MONA LISA 2.0 SECURING THE CHAIN BY INTELLIGENCE AT SEA

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1 Executive Summary

The purpose of this report is to conduct a business case analysis of the benefits deriving from introducing an 'ideal' STM. In order to establish a basis for the evaluation, we scrutinized all available documents describing the five concepts within STM. This revealed that the most relevant benefits could be grouped into two overall areas of optimization:

- Improvement in planning and conducting the **voyage** to reduce bunker consumption and increase the utilization of fixed assets, such as ship and crew
- Improvement in **port operations** from the very first estimation of ETA/ETD to the actual arrival/departure of ship at/from the port

A business case analysis can in principle be carried out for every single one of the more than 20 different actors within the maritime transportation ecosystem. This is neither possible nor relevant given the fairly, rather vague description of STM currently available. Accordingly, we decided to concentrate on two main actors: the **shipping company** as representative of the STM initiatives of the voyage, and the **agent** as the representative of the port optimization.

We are taking the perspective of the end-customer/charterer, who represents whoever requested and has the prime interest in the transport of the goods/passengers.

We conducted most of our interviews with representatives of the agents and the shipping companies. However, in order to get a more comprehensive view, we also interviewed a number of public organizations in order to get confirmation of the inefficiencies in the current systems and get further evidence for the evaluation of the benefits of the future STM. However, e have only evaluated the situation for private actors and not explicitly analyzed the business case for public organizations.

The result of our analysis is a description of the changes in the business models of the two representatives using the Business Model Canvas (Osterwalder and Pigneur, 2011).

This analysis shows that the introduction and implementation of an 'ideal' STM would make it possible to save 10 – 15% of planning and operational costs both for voyage optimization and for port operation optimization. These figures are estimates based on data from the Scandinavian countries, and it is evident that there are huge differences between highly automated/sophisticated ports like Singapore and ports in many developing countries. Overall, we presume that the benefits potentially achievable in ports in the Nordic countries would be even larger in most other ports in the world, where current systems are less optimized.

The analysis did **not** attempt to quantify the more societal criteria, including potential reduction of CO_2 emission, how much reduction in pollution of the waters can be achieved, or the economic value of increased safety. These are extremely important dimensions, but they are very difficult to quantify with a business case analysis.

Finally, the introduction of an 'ideal' STM is likely to make a significant re-engineering process of the overall ecosystem very beneficial. Accordingly, one could say that the biggest advantage of the STM system is exactly this –a reinvention of the maritime shipping industry. However, in such a process there are bound to be both losers and winners.

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2 Objective and Scope

The objective of the business case analysis is to assess the potential benefits of an implementation of STM, including the five concepts, for the key actors in the maritime ecosystem. Employing qualitative research methods, we carried out an analysis of the benefits of introducing the proposed STM for the key actors in the maritime ecosystem. The business benefits analysis was carried using the dimensions of better transparency, more effective operations, bunker savings, savings through effectiveness gains, and reduced workload. These dimensions are derived from the success criteria discussed in the MONALISA documents. These were systematized to deduce higher-level dimensions (cf. *Figure 4: Benefits Hierarchy*, Appendix, p. 25) and thus validate the MONALISA 2.0 objectives.

2.1 Delimiting the Scope to Business Level Analysis

The MONALISA 2.0 project focuses on the full maritime ecosystem, which suggests an analysis of benefits on a societal level.

As formulated in the description of MONALISA 2.0, the most significant benefits on a societal level could be derived from:

- Reduced **bunker** consumption, which translates into reduced CO_2 emission and thus leads to increased environmental sustainability. In order to achieve reduced bunker consumption, efficiency in operations must be improved throughout the ecosystem, but especially through the optimization of route planning and execution of the most effective routing even under unexpected/unpredictable conditions. Reduced **CO_2 emission** is more or less directly related to the reduction in bunker consumption, and only the economic benefits for the organizations will be covered here.

- Increased **utilization** of fixed assets (ships, ports, labor etc.) through better planning and coordination. Such efficiency can be reached through optimized port operations. Better **utilization of fixed assets** will primarily be dealt with in the benefit assessments of the main actors, but we shall not attempt to carry out a full-blown societal analysis of the environmental benefits of better utilizing ships, harbor facilities, etc.

  This is beyond the scope of this analysis. For instance, other reports suggest that if port efficiency was improved from the 25th to the 75th percentile, shipping costs could be reduced by more than 12%, since inefficient ports heavily increase the handling costs (Clark, Dollar & Micco 2004). Furthermore, factors such as excessive regulation, the prevalence of organized crime, and the general condition of a country's infrastructure are factors that explain the great variations in port efficiency; they can either have a positive or negative impact on the overall port efficiency. Moreover, the quality of the onshore infrastructure is a key determinant of transportation costs. That is, if a country with relatively poor infrastructure (75th percentile) is able to upgrade to the 25th percentile, transportation costs will be reduced by 30-50%. These are a number of the contingency factors that we do not

explicitly evaluate. Due to resource constraints, we have only attempted to get an understanding of these factors through interviews with key players.

- Increased **safety** is another area that we have not attempted to quantify. Increased **safety** stems both from doing the right things and by doing the things right. However, very few of the individuals interviewed identified safety as a big problem for their company as long as the individuals did not make any mistakes. It was felt that already today; there is a variety of tools available, which, if properly utilized, would solve practically all safety issues. In many ways, this is a compelling argument. Nevertheless, the fact is that when interacting with any kind of technology (from household technologies to aircrafts and nuclear power stations), humans often do mistakes that could or should have been avoided. Proper technological design and better interfaces could make it almost impossible for humans to err. We believe that this is also very much the case when it comes to Sea Traffic Management. We are convinced that tools, methods, and concepts developed within STM can reduce the number of accidents and thus increase safety at sea. However, we have not been able to estimate the actual level of economic value of this. None of the interviewees was prepared to estimate the value of better STM tools to increase safety through reduction of human error, because the number of incidents is fortunately relatively small and far apart. For example, is it possible to mitigate against an irresponsible captain who is not showing adequate responsibility creating a hazardous situation? Further, what is the value of that? Accordingly, it seems virtually impossible to estimate the value of increased safety, even though cases like the wrecking of Costa Concordia—estimated to cost € 1.5 billion—is a terrible reminder of what is at stake.
- **Security** has become a very important topic in recent years due to the high risk of seaborne terrorist attacks. As current technology does not make it possible to scan all containers on a container ship upon arrival in a port, tracking ships from origin to destination and knowing intentions and routes is a crucial security feature. We have not seen this explicitly discussed in the MONALISA 2.0 documents, and we are not in a position to quantify such improvements.
- **Sustainability** covers many areas; the most important of which are reduced CO_2 emissions, better utilization of fixed assets, and reduced pollution. However, beyond bunker reduction, our data does not allow us to quantify the overall reduction of CO_2. Therefore, we have abstained from carrying out a detailed societal analysis using any green metrics, and we have limited ourselves to an analysis on the business level.
- **Pollution of the waters** is obviously a huge challenge. Examples reach from illegal the cleaning of tanks at sea over cheating on the use of quality of oil, to corruption and bribing. There is no doubt that a fully implemented STM with increased transparency can contribute significantly to this area through 'forcing' actors to be more environmentally conscious. Almost all individuals interviewed were very optimistic about a fully implemented STM contributing to identifying violators of

pollution regulations and motivating everybody to be environmentally conscious. Again, we have not been able to quantify this in money terms.

