Technology Growth in Shipping Industry: An Overview

Praveen Kumar Donepudi

Senior Architect, IPM Practice Division, Cognizant Technology Solutions, Pittsburgh, Pennsylvania, **USA**

Received: Oct 25, 2014; **Accepted:** Nov 25, 2014; **Published:** Dec 31, 2014

Source of Support: Nil **No Conflict of Interest:** Declared

ABSTRACT

Being the backbone of the world economy, the shipping industry impacts the lives of many people directly and indirectly. It needs continuous innovation and the adoption of new thought processes to handle the ever-growing demands of materials and goods around the world. It faces several challenges such as compliance with the environmental regulations and laws, changes in the global business models, the complexity of operations and management, risks and hazards to the people and the assets, and the cost of adopting new changes. This study highlights the benefits of greater collaboration with partners, more automation of manual processes, and higher productivity and capacity to handle future loads.

Keywords: Technology Growth, Shipping Industry, Manual Processes, Automation

INTRODUCTION

Shipping is one of the oldest industries in the world and has played a great role in human evolution and economic development of every country. While it started with early man ferrying eatables on boats made of wood logs, today shipping is an extremely advanced and fast-paced industry. The ships today are bigger than football fields and capable of carrying tons of goods from one place to another via sea route. Shipping was amongst the few industries that kept working day-and-night to ensure that there was continuous in-flow and out-flow of all necessary goods from one country to another.

The shipping industry can be truly termed as the backbone of the world economy. It makes all imports and exports possible. Without shipping, countries would have to work so much more to manufacture every small thing that they need. Today, a majority of the items are manufactured in locations that have cheaper resources and then transported around the globe. With 75% of the Earth made of water bodies, data indicates that there are over 2500 ports around the globe handling more than 50,000 professional merchant ships and several thousand smaller vessels. The shipping industry employs more than 2 million people directly and indirectly across the globe to support the complete workload.

Ships, aka *Vessels*, carry all kinds of cargo which are categorized under organized and unorganized sections. The table below shows high-level varieties of cargo.

Data indicates that the shipping industry has been steadily growing in the past decade and the growth rate further going to increase in the future. It means that more load on the ports and more load on the people managing the ports.

The shipping industry has been labor-intensive and involves a lot of niche skills for operating specialized equipment and machines. The people from various organizations need to work in complete cohesion to make the cargo move from one country to another.

For making the entire process of import and export smooth and fast, a bigger technological push and transformation is needed for the entire industry.

APPETIZER TO INDUSTRY 4.0

The 4th Industrial Revolution (***Industry 4.0 or 4IR***) has already started and is continuing to charm the world of business from where the third industrial revolution left. The process of computerization and digitization started in Industry 3.0 with the advent of computers and continued with the automation of machines. Industry 4.0 has brought in the digital transformation with the increase in the reachability of the internet, smart devices, robotics, the interconnection of devices, automated collection of large volumes of data collection, machine learning and artificial intelligence, augmented and virtual reality, and experience sharing.

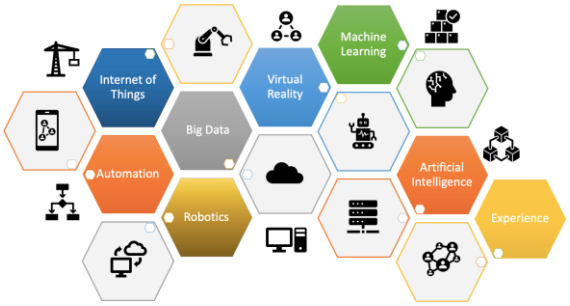

Figure 1: Representation of Industry 4.0: Technical Stack

All domains and sections of the economy are deeply impacted due to the digital transformation taking place all around the world, including banking, healthcare, retail, communication, telecom, manufacturing, travel, transportation, shipping, logistics, hospitality, eCommerce, and public governance.

Industry 4.0 is a disruptive process that replaces human involvement in regular and innovative activities with smart machines. These smart machines produce the data, analyze the data, learn from it, and start taking actions based on the data. Smart machines do not stop at taking action, they go further ahead in networking with other smart machines to share information and produce totally unexpected outcomes.

