



Understanding the Maritime Transport Ecosystem

By Heather A. Smith

Queen's University School of Business
Kingston, Ontario,
Canada

hsmith@business.queensu.ca



Co-financed by the European Union
Trans-European Transport Network (TEN-T)



MONA
LISA

SECURING
THE CHAIN BY
INTELLIGENCE AT SEA

2.0

"Isn't she beautiful? My first command," typed newly-minted captain Julian Sundin into his phone's Facebook app next to a photo he'd just taken of a nondescript ship bearing the name "Eleni". The sun was just rising when Julian arrived to meet his new crew. The previous captain had been taken ill a few days' ago and the ship's owner, Hellenic Shipping, a small shipping company, had promoted Julian from his job as Chief Officer on a similar general bulk cargo ship. "We've got a cargo of grain to take to Bigglestowe in England," he was told by his boss, "and timing is critical so get on a plane to Port de Lachute now. You can be there by the time the loading is done."

Julian knew that meeting schedules was a key part of his job and increasingly important in a world where everything was needed "just-in-time". The grain he would be transporting across the Atlantic had already been shipped by train from the Canadian prairies and would be destined for British tables in very short order. Fortunately, the complex bulk loading procedure had gone smoothly, according to an email he had received from his new second-in-command, Pieter Rostov, who had taken charge while Julian was en-route.

As he walked up the gangway to greet the boatswain, his eye was already roving over his new domain, assessing it for flaws and noting the cleanliness of everything. Once he officially took charge, he would be responsible for everything and everyone on board. The shipping industry was almost feudal in the way authority was ascribed. Once at sea, the captain was king and his word was the final say in everything.

The boatswain greeted him smartly and escorted him to the bridge, where he met his Chief Officer and Chief Engineer. "Sundin," mused Alex "Scotty" McTavish, the engineer. "Wasn't your father a pilot in Sweden for a number of years? I seem to recall..." "You're right on the money, Scotty," said Julian with a smile. "He was a master mariner for many years until my mother made him settle down in one place as a pilot. He was a pilot and chief pilot in the port of Lind, outside Stockholm for over 18 years. He just retired." "Those are tricky waters there," commented the second officer, Anders Haraldson, a Swede himself. "He must have some stories to tell." "You'd better believe it," grinned Julian. "Some of them are pretty hair-raising. I'll tell you sometime, but we'd better get busy or we'll miss our departure time."

Julian and Anders got down to work, while Scotty went down to the engine room and Pieter went to check on the final arrangements for the cargo. "What route have you planned?" Julian asked. Anders pointed to the planning computer where he had mapped out his proposed route to Bigglestowe on the northwest coast of England. As navigation officer, he was in charge of plotting the optimal route, given weather and other conditions. Although a few of the very large shipping companies now had a data base of routes, Hellenic didn't, and so before each voyage, as required by the International Maritime Organization (IMO) (see box), navigation officers had to pull together and log an appropriate voyage plan using a variety of

What is the IMO?¹

A specialized agency of the United Nations, the International Maritime Organization is the global standard-setting authority for the safety, security and environmental performance of international shipping. Its main role is to create a regulatory framework for the shipping industry that is fair and effective, universally adopted and universally implemented. IMO measures cover all aspects of international shipping including ship design, construction, equipment, manning, operation and disposal. Energy efficiency, new technology and innovation, maritime education and training, maritime security, maritime traffic management and the development of the maritime infrastructure such as global standards, underpin the institutional framework it is developing for a green and sustainable global maritime transportation system.

¹ www.imo.org

navigation techniques. Although e-navigation to integrate such diverse information as nautical charts, meteorological data, environmental sensitivities, and regulated ship traffic routes, had been a strategy of the IMO for some time, it was still just a concept and would take a number of years to implement, given the slow pace of change in the industry.

It was therefore up to Anders to plot their course using the best available data, and to Julian to approve it. The course would be updated as the voyage progressed and new information became available. "I think it's good to go," Julian said, after reviewing Anders' handiwork. "You can upload it into the ECDIS computer." The Electronic Chart Display and Information System would assist and support the safe navigation of the ship by the bridge crew, plotting its progress, and updating the ship's Voyage Data Recorder (VDR), the newly required "black box" of all ships.