Accordingly, our analysis will focus on carrying out a business case analysis of the impact of a fully implemented STM on voyage optimization and on port optimization seen from the point of view of the charterer.

2.2 Defining the Characteristics of STM

When conducting a business case analysis of a particular technology/system like STM, it is necessary to define the actual characteristics of STM as clearly as possible. Consequently, we have analyzed the different reports and PowerPoint presentations in the MONALISA 2.0 project in order to get a comprehensive understanding for both ourselves and for the individuals interviewed. The result of these deliberations is that we based our business case analysis on what we call an "ideal" STM. This is an STM that integrates the four different concepts and provides a perfect bundling of all information to be immediately, transparently, and ubiquitously available. Furthermore, we assume a fully implemented set of systems, i.e. IT-systems, (new or changed) organizations, and a fully transparent and shared information flow between them. The main beneficiary of such an integrated STM concept is the end-customer, that is, the charterer representing whoever has requested the transport of the goods/passenger. We exclusively conducted our analysis from the perspective of this stakeholder.

2.3 Competition and the Issue of Winners and Losers

One of the complications in assessing benefits for individual organizations is that there are huge differences in the levels of competence and sophistication of their current systems. Some shipping companies already have their own very advanced systems in place, and for that reason, they enjoy competitive advantage. For these, the introduction on an all-pervasive STM for everybody might not be that valuable. It is likely that for them, the marginal benefit would be much lower than for say smaller and less sophisticated shipping companies.

Moreover, since different seaport stakeholders hold different goals in respect to efficiency and profitability, seaport effectiveness becomes a matter of perspectives (Dooms et al. 2004). Da Cruz et al. (2013) have found that different port stakeholders internalize numerous factors that interfere with a seaports striving for competitiveness. The major reason is that the different port users and providers have a quite different understanding of the key factors of seaport competitiveness. Whereas the seaport facilities and equipment are the most important factors for the authorities and terminal operators, ocean carriers care most about the turnaround time. Therefore, seaport competitiveness becomes a matter of perspectives as the different stakeholders pursue different goals and thus prioritize different features (Dooms et al. 2004). The most common factors mentioned in literature for seaport competitiveness are: geographical location, infrastructure, service quality, costs, operational efficiency, cargo handling charges, reliability, product differentiation (Da Cruz et al. 2013). Additionally, the competition between different seaports is also

determined by regional factors, such as level of industrialization, government policies, and operational performance (Verhoeff 1981).

Also in another way, it is likely that the implementation of a socio-technical system like STM, which will radically change an industry, will produce both winners and losers. The role some actors play today will change in the future due to new technologies providing increased opportunities and different requirements. Accordingly, some of the businesses might need to reinvent themselves in order to provide value and/or to keep up with their competitors. Likewise, possible profits gained through optimized routes and port operations might raise the question of sharing the benefits of bunker savings, less demurrage, and other savings. While the demurrage affects the cargo charterer quite substantially in terms of extra costs, the shipping company rather welcomes it— especially in times of surplus capacity, where it can be difficult to get charters. However, from a societal point of view, demurrage represents an opportunity costs and should therefore be reduced. This is also a clear example of how the actors are motivated and influenced by the same events in fairly different ways. This is typically regulated through individual contracts.

> *There will be winners and there will be losers. It is the same with the pilots, one can say. Soon we will take care of [many of the activities] from the shore. And we have the ship owners who are scared to death to lose one single cent of the notice of readiness[1] [which might make it impossible to claim demurrage](Möller, Tärntank).*

> *In the end, pilots might be obsolete due to on-shore piloting. Once satellites work well together with the ships and the ship machinery, on-shore piloting will be possible. [Instead of having pilots come on board,] there will be these central pilot stations–like you have in the Great Belt or in the Øresund–monitoring the ship traffic in the sound and also making recommendations for the ships. So you could have pilots [on-shore rather than on-ship], who monitor the ship traffic and then come up with recommendations for the captains (Nørgaard, CMP).*

> *There are always discussions about it [how to share the profits that result from slow-steaming[2]] and it's very tricky to be fair to both parties. They save bunker, we save demurrage time. …It is not supposed to be that one part benefits more than the other (*Sundvall, Preem).

Benefits (or reduction of extra costs) of STM are reflected both in standard situations, e.g. the optimization of common routines and coordination, and in the

[1] Notice of Readiness:
The Notice of Readiness (NOR) is the document used by the captain of the ship, in the event of voyage chartering, to notify that his ship is ready, in every respect, to load and/or unload the goods.
In the event of voyage chartering, the charterer has a certain term within which the loading and unloading activities must be carried out: the lay days. When exceeding the lay days, the charterer must pay the ship owner compensation (demurrage). Depending on the moment when the NOR is issued, the lay days count start.

[2] *Slow steaming* refers to the practice of operating a ship at significantly less than her maximum speed in order to save fuel consumption.

situations of unexpected events, where the STM will reduce/eliminate the risk of occurrence of these events as well as allow for a quicker recovery from emergencies. Although most information is already available today, there are many different sources of information making it hard for the individual actors to gain access to the benefits of different information sources and form a coherent/accurate picture.

> *It is very important to coordinate this information or information flow because too much information is "disinformation". It is hard to know how to use this information. [For instance, to approach Gothenburg] you look into the website of the Port of Gothenburg, but then you also have to go into the SMA website and the transport agency and probably on the agent website and ... That is crazy. There is no bundled information for the approach to Gothenburg. If you are on the ship, how are you supposed to do that? (*Kärnebro, Port of Gothenburg*)*

> *The information is there, it is just a question if it actually reaches us in the end (*Sundvall, Preem*).*

> *There is no integration of the systems […] It is all retrieved manually by email or phone (Nørgaard, CMP).*

2.4 Structure Of The Analysis

We analyze the effects of STM on the business models of the different stakeholders making up the comprehensive maritime ecosystem by using the Business Model Canvas (Osterwalder and Pigneur, 2011). In order to gain a more comprehensive understanding of how STM affects the business models of individual organizations within the ecosystem, the business model of the two most important stakeholders—the shipping company (for the optimization of the voyage) and the agent (for the optimization of the port operations)—will be analyzed thoroughly. To a very large extent, these are representatives of the full ecosystem.