With the benefits and opportunities, Industry 4.0 brings along the threat of cyber theft and crime. Cyber-attacks have become severe and the vulnerabilities are only going to increase in the future.

Table 1: Cargo types handled by Shipping Industry

Unitized Cargo		Bulk Cargo		Break Bulk Cargo
Containers	RORO/Vehicles	Dry bulk	Liquid bulk	Packaged
20 feet	Cars	Iron Ore	Petroleum	Eatable Bags
40 feet	Trucks	Coal	Palm Oil	Boxes
Open Top	Tractors	Grains	Chemicals	Barrels

Opportunities in Industry 4.0

One of the key focus areas of Industry 4.0 is to provide maximum customer satisfaction and there comes the need to capture the experiences of the customer and act upon them. This characteristic of 4IR is leading us to the Experiential Age. The next age business decisions are not only driven by the cost-benefit analysis but also by the experiences of the past transactions.

While 4IR brings in automation, artificial intelligence, and smart interactions as key benefits, all this is becoming possible because of the growth in the area of telecom. The telecom industry has grown by leaps and bound in the past decade with a decrease in cost and increase in reachability. This has resulted in the deep penetration of the internet in all walks of life. Almost everyone is carrying a smart device with internet-enabled on it. People are in constant connection, either willingly or otherwise, and generating large volumes of data, experience, and sentiments. With all these factors in its kitty, 4IR presents great opportunities in front of the organizations to grow with the tide.

Intelligent Decisions

The information age was all about capturing the data and analyzing it to present the information for the decision-making teams. That was the time of informed decisions.

With 4IR, AI and ML started looking at the data, determining trends, and prescribing actions along with the most probable results. The decision-making team now has the consequences presented in front of them for every decision that they make. The organizations can now focus on their actual business while the smart programs and machines take care of the consequences of their actions.

Competitive Edge and Collaboration

The world is shrinking into a shared space where multiple organizations from within and outside the geography are competing with each other for a share in the market. The competition between the service and product providers is no more limited to a location or a domain. In fact, there are no boundaries. Every organization is competing with the other one, irrespective of their businesses. More and more organizations are coming together to collaborate and form a one-stop-shop for the multiple needs of the customer. Such collaborations are driven by common protocols and communication models which is allowing disparate organizations to talk to each other in a common language. Smart machines and technologies are playing a great role in this collaboration along with simple and secure ways of sharing the data and information amongst the partners. The growth and profits of the organizations are dependent on collaboration with the correct partners. 4IR is driving this new trend of making new macro-organizations.

High Productivity at Low Risk

4IR has been important in bringing along employee safety while improving their productivity with the use of interconnected devices that can work and talk at the same time. This unique benefit has allowed the employees to build the ability to carry out tasks that used to cause physical risk to their safety earlier. It includes tasks such as the connecting of pipelines for discharging liquid cargo from a tanker vessel under the sea waters or verifying the twist locks of containers when attached to a quay crane.

With greater safety, comes more commitment and higher employee satisfaction. All these lead to a better outcome for the customers and high customer satisfaction.

4IR in Shipping Industry

The shipping industry has been slow in digitization and is even slower in adopting 4IR technologies. The good news is that the Shipping industry uses a lot of different types of machines and equipment. Once these machines and equipment start talking to each other, collecting and analyzing data, and making decisions in real-time

without human intervention, the productivity of the Sea Port would go up manifolds.