The bridge of the Eleni was perched high above the deck near the stern of the ship (see Figure 1). From there, Julian could see the tops of the five cargo holds stretched out in front of him. Beneath his feet, the engines started to hum. While not the most modern of bridges, it contained a full array of equipment and computers, including radar, GPS, the navigational computer, and a host of controls, in addition to the traditional helm at the center. From there, he had an excellent view of what was happening ahead and on either side of the vessel. Although all this technology certainly helped, the captain (or his officer) was ultimately responsible, according to the IMO, for navigating visually, although other means could be utilized for guidance.

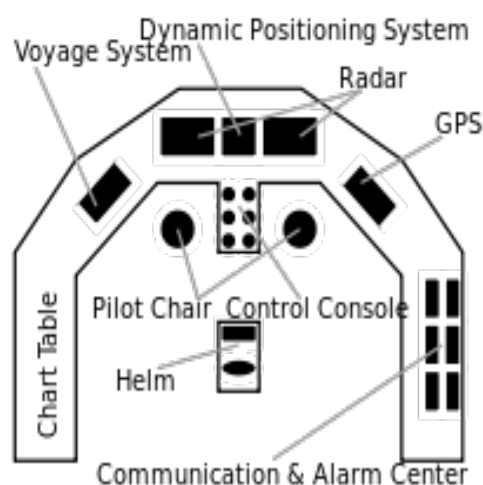


Figure 1. A Typical Ship's Bridge

Like all other ships over 300 tonnes, the Eleni was also equipped with an automatic identification system, known as AIS (see Figure 2). This allowed ports and other ships to identify her, her position, and other basic information. Mandated by the IMO a few years' ago, AIS was designed to improve situational awareness for navigators and thus prevent collisions. Unfortunately, Julian like other ship's officers, had learned to be wary of AIS – it was just too easy to hack. The shipping world was rife with stories of ships being located somewhere other than where AIS said they were. Sometimes this was done for nefarious purposes, such as fishing in environmentally sensitive areas, and sometimes it was simply because the ship owner/operator didn't want his position known for commercial reasons.

The bottom line was that although the technology was improving, it still operated in a piecemeal fashion on a ship, and it was up to its officers to integrate all the information that was provided. Julian knew he was lucky that the Eleni's bridge and equipment were very similar to that of his former ship. Otherwise, he would have had a significant learning curve. The sheer diversity of technologies was a well-known cause of confusion and accidents when officers and crew changed ships. Different manufacturers and software providers designed



Figure 2. An AIS Display

bridges and systems differently. Understanding the layout and information on one ship was therefore not necessarily going to help much when transferring to a different ship.

Pieter came onto the bridge with the shipping agent and a sheaf of documents. "I've given the okay to cast off in a couple of hours," he said looking at the linesmen working at the next berth, "but you've got to review and sign off on these for the port so we can get underway. I'll go collect the pilot."

"Bonjour, I am Francois," said the agent in a heavy Quebecois accent. "I have prepared your departure paperwork for you. Shall we get started? There are quite a few..." Over the next hour, Julian labored over several dozen documents that would inform customs, the port, and governmental authorities when they would be leaving, who was leaving, where they were going, what their cargo was, and that they would need a pilot and a tugboat to depart. Francois had helpfully organized them well and filled in most of the blanks, but it was clear that bureaucracy worked overtime in the maritime transport industry. Many of the reports provided the same information to different organizations. Over and over, Julian confirmed his estimated time of departure and cargo on assorted official documents. "What an exercise in 'busy work' this is," he thought. "My time would be much better spent doing other things. It would make lots of sense if we could just sign once on a master document and have the agent produce reports for all these organizations, or, better still, have the reports generated automatically from one basic set of information." A child of the information age, he was continually amazed at how much of his work in shipping was still paper-based.

Finally, Francois left, documents in hand, promising to expedite the customs clearances for the vessel, process the official paperwork, and electronically transfer the remaining paperwork with all the actual departure information (as opposed to the estimated departure information) to him for approval asap and to fax their estimated time of arrival to their appointed shipping agent in Bigglestowe, who would organize a similar sheaf of documents for him to sign when he entered port.

Activity on deck and on the pier picked up as departure procedures got underway. The pilot came on board accompanied by Pieter. The phone rang. It was Francois saying that he'd received final customs clearance. "I've emailed it to you just now. You're good to go. Have a safe voyage."