Regarding route optimization, the shipping company acts on behalf of the end-customer, and is thus the main beneficiary of an optimized sea voyage. Expressed in a different way, the shipping company is the actor, which is able to harvest the efficiency benefits, which could then be translated into higher profits for the shipping company, better prices for the suppliers to the shipping company, fewer efforts for the different service providers or lower costs for the charterer. Competition among the different actors will decide who benefits the most.

Regarding the optimization of the port operations, the agent has the most important role in facilitating and coordinating the port call for all actors involved, since he/she is regarded as “coordinator of all ship calls” (Nørgaard, CMP). Accordingly, the STM effectiveness benefits will be visible for the agent, who might have the possibility of obtaining higher profits or to quote lower prices for the different port services (tugboat, pilot, etc.), and who would be able to conduct his/her work faster.

Therefore, we find it most relevant to assess the overall benefits of STM under two headings:

- The *optimization of the sea voyage* (route optimization including Strategic Voyage Management, Dynamic Voyage Management, and Flow Management, dealing with the ship sailing from one port to the next) taking the perspective of the shipping company.
- The *optimization of the port operations* (primarily focusing on Port CDM and the collaboration effectiveness in the port of arrival as well as in the port of departure) by taking the perspective of the agent.

Finally, we would like to stress that there are major differences between the different types of shipping companies (tramp business, scheduled passenger/cargo traffic, line service, and chartered transport). Furthermore, there are major differences between the different types of cargo transport (container, RORO, dry cargo, and tanker). While certain benefits apply to all types of transport, other benefits might only relate to, for example, tramp shipments. We will point this out wherever relevant. However, we have to stress up front that we cannot cover all the differences.

3 Methodology

To perform our research, we adhered to the principles of "triangulation" employing qualitative research interviews as our main methodology (Amaratunga et al. 2002). Initially we conducted two interviews with the shipping company TKB based in Copenhagen, Denmark, in order to obtain a more solid understanding of the possible research problems and to highlight potential gaps and opportunities (Sampson 2004).

Based on this knowledge, we developed a semi-structured questionnaire and conducted 12 interviews in two rounds. Eight interviews were conducted in the fall of 2014 with various actors within the Swedish maritime ecosystem. After refining the scope, a second round of four interviews was conducted in April 2015 in Sweden focusing on the route optimization and port optimization. The interviews were semi-structured following a tracer study approach (Amaratunga et al. 2002), which applies the use of "tags" (grouping of key findings) as well as the extraction of knowledge to refine the following interviews and gain a deeper insight into the complex of problems. The interviews were partly transcribed. The transcription focused on the understanding of the business models and the potential changes as well as on capturing essential statements in form of insightful quotes. For a full list of interviews, see references.

4 Optimization of the Sea Voyage

The optimization of the sea voyage focuses on route optimization between the port of departure and port of arrival including Strategic Voyage Management and Dynamic Voyage Management.

4.1 General Conditions

The introduction of AIS and ECDIS systems has already provided a substantial improvement regarding safety and efficiency. Nevertheless, national requirements, which can differ greatly between countries and between ports, pose a big challenge to the assessment of the effects of STM as well as to standardization/optimization within full ecosystem. Furthermore, some shipping companies and some ports already have very advanced systems, which are not very different from what is proposed in STM. Finally, even though some companies own more or less the whole value chain, estimates of key data like the ETA are often very imprecise until rather late.

> *It was a Preem voyage loading on a Preem berth, it is Preem planning - Preem people all the way. […] Everything Preem and still the [estimates of ETA] were off by 2 days. This sort of proves the challenges (Gustafsson, Tärntank).*

With these reservations in mind, we shall now proceed to an evaluation of the benefits.

4.2 Benefits

The overall benefits of the optimization of the sea voyage can be grouped into three different categories: 1) bunker savings, 2) efficient operations, and 3) increased transparency/ reduced variability.

4.2.1 Bunker Savings

Some shipping companies, such as Stena Line, have integrated systems for their own processes all the way from berth to berth. Energy-saving projects are also priority for Stena Line. Subsequently, they feel that the potential benefits from STM will be rather small for them, as they have excellent systems and the capability to dedicate some of their staff to work solemnly on energy saving projects.

> *Energy saving is on top of our agenda. For the time being, we have 10 guys fully employed just working on energy saving projects. From big projects such as the methanol conversion down to small projects, just to save energy (Lewerentz, Stena Line).*

In other cases, the actors were very excited about the potential value of a fully implemented STM and they agreed on the potential high bunker savings they could achieve.

> *I think, to cut 10-15% on bunker over the year is possible - more than possible. And also if you can have a system in ports, [it could] cut 1-2 hours, which is around 10-15%. Of course you can do it (Möller, Tärntank).*

> *Every ton we can save due to reliable information is worth something. [By slowing] down to 10 knots and then being there [just-in-time] for berthing, we can save 6-7 tons in 20 hours. That is fantastic. There is a value … for the environment as well (Gustafsson, Tärntank).*

Just one knot is a lot of money already (Lewerentz, Stena Line).

4.2.2 Efficient Operation

Efficient voyage planning starts very early in the process. We were surprised to learn that a tramp shipping company like TKB might be involved in bidding for 100 voyages in order to get one shipment. This obviously requires good information systems internally and really effective networks to their potential suppliers. Furthermore, once they have got a contract for a voyage, the operations department has the challenge of optimizing the voyage to improve their business by making the voyage as effective as possible. This planning takes place on a basis of limited transparency and many uncertain elements. In the estimation of one of the other shipping companies, it takes an operator around 15-20 emails to agree on the terms and conditions for a cargo transport. The extensive crisscrossing of information between all the actors, such as shipping line – agent – customs or shipping line – agent – port, plays a major role in creating these large inefficiencies since it takes time/effort to do information search, dissemination or double confirmation.

A good operator … can earn his/her salary in one week or a couple of days. That is what good operators are doing today already (Möller, Tärntank).

Optimized sea voyages as with STM will lead to reduced voyage turnaround time due to less time spent in the port. This saved time translates into savings on fixed assets, such as ship, crew, and provisions. Moreover, real-time and bundled information offers the possibility to decrease the leeway in the planning of the voyage capitalizing on capacity utilization.

4.2.3 Increased Transparency/ Reduced Variability

An optimized sea voyage with STM will also lead to more transparency and less variability. Shipping companies will be able to handle unexpected events in a more effective manner.

Sometimes, there are hiccups during the voyages. If you can't foresee [these unexpected events], it could be beneficial [to be connected to such a STM system]. If we knew five hours ahead that there will be congestion in Gothenburg Harbor, then we could slow down all the way. If that were possible to foresee [with STM], that would be perfect for us (Lewerentz, Stena Line).

