

Impact of Labour Unionisation on the Adoption of Automation Technologies in Ports

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Abstract

This paper examines how labour dynamics in Singapore and France influences the pace, direction and scale of automation in ports. The comparative study highlights the contrasting nature of labour unions and institutional contexts that shape port operational capacity and labour outcomes. In Singapore, the consensus-oriented strategy of the labour union facilitates the rapid adoption of extensive labour-substituting technologies. Conversely, the protective and combative stance of French unions prioritises labour-augmenting automation, resulting in slower adoption.

1 Introduction

The Fourth Industrial Revolution is revolutionising economies. The maritime and port sectors, despite being considered as legacy industries, have felt the impact of technology. In fact, many scholars argue that it is undergoing a digital and automative transformation termed “Maritime 4.0” (Sullivan et al., 2020). Yet, this transformation is faced with a paradox: in a historically-labour intensive industry, automation has raised significant tensions regarding workforce displacement and the erosion of the “social license to operate” (Bottalico, 2022).

Forming the backbone of the global economy, ports are crucial in connecting local sectors to international markets, facilitating trade and economic growth. Consequently, automation is frequently discussed as a logical imperative for modernisation. However, recent literature suggests that despite the theoretical presence of tremendous economic benefits from automation, its actual implementation and long-term economic consequences are heavily contingent upon local contexts. Indeed, the pace and scale of adoption around the world are not uniform. They are affected by negotiations between global economic incentives and local institutional frameworks, where the bargaining power of labour unions often acts as the primary moderator (Bottalico, 2022).

This paper examines how labour unions’ behaviour and leverage affect the direction and speed of automation technologies in ports, with Singapore and France as comparative case studies. By using two case studies that demonstrate distinct labour regimes and local contexts, we contribute to literature by effectively showcasing how different systems shape distinct outcomes.

The Port of Singapore predominantly serves as a transshipment hub for global markets. In contrast, the Port of Le Havre, known in French as the Grand Port Maritime du Havre (GPMH), functions as the maritime gateway to France and the European region. Simultaneously, the two cities exhibit sharply different labour relations systems. The labour movement in Singapore is state-directed and non-adversarial whereas the French labour unions wield significant influence and frequently conduct labour activism.

This paper first details the motivations and outcomes that drive automation in ports. Subsequently, it discusses the governance structures in each port and the local participant institutions. Finally, it analyses the scale and progress of automation in both ports, linking technological trajectories to labour relations. Due to a lack of reliable quantitative data on specific port statistics, the paper adopts a qualitative approach aided by simple economic modelling. It is further supported by an exclusive interview conducted with an official from the port regulator of Le Havre (HAROPA).

2 Port Context

The Port of Singapore is a transshipment hub, focusing on container cargo. As of 2020, Singapore is ranked the second most efficient container port in Southeast Asia (Nguyen et al., 2020). It faces growing competition as cargo volumes shift to neighbouring ports and trade.

The Port of Singapore is governed by the Maritime and Port Authority of Singapore (MPA). MPA regulates port and marine services, ensuring safety, security and environmental protection, while also growing the merchant fleet and protecting Singapore's maritime interests (Cullinane et al., 2006).

Port terminals are operated by commercial firms which include PSA Corporation and Jurong Port Private Limited. As the major terminal operator, PSA was originally the Port of Singapore Authority, then later commercialised in 1997 to optimise firm performance and agility with market incentives (Cullinane et al., 2006). Government ownership of PSA through its investment arm Temasek enables the Singapore authorities to align PSA's business strategies with national interests. The government's objective is to build a resilient maritime ecosystem to meet the evolving long-term demands of global trade (Ministry of Transport (Singapore), 2026).

In the case of Le Havre, the GPMH is situated in the European "Northern Range", a concentration of main European ports aligned along the southern coast of the North Sea from Le Havre to Rotterdam, serving as a maritime front to a vast territory centered on the Rhine region of Europe. Within France, Le Havre ranks second behind Marseille. Regionally, Le Havre ranks fifth in port traffic (Haropa Port, 2023b). Le Havre faces intense competition with other ports in the European "Northern Range" region like the port of Antwerp (Thorez and Joly, 2006). As such, there is a need for the GPMH to adopt new technologies to increase its competitiveness in the region (Danaradjou, personal communication, December 23, 2025).

