using all harbour services. It’s essential to equilibrate the marginal social cost to the marginal social benefit. Establishing appropriate tariffs this objective can be achieved. Because it’s extremely difficult to obtain the demand curve of the container market and another economic values, in this work we make a theoretic analysis.

Finally, all this theory is applied in a particular example. Using some characteristics of the ships operating in the container terminal of Barcelona harbour, TCB, the value of the indicators and its optimal values are calculated. Applying heuristic algorithm it is probed that it is better to improve the organization of work than increasing the number of cranes. The values of this example indicate that the model exposed in this work produce coherent results.