Increased transparency and reduced variability will also provide a much better possibility for monitoring ships more precisely and effectively, and 'this is one of the best solutions in terms of accident prevention' (Nørgaard, CMP).

5 Optimization of the Port Operations

The optimization of the port operations focuses primarily on Port CDM and the collaboration effectiveness within the ports.

5.1 General Conditions

A major challenge in establishing efficient port operations is the fact that the different activities within the port ecosystem differ greatly with regards to services, level of skills or regulation required. The many different actors––constituting the port ecosystem––share the responsibility for superior service delivery. For instance, ports have always had a strategic role for the economic development of a country or a city. For this reason, government involvement has always been a part of the way ports operate (Trujillo & Tovar 2007). Accordingly, when analyzing port efficiency, each component needs to be look at from several different angles and deserves differentiated approaches for taking the specific peculiarities into account.

In our benefits assessment, we also need to distinguish between ships, passengers, and freight as ports cater to both types of clients: ship owners who need to berth their ships and private operators who load/unload passengers or freight. Additionally, the multi-country perspective as well as private information make the assessment of port efficiency even more complicated (Trujillo & Tovar 2007). Along these lines, and in accordance with Friedrichsen (1999), an assessment of a port's performance needs to address the efficiency of the overall port ecosystem.

According to literature, in order to optimize internal seaport processes and to boost a port's level of efficiency, a collaboration between all stakeholders of the seaport ecosystem is essential (Da Cruz et al. 2013). Within this ecosystem, the shipping company represent the key actor in studying seaport competitiveness (Tongzon 2009). Service providers need to have a thorough understanding of the user's port experience in order to be able to improve a port's competitiveness. Therefore, it is crucial to determine antecedents of competitiveness, identify performance gaps, and ascertain where exactly the port may optimize its operational efficiency. Moreover, efficient door-to-door cargo transport from departure to destination of the goods needs to be enabled through the integration of the seaport into intermodal links (Da Cruz et al. 2013).

Currently, there are many different (but often not integrated) systems, but none of them can deliver the necessary accuracy and validity regarding the time estimates. If one could always trust that the information displayed in the future STM system was the most up-to-date and the most valid one, planning could be optimized much better. Some actors predicted that in the best case, timesaving of more than 50% was possible, especially because they did not constantly have to "chase" desired information.

Public organizations in ports (like customs, security, and immigration authorities) need different types of information about content of cargo, passenger lists, etc. However, very often, there is an inadequate knowledge and the public organizations have to rely on experience or expert knowledge about the country of origin, the charterer, the shipping line, etc. In terms of security, an integrated STM would make it possible to exchange much more relevant information/knowledge about the content of the cargo and all the other types of contextual information. This would help in the planning and operation process. For instance, in the container terminal, knowledge

about dangerous goods in a container could trigger the action of stacking the container in a specific place for scanning and/or further investigation. Right now, a container that customs needs to inspect could be the bottom-most in a stack and hence, it could be very time-consuming to retrieve exactly this container for inspection.

5.2 Benefits

We grouped the overall benefits of the port optimization into four different categories: 1) coordination efficiency and reduced turnaround time, 2) reduced workload, 3) elimination of work, and 4) learning effects and less mistakes.

5.2.1 Coordination Efficiency and Reduced Turnaround Time

An efficient coordination within the port ecosystem will lead to the optimization of the resources as well as a reduction of the amount of resources needed. Currently, the different organizations within the port-ecosystem are trying to make their own operations as efficient as possible largely ignoring the interdependencies that impede the overall efficiency gains. By optimizing the port ecosystem as a whole and benefiting from resulting synergies, the turnaround time could be reduced significantly. Our respondents estimate that an optimized port-collaboration-efficiency could easily translate into a 10-15% reduction in waiting time as well as into a 10-15% operational improvement (Möller, Tärntank). In the ports, every minute counts and even the slightest improvement will make a huge difference in monetary terms. Since a ship costs per time unit both at sea and while lying in the port, the reduction of the time spent at port improves voyage efficiency, providing the owner/ship charterer with enhanced flexibility in arranging the next use of the ship.

> *We had the aim in Göteborg to decrease [the turnaround time by] 15min. Because you have a lot of money when you talk about 15min. Then everyone is more alert. We talk about minutes and then it results in hours (Möller, Tärntank).*

> *There is no doubt that there are some efficiency gains for Svitzer [with better information for coordination. [This is] also part of offering something to our customers. We discuss with Maersk Line how we can best cater for their shortest turnaround time. That is our prime value proposition. If a container line is delayed by some hours compared to if we need to use another tug or be [better] ready for the job. Our fee is peanuts compared to [the costs] if they are delayed (Christensen, Svitzer).*

Furthermore, a better information flow between the different actors could allow for a reduction in the notice time for ordering a pilot or tug in order for the actors to be able to react more quickly and flexibly to unexpected events. At the moment, a big challenge is the lack of common standards and requirements regarding the way business processes are handled.

> *Every port is different. For example, in Slagen (Norway) the cost of lying at the quay is quite expensive and the cost for pilot to anchorage is quite cheap [if you compare*

it to the cost of laying at the quay]. However, the cost for the quay is carried by the charterer or the cargo owner, and the cost for the pilotage will be on the agent. So the agent will tell the ship to stay at the quay even if it costs 100k to stay at the quay. [In that way] they are saving a couple of thousand quid on the pilotage, but the ship and the organization are charged a couple of hundred thousand. Who's to decide? I mean it should of course be the one that pays the most but then again ... there might be a better way (Karlsson, SMA).

Through tighter collaboration, coordination, and information exchange, the yard planning of the port/terminal could be made even more efficient leading to shorter loading/unloading operations and thus shorter turnaround time.

The ability to use only one system as well as the option for automatic exchange of information would bring significant efficiency gains. For example, right now, we have to login to their [government/state] system in order to access specific information; and it would be a great improvement if that could be done automatically (Nørgaard, CMP).

If we knew there was [going to be] an inspection [by the custom authorities], we could already separate the containers accordingly […] Or if we knew exactly when the trucks come to pick up the container, we could already put them on the right spot where we have less necessary movement (Nørgaard, CMP).

Moreover, planning operations in ports can be seen as some kind of certainty funnel, where initial vague information, e.g. about ETA, becomes more and more certain the closer the ship gets to the port. For many of the actors it is therefore impossible to optimize and realize efficient capacity planning.

[In the tug business] we don't have a [planning horizon of a] day or two, [and we certainly] don't have two weeks. That means we can't actually plan our capacity way in advance. We only have experience and annual peaks … to actually plan capacity. […] The complexity means that the focus from our side becomes 'just getting things done' in order not to hamper the effectiveness of the port, instead of the bottom line of our company (Biangslev, Svitzer).

