

# The role of a landlord port authority in the introduction of lean production theory in a port environment

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By K. Oganessian (332884)

Thesis coordinator: Martijn Streng

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# 1 Introduction

## 1.1 General introduction

Seaports can have a huge impact on the economy of the port region and the environment it is in (Langen, P.W., Nijdam, M.H, 2012). They are gate way for international trade. A large portion of international trade are handled by seaports. The European commission estimates that seaports in Europe facilitate 90% (in terms of weight) of the continents external trade (European Commission, 2012). Seaports generate employment directly in the port region en indirectly through the economic activity it attracts. It is therefore of crucial importance that a seaport functions properly and efficiently to create value for the economic hinterland it services. Ports that perform poorly waste resources and they are a missed opportunity for the region to benefit from the trade it can attract (European Commission, 2012).

## 1.2 Short introduction to lean production theory (LPT)

The increasing cost and quality competition in seaports and between seaports, the volatile demand of consumers and the efficient use of scare land amongst others contribute to a need for port efficiency. One such approach to achieving waste reduction and efficiency improvement is lean production theory.

Womack and Jones (1990) analyzed the success of car manufacturer Toyota in the second half the twentieth century. Toyota outperformed traditional car manufacturers like General Motors (GM) by a production method which was more efficient than the traditional mass production implemented by GM. The authors called this production method lean production. Lean production is in essence the elimination of waste in the production process of a plant. Lean organizations are in the position of constantly adding value to their customer with less resources.

Over the years lean production theory has evolved from set of tools and principles used by Toyota to an overarching business philosophy and practice. Lean production theory is applied to wide range of business fields including services industry, construction industry and healthcare (Marodin & Saurin, 2013).

## 1.3 Scientific Relevance

(Robinson, 2002) describes the increasing importance of the role of the port in a supply chain. A port contains several supply chains which compete with one and another. The author argues that the role

of a port should be analyzed as an element in such a supply chain. The supply chain as a unit of analysis for lean production theory has been intensively researched (Marodin & Saurin, 2013). There is less research however for the port as unit of analysis in LPT. In the current literature the roll of the port authority is not researched and is rarely mentioned.

The port authority however does have role to play in implementing lean production theory in the port environment, because of the complexity of the tools required for the implementation and the requirement of the external environment of the port operator.

#### **1.4 Structure of bachelor thesis / Methodology**

This research will focus on the role of a landlord port authority model as described by the (WorldBank, 2003). The landlord port authority is a widely used model for port reform in the 1990's and 2000's. Currently the majority of the ports in Europe have a form of a land lord port model.

This bachelor thesis answers the following research question:

*“What is the role of a landlord port authority in the application of lean production theory in a port on micro, meso and macro level?”*

This analysis will be conducted by developing a theoretical model with which this thesis assesses the role of the port authority in applying LPT. The development of the theoretical model will be done in chapter 2. We begin with explaining LPT principles and tools as used business today. This step is not straightforward as it seems considering that over the years LPT has grown to be an expansive and complex theory by years of research and implementation. (Shah & Ward, 2007) found that there exists widespread confusion and inconsistency associated with LPT.

After establishing a thorough theoretical basis for LPT this paper identifies three levels of implementation of lean production theory, namely: micro, meso and macro. The micro level is the level of an operator in a port; meso is the port environment and macro is the application of LPT between ports. In chapter 2 we will identify key implementation issues on each level based on current literature. The theoretic background for a landlord port model will be given after which we will assess the influence a landlord port can have on a port. In chapter 3, 4 and 5 the key implementation issues of LPT are coupled with the influence tools the port authority has. After a comprehensive overview of each assumption made the validity of the assumptions are checked through a case study of the port of Rotterdam port authority at the end of chapters 3, 4 and 5.

## 2 Concepts

### 2.1 Principles of Lean production theory (LPT)

As mentioned earlier the key idea behind LPT is the elimination of waste, which the Japanese call *Muda*, in a production process, creating value for the customer and to permanently improve all factors of the production process. In doing so the company creates a competing customer oriented value proposition for the customer. There is however no easy “implementation recipe” for LPT. Each company needs to identify the relevant set of tools for their company in their own sector of business. As with each change in organization implementation of LPT requires solid commitment and constant improvement.

Waste can be defined as an activity that does not create value (Clegg, Pepper, & Spedding, 2010). Companies need to identify these wastes first before they can try to eliminate them. Womack and Jones (1990) described 8 key forms of waste:

1. Defects of product
2. Unnecessary transportation/transferring of goods
3. Waiting time in production process
4. Overproduction
5. Excess storage capacity
6. Unused capacity
7. Unnecessary repetition

After initially describing the Toyota production system (J. P. Womack & Jones, 1996) identified five principles for reducing waste and building an enterprise based on LPT:

1. Specify value by specific product/service
2. Identify the value stream for each product/service
3. Make the value flow without interruptions
4. Let the customer pull value from the producer
5. Pursue perfection through constant improvement

The authors defined the elements and described tools for which to implement these elements. Over the years the set of tools and the knowledge of the tools for LPT have expanded with researches and companies adopting and innovating. A good example of this is the introduction of Six-sigma by Motorola in the nineties (Salah, Rahim, & Carretero, 2010). Because of the overlap between LPT and Six-Sigma many companies use a combined strategy of these theories. For the purpose of this study

we will refer to only the LPT tools. In the next section we will discuss each element with the accompanying tools briefly. These tools are relevant since implementation in the port environment requires knowledge and understanding of the implementation of LPT not just the overarching principle. This knowledge also allows us to determine the applicability of a tool to the port environment. There are of course conflicts in specific tools in a port environment which we will discuss in the conclusion.