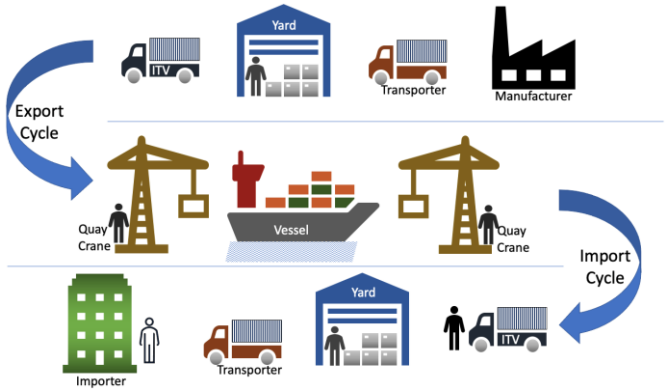

Figure 2: Traditional Port model with complete manual operations

X-as-a-service is the new business model of the world economy. It requires greater collaboration between the participating players of the industry, such as the port operators, the vessel operators, the cargo agents, the equipment providers, the freight forwarders, the transporters, the customs authorities, and many others. The end result of such a collaboration is reduced cost and risk and increased satisfaction and profit. 4IR is the mechanism that is enabling such collaborations. The factors driving 4IR in the Shipping industry include the challenges of meeting the demand and supply, increasing productivity without safety concerns, optimized utilization of resources, shared pool of skilled laborers, quick service delivery, and strong customer experience.

The implementation of 4IR includes the areas, such as scalable computing and storage using the power of cloud computing, constructing paperless contracts using blockchain architecture, collecting a vast amount of data using IoT and sensing devices, intelligent decision-making using machine learning and deep learning patterns, addressing safety concerns using augmented and virtual reality simulations, and so on.

In spite of the benefits and trends of 4IR, there are also a number of challenges faced by the shipping industry while taking up the 4IR. The primary challenge is the concern around data security in the cloud environment. There are other challenges such as lack of skilled resources to operate in the new smart environment, and the higher cost of implementing the smart technology stacks.

Shipping Industry Use Cases

There are various workflows that are executed on a regular basis at any seaport around the world. The standard ones include the following.

- The standard export cycle that involves receiving the cargo via a truck or a train through the gate of the port, storing the cargo in the yard, and loading cargo on the outbound vessel.
- The standard import cycle that involves unloading the cargo from the inbound vessel, storing the cargo in the yard, finding the appropriate transport to dispatch the cargo to the recipient, and sending off the cargo on a truck or a train accordingly.
- The planning of the yards for storing the cargo for optimally utilizing the physical storage space and shifting the in-transit cargo within the storage area.
- The berthing and unbreathing of the vessels based on the tide timings and free berths. It also involves guiding the large vessels to the berth using a pilot and a tugboat.
- Providing various services to the vessels and cargo agents, in terms of cleaning, packing, unpacking, drying, washing, and so on.
- Providing assistance and clearances with customs and other regulatory paperwork.

Common Challenges

The shipping industry is going through the process of transition with changes happening on all fronts, including business factors, compliance with laws and environmental regulations, technology adoption, macro-economic trends, and employee expectations. These challenges are real and here to stay.

Regulatory Compliance: International Maritime Organization (IMO), which is the body that regulates the shipping industry around the world, committed itself to reduce greenhouse gases (GHG) by at least 50% by 2050. Given the global treaty, IMO issued the guidelines making the ports play a strategic role in emission control and decarbonization. The measures focus on fleet improvement and speed optimization programs, vessel modifications, and eco-friendly smart vessels.

Global Business Trends: The pressure of the new service-based business model is such that the ports need to collaborate with manufacturers, transporters, agents, owners, and government bodies to provide a single-window type one-stop-shop to their customers. Customers should be able to import, export, track, and get clearances for their cargo from a single point-of-sale. This means uniform, seamless, and continuous flow of business messages between players from different domains and backgrounds.

Operational Complexity: Port operations involve the usage of various types of devices, equipment, and machines. Most of these machines are very specific to the environment and require experienced and skilled laborers to operate them. The most common equipment includes forklifts, weighbridges, RFID scanners, cranes, trucks, RDT devices, and so on. The specialized equipment includes quay cranes (QC), straddle carriers, rail-mounted gantries (RMG), rubber-tyred gantries (RTG), reach stackers, intra-terminal vehicles (ITV), and so on. These devices are manually controlled from within or remote locations for

handling different types of cargo. The biggest challenge is to make use of hand-held mobile devices and vehicle-mounted smart devices to instruct these machines to work. This needs to be achieved without any loss in productivity.