It is clear that more transparency in port operations, especially the crucial ETA/ATA, will contribute to a reduction of costs, since it becomes easier to optimize planning and operations. The earlier one gets the information, the better. Examples of that could be a notification about a container ship blocking the fairway. This kind of information would be very beneficial during maneuvering in order to adjust speed and thus reduce bunker consumption.

If we know 5 hours ahead that there will be congestion in Gothenburg Harbor, of course, then we slow down all the way. If that were possible to foresee [with STM], that would be perfect for us (Lewerentz, Stena Line).

5.2.2 Reduced Workload

Reduced workload derives mainly from less administrative work due to the availability of accurate information, higher transparency, templates, electronic transmission, and digital procedures.

> *If STM was reliable, that means, if you could really, really trust that the information is reliable, I think everybody within the complete nautical chain could make their own business better by planning their resources in a better way. For example, linesmen. Instead of having 35 employees, maybe they could [make due with] 30 or maybe they could decrease their prices. The same [applies to] tug companies. For us, yes, maybe we could make our organization up here in a better way. We can use our employees in a better way (Kärnebro, Port of Gothenburg).*

> *Crew for us is about 75% of our costs. So we must make sure that they are not sitting twiddling their thumbs and not having jobs. It's capacity planning. You could even roster people off [the tug]. If you can see that you are in a market dip - why even equip the tug with people. Our operators spend a lot of time and energy to predict what is going to happen. They don't have a lot of transparency; they don't have a lot of notice. […] And flexibility here is rather limited as the whole set-up depends very much on the union (Biangslev, Svitzer).*

> *We have to pay our dockworkers regardless of whether the ship is on time or not (Nørgaard, CMP).*

The quotes above clearly document that a better information infrastructure and exchange will lead to a significant reduction of the workload for some of the actors in the port, e.g. agents, linesmen, or pilots, but also for the captain and his/her crew on the ship. Almost all interviewees stated that STM would reduce phone and email communication significantly and finally provide more possibilities for both customers and organizations to do it as much as possible electronically. Some of our respondents reported a huge waste of time.

> *… It is very stupid. Sometimes 50% of our time is about having phone calls [and chasing or giving information]. We could use our employees in a better way. Instead of all these phone calls, they could start to be involved in different projects and help developing other affairs (Kärnebro, Port of Gothenburg).*

Additionally, a tug operator would be able to group the different journeys together and thus reduce the commuting time for the crew and the impact on the environment significantly.

> *In Milford Haven (UK) there is a lot of tugs, because there is Terminal that takes in oil and gas. They are based quite far away from where the tug jobs are. That means that tugs steam back and forth to do their jobs. And if they had better knowledge [about] what was going to happen for the next 24 hours or something like that, they could kind of wait out there instead of going back and forth (Christensen, Svitzer).*

5.2.3 Elimination of Work

Better overall transparency, better estimation of variability in unexpected events, better integration, better collaboration, and better situational awareness will open the possibility for the elimination of work. The administrative burden for both the captain at sea and the different actors on shore will be minimized. In the long run, other changes might be possible. For instance, instead of having pilots on board, it might be possible to handle this task more effectively from the shore (Möller, Tärntank). That would reduce the number of pilots needed, and it would reduce the costs of the port call by up to 20% (Boesen, T.K.B. Shipping). However, the current STM is not suggesting on-shore piloting in the immediate future nor should it be applied until the systems are very well established; the risks are simply too great.

5.2.4 Learning Effects and Less Mistakes

Through collaborating more closely with each other, learning and spillover effects will complement and nourish the coordination effectiveness.

Seeing that there are almost no standardization processes in place at the moment, joint effort might change this in the future improving the port ecosystem beyond the goals of STM. Nevertheless,

> *Before you can launch a tool [like STK and initiate major changes], you need to know the processes and understand them very well (Kärnebro, Port of Gothenburg).*
>
> *When they get the information from the agent that they will have to anchor, they are instructed to slow-steam immediately. That works actually very well. […] The small ship saved close to 14 tons of bunker last month (Nässtrom, Preem).*

In other words, one thing is to define and develop the STM, but it is likely to be an even larger challenge to implement such systems. This should not be underestimated.

6 Business Model Analysis

As mentioned before, we decided to concentrate our analysis of STM by focusing on the effects STM will have on the business models of (1) the shipping company (for the optimization of the voyage) and (2) of the agent (for the optimization of the port operations). The following section illustrates the Business Model Canvas (BMC) (Osterwalder and Pigneur, 2011) for the current situation and the STM scenario.

6.1 Shipping Company

Through an optimized sea voyage and efficient port operations, the shipping company can offer better quality with regards to reliability of meeting schedules and flexibility. This is obviously of huge importance. Many activities are dependent on the ETA/ATA, and ideally, all port resources should be optimized to handle the off-loading as well as on loading as effectively as possible. Although we could not get any concrete estimate from any of our respondents, they all saw clear efficiency

gains through better turnaround time that will decrease the port service costs. The idea here is not to deprive the shipping companies from their business tools, such as earning demurrage. The overall goal of STM is to eliminate the need for demurrage.

Moreover, slow steaming will have rather large impact on the company's cost structure as less bunker consumption translates into reduced fuel costs. Here again figures of 10% savings were mentioned, but it was clear that none of our respondents had any figures that even remotely could relate to the full industry.

We have shown the current BMC of a shipping company in Figure 1. We believe that the canvas is more or less self-explanatory, and we shall not go in detail with all the nine elements. The suggestion is to read the BMC starting in the middle with the 'Customer Value Proposition'. If one then moves to the right in the BMC, we move closer to the customer, and if one moves to the left in the figure, we have the key activities, the key resources, and most to the left the key partners. The bottom of the BMC shows how the activities in the top of the model are reflected in the cost structures and revenue streams in the bottom of the BMC.