Before we discuss the elements we need to address the key role of the human aspect of a lean organization. Good teamwork and communication within the organization drives for a well function lean organization. Toyota adopted a strategy of empowering its personnel by giving them the ability to stop an entire production line if needed to fix a mistake. This empowerment was called *autonomation*: automation with a human touch. This was a different in mass production: each individual did a highly simplified and specialized job and later on any defects were corrected. At Toyota motor company workers worked in teams to produce part of the vehicle. The low-level employees were empowered and encouraged come up with improvements for the production process. Thus employees are key in achieving a successful implementation of LPT.

### **2.1.1 Specify value for each specific product & Identify the value stream for each product**

To identify waste in a production process one must first identify the value through the eyes of the end-user: the customer. A value proposition is made for each product and service. The value proposition clearly defines which value the customer gets upon use.

The next step is to backtrack the value offered by identifying value stream of the product in the company. At any stage of the production process the value added can be mapped and defined. This principle is referred to as *Value Stream Mapping (VSM)*. There are several ways tools developed for doing this each with a specific type waste identification (Hines & Rich, 1997).

The ultimate goal is to determine whether or not the activity creates value. Three types of activities can be defined (Monden, 2011):

1. Non-value adding
2. Necessary but non-value adding
3. Value adding

The production process needs to be adjusted to eliminate the first type of *Muda*. An example of waste in this regard is waiting time. The second type of activity is harder to eliminate thus is accepted under the current operating conditions.

### **2.1.2 Make the value flow without interruptions**

The goal in this step is to make sure that there is no waiting time or downtime in the production process in other words: reducing lead time. The term flow refers to ease and speed of which a half-fabricate “flows” through the production process. Traditional mass-production companies are reliant on large batch production with the waste associated with it (Mi Dahlgaard-Park, Dahlgaard, & Mi Dahlgaard-Park, 2006).

One of the most important tools of creation flow is just-in-time production or JIT. JIT is defined as “only the necessary products, at the necessary time, in the necessary quantity” (Sugimori, Kusunoki, Cho, & Uchikawa, 1977). By reducing stock to the bare necessity it forced workers to work efficiently and plan ahead. JIT requires the company to closely cooperate with its suppliers. Other forms of variability need to be eliminated as well like: product variability, demand variability and task variability of workers.

### **2.1.3 Let the customer pull value from the producer**

This element of LPT heavily relies on engineering and customer relations of the company. If a company knows exactly what the end user wants it can prevent *Muda* in the form of unsold items and the engineering and production costs associated with it. Target pricing and costing are key tools in creating a production which fits the description of the end user.

The Toyota Motor Company managed this by having closer relationships with their buyers: there were auto dealers all over the country and the personnel had often personal relationships with the buyers. This way information about demand could flow bottom up.

### **2.1.4 Pursue perfection through constant improvement**

Upon implementing the previous steps one can see that there is no end to the reduction of waste opportunities. To achieve a competitive quality all personnel need to strive for constant improvement or *Kaizen* as it is called in Japanese.

Over the years Total Quality Management (TQM) arose as a method for constant improvement and quality management in organizations implementing LPT. “TQM is a philosophy or an approach to management that can be characterized by its principles, practices and techniques. Its three principles are customer focus, continuous improvement, and teamwork.” (Dean & Bowen, 1994)



## 2.2 Application of lean production theory at terminal level (micro)

Lean production can transform a production site in such a way that it uses half of the available resources (Womack & Jones, 1990). Other benefits include reduced customer lead times, an increase in market share, a quick launch of new services and productivity gains (Paixão & Bernard Marlow, 2003). Loyd et al. (2009) identified lean production as a solution to bottle-necks in seaport operations.

To date several ports have successfully implemented lean port operations. (Loyd et al., 2009) describe this process for the Port of Mobile in Alabama after experiencing growth issues. The authors identify lean implementation tools for the port environment. (Olesen, Powell, Hvolby, Fraser, & Pitt, 2015) expand on this work by introducing the concept of “lean terminalization.” The authors describe the implementation of the concepts at Alnabru freight facilities (Norway) and Aalborg port facilities (Denmark).

For the purpose of this study the following key elements can be described based on the existing

body of literature on lean production and the application of this theory at micro level:

Key element / Source literature	(Loyd et al., 2009)	(Olesen et al., 2015)	(Marlow & Casaca, 2003)	(Paixao & Marlow 2003)	(Casaca, 2005)	(Beskovnik & Twrdy, 2011)
Management commitment	x	x	x	x		
Supporting ICT infrastructure and performance indicators	x	x	x	x	x	
Efficient terminal lay-out		x				

Effective training of personnel	x	x	x	x	x	
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*Table 1 - Key elements at micro level*

### 2.3 Application of lean production theory at port level (meso)

Port operators/terminals can increase operational efficiency by implementing lean production theory. One actor in a port, however, cannot fully make use of the benefits of LPT. The external environment of the operator plays an essential role in achieving operational efficiency (Paixão & Bernard Marlow, 2003). For example, the availability of several modes of transportation ensure that the firm can switch easily if congestion arises in a particular mode. LPT also requires a certain streaming of arrivals and departures of vessels (Olesen et al., 2015). Port accessibility is key regarding this issue.

For the purpose of this study the following key elements can be described based on the existing body of literature on lean production and the application of this theory at meso level:

Key element / Source literature	(Loyd et al., 2009)	(Olesen et al., 2015)	(Marlow & Casaca, 2003)	(Paixao & Marlow 2003)	(Casaca, 2005)	(Beskovnik & Twrdy, 2011)
Overall port performance measurement			x			
Port accessibility		x		x		
Intermodality				x		x
The presence of distriparks				x		
Knowledge sharing and sharing of best practices	x					

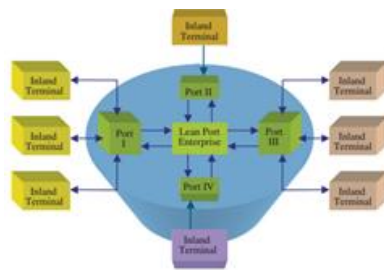
Table 2 - Key elements at macro level

## 2.4 Application of lean production theory at inter-port level (macro)

The fourth generation of ports is described as ports which are physically separated but linked through common operators or through a common administration (Secretariat UNCTAD, 1999). This is the basis for (Paixão & Bernard Marlow, 2003) to propose the concept of a lean and agile port. The concept of an agile port is beyond the scope of this research.