Physical Risks and Hazards: For the seaports, physical safety and protection against hazards always remain a top priority. As the volumes of cargo increases, the demand for higher productivity and strict timeline adherence also goes up. This puts tremendous pressure on the people working on the port, amongst the heavy equipment and machinery to work fast. Apart from the risk to the life of the people working on the port, the risk of financial losses, due to accidents and manhandling of specialized equipment is also very high at all seaports.

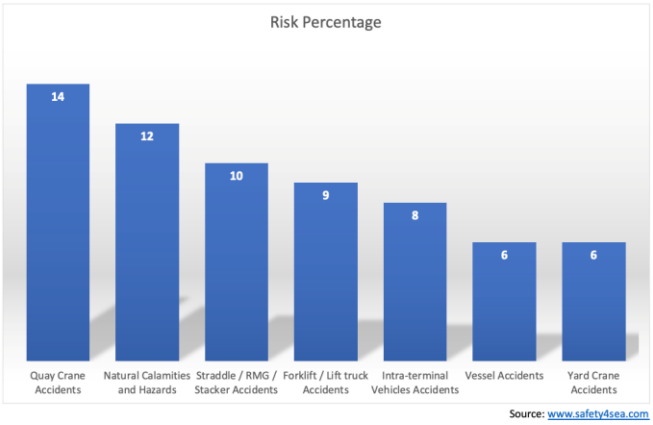

Figure 3: Physical Risks and Hazards experienced at a Sea Port

Cost of Technology Upgrade: The technology upgrade is merely not related to software or computer related hardware. For a seaport, it means changes to several field devices, network setup, communication protocol changes, infrastructure changes, and so on. Put together, it adds up to a significant cost for the seaport. The devices on the field should be upgraded completely or partially to support automated instructions and robotic control. These devices should be enhanced to be able to capture data using sensors and communicate with other devices and servers for exchanging data, position, location, and other information required for smooth operations. Likewise, the IT infrastructure also needs to be enhanced to become capable of storing and processing the large volume of data produced by field devices, to optimize the operations and make it faster than the manual alternative and produce insights.

Resource Optimization: The workforce at seaports across the globe follow a very traditional approach of work and needs an upgrade in terms of training and experience to manage the work in a fast-changing environment. The workforce needs to be reorganized for better utilization at the correct work areas. In a technologically superior environment, there would be a need for monitoring and control from a remote location using semi-automated and fully automated equipment. Resource optimization has a direct impact on the cost of operations, which changes the entire revenue and profit scenario for a seaport.

Opportunities in Shipping Industry

With the latest technology that is driving the 4IR, several opportunities seem eminent to be acted upon within a seaport. With one step at a time approach, seaports are sitting on one of the biggest technology revolutions ever seen. This technology revolution could be bigger than the creation of assembly lines and the definition of standards and processes for various industries in Industry 2.0 and 3.0.

Cloud Computing: The cloud has become the de-facto infrastructure for most of the computation and storage needs. All modern apps are deployed on the cloud platform that remains highly available and scales up and down on the need basis. The shipping industry has been slow in adopting the latest technology. Migration to the cloud platform has become the first step that most of the ports are taking now. Moving on to the cloud comes with special opportunities for the shipping industry and participating players.

- Deploy applications and processes in high availability and scalability.
- Store the large volumes of data which is collected from multiple devices and equipment.
- Perform resource-intensive data analytics on the data collected from various sources.
- Create a uniform integration platform to bring together all the stakeholders of the port, such as agents, transporters, customers, and others.

Figure 4: Cloud platform: High availability and Continuous communication

With the adoption of the cloud platform, ports can focus on their core business as they use the infrastructure of the cloud and in return, they get processing speed, cost-efficiency, security, high availability, and robustness.

Internet of Things (IoT): IoT solutions are the first step towards the automation of ports. They enable the devices to become smart, connect with other devices, and collect and report data about their working conditions and status. For implementing the IoT solutions, older machines and devices need to be replaced by new ones and where new devices cannot be brought in due to cost or feasibility, new sensors need to be installed. There are thousands of small

and big machines and equipment that operate at a single port. So far, humans have to manually monitor these devices for correct functioning, accuracy, and maintenance. With IoT, a variety of scenarios can be implemented.