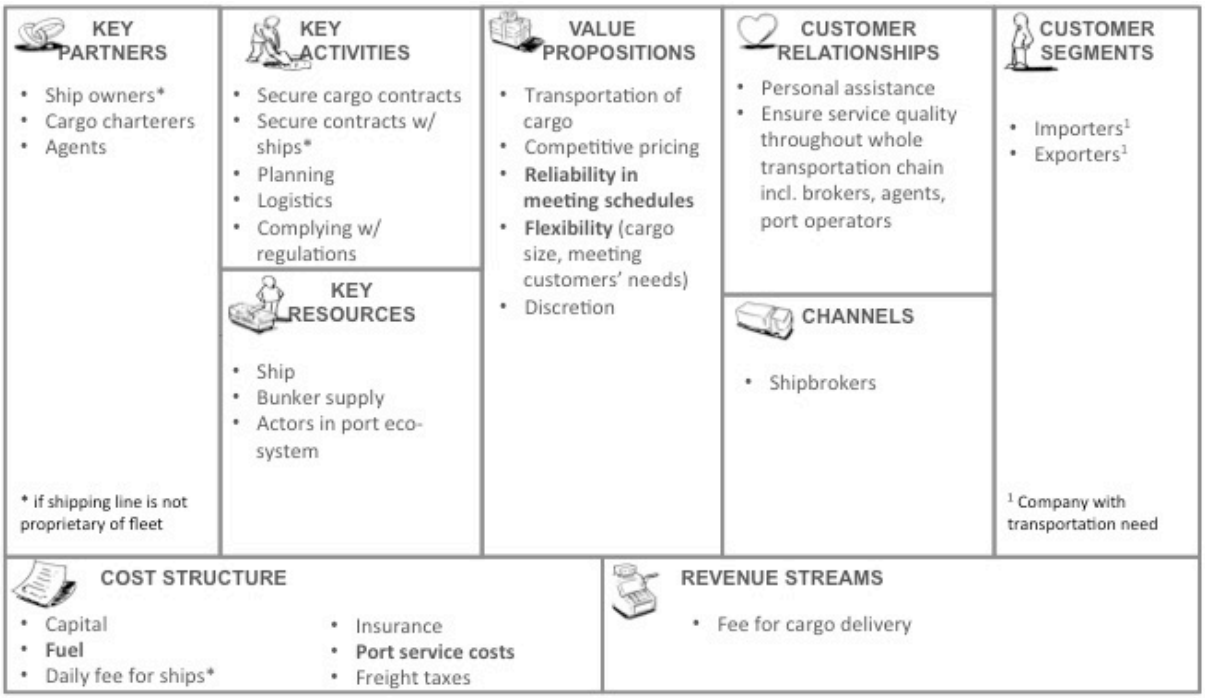

Figure 1: BMC for Shipping Company

If we then develop the BMC for the future situation after the introduction of STM, it is characteristic that the implementation of the STM does not mean major changes in the main elements of the business model. The value propositions, the customer segments, and the customer relationships, etc. are still the same. Yet, with the introduction of the STM, it is possible to deliver more on the different value proposition, such as *reliability in meeting schedules*, *flexibility* and '*security*'. Furthermore, there are substantial improvements in terms of cost reductions for bunker, increased utilization of fixed assets, and reduced port costs. We have

highlighted (in bold) the areas where our respondents expect substantial improvements.

The increased transparency will create more competition leading to more perfect markets with lower profits, if volume stays the same. However, lower overall costs will lead to more traffic, and it is not unlikely that the growth in business will more than offset the losses. On the societal level, lower profits translate into higher overall societal benefits.

6.2 Agent

STM port optimization effects the business model of the agent in various ways changing the role that agents play today quite significantly.

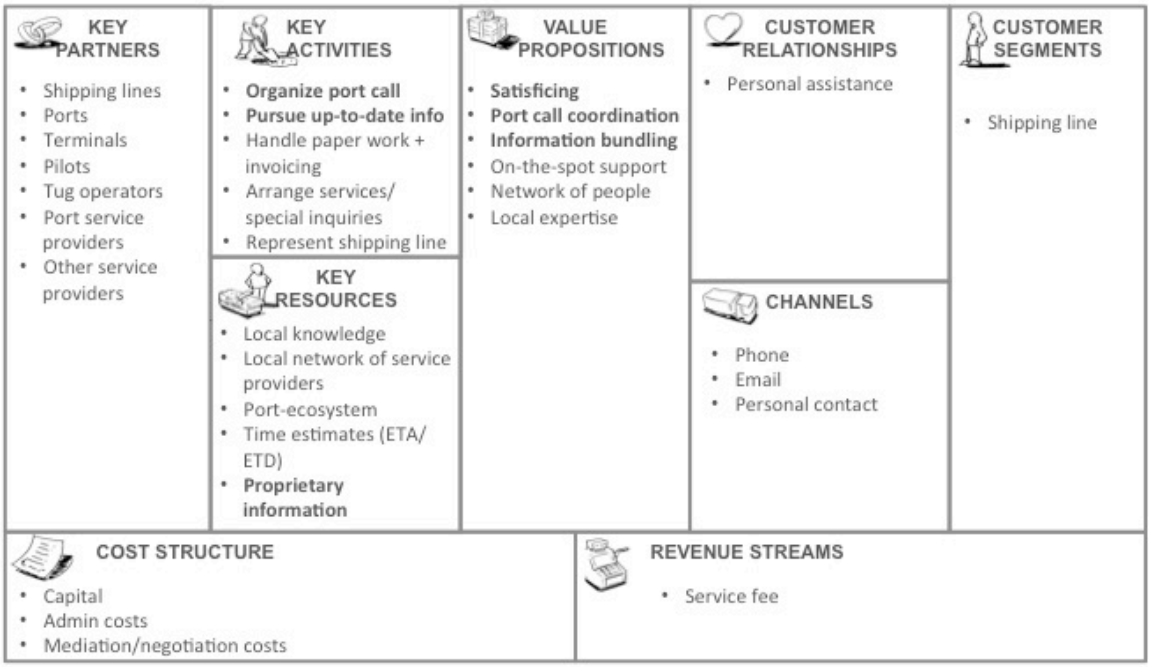

Figure 2: BMC for Agent | Current Situation

In Figure 2, we show the current BMC for the agent. It is characteristic that the agent has to act on an incomplete set of information. This is clearly not optimal. We can therefore characterize the decision making as *satisficing*. There is no chance of achieving near optimal planning. Most of the time, the agent will stop investigating when a satisficing situation is achieved, or even worse, when time has run out. If the agent is able to find such a solution, he/she then needs to negotiate with a range of actors to (re-)arrange and coordinate the port call. In other words, the current task of the agent is to try to find satisfactory solutions acting on incomplete information.

With the introduction of an advanced STM, the situation for the agent might look very different, as illustrated in Figure 3. Many tasks like the gathering of ETA/ETD, booking of pilots and tugboats or arranging other port services, can be made much more effectively. In such a situation, the decision-making can approach *optimizing*. In this

future scenario, instead of relying on informal and negotiated information, the agent will have access to much more reliable, formalized, transparent and externalized information. Current dyadic communication will be substituted with a network based communication ecosystem, where it will be possible to optimize all activities based on an almost complete and up-to-date information flow between all actors involved. Moreover, the agent will have the chance to focus on his core value proposition, quality of service, rather than firefighting. For the agent, the local expertise, the network of key partners, and the spot support for the shipping company will change the focus of the business model from being coordination-centric to being service-oriented and customer-centric.

