Using the Framework of the Social Construction of Technology to Analyze the Adoption of Automation and Digitalization at the Port of Virginia

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

This STS research paper, created alongside a technical project sponsored by the Port of Virginia (POV), will use the framework of the Social Construction of Technology (SCOT) to analyze and explore how human action and social influence drive the relatively slow adoption of innovation at the port, specifically automation. It will also analyze the social benefits and challenges of automation for the port and surrounding areas. Because such analysis has not been done specifically for ports, it will study other related sectors and extrapolate the analysis to the port. The paper will first analyze the main stakeholder groups of the Port of Virginia by looking at their motivations and interests. Then, a close look at labor issues at the innovative Port of Rotterdam as a case study will show how stakeholder interests can come into conflict. Finally, it will discuss how the analogous construction sector has handled automation, and this will be compared and contrasted to the port.

Background

As technology and competing ports continue to innovate, there is pressure on the Port of Virginia to employ automation in their port. However, in the Norfolk/Hampton Roads area, maritime commerce and the Port of Virginia are major drivers of employment. For example, over 397,000 jobs or nearly 10% of Virginia's workforce, have ties to the port and automation may put some of those jobs at risk (Port of Virginia, 2020). It is important to note that the Port of Virginia, while run like a business driven by profits, it is owned by the Virginia Port Authority (VPA), which is an autonomous agency of the Commonwealth of Virginia. This is reflected in the POV's mission statement, which reads "The Port of Virginia delivers opportunity by driving business to, *and through*, the Commonwealth". What this means that despite their profit motives,

they have express interest in contributing to Virginia and its economy as a whole. With this key interest in mind, they do not want to cause the loss of jobs.

As we see the growth of globalization, digitalization, and automation across almost all sectors, it is clear that we are in the midst of a fourth Industrial Revolution. Each of the first three have brought their own challenges such as resistance to change and predicted job loss that did not come to fruition. The first occurred in the 1700s, which brought mechanical looms and steam power allowed more people to move to cities, and the economic structure of Europe and the USA began to generally resemble its current state. The second revolution began in the 1870s with the introduction of electricity, which allowed for assembly lines and mass production. The third revolution, known as the digital revolution, in the 1970s brought the shift from analog electronic and mechanical devices to digital technology. Building upon the digital revolution, the current fourth industrial revolution sees the ability to connect people and technology in ways not seen before (Alaloul, 2019).

Social Construction of Technology

The concept of Social Construction of Technology (SCOT) emerged in the 1970s in Northern Europe and the USA along with a growing movement to more closely tie science and technology education with studies of human and social factors. With technological and manufacturing growth rapidly expanding worldwide, issues such as nuclear energy and weapons, environmental pollution, and globalization began to have enormous impact on the global social order. A key starting point for the development of SCOT was as a criticism of technological determinism. “Technological determinism was taken to comprise two basic claims: (1) technology develops autonomously and (2) technology determines societal development to an important degree” (Bijker, 2015). Proponents of SCOT saw technological determinism as a

reductive and one-dimensional way of looking at the development of technology, and sharply opposed the idea that innovation progresses without influence of social, cultural, economic, and political factors (Bijker, 2015).

In opposition to technological determinism, SCOT claims that "a variety of social factors and forces shape technological development, technological change, and the meanings associated with technology" (Johnson, 2021). Rather than technologies succeeding through any objective measure of goodness or efficiency, technologies succeed because they are "perceived to achieve particular human purposes and to improve a particular social world or to further the interests of individuals and social groups". That said, they do not wholly deny that technology does not subsequently influence society, but that the influential forces move in both directions (Johnson, 2021).

SCOT in the Maritime Supply Chain Industry

In almost every industry, a wave of technological innovation is changing the business landscape and pushing firms as well as government agencies to innovate, integrate, and embrace new technology or fall into obsolescence. Innovations like automation, artificial/augmented intelligence (AI), big data, blockchain, and internet of things (IoT) are driving productivity to unprecedented levels and driving a changing commercial landscape for supply chains. Situated as one of the key players in global commerce, ports are no different, and while they are somewhat behind the curve in the adoption of technology, they have some of the greatest potential in taking advantage of these developments (Berns, 2017).