- Automation of processes and workflows such as loading and unloading of cargo and containers from the vessel or vehicles. It starts with a unidirectional conversation but extends into full-fledged automation.
- For performing predictive and prescriptive analytics, data is the key. IoT devices and sensors are the key sources for all such data. They produce or capture data without interfering with the functioning of the machines and equipment and communicate back to the cloud platform for further processing.

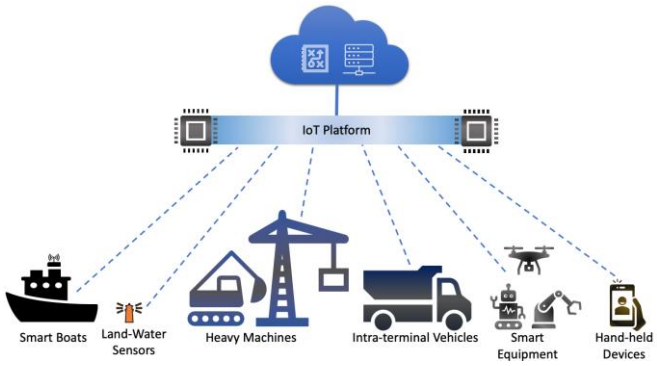

Figure 5: IoT and Device communication at Sea Port

As the ports and related partners embrace the IoT solutions, the foreseeable future of the shipping industry appears to be moving in the direction of fewer accidents, lesser losses, more productivity, and more profits.

Data Analytics: The data of almost entire port and maritime operations is collected by the IoT devices and sensors and uploaded to the cloud platforms using appropriate solution interfaces. Next in the queue comes the analytics of the large data sets. It requires setting up algorithms that can analyze the collected data and produce insights that are meaningful and intelligent. Insights produced by the analytics algorithm have a direct impact on the cost and operations of the various aspects of the shipping industry, such as the following.

- Designing the most profitable routes for the vessels by looking at the commercial viability, distance, fuel consumption, emissions, and demand.
- Chartering the most economical options to ship cargo from source to destination, including the selection of correct agents, vessels, routes, and ports.
- Building an efficient workforce by learning from the operational bottlenecks of the past and removing them from the present operations.
- Optimizing operational costs by predicting the resource requirements accurately in advance along with predicting the downtime of machines.
- Enhancing profits by optimizing key performance indicators, focusing on targeted customers, making informed and intelligent decisions, and creating new business delivery models as per the specific needs.

Big data and analytics are playing a crucial and valuable role in making the overall industry more profitable and satisfaction oriented.

Robotics and Artificial Intelligence: Robotics, artificial intelligence, and machine learning go hand-in-hand with IoT and analytics. These come next in the technology adoption curve for any seaport and maritime operator. It involves investment in modernizing the existing machines and equipment to handle the automated instructions. The investments in the area of robotics can be significantly high for a port and therefore factors and drivers need to be considered with a lot of care. Automation is the most basic outcome of robotics and AI. However, there many more practical and cost-effective use-cases to consider.

- Enhance the productivity of heavy machines at the port by predicting the cargo handling patterns for the current and the next vessels in advance and acting on them without manual intervention.
- Using robotic machines to reduce the physical risks and hazards faced by humans while operating on the vessels, berth-side, in the yard, or elsewhere on the seaport.
- Use of robots to handle services such as cleaning of vessels, packing-unpacking cargo in the yard, inspecting hazardous materials, handling safety situations like fire or flooding of vessels, and so on.

Robotics and AI bring the capabilities of managing ports without any risk to human lives and enhanced profits and productivity.

Virtual Reality and Augmented Reality: Virtual reality and augmented reality imaging are the trends that are rapidly growing in the direction of managing complex operational activities on a port. It means that the real-time operational steps are gamified and presented to the user in a format that enables the user to view the decision support data on a screen along with the equipment and then take action. The results of the action are also updated on the screen immediately. This is particularly useful in places of high accidental risks, but it can be used in several other places as well.