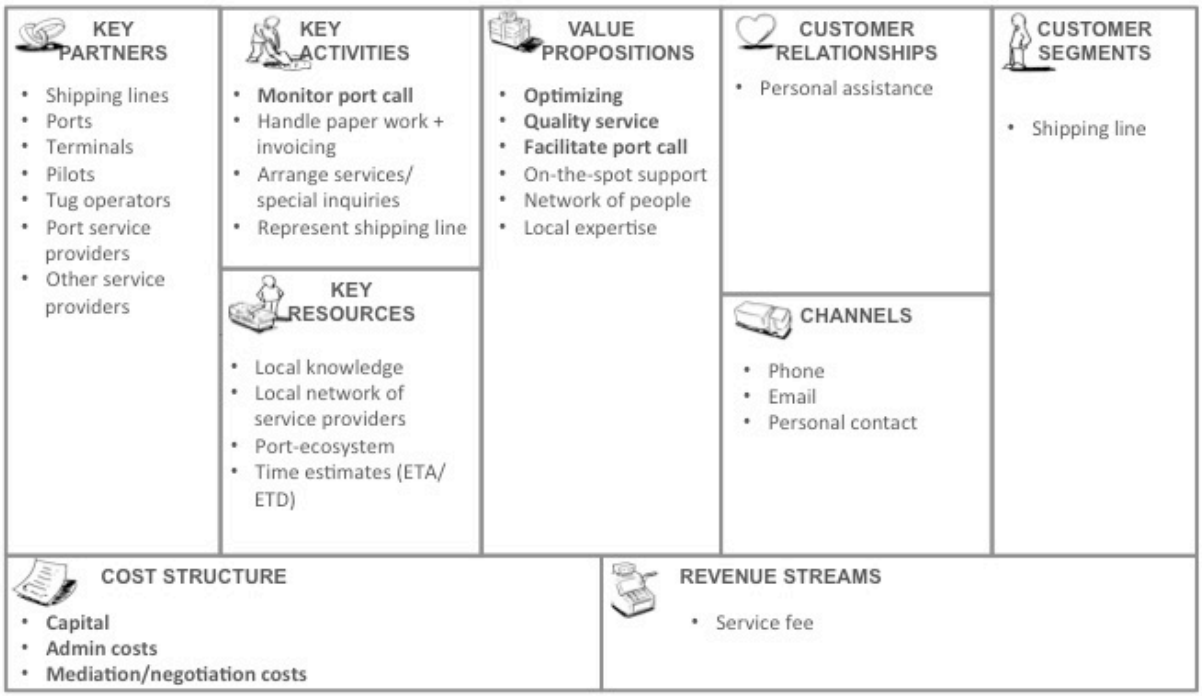

Figure 3: BMC for Agent | STM Scenario

7 Conclusion

Trujillo & Tovar (2007, p. 5) argue "the inclusion of ports as interconnection points is critical to the performance of intermodal transport within a multimodal infrastructure network." The Maritime transport chain is "a network [or ecosystem] in which carriers, ports, shippers, etc. are involved in the movement of cargo" (Talley & Ng 2012, p. 301). If port networks are integrated in combined transport networks, they will be able to compete with the road network (Trujillo & Tovar 2007). The European TEN-T program already aims at integrating the port sector in a trans-European transport network in a coordinated way with a common legal framework. Furthermore, the project intends to make both short and long distance transport attractive for an integration of land and waterborne transport. To do so, the port efficiency plays a key role in the success of promoting the "sea motorways" as an efficient and environmentally friendly transport system. STM is likely to set the future

of maritime shipping. However, this approach calls for more efficient interconnections of ports with other transport modes in order to reduce the total transportation costs, i.e., reduce the intermodal handling cost through standardization of freight loads, provide more competitive port services, or a better selection of service providers (Trujillo & Tovar 2007).

Our research reveals that independent players within the port ecosystem, such as the port authority, tugboat operators, pilots, terminals etc. would perceive large potential cost reductions from the implementation of STM as more accurate and valid ETA/ETDs makes planning and execution more efficient. The different actors would be able to adjust their capacities more appropriately according to actual market demand. By optimizing the port ecosystem as a whole, sub-optimization can be prevented, and all players would benefit from a more efficient and effective collaboration and coordination.

When it comes to more effective voyage planning, nobody questions that more precise ETA/ETD would contribute substantially to reduced bunker consumption, less CO_2 emissions, and more effective use of fixed assets like ships and port facilities. This is especially true for the non-line shipping companies. The largest and most effective shipping companies that have their own processes or control most parts of the value chain themselves believe that they have less need for the STM developed in MONALISA 2.0.. However, they all confirmed that there could be positive side effects for them, such as foreseeing congestions and reacting to them as early as possible in order to save bunker through adjusting speed instead of waiting outside the port for a berth.

Although many of the respondents state that their current systems work pretty well and they cannot imagine how another system could be better, they continuously highlight the fact that there is a lack of information regarding accurate and valid ETA/ETD, and that they lack transparency. Today, the agent is basically the “information hub”, constantly calling the different parties involved to identify the latest and most accurate time estimates in order to arrange everything as well as possible for the port call. The task of the agent is currently mainly a manual one based on different, sometimes even conflicting, sets of incomplete information.

The current business model of some of the stakeholders will change with the implementation of STM. For example, instead of satisficing and serving as the “information hub,” the agent will be optimizing and thus be able to provide superior service focusing on the role as local expert and facilitator. Nevertheless, the implementation of STM could result in some disadvantages for agencies that are incapable of adjusting their business model to the new normal leading to decreased competitiveness and expulsion from the market.

Important questions relate to how to distribute the profits from saved bunker, more efficient port operations, etc. between the different parties, for instance between the shipping company and the cargo owner.

Another major issue in this respect is the costs associated with developing and operating a future STM. It is likely that public authorities will have difficulties in

funding development and shouldering costs of running a STM. Furthermore, private organizations, which to some degree already have their own systems, are also likely to be dragging their feet, especially when it comes to investments that might not give them a competitive advantage. In this situation, it might be difficult to develop a good business case for them.

Still, we believe that a successful implementation of STM pilot projects to a substantially higher degree will make it possible for all stakeholders to understand how the STM concept works and to assess the direct implications for the overall ecosystem and for themselves. We have no doubt that there will be large overall benefits, but it is not necessarily clear that all individual actors will benefit.