One framework for the port of the future is the concept of a Smart Port. The Smart Port is the ultimate integration of the aforementioned technologies such that it is fully integrated within

not only its own business functions but with shipping companies (maritime, rail, and truck) and the port's community at large. As the technical portion of this research project is sponsored by the Port of Virginia, it will focus on the Hampton Roads area and the strategic investment of technology at their four terminals centered in that harbor. The port itself is a key player in international imports and exports on the East Coast and one of the largest on the east coast of the United States

Analysis of Stakeholders

At the Port of Virginia, there are four key groups, all with very significant influence on the port operations. The first is the Port of Virginia Leadership. Headed by new CEO, Stephen Edwards, they lay out the strategy, planning, and long-term direction of the port. The second is the State and local governments, which hold the power of regulations and grants. The third are the actual customers of the port. These include the slew of ocean carriers, motor carriers, cargo owners, and freight forwarders doing business with the port. The fourth is the ILA workers union, representing the interests of the workers at the port and headed by the chapter's president, Ron Rascoe.

This section will take a deeper dive into these stakeholder perspectives, their interests, and the power they hold over the Port of Virginia. It will also look at how investment in various technologies within the port are influenced by these stakeholders. The stakeholders represent the social factors that drive the port's investment into new technologies, and so the SCOT framework will drive the analysis.

The Port of Virginia Leadership

The leadership at the Port of Virginia is essentially a standard corporate structure headed by CEO and Executive Director, Stephen Edwards. The leadership teams general goal is to bring in new business and new revenues into the port. The leadership group seeks to reduce vessel time spent at berth, storage time in stacks/warehouses, and land-side wait time for trucks and rail by modernizing the port through automation and integrating data with operations Intermodal transport is key to the port, and efficient loading, unloading, and scheduling would bring more business into the port, fitting in with their primary objectives. Long term, the Port of Virginia leadership's established goal is to do "everything necessary to become the US East Coast's leading gateway for global trade for the next several decades, and to make Virginia the #1 place for business in the country" (Port of Virginia). This goal involves working with the Virginia state government to make Virginia more attractive to businesses, and therefore creating additional business.

Government

Similarly, the government, which has regulatory and grant-giving power towards port investments wants to see not only greater volume moving through the port but also greater economic opportunity. To the state and local governments, the Port of Virginia is one of their greatest assets. The port is essential to fueling the expanding economy of the state, and greater efficiency in the port means greater potential for economic growth. The ultimate goal is economic opportunity for people and businesses residing in the state. Politics, of course, drive the government, so job growth, sustainability efforts, crime, civil rights, energy can all play a role in how the government will legislate, regulate, and provide funds.

The current relationship between the government and the port is that the Virginia Port Authority is exempt from state and federal taxes but receives no funding from the state's General Fund, meaning port operations are wholly self-sufficient through their own revenue creation. However, the port authority does receive financing for capital projects, which is typically invested towards maintenance and improvements to the facilities as well as marketing efforts. Total revenue from grants were $5.7 million, which is fairly small in comparison to the 496.3 million in revenue from terminal operating revenues.

Shippers Operating Through the Port

By far the least centralized of the stakeholder groups are the customers doing business through the port. This primarily consists of ship operators, rail operators, truck operators, and freight forwarders. These firms are purely profit-driven, and without a strong value proposition from the port, they will redirect business to the Port of Virginia's key competitors such as the Port of New York/New Jersey, Port of Savannah, and the Port of Charleston. Accurate forecasting and scheduling as well as costs are key drivers to bring more of these groups into the port's business.

Workers Union

The International Longshoremen's Association, ILA Local 1248 AFL-CIO, is the local chapter representing the rank-and-file workers at the port. The union, along with the Norfolk area at large, would not want to see a fully automated port and is fully capable of taking action to prevent this. According to ILA 1248's mission statement, they are "committed to safe working conditions, reasonable work schedules and a vision to continue to improve the lives of its members and their families", and "will continue to focus on, justice and equality helping all of us

to prosper together" (ila1248). Many of the goals here, especially those focusing on safety and work schedules actually fall in line with what automation and integration can provide. One of the major points here is that any action leading to loss of jobs from automation would be opposed by the union. However, if business growth can offset the relative job loss, the jobs would be preserved while more volume passes through the port with higher efficiency.

We can compare this to the fully automated port in Shanghai, where there is less regard for worker's rights and the government has full control to implement any technology they wish. However, as Chao Li discusses, "the port economy is a growth pole for Shanghai. The development of the port economy and the development of Shanghai's overall economy have a guiding and promoting role". It is possible that despite lost jobs at the port, job growth in other areas could create a net benefit (Li, 2019).