Slowly, the Eleni glided out of her berth, nudged by the tugboat sent to move them safely through the large, crowded harbour. The pilot consulted the charts and the route plotted by Anders and nodded approvingly. "We'll be fine if we stick exactly to this route," he said. "But be careful. Going only a few meters off course could cause you to run aground in the shallows on this tide. They're pretty treacherous around here." Piloting today's extra large ships, whether container vessels, cruise ships, tankers or cargo liners, was a tricky business. The boats kept getting bigger and harder to manoeuvre, but the navigation channels stayed the same size. The whole industry had reeled when the Costa Concordia had sunk off the coast of Italy a few years' ago with significant loss of life. Yet, according to published reports, the ship had been a mere 150 meters off course when it hit a rock which tore a hole in its hull fatally damaging it.

"We'll be fine if we stick exactly to this route," he said. "But be careful. Going only a few meters off course could cause you to run aground in the shallows on this tide. They're pretty treacherous around here."

Julian shuddered thinking about it. Shipping accidents were much more common than most people knew. He'd seen the stats on the captains' website. In Europe alone, there had been over 700 accidents in the past year, compared with just 30 in the air. Collisions and groundings were the most common accidents, often leading to loss of cargo and environmental damage due to leaking fuel oil, and sometimes, loss of life. The resulting costs were astronomical. While the major accidents got most of the press, the lesser ones caused delays not only for the ships involved but also for any others using that route. Just recently, a relatively minor collision between a container ship and a cargo ship in the Suez Canal had left traffic tied up for several days and had created ripples throughout the entire supply chain (see box).

As the Eleni negotiated her way through the hundreds of small islands dotted throughout the harbour's mouth, Julian recalled a lesson from his first officer-cadet assignment – one he'd never forget. They'd been late arriving in port due to congestion in the narrow channel leading to the Port of Ebro in southern Spain, and had had to lie offshore for several hours waiting for a berth. The phone calls had been fast and furious and the language strong as the captain had tried to explain their situation to his superiors at the shipping line, who were on the hook for substantial contractual penalties because the ship hadn't been able to berth on time, even though a spot had been booked for them. The language used had left it clear that time was money in the tramp shipping business. The exporters whose cargo they carried had made commitments to the importer who was waiting for the cargo, who in turn had made commitments to a manufacturer. Very little slack was built into the system and woe to the captain who didn't understand his key role in making everything run smoothly (see box).

They had now reached relatively open water and the pilot announced, "I'm off then. Just be careful to go slow around the Cape of Rimouski. It's a designated a particularly sensitive sea area (PSSA). The monk seals are breeding out there now." He strode off to climb the ladder down the steep side of the ship onto a waiting pilot boat. With two hoots of its horn signalling the all clear, the Eleni was free to move into open water. Calling down to Scotty, Julian gave permission to increase her speed to 12 knots. This speed was still slow for this class of ship, but with land and other boats still in sight, it was appropriate. Anders took the first watch while Julian went below to store his gear and Pieter set out to assemble the deck crew to meet their new captain.

The Economic Importance of Shipping

Shipping is the lynchpin of a global economy between exporters and importers. Today, about 90% of the world's goods are transported by water connecting with various land transfer systems, such as rail, truck, and air. Globalization has fueled huge growth in the industry, with manufactured goods coming from Asia, increased need for commodities, and the growth of specialised manufacturing in North America and Europe. Low cost shipping is the means that enables countries to import consumer goods relatively cheaply and export their own products in a cost-effective way.

Differing Time Horizons in Maritime Transport

Time plays different roles in different forms of maritime transport. In the liner business, ships (typically container vessels) operate according to a fixed plan and schedule set up to a year in advance. Similarly, cruise ships plan and schedule their ports of call up to two years in advance.

However, other forms of maritime transport, such as tramp shippers or tankers are private business ships arranged on an as needed basis between the exporter and importer. This business is facilitated by the vessel owners or operators, who offer their vessels for hire to any suitable port(s) in the world, according to a specifically drawn contract called a charter.

The Eleni carried 17 crew members. Each had their assigned duties. The deck department consisted of the three officers, the boatswain and about six deckhands, with the Engineering and Steward's Departments making up the rest. Crew and officers worked round-the-clock, overseeing navigation, ship safety and security, maintenance and repairs, and of course, food. Crew and officers were a multi-national mix from many countries each of whom used English as the main means of communication – some with greater difficulty than others. Crew worked on a ship for up to nine months without leave, and officers up to four months at a time. Contrary to common perceptions of the work as an opportunity to see the world, the reality was that the crew barely left the ship while in port. With modern turnaround times averaging less than 24 hours, and increased security concerns, there was very little glamour or rest in port. At sea, though, life took on a steady routine with its six-hours on, six-hours off rhythm of watches.