The internal integration, as proposed by the authors, refers to the application of lean production theory to its operations. The external integration is then necessary to manage factors over which the company has no control over. The external integration ultimately leads up to the creation of a lean port network which is the authors proposed model for the fourth generation port. The following diagram depicts this system:

Figure 1 - Lean Port Network



source (Marlow & Casaca, 2003)

The need for coordination arises in the proposed lean port network which is filled in the by a lean port enterprise. In this context the lean port enterprise refers to a virtual entity or a governing body.

For the purpose of this study the following key elements can be described based on the existing body of literature on lean production and the application of this theory at macro level:

Key element / Source literature	(Loyd et al., 2009)	(Olesen et al., 2015)	(Marlow & Casaca, 2003)	(Paixao & Marlow 2003)	(Casaca, 2005)	(Beskovnik & Twrdy, 2011)
Coordination and cooperation with hinterland ports			x	x		
Coordination and cooperation with adjacent ports			x	x		
Creation of the lean port enterprise			x	x		

Table 3 - Key elements at macro level

## 2.5 The landlord port authority model

After a wave of port reform in the 1980's and 1990's many countries struggled with implementing an adequate port administration for the changing environment. The World Bank provided a model for a port authority in their port reform tool kit (WorldBank, 2003). The object of this port reform toolkit was to help policy makes by presenting best practices and a thorough literature review.

The World Bank classified ports as service, tool, landlord or private ports as can be seen in the following figure:

Figure 2 - Basic Port Management Models

Type	Infrastructure	Superstructure	Port Labor	Other Functions
Public Service Port	Public	Public	Public	Majority Public
Tool Port	Public	Public	Private	Public/Private
Landlord Port	Public	Private	Private	Public/Private
Private Service Port	Private	Private	Private	Majority Private

source:(WorldBank,

2003)

The landlord port model is the most encountered form of public administration, because it effectively balances public interest of the society and private interests of shareholders. Fully private ports of course tend only the shareholders which is why it has gained little adoption by ports around the world. Public service ports and tool ports are on the other side of that spectrum.

The landlord port operator owns the land and maintains the port infrastructure while the superstructure is built by the private operators. Port labor is mostly private but some ports do have (semi) publicly financed education. Land is leased to the port operator through concession agreements. The port operator is then fully in charge of the terminal operations and bears the economic risk.

Of course many researchers find this model too simplistic it also omits the functions of the ports (Brooks, 2004). In practice of course lots of differences arise between actual ports especially in the area of what the World Banks calls "other functions." This model is adequate for this study because a clear distinctions can be made in public/private interests. We will however the address the complexity issue by adding a case study of the Rotterdam port authority to refrain from a pure theoretic discussion.

## **2.6 Influence of landlord port authority on the port environment**

At the three identified levels of the application of LPT (micro, meso, macro) there is a role to play for the governing body of port, the port authority. This is can be most clearly seen at meso and macro level where intra-port planning and inter-port planning are necessities. At micro level the port authority has an assisting role to play in, for example, helping operators with the knowledge required to implement LPT techniques.

For the purpose of this study we will use the landlord port model. A primary reason is the need to focus this research paper. These two port models are the most common in multi-user ports.

The following elements of influence by the port authority are described by the author:

1. Concession agreements with port operators
2. Infrastructure investments
3. Education and training in the port
4. Strategic aid of port operator's management
5. Leadership in collective action
6. Collaboration and coordination with other ports

These elements will be briefly discussed in this section.

### **2.6.1 Concession agreements with port operators**

"A concession is a grant by a government or port authority to a (private) operator for providing specific port services, such as terminal operations or nautical services (Notteboom, 2006)."

This agreement is the main mean of influence for the port authority. Under the landlord port model the port authority assures its interests through this agreement. Depending on what property is leased the concession agreements can have different forms. For large terminals often the parties sign a long-term lease.

Three major parts of the agreement are: throughput guarantees, duration of lease and concession fees. Throughput guarantees ensure that operator uses the land provided optimally. If no such measures are agreed upon operators may lack the incentive to increase throughput. Regarding the duration: there standard duration periods for specific types of terminals in Europe (Notteboom, 2006). The most important issue in these contract is the fee structure. Usually the operator pays a fixed fee per used surface after which it can decide its own tariffs. Schemes of profit sharing are also common though.

### **2.6.2 Infrastructure investments**

The landlord port authority is of course responsible for the port infrastructure which include the general roads in the port, railway connections from terminals and the maritime access routes to the port. Terminal quays are often also developed by the port, though fees may be charged to operators depending on the negotiations.

There are potential bottlenecks in any port for which the port authority needs to pay special attention to. Bottlenecks can be managed by demand management or infrastructure investments. The potential bottlenecks are:

1. *The depth of the draft.* Draft can be deepened by dredging of course and often need to be maintained.
2. *Congestion in the port waterways and hinterland waterways.* Busy terminals can congest a port but also rivers can face congestion, accidents and natural disasters.
3. *Congestion of the motorways around the port.* Especially a busy motorway with commuters in busy cities can cause trouble for a port.
4. *Railway congestion.* Some ports have dedicated railways to the hinterland but often times they need to be shared with commuter trains. The differing speeds of these trains can cause challenges for railway planners.

All of these issues can be addressed by the port authority though often times regional and (inter)national governments need to be involved to solve issues. The port authority's role is essential as it holds information to forecast demand and signal bottlenecks before they arise.