The GPMH is governed by HAROPA Port, a French government-owned agency formed in 2021 to encompass the GPMH and two other in-land ports: Rouen Port, and Paris Port. It is now the leading port in France for external trade (Haropa Port, 2023b). Since major reform in 2008, the port authority is no longer in charge of operational management and equipment acquisition, functioning now as a regulatory body. The operations within the port are managed by private port operators, with the main few being Compagnie maritime d'affrètement - Compagnie générale

maritime (CMA CGM), Mediterranean Shipping Company S.A (MSC), and Apagloid.

As evidenced by the contrasting industrial climates of Singapore and Le Havre, the success of these technological integrations remains deeply contingent upon the socio-political dynamics of labour unionization and the management of a just transition for the workforce.

3 Economic Impacts of Automation

3.1 Business Impacts

Research across countries has suggested that automation can greatly lower ports' operational costs (de la Peña Zarzuelo et al., 2020). On a national level, this is represented by an increase in total factor productivity and capital. We use a representative firm's production function (1) to understand the economic impact (Cobb & Douglas, 1921).

$$Y = AF(K, L) \tag{1}$$

Where

Y= Real Total Production Output

A = Total Factor Productivity

K = Real Capital Input

L = Real Labour Input

Shifting to an automated port enhances total factor productivity (A) with better technology and real capital (K) with investments in a bigger facility. As such, a port is able to produce greater real output (Y). This is corroborated by the increase in the port's operational capacity below.

Due to the distinct contexts of Singapore and Le Havre, there is varying significance and outcomes. The land scarcity in Singapore restricts the size of port operations, impeding operational efficiency, especially during trade volume fluctuations (Tang, 2024). In Singapore, the creation of Tuas Port aims to integrate all container port operations across Pasir Panjang, Tanjong Pagar, Keppel and Brani terminals into a mega automated facility (PSA, 2019). Automation will enable Singapore to maximise its port capacity given land constraints and offer greater flexibility and resilience in handling cargo.

In 2024, the collective terminals in Singapore handled 40.9 million Twenty-Foot-Equivalent-Units (TEUs) (EDB Singapore, 2025). The completion and full operationalisation of Tuas Port in the 2040s is expected to yield a capacity of 65 million TEUs annually, which is nearly twice the capacity of the current Pasir Panjang Terminal (34 million TEUs). As of February 2025, Tuas Port has already handled a cumulative 10 million TEUs since opening in 2022. The increase in the national port's throughput below demonstrates Singapore's ability to leverage its enhanced operational capacity to meet trade demands (Figure 1).