> *Obviously, if more people got connected to the same sort of system/platform, then this guy would also be canceled early and then there would be sort of a balance. Rather than him being smarter than me in being able to keep his ships on schedule, I think it would balance out. I don't think you want to be the first guy to be totally transparent (Gustafsson, Tärntank).*

> *The day [Mona Lisa 2.0 STM] works, we will be part of it. The environmental aspects will be huge if its works the way it is supposed to do. And I think, sooner or later, we have to […] optimize our routes and to be more efficient when it comes to emissions (Sundvall, Preem).*

In conclusion, if STM concepts, methodologies, and tools are implemented in accordance with the scenarios, it seems realistic to save 10-15% of current bunker consumption on making the optimal voyage planning and execution. Furthermore, it will lead to an increase in the return on assets (ships, crew, provisions, etc.) by about 10%.

Finally, with regards to port optimization, figures up to 50% were suggested by some interviewed, but we could not find evidence to support such high claims. Overall, and taking into account the many different ships and types of transportation, our study points in a direction of a 10-15% increase in effectiveness of port operations.

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9 Appendix

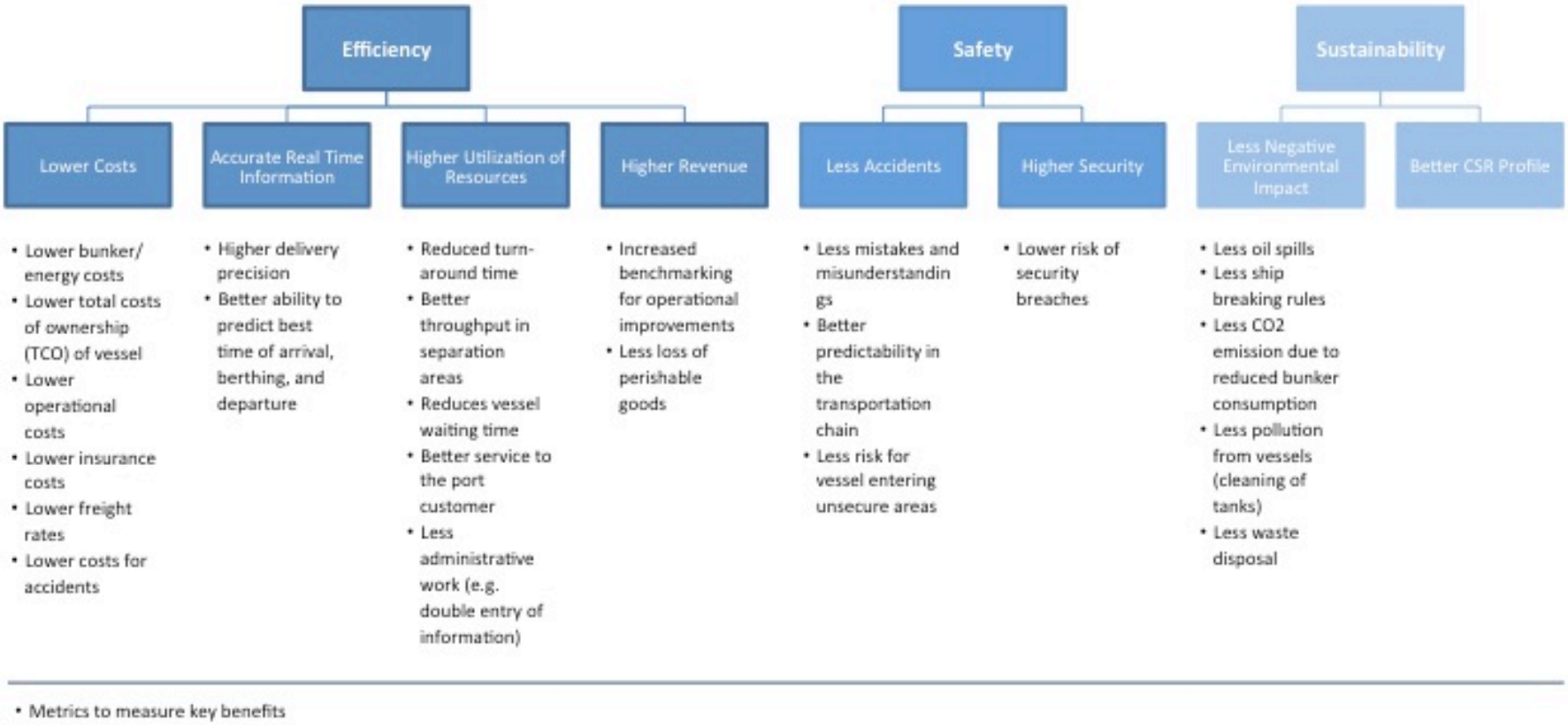

Figure 4: Benefits Hierarchy

Table 1: Definition of Terms in Relation to the Actors

Cargo Owner	**(Export) company, which contracts a shipping company to transport the cargo from A to B**
Shipping Company	Company that executes the transport (acting as cargo charterer while cargo is on board, if ship is not owned by the company, it also acts as ship charterer and thus represents both the cargo owner and the ship owner)
(Shipping) Agent	Responsible for handling shipments and cargo, and the general interests of its customers, at ports and harbors, on behalf of ship owners, managers, and charterers (sometimes also referred to as cargo brokers or port agents).
Port Operators	Actors of the Port Ecosystem, such as Port Authority, Port Control, pilots, tug operator, terminal, stevedore, linesmen, or other port service providers
Master	Captain on board of a vessel, in charge of everything while on sea
Importer	(Import) company receiving the cargo

Table 2: List of Interviews Spring 2015

Name of Interviewee(s)	Company Name	Actor
Mathias Karlsson	Viktoria ICT	Agent
Tryggve Möller (Vice Chariman), Claes Möller (Fleet Manager) **Joel Gustafsson (Charter**	Tärntank	Shipping company
Åsa Kärnebro (Harbor Master)	Port of Gothenburg	Port
Martin Lewerentz (Safety & Environmental Manager Ship Management) **Jörgen Gustafsson (Marine Safety Superintendent Ship Management**	Stena Line	Shipping company
Katarina Sundvall (Manager Shipping Department) **Tor Näsström (Charterer)**	Preem	Cargo Owner
Fredrik Karlsson	SMA	Port
Jens Boesen (Chartering Manager)	T.K.B. Shipping	Operator
Jesper Christensen (CIO)	Svitzer	Tug Operator

Christina Biangslev (Delivery Manager)		
Gert Nørgaard	Copenhagen Malmö Port (CMP)	Port

Table 3: List of Interviews Fall 2014

Name of Interviewee(s)	Company Name	Actor
Roger Kullberg	SMA	VTS
Patrick Delér	Svitzer	Tug Operator
Lotta Åkre (Chartering Manager)	SCA Transforest	Charterer
Björn Garberg (Pilot Area Manager)	SMA	Pilot
Ingela Berntson	GAC Agency	Agent
Fredrik Rauer (Traffic Coordinator)	Port of Gothenburg	Port Control
Peter Hägg	APM Terminal	Terminal
Marie-Luise Heddens	AtoB@C Shipping	Operator

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