In his first day, Julian met his crew and toured their quarters, noting the fully-equipped lounge for recreation. His first meal, eaten with the crew, was pronounced "excellent", and he observed a positive, jovial atmosphere. There was a natural segregation into nationalities and a real mixture of languages spoken, but who could blame a crew member for seeking out those who shared the same background? Life at sea was lonely and communications with family and friends very limited due to the expense of communication. Thanks to satellites, ships on the high seas were no longer as isolated as in the past, but on all but the largest ships, communication was strictly limited to business and operational needs.

Then, it was back to his office to deal with the ubiquitous paperwork. He had not yet finished dealing with the final forms from the previous port call and he needed to get started on the documentation for Bigglestowe, which required 24-hour advance notice of cargo documents, crew lists, certifications, estimated time of arrival, berthing and port needs, navigation services needed, border control forms, customs forms..... The list was endless. "I'll never get out of this office," he groaned.

Steaming on the open sea at the smart pace of 16 knots per hour, the Eleni made an uneventful crossing over the next few days. This was the part of the job he liked best, Julian decided. Good weather, a good ship, and a contented crew, gave him time to enjoy his first command. In this, he was decidedly lucky. It wasn't always so easy, he knew from personal experience.

Then, they hit the English Channel."Holy cow! What a lot of traffic!" he said to Pieter, as they looked at the AIS map. It was cruising season and over 400 ships of all types were displayed. "It looks like a dog's breakfast!" he muttered to no one in particular. The AIS wasn't much help. Although it showed all the large ships and their likely direction, he had no way of knowing their routes. Several ships on the display looked like they were going to collide any minute as they headed into and out of the various ports along the coasts of England and France. And the display only showed the ships over 300 tonnes! There were any number of non-identified smaller craft out there. Fortunately, the IMO had defined directional traffic lanes (called fairways) for tight sea corridors that ensured separation of the majority of ships, but they still left a lot to visual navigation. The "rules of the road" had also been long-established for mariners by the International Convention for the Prevention of Collisions at Sea (ColRegs) so that everyone knew (or should know) when to yield to others. The problem was that it was not immediately obvious, from AIS, radar, or visual means, which paths ships were going to take once outside of these fairways. "It sure would be nice to see their planned routes," he thought, though that wouldn't be a guarantee of safety since ships had been known to deviate and not follow the rules. At least AIS told him which ships were out there, enabling him to radio their captains and find out more about which way their ships were going.

Then, they hit the English Channel."Holy cow! What a lot of traffic!"

No one owned the high seas so there were no regulations to worry about except those of the IMO. But once the Eleni hit the Channel, it was in the coastal waters first of France and then of England, and with this it came under control of their coast guards and both European Union and national regulations, which were confusing, to say the least. Just staying on top of them was challenging. "It's funny," he thought wryly. "Every country is interested in the same three things: safety of