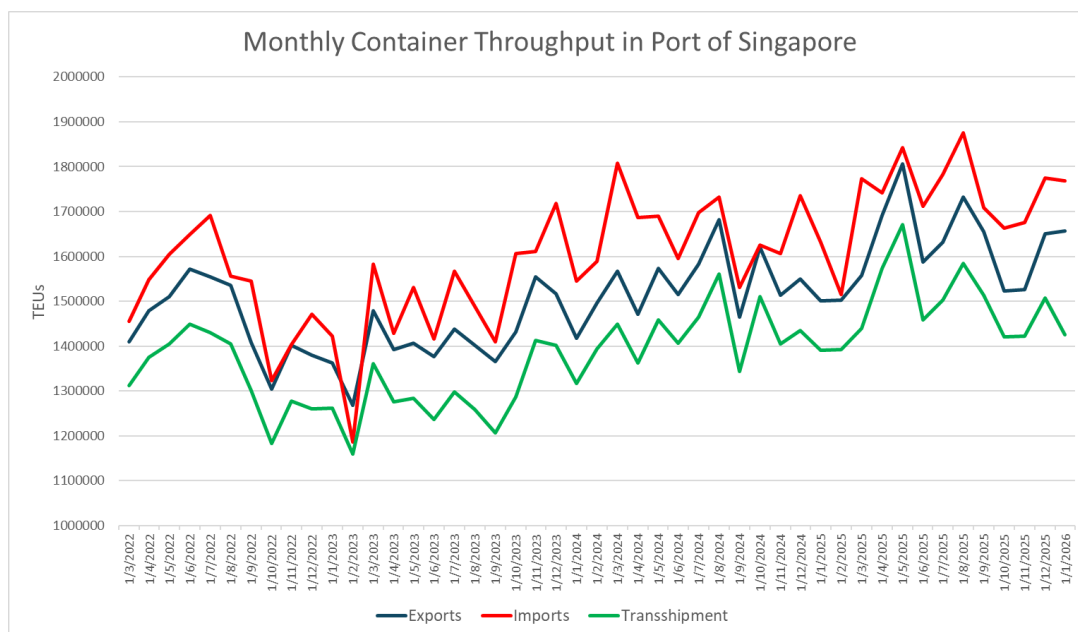


Figure 1: Monthly Container Throughput in the Port of Singapore 2022-2026. (Econdb, n.d.-b)

As the firm's output curve with automation pivots, the marginal productivity of labour (MPL) is expected to rise. This is foreseen in the 20 to 25 percent productivity increase in Pasir Panjang terminal with the partial trials of an automated yard system (Liew, 2018). From table 1, the partially operational Tuas terminals' throughput and turnaround have remained comparable to the established Pasir Panjang terminals 3 and 5. Therefore, the fully automated Tuas port is expected to realise greater efficiency gains.

Table 1: Operational Metrics for Singapore Container Terminals

Terminals	Mar'26	
	Throughput ('000 TEUs)	Turnaround (Days)
Pasir Panjang Terminal 1	103	1.6
Pasir Panjang Terminal 2	239	1.3
Pasir Panjang Terminal 3	603	1.4
Pasir Panjang Terminal 4	89	1.5
Pasir Panjang Terminal 5	487	1.6
Pasir Panjang Terminal 6	504	1.6
Tuas Terminals	594	2.1
Brani Terminal	149	1.1
Keppel Terminal	13	1.6
Tanjong Pagar Terminal 1	15	0.9

Note. Data is adapted from Econsdb (n.d.)

In the case of Le Havre, it is harder to gauge the overall impact as there is no single project on-going. Instead, there is an array of primary projects by various different private port operators.

In 2025, the terminals of the GPMH collectively handled 3.21 Million TEUs. Though this is

vastly less than the throughput in the Port of Singapore, it sees a growth rate of nearly 4 percent per annum (Haropa Port, 2026), owing to its investments in capital infrastructure that allow port operators to service a larger range of vessels (Danaradjou, personal communication, December 23, 2025). This is evident by Figure 2 which showcases the GPMH’s capacity to meet greater container volumes from 2022 to 2026.