### **2.6.3 Education and training in the port**

Port environments require specifically skilled workers for its employers. Port workers are trained at all levels: logistic planners, ship operators, towage workers, shippers, safety inspectors etc. Secondary education arises in a port environment to prepare its students for work in a port environment. These schools can be publically, privately or mixed funded. The landlord port authority can invest in education to guarantee quality and supply of skilled workers.

### **2.6.4 Strategic aid of port operator's management**

Investments in the port environment can require substantial investments for the operators. The operators need to gather as much information as possible before deciding upon which course to take. The landlord port authority or any port authority in general has a lot information regarding the port, possible competitors and changing business environments. It can harness more knowledge by

funding or collaborating with scientific institutions. Sharing this knowledge is in the best interest of both parties as both generally strive for more and better business opportunities.

#### **2.6.5 Leadership in collective action**

Collective action regimes are ways the actors in a port deal with issues that supersede one single firm (De Langen, 2004). Education and training as previously mentioned is one such issue. The way a cluster of firms deals with these determines the efficiency of a port environment. The port authority can play a role in collective action regimes though their influence is not necessary needed. Port authorities can take charge in collective action regimes to make a certain goal is reached. Best would be for the port authority to create trust amongst operators, create a platform for negotiation and empower leader firms.

#### **2.6.6 Collaboration and coordination with other ports**

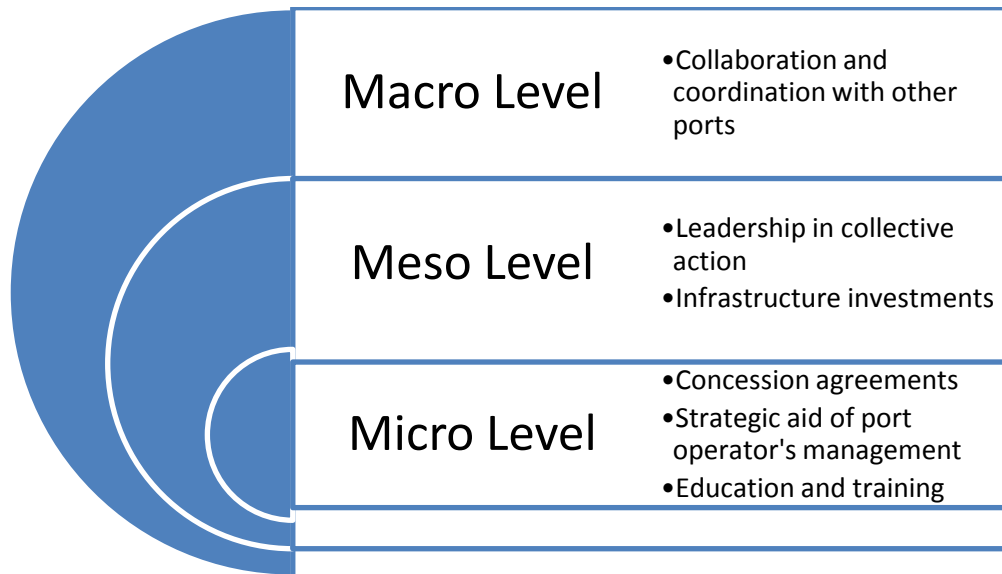
Collaboration between ports, which service the same hinterland, can be relevant for a port authority to ease competition and increase efficiency. Tough there is a field of tension between collaboration and competition. National interests may give rise to collaboration within a nation. Coordination refers to the hinterland ports where it is more natural for port authority to cooperate with hinterland ports.



## 2.7 The preliminary model

After assessing the key elements of LPT at micro, meso and macro level coupled with the landlord port authority's influence we have the model as displayed in figure 3. In chapter 3, 4 and 5 relationship of influence on each level will be further explored.

Figure 3 - Influence of landlord PA



## 2.8 Introduction Port of Rotterdam (POR)<sup>1</sup>

The port authority managing the port is called the Port of Rotterdam. The need for reform of the authority was necessary for the port to maintain its competitive position. In 2004 POR was privatized but with its shareholders still being the municipality of Rotterdam for 70 percent and the Dutch state government for 30 percent. After the privatization the PA fits in the model of the landlord port authority.

In its vision POR states that its goal is to develop the port to become safest, most efficient and most sustainable ports in the world (Port of Rotterdam, 2015). It explicitly mentions that it sees itself as an "entrepreneurial port developer" which translates amongst others in investments in subsidiaries. They also mention in what way they create value for their customers: by developing chains, networks and clusters within Europe and worldwide. In terms of turnover POR has an annual budget of 600 million euros which it mainly collects by port fees and dues.

<sup>1</sup> Confusion may arise when referring to the Rotterdam port authority or the Rotterdam port. The port authority will be referred to as Port of Rotterdam or POR for short; the port itself will be referred to as port of Rotterdam.

## **3 Role of the landlord port authority at micro level**

### **3.1 The lean port operator**

The lean port operator makes best use of its available natural, financial and human resources. It uses LPT tools to maximize value for its customers and cut costs by eliminating waste at all levels of its operations.

#### **3.1.1 Management commitment**

Any major changes in business require a strong top and lower level management commitment, because changes can be rough for any organization and success can only be guaranteed if there is at least a top down commitment and persistence.

(Paixão & Bernard Marlow, 2003) recognize this as they see that management decision regarding strategy, technology and personnel are key in successfully implementing and running LPT. Management needs to be familiar with the key concepts and tools of LPT. The next step would be to design a strategy of implementation where employees of all levels are involved. LPT requires empowerment of personnel and this best achieved by flatter organizations rather than strongly hierarchical organizations (Marlow & Casaca, 2003). If this is not yet in place a further hurdle must be taken in changing the company structure and philosophy.