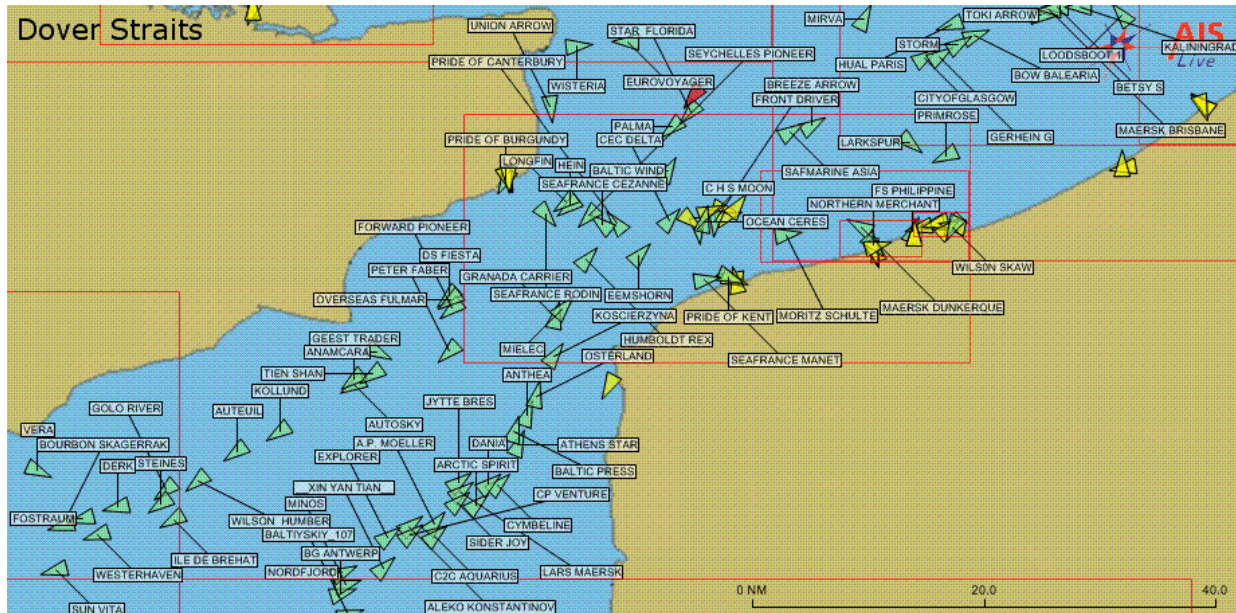


Figure 3. An AIS Display of Ships in the English Channel

people and cargo; security of ships, ports and countries; and protection of their environment. Don't they recognize that all this complexity just increases the risk of a problem?" Ideally, IMO standards should be the same worldwide, but failing that, at least large continents like Europe and North America, could harmonize their regulations. "So many problems must be caused by this," he mused.

Once through the Straits of Dover, a more active series of communications began with Reggie Finch, their shipping agent in Bigglestowe. "Am in receipt of your request to berth and your ETA," his first email began. "I have notified Hellenic of your estimated arrival, as well as customs, the terminal, your freight forwarder, and pilot and tug services. Please complete the attached forms and stand by for further instructions. Please also advise about any further supplies needed." A hefty list of forms was attached, including a form to estimate all waste that was to be disposed of, detailed information on the crew, and what type of unloading and loading services would be required.

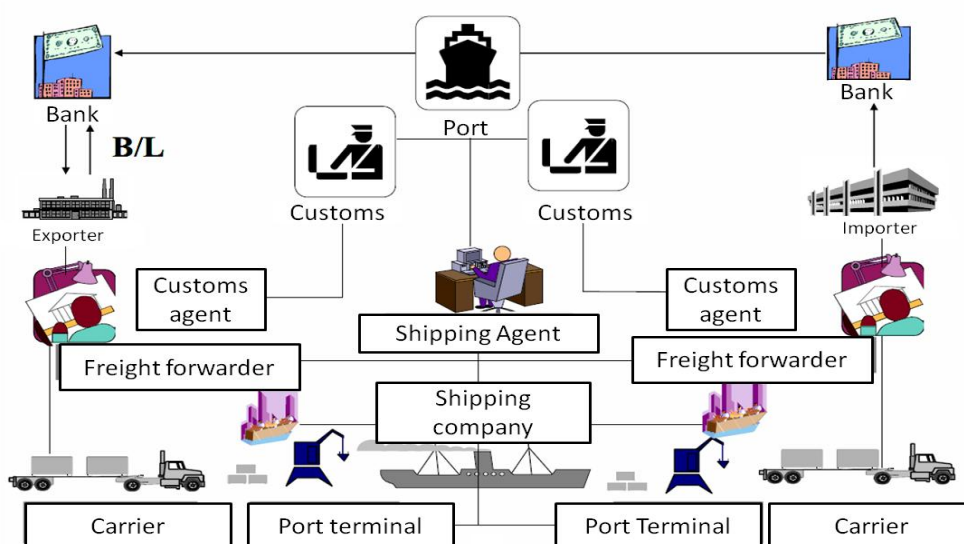
Information about his next voyage was also attached. Scanning it, he saw that he'd soon be bound for Croatia. "Some of the crew will like that," he thought, given that many were Croatian. Then he looked at his cargo and groaned, fertilizer! That was considered a hazardous product and meant a whole new degree of oversight and paperwork. But he'd worry about that tomorrow. Right now, he had today's paperwork to deal with, as well as docking and unloading his current cargo.