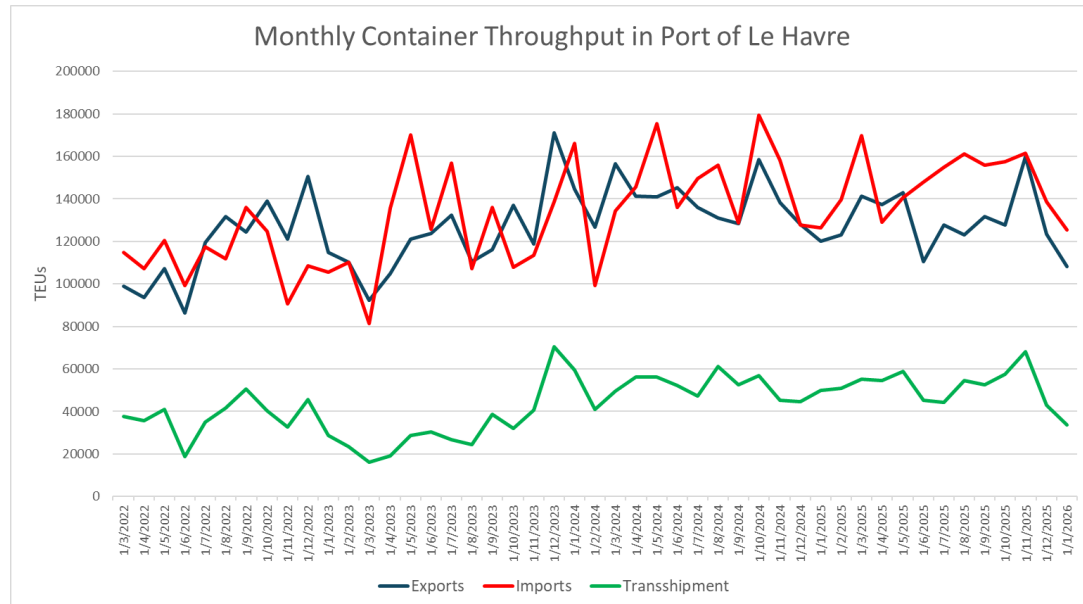


Figure 2: Monthly Container Throughput in the Port of Le Havre 2022-2026. (Econdb, n.d.-a)

One of the largest expansion projects in the GPMH is that of the “Port 2000”, which aims to increase port handling capacity to 6 Million TEUs of traffic (Groizeleau, 2006). In 2024, the port terminals Terminal Porte Océane (TPO) and Terminaux de Normandie (TNMSC), part of the Port 2000 terminal project, received their first two XXL gantry cranes as part of a series of 9 cranes. These allow the terminals to service the world’s largest container ships (24,000 TEUs) (Haropa Port, 2024b). As shown in table 2, TNMSC has recorded the highest throughput and a relatively fast turnaround time amongst the five terminals, though data for TPO is unavailable.

Table 2: Operational Metrics for Le Havre Container Terminals

Terminals	Mar’26	
	Throughput (’000 TEUs)	Turnaround (Days)
Terminaux De Normandie	153	1.3
Terminal De France	108	1.5
Terminal De L’Atlantique	24	1.2
Terminal Nord, Quai Des Ameriques	16	1.0
Terminal Port Oceane	—	—

Note. Data is adapted from Econsdb (n.d.)

3.2 Labour Impacts

With greater production capacity and higher MPL, real wages are expected to rise. However, automation remains a danger to certain port workers (Vaggelas, 2020). Existing driverless vehicles and automated rail mounted gantries for container transfers, threaten current human-centric jobs. Port workers have to remain adaptable to new roles within port operations as jobs evolve into skill-based.

In Singapore, as port-specific wage statistics are unavailable, this paper uses metrics from the broader sector of transportation and storage to gauge. Afterall, the logistics industry is experiencing automation trends. In 2024, nominal wages of operational workers grew by 5.3 percent and management employees grew by 5.7 percent (Ministry of Manpower, 2025a). With 2024 core inflation of 2.7 percent, real wages increased by 2.6 and 3 percent respectively.

There can be possible negative externalities involved in automation as port operators prioritise private benefits while ignoring the unaccounted external cost of structural unemployment on workers. Hence, the government faces a higher fiscal burden as it internalises these costs by providing an unemployment welfare system for laid off workers. The Jobseeker Support Scheme in Singapore provides tiered financial aid and prompts job searching and upskilling for the involuntarily unemployed, low and middle income workers (Yi, 2024).

Conversely, automation is deployed less as a substitute for labour and more as a complement. In Le Havre, the GPMH directly employs 1,200 employees, and the total number of workers in the maritime and port sector in Le Havre is nearly 14,000 (Haropa Port, 2023b; Insee, 2024). HAROPA Ports' adoption of XXL cranes enables it to support the transportation of more new green technology equipment, such as wind turbines. With the turbine masts each weighing 4,000 tons, they present a new challenge for port handlers (Haropa Port, 2023a). Port handlers must receive special training to facilitate the unloading, carrying, storage, assembly and loading of the new capital equipment (Danaradjou, personal communication, December 23, 2025).