Case Study of the Port of Rotterdam

The Port of Rotterdam, located in the Netherlands, is the largest seaport outside of Asia. Its total throughput in 2019 was 496.4 million metric tons of cargo, and it is pioneering the concept of a "Smart Port" with automation and digital integration. Directly or indirectly contributing 40.9 billion euros or 6.2 percent of the Dutch economy, it is vital to the Netherlands and a huge driver of growth. Rotterdam's dominance over other regional ports can be attributed not just to its excellent location but also, its heavy investment into modernization, digital integration, and automation. Innovative port technology such as the Euromax-terminal, data communication systems like Portbase, berthing optimization like PortXchange, and an almost fully automated container hub at Maasvlakte 2 make them a global leader in port innovation (portofrotterdam.com).

With port workers angered by the forecasted loss of hundreds of jobs to automation, in January 2016, the Port of Rotterdam faced its first workers strike in 13 years. As the national secretary of dockworker's union FNV Havens explains, "You see traditional harbour work disappearing. People used to work in big teams. Canteens were full during mealtimes. Now, small crews remain and machine operation has become a one-man job". However, the port leadership saw such innovation as key for the survival of the port (Witsche, 2019).

It is clear that differing societal pressures are driving why and how ports innovate. Governments push for environmental sustainability and economic growth, port leadership push for profit maximization and costs cutting, and the workers push for job preservation. This strike was an example of how these motivations conflict and how the workers can leverage the power they have to affect the adoption of new technologies. Although leading seaports are now quickly modernizing, they have been historically quite slow in adoption of new technologies. This example shows how a clear objective good technology like a fully automated port is not possible for a democratic country friendly to labor.

Study of the Construction Industry

Similar to seaports, the construction industry has also been slow to adopt digitalization and automation. Furthermore, the benefits and application of digitalization and automation are similar but not directly comparable; both industries face far greater variables and uncertainties in their operations that sectors such as manufacturing do not face. Integration of IT systems, automation, and networks of data flows stand to greatly increase the efficiency and economic bottom line of both sectors while also threatening jobs. Because such analysis has not been done specifically for ports, analysis of the construction industry is useful to try and analyze the port.

A paper by Oesterreich and Teuteberg analyzes how the construction sector has dealt with the fourth industrial revolution by pointing out economic and social implications of its adoption. These are outlined in Table 1. Almost all of these can be directly applied to the Port of Virginia and used to analyze how it may be resistant to innovation. The paper points out that in order for modernization to happen, the "industry has to embrace more than technological changes". From a manager's point of view, responding to these challenges are an important first step to align the interests of all stakeholders involved.

Benefits	Challenges
Economic • Cost savings • Time savings • on-time/on-budget delivery • improving quality • improving collaboration • improving customer relationships as economic benefits Social • Enhancing Safety • Improving the image of the industry	Economic • High Implementation Cost • Organizational and process changes Social • Need for enhanced skills • Knowledge management • Acceptance/resistance to change

Table 1: Economic and Social Benefits and Challenges

New technologies have huge implications for both sectors. In the long run, firms must innovate or die and thus must face the significant hurdles in the way of adoption of new technologies. Ignoring the technical hurdles, the myriad problems these sectors face include "organizational and process changes, with high implementation costs and the unclear prediction of cost savings or with the increasing need for data security and data protection. Employees have to handle with increasing job requirements and a higher level of mental stress due to the fear about job losses." The paper concludes that it may take government incentives to force through

many of the necessary structural changes. In the context of the port, this is luckily far easier than in construction because it is directly overseen by a state regulatory agency. (Oesterreich, 2016)

Conclusion

The fourth industrial revolution is here for good and firms must learn to adapt to new challenges that they will face. SCOT is a useful framework for looking at how innovation may be spurred or resisted by social forces. The stakeholders must find a way to create some kind of synergy to align their objectives for the long-term survival of the Port of Virginia and healthy economic growth of the state at large. Lessons from the Port of Rotterdam and the construction industry make clear many of the problems that are faced. Moving forward into the future, automation and digitalization as well as the rise of Artificial Intelligence may see massive job loss, and society will have to find a way to meet the needs of all members of society because the traditional structure may no longer work.

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