As he neared port, Reggie phoned. He had confirmed a berth in Terminal 2 which could provide the specialized crane and conveyor belt that would dramatically speed up both the unloading of the grain. He had also received clearance from the port for the Eleni to enter. As the pilot neared the

ship to take it the last few nautical miles into port, Julian sat down with Rostov to finalize the unloading plans and strategize for loading the next cargo. These processes were dangerous as cargo shifting errors could cause the ship to capsize or break in half while. They'd be in port longer than usual because of the challenges involved with this type of bulk cargo, but the crew would be working non-stop. As soon as one cargo was discharged, the crew would begin to clean the holds, in order to be ready for the next cargo to be loaded.

Crew Certifications¹

¹ Attitudes to Automatic Registration of Certificates, September 2012



smoothly and fixing things when they didn't. In short, it was like the ecosystems he had learned about in school – organisms each interacting independently with their environment and with each other seeking to thrive as individuals yet also contributing to the stability of the whole system.

Julian knew that some in his industry felt that shipping agents were simply “paper pushers”, given the vast amounts of documentation they managed, but he felt that was undervaluing their job. Certainly, some parts of it were repetitive and merely involved translating information from one form into another, but even if all the paper were automated (unlikely given the differing layers of regulations and interpretation of regulations involved, he thought), they would still be needed as a key link between all the different parts of the system. Accidents, logistical matters, national concerns, and people issues would still require someone who could be a “fixer” in such a complex ecosystem.

About 24 hours later, after safely discharging the cargo cleaning residues (with the appropriate paperwork, of course), and changing berths to load the fertilizer, the Eleni was ready to leave with her next cargo and Reggie arrived with the inevitable departure paperwork. “What do you think about computerizing some of this documentation, Reggie?” Julian asked. “It can't happen fast enough for me,” Reggie answered. “Some of the larger shipping agencies already have systems to help them with the paperwork. They work well, as far as they go. In fact, I wish we had more of a system,” he sighed. “The problem is, as far as I can tell, that there are lots of *different* systems out there and they each have to work with the Port Authority systems, which are all different too. Although they require mostly the same information, they each put a little twist on things so that the data can't be easily shared. It's okay to set things up between one agency and one port, but when you get to another agency or port, things don't work the same way. And *everything* between a ship and the shore is either by email, fax, or paper. No electronic data flows between them.”

Sketching a little ship on a piece of paper, Reggie showed all of the communications moving between a ship and the rest of the world (see Figure 5). “What we really need,” he said “is a better

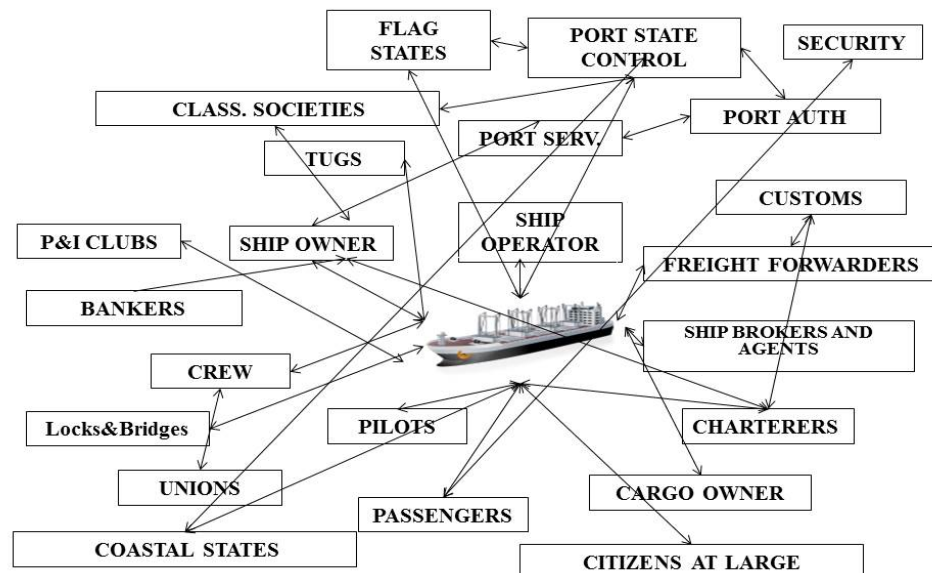


Figure 5. The Ship in an Information Hub

way for a ship to dynamically communicate its information with the rest of the world as it goes about its business. If this were available when it is needed, such as when a ship moves in and out of port or into coastal waters, it could be communicated to the proper people or organizations, at the push of a button."

"Well, we can always dream, can't we," smiled Julian, signing the last of the documents with a flourish. "Thanks for all your help with this."