The Le Havre Smart Port City programme includes the adoption of 5G and internet of things (IoT) networks by private port operators. Contrary to the Port of Singapore, automation in the GPMH complements labour in ensuring greater safety in port operations (Danaradjou, personal communication, December 23, 2025). It allows for uninterrupted and interference-free, ultra-high-speed connections that facilitates a robust "collision avoidance system" (Haropa Port, 2024a), which reduces the risk of collision between cranes and other objects and/or personnel in the port. Automation ensures that human workers operate in a safer environment, without directly replacing their scope of work.

4 Labour Relations

4.1 Tripartism in Singapore

The National Trades Union Congress (NTUC) is the overarching union body in Singapore. Under NTUC, there is the Singapore Port Workers Union (SPWU) for blue-collared employees, the Port Officers' Union (SPOU) for white-collared executives and the Singapore Organisation for Seamen (SOS) for seafarers. Working with the Ministry of Manpower (MOM) and Singapore National Employers Federation (SNEF), NTUC balances the advancement of workers' interests,

and supporting business objectives amidst economic pressures. The union's close affiliation with the ruling People's Action Party (PAP) (Tan, 2020), reflected by its Secretary General typically serving as a PAP Member of Parliament and in the cabinet, further underscores the cooperative nature of labour relations. NTUC is focused on a tripartite arrangement with the government and businesses to optimise employment. Its macro-focus on all workers incentivises the union to prioritise employment instead of competitive wages through collective bargaining with the government (Chew, 2014).

Tripartism serves a long-term purpose where the Singapore government (MPA), employers (PSA), and unions (SPWU, SPOU and SOS) move beyond traditional labour disputes to co-design the future of the maritime workforce. This collaboration is institutionalised through various platforms like the Maritime Industry Tripartite Transformation Committee, which ensures that workers are not displaced as Tuas Port transitions into a fully automated AI-driven mega-port. Instead, they are upskilled through schemes like Company Training Committees (CTCs) and the Sea Transport Industry Transformation Map (MPA Singapore, 2022). To enforce these plans, the government utilises a "carrot and stick" regulatory framework. While the state provides massive capital investment and Research and Development grants such as the Maritime Innovation and Technology (MINT) Fund to incentivise digital adoption (MPA Singapore, n.d.-a), it strictly mandates compliance with operational standards like the Next Generation Vessel Traffic Management System and environmental quality objectives during the reclamation. By embedding union buy-in early in the planning phases, the government can secure the industrial peace necessary to execute multi-decade infrastructure projects, ensuring that Tuas Port remains a competitive global hub through a "one Singapore team" approach.

Tripartite arrangements also ensured that there was no workforce disruption during the 2017 shift to the Pasir Panjang terminal from Tanjong Pagar terminal (Ting, 2017). PSA informed the SPWU of its business plans early, enabling sufficient time for the union to prepare all the port workers for higher-skilled roles at the new terminal.

Additionally, port labour in Singapore faces a supply issue. Facing an ageing population and declining birthrates, Singapore overall is facing a shrinking workforce. The less ideal perception of jobs in the maritime and logistics sectors repel individuals from entering the industry (Yong, 2022), exacerbating labour scarcity. In response, MPA has launched a job redesign initiative to transform those traditional and labour-intensive roles into technology-centric positions to attract more locals.

4.2 Unionisation in Le Havre

The private unions in Le Havre have showcased a strong ability to organise large-scale strikes significant enough to paralyse port operations. They thus pose a credible threat and thereby are able to strongly influence policy decisions.

The *Confédération générale du travail* (CGT) represents the one of the several, but the largest, trade union confederation of the city of Le Havre. Within the port labour ecosystem, the *Syndicat CGT du Grand Port Maritime du Havre* (CGT GPMH) manages the worker population of the GPMH. In 2010, the management of the GPMH and CGT GPMH signed a procedural agreement to institute a process of negotiations and prevent port strikes from disrupting the business operations of the port (Groizeleau, 2010). This has ensured the efficient and effective resolution of labour disputes at a local port level. CGT GPMH and the association of private

port operators of GPMH have been able to since prevent the incidents of strikes arising out of local labour disputes like working hours or employee remuneration (Danaradjou, personal communication, December 23, 2025).