The role of the landlord port authority in this case can be examined with the initial step to implement LPT and the actual running of the organization. We have two papers regarding examples of implementation of LPT. First the European facilities in Alnabru and Aalborg. The application of LPT in these facilities was a result of funding by the European Commission of joint-ventures of research institutes and private companies (Olesen et al., 2015). The European Commission sought to find ways of increasing efficiency in container terminals. Terminal management was paired up with researchers to implement LPT. Management firstly underwent a vigorous training before implementation and were aided by the researchers during the operations phase. This same approach can be seen at the Alabama freight facilities (Loyd et al., 2009). The difference was that in the case of Alabama operations management sought ways to improve terminal efficiency because of spatial constraints.

So the landlord port authority can influence management of already existing facilities, which clearly seek to implement LPT, with strategic aid in the form of evaluating the existing business then searching for researchers with knowledge of LPT within the port authority or external partners. If a landlord port authority seeks a private partner to operate a new facility it can set up provisions in the concession agreement which specifically mention the use of LPT.

### 3.1.2 Effective training of personnel

Training of all personnel at every level of the firm determines the success of a lean enterprise (Womack & Jones, 1990). Human skills and knowledge need to be developed over time. It is one of those things the company needs to get right from take-off. The firm needs to offer the employees strong incentives to stay which need not necessarily be financial. They also need to be motivated to keep productivity increasing.

The implementation of LPT in Alabama was a gradual process where first medium level management and support staff were trained. Upon implementation at each business unit all employees were given an introductory course after which specific employees were given further training. At the facilities in Norway and Denmark no specifics are given in the paper regarding training of personnel.

Employees need to be trained in team work, cross-training and the basics of *Kaizen* (Loyd et al., 2009). Cross-training allows for workers to gain knowledge of other elements of the workplace to better understand the flow of goods through the company. *Kaizen* is the constant improvement process which people in small teams thoroughly focus on waste elimination in a specific process.

It is clear that this process is an affair for the private company to apply. The landlord port authority has no role in the implementation. It can however address training for LPT in the education systems preparing young people for a job in a port if this is required by private firms.

### 3.1.3 Efficient terminal lay-out

The Toyota Motor Company operated with a compact and open production floor. The idea behind was that workers are able to communicate better and with lack of space workers couldn't stack up piles of work-in-progress. So the workplace forced the employees to be efficient.

When looking at a terminal, for example, a compact work space is not necessarily the way to go, because it is not a production plant. A terminal contains large cranes, vehicles loading facilities etc. A lean port lay-out does however help to utilize scarce space as was the case in Alabama. Waste reduction can be achieved by reviewing every step in the process to eliminate any unnecessary movement of equipment and personnel. This process is easier in greenfield projects, because a facilitate can be built from the ground up.

Landlord port authorities use concession agreements to make sure a private party uses specific pieces of land for a dedicated purpose like certain berth spaces (Notteboom, 2006). This is however not applicable in this situation for implementing LPT since it is for the company to design an efficient terminal layout. The landlord port authority leases the land as the name indicates.

### **3.1.4 Supporting ICT infrastructure and performance indicators**

Information technology has become increasingly important in business since the initial introduction of LPT. ICT infrastructure is the backbone of all operations since value stream mapping requires to be able to identify every step of the business process. The reviewed papers do not give specifics regarding ICT but they do all mention and underline the importance of it.

Performance indicators are however essential to the lean port operator. (Marlow & Casaca, 2003) propose performance indicators for measuring lean performance in a port environment such as lead-times, adaptability of customer's needs and employee interaction with customers. The facilities in Alabama, Denmark and Norway all used custom performance and tracking indicators to review business processes.

As was the case with the previous section this is a purely private matter for the port operator over which the port authority should not have a say in. The private operator can however request that certain lean performance indicators are taken into account when addressing performance under the concession agreement.

### **3.1.5 Sub-conclusion**

It is clear that the landlord port authority has limited role to play at micro level in the port. This as expected since the very reason for a landlord port authority to be created is to allow for competition and let private firms exploit their business. The authority has its strongest influence at the management level where it can have direct contact of top management of the firm. In the rest of the cases the landlord port authority has an indirect influence at best.

## 3.2 Port of Rotterdam

Key Element	Mean of Influence	Assumption made	Assumption Number	Congruent with POR
Management commitment	Strategic aid of port operator's management	Evaluating the existing business then searching for researchers with knowledge of LPT within the port authority or external partners	1	Inconclusive
	Concession agreements with port operators	Provisions in the concession agreement which specifically mention the use of LPT	2	No
Effective training of personnel	Education and training in the port	address training for LPT in the education systems	3	Yes
Efficient terminal lay-out	None	Landlord port authority does not influence this process	4	No
Supporting ICT infrastructure and performance indicators	Concession agreements with port operators	Certain lean performance indicators are taken into account when addressing performance under the concession agreement	5	Yes

*Table 4 - Overview assumptions and congruence with POR*

Currently there is no evidence of a complete and structural implementation of LPT in any of terminals of Rotterdam like is the case of the previously mentioned facilities in the US (Alabama), Denmark and Norway. This does not mean however that LPT techniques are not used in the port. Lean thinking has become a familiar term for many managers in the port and lean theory is taught at the Erasmus University where many of the port managers receive their education.

Our first assumption was that a landlord port authority can offer strategic aid to port operator's management and help them with implementing LPT. POR offers a wide range of services and advice for companies seeking to start a business in the port. It has dedicated business team for commodities, certain areas and countries and general port business. Our assertion that the PA can help with evaluating the current business might not be the case in the port Rotterdam, but POR does have an extensive network of partners at Erasmus University and Delft University (Port of Rotterdam, 2015). For example, it set up a research group called SmartPort in collaboration with Erasmus University. A company seeking guidance with implementing LPT in Rotterdam does not

need help from the PA. Independent consultants assist many companies in the port and Deltanlinqs, which is collaboration of all port companies, can offer similar services as well.