Reggie said goodbye and strode purposefully down the gangway. Looking at his watch, he realized that he was late. There was a Swedish oil tanker arriving shortly and he had to confirm arrangements for a pilot and tugboat and check with the oil terminal so that a pump and linesmen would be available to get the oil into a storage tank (see box). After that, he had a small cruise ship to process, bills to pay for the Eleni, and a charter to negotiate.

Back at the office on his computer, he reflected that what he had said to Julian wasn't quite accurate. He had a computer and some basic systems as well as the ability to tap into the Bigglestowe Port Community System (PCS), which let him connect electronically with the port, its different terminals, customs and a variety of other port and navigation services. Yet he'd been correct when he said it all felt manual. He was still the translation hub, taking information and documents from the ship and entering them into the various other systems involved. He knew what the different fields on the different forms meant and how to work the systems here at Bigglestowe. But if he were to be magically transported to another port to do this job, even if it were in England, nothing would be quite the same. And when it came right down to the wire, most of the important work was done by phone.

The true value of his job lay not in his translation activities, but in the specialized work he did for each ship, meeting their port needs – whether for supplies, food, or other services – and in his knowledge of how his port actually worked in order to smooth things along both for the ship and for the importers/exporters and freight forwarders.

He pulled out the crumpled diagram of the ship and its communications, which he had shoved in his pocket. This certainly reflected the ship's perspective on the world, he thought, but there was another one as well. A ship had one view. And a port had another. Although ships were certainly key players in the maritime transport system (obviously), ports were their links with the rest of the world. And although he was an independent business person, receiving fees for his services, to many, he was the face of the port. Behind this face however were a number of services and regulatory bodies that he dealt with, all held together loosely by the Port Authority.

He pulled out another piece of paper and began to sketch (see Figure 6). In Reggie's view of the world, ships were just single pieces of a much larger puzzle. His world consisted of: multiple ships and types of ships; the specialized equipment they needed to load and unload them; the various port services, like linesmen and stevedores, to berth the ship and move the cargo to the freight forwarding areas; the navigation services that provided tugboats and pilots; the coast guard and

Types of Ships

- **Tanker.** Carries bulk liquids, such as oil. These represent about 46% of European shipping.
- **Bulk Cargo Ship.** Carries dry bulk commodities, such as grain or coal. These represent about 20% of European shipping.
- **Container Ship.** Carries containers of manufactured goods. These represent 13% of European shipping.
- **Roll-on/Roll-off Ship.** Carries rolling stock, such as cars. These represent about 13% of European shipping.
- **General Cargo Ship.** Carries a variety of cargo.
- **Passenger Ship.** A cruise ship or a ferry. In 2013, almost 200 cruise ships operated in European waters and over 20 million passengers were transported by these ships.

customs agencies who provided security; the other port and national entities set up for specialized activities, such as waste removal, environmental oversight, and immigration; the individual terminals which offered berths and specialized services; and disaster services for when accidents happened, like salvage and search and rescue. Not only did Reggie handle interactions with all of them, from fee negotiations, to booking, confirmation, ensuring all went smoothly, and to the departure process, he also managed the flow of money on behalf of the shipping company, confirming that fees were appropriate and bills and tariffs were paid to the port, the terminals, and the service providers.