CGT GPMH has, nevertheless, remained combative. Policy changes that occur on a national level also affect the city of Le Havre and the workers of GPMH. Port strikes occurred in 2008 in response to the passing of a law ('Loi du 4 juillet 2008') aimed at privatizing port handling operations. This strike manifested through blockages lasting 38 days and severely paralysed port operations (Lenormand, 2016). Similarly, more port strikes occurred in 2024 and 2025. On 2 October 2025, as a collective national response part of the 'Bloquons tout' ('Block everything') movement against the French government's proposed national budget and austerity measures, a full-scale blockade took place (CGT, 2025). Consequently, the strike severely disrupted local port operations. Though these strikes are not traced to a local port policy within the GPMH but are instead a response to national-wide policies, they demonstrated the unions' remarkable ability to organise labour strikes that can paralyse the port economy (Barzman, 2012).

5 Automation Progress

With the port and labour contexts in Singapore and Le Havre outlined, this section compares the pace and direction of automation practices in both ports and how the unions have influenced it.

5.1 Automation Initiatives

The automation progress in Singapore's port sector is primarily driven by the development of the Tuas Port project which aims to consolidate all container port operations. Plans for Tuas Port were announced in 2012, with the first development phase completed in 2021, and the full expansion expected in the 2040s (MPA Singapore, n.d.-b). Gradual operationalisation of the automated port ensures moderated organisational restructuring.

Throughout the period, Pasir Panjang terminal has been a testbed for automation technologies to be used in Tuas. These trials of automated guided vehicles (AGVs) and an automated quay crane system began at selected berths in 2018 (Knatz et al., 2022). Currently, Tuas Port features fully automated and electrified yard cranes. The extended timeline until 2040s is deliberately utilised to allow the unions and the primary operator PSA to effectively prepare the workforce for the necessary changes through internal training and national upskilling programmes.

Central to this transformation are the fleet Automated Guided Vehicles (AGVs), which are critical to the mega-facility's operations due to their operational versatility, such as in quayside to yard transport and horizontal movement (MPA Singapore, n.d.-b). Tuas port's AGVs are planned to be battery-electric powered which are more sustainable compared to conventional transport and will be charged through automated, smart charging stations. These fast-charging AGVs can support round-the-clock port operations more efficiently and be scaled up easily (PR Newswire, 2023), reducing the need for prime movers. To build such a large AGV ecosystem, the port utilises Event Driven Architecture (EDA), which ensures systematic flow of real-time information to instruct the AGVs. This enables seamless operations and adaptability (Leung, 2024).

Furthermore, the port is integrating Intelligent Maintenance Systems which represent a highly

technical, data-driven framework replacing traditional time-based maintenance with Predictive Maintenance (PdM) (Aslam et al., 2025). These systems leverage the Internet of Things (IoT), deploying a vast network of sensors, such as vibration, temperature, and pressure monitors, on container handling equipment like AGVs and cranes to collect large and continuous streams of operational data, which are key to the next generation of port management. This data collection and analysis will generate insights which enable the terminal to schedule maintenance proactively, hence minimising unscheduled downtime, reducing maintenance costs, and ensuring the consistent and predictable throughput which is a main benefit of automation.

As for Le Havre, the HAROPA port provides the infrastructure for the adoption of automation technologies by private operators. As early as 1984, the GPMH began adopting a digital data management system known as the Port Community System. Since this, the system has gone from its first generation (1984) to its fourth generation (2015) that is today extremely important in port operations.