Assertion 2 that the landlord port authority can find a company willing to implement LPT through provisions in the concession agreement does not hold up in the case of POR. For larger tenders POR uses a point scale to evaluate the biddings which are followed by negotiations with companies with the highest points. The bidding process nor the concession agreement of POR contain specific information about a how a company is run (Evertse, 2014; Pallis, Notteboom, & De Langen, 2008).

Assertion 3 is congruent within the port. POR has an extensive network of partners at universities as mentioned previously and they can address LPT training in vocational education. POR invests in the STC-group which is a port wide school for mainly vocational education, but higher education is provided as well (Langen, P.W., Nijdam, M.H, 2012).

We assumed that POR could not influence the terminal layout other than providing the initial greenfield land with berths and quays under assumption 4. For the case of Rotterdam (Pallis et al., 2008) find that the capacity calculations need to demonstrate that an efficient terminal layout will lead to the projected throughput. Assumption 4 is thus not congruent for the case of POR. The concession agreements of POR do take into account efficiency criteria (Evertse, 2014), thus assumption 5 is confirmed.

## **4 Role of the landlord port authority at meso level**

### **4.1 The lean port environment (meso)**

When a port operator becomes a lean port operator it has harnessed and built the knowledge needed to effectively run a lean company; waste is reduced to a minimum and it keeps getting reduced through kaizen; response to market and customer is enhanced; productivity of personnel has increased and variability in the company is low. The company does not operate alone in a port: it still faces external threats which can disrupt operations. In the lean port strategic alliances and partnerships arise between companies.

#### **4.1.1 Port performance measurement**

Traditional port performance measurement is based on examining input indicators and one output indicator which usually are the amount of TEU's or tonnage (Marlow & Casaca, 2003). The authors propose a new set of port performance based on value streams mapping of port business processes. Lean port operators can have better benchmarks of their performance compared to other port operators. Corrective measures can be taken if any deviations exist.

When addressing the role of the landlord port authority we cannot address a measure of influence as described in section 2.6. Port benchmarking and performance measurement is an essential part of the tasks of the port authority and it can take in extra parameters to measure lean port performance.

#### **4.1.2 Port accessibility**

The lean port operator needs to create flow in its operations. In order to do so it is reliant on the external environment in the port. Bottlenecks in port call frequency and gate access disrupt the flow and thereby impede performance and efficiency (Olesen et al., 2015).

One of the main duties of the landlord port authority is to keep the port accessible 24/7. The port authority can perform this task through infrastructure investments and leadership in collective action which it uses to synchronize port movements of all companies.

#### **4.1.3 Intermodality**

Intermodality is very relevant when discussing lean port operations. The lean philosophy acts as a natural addition to intermodal terminals and are necessary to create flow in a terminal (Olesen et al., 2015). The availability of intermodal options when a disruption occurs in the hinterland or because of specific customer demands shift increase flexibility of operations. Intermodality also offers operators the possibility to redirect cargo, for example, when value stream mapping finds

possibilities for improvement in the logistics department. The role of the landlord port authority is in this case clear: facilitate intermodality through infrastructure investments.

#### **4.1.4 The presence of distriparks**

Distriparks are designated pieces of land for logistic operations for storage, packaging and distribution. They also offer value added services for operators. Distriparks were created to offer these value added services (Secretariat UNCTAD, 1999). (Paixão & Bernard Marlow, 2003) propose for these distriparks to be new customers for the port meaning outsourcing logistic activities. This requires a greater collaboration in the given supply chains. The aim of this process is to let the lean port operator focus on its core capabilities and further streamline their process.

The landlord port authority is in the position to dedicate land for these parks and construct the necessary infrastructure. Through collective action in marketing the landlord port authority can attract firms to the new distriparks.

#### **4.1.5 Knowledge sharing and sharing of best practices**

For the Toyota Motor Company it was common to involve its suppliers in its company. Often Toyota workers would do cross-training at its suppliers firms and vice versa. They divided their suppliers in different tiers based on overall performance (as oppose to price competition). This system was based on trust and knowledge sharing. This business practice can be translated to the port environment where trust in the supply chain and between firms is increased.

The landlord authority can try to create trust in its port environment by making sure there is enough interaction between firms. It can set up a lean port research/implementation group which can aid operators implementing lean. This way competition concerns are addressed as the research group will not be affiliated with any single company.

#### **4.1.6 Sub-conclusion**

The role for the landlord port authority at meso level is more prominent, because we are dealing with the port environment which the authority naturally has control over and responsibility for. The lean port environment demands the landlord port authority to invest in infrastructure; to safeguard and enhance port accessibility; to create trust in the port environment. The port authority should be proactive in this case and anticipate demands of its operators.



## 4.2 Port of Rotterdam

Key Element	Mean of Influence	Assumption made	Assumption Number	Congruent with POR
Port performance measurement	None	Performance measurement is an important task of the PA. It can add lean port performance indicators	6	Yes
Port accessibility	Infrastructure investments	Keep port accessible through infrastructure investments.	7	Yes
	Leadership in collective action	Synchronize port movements of all companies	8	Yes
Intermodality	Infrastructure investments	Facilitate intermodality through infrastructure investments	9	Yes
The presence of distriparks	Infrastructure investments	Dedicate land for these parks and construct the necessary infrastructure	10	Yes
	Leadership in collective action	Attract firms to the new distriparks	11	No
Knowledge sharing and sharing of best practices	Leadership in collective action	Create trust amongst firms	12	Inconclusive
	Leadership in collective action	Fund / partner with LPT research group	13	Yes

*Table 5 - Overview assumptions and congruence with POR*

POR presents key performance indicators in their annual report. They benchmark their own performance with a predicted score for each performance indicator. Comparisons are made in the Hamburg-Le Havre range where POR finds its direct competitors.