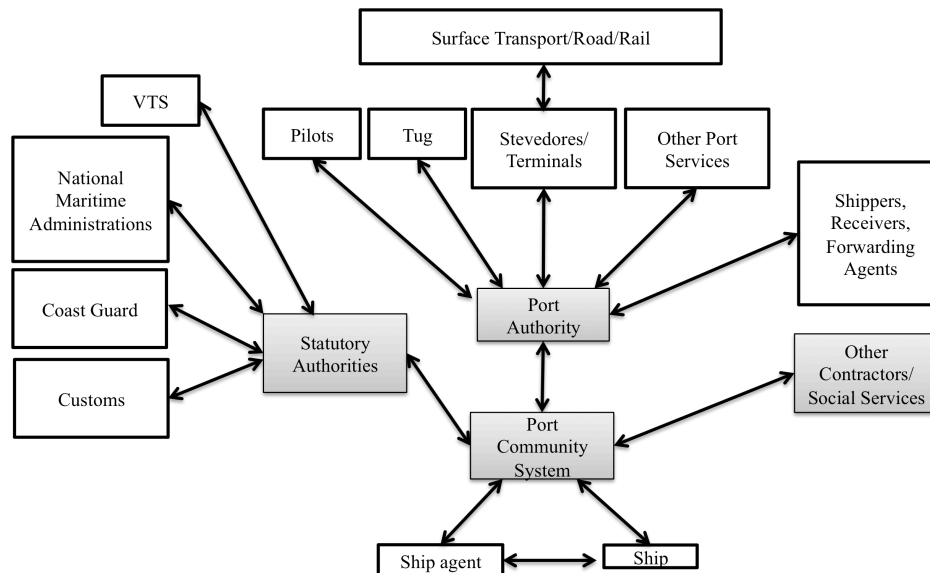


Figure 6. The Port as an Information Hub

Then of course, there were the *real* people he worked for. He was directly responsible to the ship owners, ship charterers, and freight forwarders to ensure their cargos got loaded, transported and unloaded, of course. But they, and he, served the same people – exporters who wanted to get their cargo *into* the maritime transport system from the land transport system and importers who wanted to get their cargo *out of* the maritime transport system and back into land transport (See Figure 7). Getting this job done and providing personal service was really what it was all about and his role was in providing the expertise to make the right connections at the right time.

Sighing, he shook his head. Everyone in this “system” looked at things from their own point of view, which was focused narrowly on *their* needs and *their* interests, struggling to make things work better for *their* business. But seeking optimization on this level didn’t really work. So what if a ship got into port a few hours earlier? If there was no berth for her or if the freight forwarder wasn’t ready for her, there was no value to be gained. No one was looking at the bigger picture, where optimization could make a *real* difference. In his mind’s eye, he could see how this could work, but without collaboration from all the actors involved, he couldn’t conceive of how change could be made at this level.

“One day that will happen”, he thought, pulling out some paperwork, “but just now, I have to get these departure clearances organized for the Eleni and hand her over to Val Antic in Croatia.”

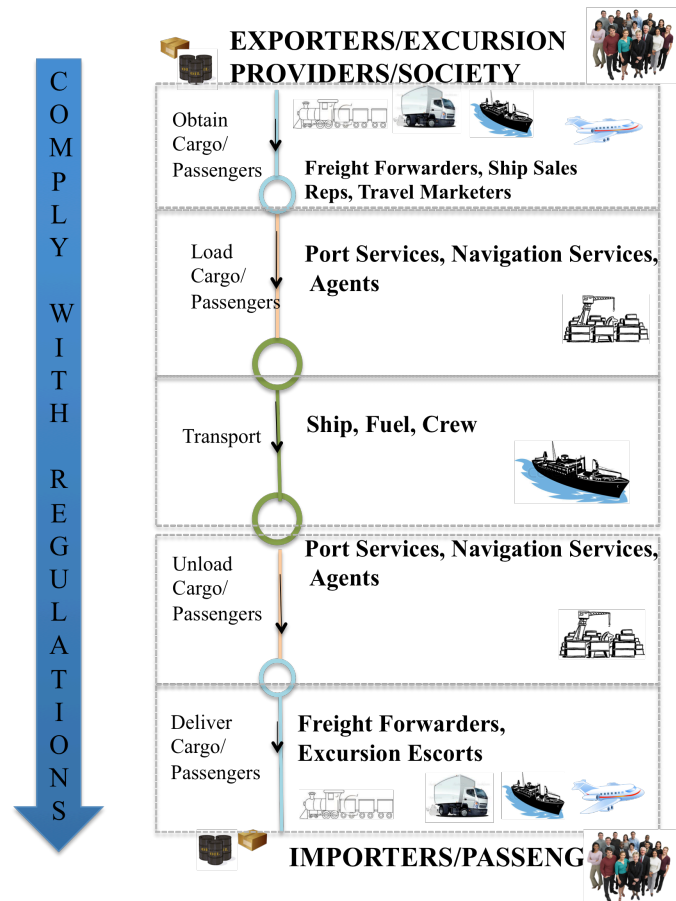


Figure 7. The Maritime Transport Business Model

Acknowledgements

The author would like to thank Per-Erik Holmberg, Ulf Swedberg, Mike Collier, Peter Hinchliffe, Mathias Karlson, José Andrés Giménez Maldonado, Anders Dalén, and Sandra Haraldson for their help and insights in preparing this case. For the sake of anonymity, all persons and organizations cited in this case study have been made anonymous, unless officially referenced.