For the adoption of 5G technologies, HAROPA port provides 5G network infrastructure, which allows private operators to then invest in their own unique use cases at their discretion (Danaradjou, personal communication, December 23, 2025). Since 2021, Nokia, Siemens and EDF have been collaborating on the 5G lab, which explores use cases for 5G technologies in HAROPA ports. (Haropa Port, 2023b). Other than these, the port embarked on a series of partnerships, such as the 2019 partnership with Airbus, to increase operational efficiencies through implementing various automation projects. (Airbus, 2019). This includes a joint software solution between GMPH and Airbus to optimise port operations. These solutions contribute to general safety and smooth movement of goods in the ports. (Airbus, 2019)

Private operators themselves adopt specific automation technologies relating to specific operational procedures. For instance, one of the largest operators, Générale de Manutention Portuaire (GMP), switched from manual carriers to Hybrid Straddle Carriers at the Port 2000 (Teillard, 2024). These carriers are more automated, thus requiring less repetitive operations, but remain manual rather than entirely automatic even though the latter is achievable.

5.2 Labour Impacts

Automation in Tuas Port has altered the nature of port work. AGVs will require technicians, engineers and software programmers to manage these systems (Subbaraman, 2016). Intelligent maintenance systems will need data analysts and operations research specialists to gain insights from the data collected. With automation assisting in tasks, existing roles such as crane drivers will be redefined into more supervisory positions like remote crane operators, reducing the need for blue-collared work. Moreover, automation enables twenty-four seven operations required in port operations, eliminating human downtime (McNamara and Marpu, 2025).

As of Phase 1, Tuas port already operates with 500 staff for 3 berths (EDB Singapore, 2022). Despite automation, PSA hired 1500 more frontline port workers in 2024 (PSA, 2024), and planned to hire 2500 frontline workers and professionals in 2025 to support higher operational demand due to trade and port expansion (Ong, 2025). According to PSA, there is a 20 to 25 percent increase in labour productivity using automated crane systems (Liew, 2018). Thus, automation functions as a tool to enable labour to scale in tandem with larger operational networks.

The shift to more knowledge-based port jobs can potentially attract much-needed locals and professionals to the maritime sector and reduce reliance on foreign labourers for the physically demanding roles (Yan, 2021). Regarding job repercussions, there is no publicly available data on retrenchment specific to port terminals. However, statistics from the broader Water Transport and Supporting Services sector reported rising retrenchment from 2022 to 2024 (Ministry of Manpower, 2024). In 2024, 110 were retrenched due to firm restructuring and 20 for poor business prospects. As of 2024, there is an optimistic outlook of 2.6 percent vacancy rate for PMET, 3.5 percent for service workers and 2.6 percent for labourers, production and transport operators. The rise in employment in this sector by 1700 in 2024 from 2023 and the vacancies suggest a continued demand for port and maritime labour.

In the GPMH, labour impacts are more well controlled. As discussed earlier, much of the new automation technologies adopted are soft-tech that assists with data and consistency, rather than handling, and are thus less labour-replacing. Even for automation that does impact port operations, we have seen with the case of the handlers that the operators prefer labour-saving rather than labour-replacing technologies.

In this circumstance, port workers are not being displaced and employment numbers have not seen a significant dip. However, there is also a trend of more roles being knowledge-based and skills-intensive, alike in Singapore. Between 2011 and 2021, the total number of workers in the maritime and ports sector have approximately remained identical, with a decrease of less than 1 percent (Insee, 2019, 2024). Previous data have shown that between 2011 and 2015, amidst declining employment, only the number of managers increased in the port authorities across the various socio-professional categories, while unskilled workers faced the worst change in unemployment, thus supporting our claim (Insee, 2019).

5.3 Interpretation

The Insider-Outsider Model predicts that current employees (insiders) hold bargaining power over the unemployed (outsiders) to secure higher wages, leading to persistent unemployment (Lindbeck and Snower, 2002). Traditionally, the unions might adopt the Luddite strategy by resisting labour-saving technologies to prevent job losses (DJangi, 2025). The case of Le Havre is consistent with this model and aligns with a distributive and adversarial bargaining framework. Strong unions such as CGT have clear incentives to resist labour-replacing technologies due to risks of job displacement and their demonstrated ability to conduct strikes pose a credible threat of disruption. This ability has made procedural agreements with port management essential to minimise conflict and maintain operational stability. As a result, the operator is steered towards labour-augmenting technologies which cautiously enhance port operations while protecting jobs.