Keeping the port accessible is a key task of POR. They expect the number of containers flowing through the port to quadruple by 2035. POR realizes that the current accessibility of the port is not optimal and they propose a wide range of measure to tackle this problem (Port of Rotterdam, 2011). The main issue right now is the congestion of the highway A15 which is one of the most congested roads in the Netherlands. Peek congestion is managed through broadening of the access route from the port to the city by POR. They built a container transferium where containers can be loaded onto barges to be taken further inland. With the building of this transferium they aim to realize a modal shift from road to barge transport.

POR shows leadership in tackling accessibility issues by funding two organizations called De Verkeersonderneming and KeyRail. De Verkeersonderneming tackles congestion of the roads by coordinating and promoting programs for companies which reduce commuter traffic. Keyrail is a subsidiary of POR which is responsible for planning and streamlining of the railway connections of the port. Railway transport is relatively costly in the port and growth lacks behind in comparison to

the ambitions of the port authority regarding this issue. At the seaside POR has teamed up with amongst others Shell, Vopak and Maersk in providing uniform business communication platforms to streamline port calls of vessels.

POR adopted and facilitates the concept of synchromodality where the customer of the logistic providers do not book a specific mode of transport. It is then for the logistic provider to decide which mode of transport to use. This approach enables the efficient use of all modes and transport.

The necessary hard measures through infrastructure investments, the soft measures in transport demand management and coordination role of POR with local governments support assumptions 7, 8 and 9.

Distriparks which support LPT in a port environment are present at the port of Rotterdam since the 1980's (Pettit & Beresford, 2009). Currently there are three distriparks which each have a different specialism. The presence of these parks are congruent with assumption 10. POR has no specific strategy to attract firms to these distriparks since they are already well established which is not congruent with assumption 11.

The implementation for a LPT research group to stimulate knowledge sharing, if necessary, need not be a problem for POR since it has solid partnerships with Delft and Erasmus University. Thus we can conclude that assumption 13 is congruent in the case of POR.

A more difficult to evaluate is the level of trust between the firms in the port and the role POR in that aspect. (De Langen, 2004) finds that trust amongst companies in the port of Rotterdam is relatively low compared to Hamburg and Antwerp. There is however no recent study regarding this issue and the paper makes no assumptions of the absolute value of trust in the port. What we can conclude however that the infrastructure for knowledge sharing is present at port through organizations like Deltalinqs and the Erasmus Smart port.

Overall we can conclude that companies seeking to implement LPT in the Rotterdam port can rely on the port authority to meet their demands and the port infrastructure to be adequate to facilitate LPT. The port authority is pro-active when it comes to dealing with and signaling of major issues facing the port. However, congestion remains a major problem for the port now and in the coming years.

## **5 Role of the landlord port authority at macro level**

### **5.1 The lean port network**

“Port networking implies a group of ports that are willing to work together to achieve the desired levels of quality and customer service, to share information, and to build trusting, long-term relationships.” (Paixao & Marlow, 2003). “Port” in this sense refers to companies working together in the narrowest sense or port authorities working together in the broadest sense of the word.

The lean port network needs to be established under with the customer in mind. A lean port network can offer customer further set of options when deciding on which port to choose. The network can compete on the basis of a uniform customer service. Offering multimodal transport services from different locations is one of the many customer service offers which can be obtained. A lean port network makes more sense on a national scale where it is easier for ports to cooperate although international cooperation offers a further degree integration.

#### **5.1.1 Coordination and cooperation with hinterland ports**

Participations in companies in hinterland ports is common practice for many port operators. Terminals often invest in dedicated terminals inland to ensure storage capacity, transshipment options and flexibility and reliance in operations. A lean port seeks coordination with hinterland ports to stream line its supply chains and to establish and maintain multimodal transport options. The high costs of inland transport can be better managed when coordination exists.

The landlord port authority is in a good position to help companies with these coordination goals though competition from other seaports or a smaller size of the PA will make this more difficult. Coordination of port authorities within the hinterland is natural since the ports operate in more or less the supply chain.

#### **5.1.2 Coordination and cooperation with adjacent ports**

More important and challenging than vertical coordination with hinterland ports is the coordination with adjacent ports. Since seaports in a contestant hinterland are natural competitors a lot of regional and national interest play a role. The basis for cooperation arises when seaports when faced with tougher competition from other seaports or seaport networks see the benefits of a degree of integration in order to compete as a network. Cooperation through national lines is the most logical in this case.

The landlord port authority can seek coordination with adjacent port authorities to establish common goals. Helping companies in different seaports to coordinate is tough ground for the port authority and it should be cautious in doing so because of competition concerns.

### **5.1.3 Creation of the lean port enterprise**

The lean port enterprise is the means with which a lean port network can be established. “As such, a lean port enterprise is a group of individual port authorities in its broadest sense (or a group of terminal operators moving cargo through dedicated terminals in its narrower sense), legally separated but operating under a synchronized environment.” (Paixao & Marlow, 2003). The entity should be responsible for creation a common mission/vision statement and strategies of the actors involved. The meaning and implementation of the lean port enterprise is twofold which is relevant for our analysis: a creation of lean port enterprise between port authorities or between private firms/terminals.

For port operators this creation of the lean port enterprise can be a business decision, but for port authorities it is more complicated endeavor since its stakeholders, which are generally not private companies but governments, need to be taken into consideration. Thus the landlord port should refrain from interfering with its lean port operators wishing to create such a network and it should considers costs and benefits for its own operations when establishing such a partnership with other port authorities.

### **5.1.4 Sub-conclusion**

When looking at macro level we see a more complex role for the landlord port authority regarding port networking. It can help companies seeking coordination in the hinterland though it should be careful with adjacent seaports.

Regarding its own position in a lean port enterprise/network the landlord port authority cannot consider implementation of lean thinking as the only reason in striving for further cooperation with other ports.