- Performing operations from within a quay crane sitting at a considerable height above the crane are extremely difficult and error prone. Having VR and AR screen helps the operator to know the exact location of the container, truck, and vessel and act with complete accuracy in loading and unloading the containers from a vessel.
- Using VR and AR to perform activities such as pilot assistance to a vessel while entering a port, managing heavy traffic of vessels or trucks on a port by predicting future scenarios and projecting them on the screen, and so on.
- Performing aerial surveillance of yards and storage locations to create a real sense of the way cargo and containers are arranged and locating holes in the storage.

Figure 6: VR and AR for managing containers from Quay Cranes

VR and AR are great tools for training as well as handling real-time operations from a safe distance.

Reimagine the Future

The shipping industry is key to the development of the world economy. It plays a major role in the import and export of goods and raw materials. On average, 1.5 tons of material is transported by sea route per person per year. These numbers are only going to go up in the future.

It is important to look at the seaports of the future from today itself. One way to gear up for the demands of the future is to embrace automation and related technologies. It is primarily a business-to-business industry and any bustling towards a new sustainable future design is going to cause a chain reaction within and beyond the boundaries of the shipping industry itself.

Smart port initiatives are being taken up by ports across the globe. It involves the usage of innovative technologies including Cloud computing, IoT, Big data and analytics, Automation using robotics and artificial intelligence, and block chain. Equipped with the latest digital technologies, the ports of the future can target to achieve their emission targets with reduced risk to their staff and stakeholders, and higher returns.

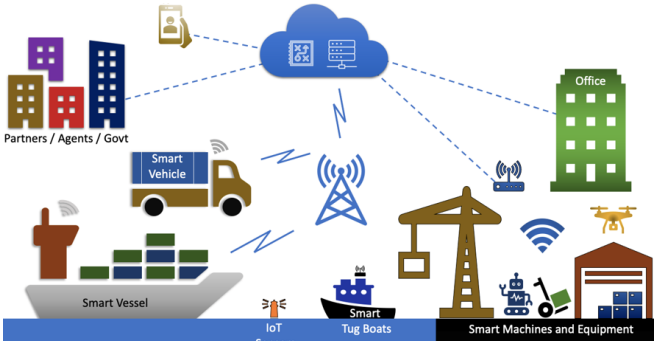

Figure 7: Smart Port model with automated operations

Industry players are already taking steps in setting up Digital Twins of their ports that can be used for making intelligent decisions in terms of planning and executing their workloads. The idea is to determine the consequences of their decisions based on the previous trends without affecting the present-day revenues, profits, or operations.

Conclusion

The seaports are already looking towards the Industry 4.0 guidelines with keen interest and willingness to adopt them. The need of the hour is to turn into a smart operations hub. For becoming smart, ports need to adopt comprehensive digital processes that can complement their existing physical operations. While it is easier for Greenfield operators to start with a smarter port, it is an uphill task for the existing ports, especially the bigger ones. It can be concluded that by adopting the latest technology trends, as prescribed by Industry 4.0, the shipping industry is going to bring a lot of benefits to itself. These include greater operational accuracy at a fast pace with the help of automation and robotics, a safe and risk-free environment for people working in the industry, higher performance and productivity, a strong edge over competitors, and better communication and service delivery for the customers. Adopting the latest technology trends and Industry 4.0 recommendations mean future-readiness, sustainable growth, and higher profits.

References

- https://maritimeindia.org/industry-4-0-in-the-shipping-industry-challenges-and-preparedness-the-prevailing-scenario/
- https://www.inddist.com/home/blog/13775677/heres-how-industry-40-is-disrupting-shipping-distribution
- https://www.statista.com/statistics/913398/container-throughput-worldwide/
- https://www.imo.org/en/MediaCentre/HotTopics/Pages/Reducing-greenhouse-gas-emissions-from-ships.aspx
- https://safety4sea.com/top-10-risks-related-to-container-terminals/
- https://www.porttechnology.org/news/what-is-a-smart-port/
- https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/the-hidden-opportunity-in-container-shipping
- https://www.industryofthingsvoice.com/iot-systems-in-the-shipping-industry/
- https://seanews.co.uk/features/role-of-internet-of-things-in-shipping-and-maritime-industry/
- https://marine-digital.com/article_ai_and_ml

--0--