In comparison, the Singapore government, port operator, and union prioritise long-term mutual benefits over short-term conflict. Under Singapore's well-designed Tripartite framework, the interaction shifts from a distributive bargaining model to an integrative bargaining one. The unions agree to the implementation of the mega-port automation, such as AGVs and AI-driven traffic management, in exchange for side payments in the form of guaranteed upskilling and higher-value roles within the Sea Transport Industry Transformation Map. This cooperation resolves hold-up problems, where unions delay technology to extract higher wages from sunk capital investments. By establishing a framework for credible contract enforcement, the union can signal their commitment to long-term stability rather than short-term rent-seeking. In a

game theory sense, this reduces the hold-up risk for the port operator, protecting their future incentives to further expand productive capacity. With a lower risk of labour disruption, the operator can confidently invest in the automation required to reach the 65 million TEUs capacity, ensuring a competitive advantage over global ports.

The commitment to worker security is evident by union efforts in job transitions. The NTUC Employment and Employability Institute (e2i) has been able to facilitate job transitions for 70 percent of nationally retrenched workers within 6 months (Ministry of Manpower, 2025b). While this is a national statistic, it demonstrates the union's ability to facilitate long-term job security for workers. The SPWU has also organised roadshows to inform port workers of relevant skillsets for future positions in the port industry and encourage up and re-skilling (Subbaraman, 2017).

Port operators like PSA also have plans to support their employees through this automation transition. In 2022, 96 percent of PSA's employees underwent at least 16 training hours (PSA, 2022). Internal programmes including "Automation Familiarisation" and "Gearing Up for a Digital Workplace", are offered to guide employees in the transition to automation and digitalisation. Collaborating with the Institute of Technical Education, PSA University co-offers a work study Diploma in Port Automation Technology for upskilling its staff. In 2022, 190 staff enrolled into PSA's Automated Equipment Specialists (AES) scheme to gain expertise in managing automated operations.

Similarly, Le Havre has a very structured ecosystem for port-sector upskilling, largely thanks to the strong union presence (CGT) which has negotiated for training as a condition for modernization. In more recent times, the focus has shifted from purely physical handling to digital competence, safety, and equipment piloting. The primary training is provided by the Institut de Formation et de Conseil (IFC) - Manutention Portuaire which provides training and issues qualification certificates for port operations. The presence of this specific training centre and its shifting focus suggests an increasing concern for port-sector upskilling (IFMMP, n.d.-b). However, compared to Singapore, there are less specific targeted programmes providing aid for specific affected communities and taking care of their unique needs (IFMMP, n.d.-a).

6 Conclusion

This comparative study demonstrates that successful port automation depends not only on technological readiness, but also on the institutional management of labour transitions. Apart from being a technical upgrade, automation is also a social process, involving labour rights.

Singapore's state aligned union model and tripartism has enabled automation to proceed as a negotiated, long-term strategy instead of a disruptive shock. Unions and workers have accepted the automated labour-saving technologies in exchange for job security and access to higher-skilled pathways. Automation in Singapore is not framed as a labour replacement, but as a productivity tool to meet greater operation requirements. The absence of labour demonstrations has allowed Singapore to pursue automation according to its plans, reinforcing its competitiveness.

In contrast, the French case demonstrates how strong union resistance can slow automation progress and reshape its implementation. Industrial actions force port authorities to negotiate jobs more cautiously. While this model offers stronger protection for workers in the near future,

signs would indicate that the overall impact on employment may prove opposite as the ports' capabilities to compete in the global market worsens.

Cooperative frameworks that guarantee income security can reduce labour resistance. At the same time, strong labour representation need not oppose technological change outright but can play a constructive role in shaping its pace and methods, protecting workers' rights without impeding development.

As we recognise both the profound economic importance of automation and the economic and social importance of labour protection, a balanced approach is warranted. Great success can be sought by combining Singapore's anticipatory workforce planning and France's robust worker protection, providing economic competitiveness and social sustainability.

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