## 5.2 Port of Rotterdam

Table 6 - Overview assumptions and congruence with POR

Key Element	Mean of Influence	Assumption made	Assumption Number	Congruent with POR
Coordination and cooperation with hinterland ports	Collaboration and coordination with other ports	Coordination of port authorities within the hinterland is natural since the ports operate in more or less the same supply chain	14	Yes
Coordination and cooperation with adjacent ports	Collaboration and coordination with other ports	Possible, but PA needs to be cautious because of competition concerns	15	Yes
Creation of the lean port enterprise	Collaboration and coordination with other ports	Do not interfere with individual port operators seeking partnership. Do consider creation of lean port enterprise for PA's	16	No

POR is focused on creating a worldwide port network as stated in their mission statement. They see the number of partnerships they make as a key performance indicator (Port of Rotterdam, 2015). POR invested in the Sohar port in Oman and in a greenfield project in Brasil called Porto Central.

The partnerships within Europe are however more relevant for our analysis. In the direct vicinity of Rotterdam POR manages the port of Dordrecht, Vlaardingen and Maassluis. POR has strategic alliances with hinterland ports. Recently POR signed a declaration of intent to collaborate with the port of Venlo-Venray which is an important node to the hinterland of Rotterdam (Dijkhuizen, 2015). POR also invests in hinterland rail freight connections and addresses transshipment conditions with hinterland barge terminals (Brooks, McCalla, Pallis, & Van der Lugt, 2010). POR is active in the hinterland which is congruent with assumption 14.

Competition is still fierce in the Hamburg-Le Havre range where the ports compete for the contestant hinterland. The most notable collaboration for POR is the integration of its port community system with that of the port of Amsterdam called Portbase. The need for an integral port database and information system outweighed competition concerns of the ports. Competition concerns did play a part in the ending of the joint-venture between POR and the port of Flushing. The two ports partnered in the development of a container terminal and an industrial site. No significant strategic alliances exist between POR and other major European ports. Our assumption

under 15 that the landlord port authority can seek cooperation with adjacent ports holds up for POR, but the addressed competition concerns are relevant for Rotterdam.

There are no far going structures of integration between the Rotterdam port and other ports as would be the case in a lean port enterprise. The Portbase platform is one such collaboration which comes close. The reason for this, arguably, is the incentive structure for the port authority. The main shareholder of the PA is the municipality of Rotterdam. Assumption 16 does not hold up for the case of POR.

## 6 Conclusion

The starting point of this thesis was determining the position of the landlord port authority in implementing lean production theory. After a review of literature three levels of implementation were identified: micro; meso and macro with the accompanying key elements of implementation. The role of the port authority is different at each level. Means of influence of the port authority were identified for the landlord port authority to evaluate its role.

The role of the port authority at micro level is that of a facilitator of port operator's demand. They can influence the process of implementing LPT indirectly. At meso level we found that the landlord port authority has a considerable role to play in implementing a lean port environment. At macro level, which more of a theoretical approach, we found that the landlord PA should not interfere in port operator's seeking to compose a lean port network. It could however create its own lean port network through collaboration with other port authorities.

The case study provided a check for the assumptions made in the theoretic construction of our model. Most assumptions were congruent for the Port of Rotterdam.

### 6.1 Limitations and Considerations

Lean production theory relies heavily on the implementation of just-in-time techniques to smooth operations. There is a field of tension with JIT and the maritime sector (Langen, P.W., Nijdam, M.H, 2012). This sector is characterized by, for example, slow steaming and low frequency deliveries. This does not mean, however, that LPT are not applicable to the port sector. The essence of reducing waste and constant improvement of processes are elements of lean which do not rely solely on JIT.

The basis for the assumptions in sections 4 and 5 are, arguable, based on a limited number of papers. This does not diminish the quality of the papers. Especially the works of Paixão and Marlow (2003) is many cited article due to its analysis and focus on port networks.

To decisively check the assumptions made for the landlord port authority a case study of just one port authority and port environment is not enough. Also POR is a relatively large port authority operation in the biggest port of Europe. A comparison of multiple port authorities of different port sizes would provide a better understanding.

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## Appendix A Overview of Assumptions

Key Element	Mean of Influence	Assumption made	Assumption Number	Congruent with POR
<i>Micro Level</i>				
Management commitment	Strategic aid of port operator's management	Evaluating the existing business then searching for researchers with knowledge of LPT within the port authority or external partners	1	Inconclusive
	Concession agreements with port operators	Provisions in the concession agreement which specifically mention the use of LPT	2	No
Effective training of personnel	Education and training in the port	address training for LPT in the education systems	3	Yes
Efficient terminal layout	None	Landlord port authority does not influence this process	4	No
Supporting ICT infrastructure and performance indicators	Concession agreements with port operators	Certain lean performance indicators are taken into account when addressing performance under the concession agreement	5	Yes
<i>Meso Level</i>				
Port performance measurement	None	Performance measurement is an important task of the PA. It can add lean port performance indicators	6	Yes
Port accessibility	Infrastructure investments	Keep port accessible through infrastructure investments.	7	Yes
	Leadership in collective action	Synchronize port movements of all companies	8	Yes
Intermodality	Infrastructure investments	Facilitate intermodality through infrastructure investments	9	Yes
The presence of distriparks	Infrastructure investments	Dedicate land for these parks and construct the necessary infrastructure	10	Yes
	Leadership in collective action	Attract firms to the new distriparks	11	No
Knowledge sharing and sharing of best practices	Leadership in collective action	Create trust amongst firms	12	Inconclusive
	Leadership in collective action	Fund / partner with LPT research group	13	Yes

<i>Macro Level</i>				
Coordination and cooperation with hinterland ports	Collaboration and coordination with other ports	Coordination of port authorities within the hinterland is natural since the ports operate in more or less the supply chain	14	Yes
Coordination and cooperation with adjacent ports	Collaboration and coordination with other ports	Possible, but PA needs to be cautious because of competition concerns	15	Yes
Creation of the lean port enterprise	Collaboration and coordination with other ports	Do not interfere with individual port operators seeking partnership. Do consider creation of lean port enterprise for PA's	16	No