Research Paper

Smart Shipping Technology and Maritime Administration:

A Comparative Study of Japan and China

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Abstract

The maritime industry is expected to be transformed by the smart shipping technology. Technical research projects and regulatory activities are being promoted vigorously in major shipbuilding and shipping countries. Much work focuses on technical development and discussions on the legal, safe and security, economic and societal implications. There has been less focus on the role of the governments in the development process. This paper compares Japan and China's efforts in promoting the smart shipping development from a public policy perspective. The comparative case study finds that both Japan and China attach much importance to the technological innovation. Different political and institutional system, and administration threads lead to different policy actions. While in the coordinative and regulatory domain engages with diverse stakeholders, Japan is doing better than China. For future implementation of the smart shipping technology, this paper suggests a proactive and coordinative approach to incorporate the new technology into the regulatory framework.

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1 Introduction

The emerging technology breakthroughs in fields such as artificial intelligence (AI), robotics, the internet of things (LoT) and autonomous vehicles herald profound shifts across all industries. The so called Fourth Industrial Revolution (Schwab, 2016) is also expected to transform the maritime industry. Mikael Makinen, president of Rolls-Royce's marine division, argues "Autonomous shipping is the future of the maritime industry. As disruptive as the smartphone, the smart ship will revolutionize the landscape of ship design and operations" (Rolls Royce, 2016, p.4). At present, research projects of unmanned or autonomous ships are vigorous in major shipping countries, such as UK, Sweden, Finland, Austria, Japan, Korea and China (Gao, 2018, pp.8-9). While technical innovation is essential to realize the smart ship in operation, much attention is also paid to how to respond to the changes and challenges during the disruptive transition.

IMO (International Maritime Organization) named the autonomous ship or unmanned ship "MASS" (Maritime Autonomous Surface Ship) and defined it as "a ship which, to a varying degree, can operate independently of human interaction" (IMO, 2018). These future vessels have potential safety, environmental and economic benefits. For example, they could provide the enhanced safety and cost savings by reducing the human elements from certain operations. Vessel operations could also be environmentally friendly, as new autonomous ships are designed to operate with alternate fuel sources, zero emissions and no ballast (UNCTAD, 2018, pp. 89-90). Further, the introduction of MASS associates the transition towards an integrated, smart and efficient shipping system. However, there are also a number of challenges and risks in implementation, such as regulatory and legal constraints, insurance and liability concerns, economic efficiency and new safety and security concerns arise from ship to shore communication, piracy and cybersecurity threats, redundancy of critical systems, data-sharing issues, etc. (Rolls Royce,2016, pp.35-73; T Hogg & S Ghosh, 2016, pp.208-213).

In general, current smart shipping development focus on two domains. One is the competitive domain where technical research and development (R&D) is gaining momentum. Major countries are striving for technological breakthroughs so as to get first-mover competitive advantages in the emerging market. The other is the coordinative domain which associates with the technical development and engages with regulatory activities at both international and national level. IMO, as the international regulator, has included "Regulatory Scoping Exercise (RSE) for the use of MASS" in its working agenda, and started the discussion on international regulatory framework since 2017(IMO, 2017, pp.78-80).

Although the MASS concept has been introduced in a relatively short time, there are considerable studies concerning the technical development and the legal, safe and security, economic and societal implications. However, so far little attention has been given to the role of the government in the development process. In many countries, maritime industry is considered as a critical interest that needs to be supported by the government. Moreover, the government is the most important regulator and administrator, which plays an important role in the implementation of smart shipping. Therefore, this paper sheds light to the government-centered efforts in the development of smart shipping technology. Japanese and Chinese policy and regulatory actions will be investigated from a perspective of public policy.

As the major shipping and shipbuilding countries in the world, Japan and China are the nearest rivals. Currently, Japan and China are the world's second and third largest ship-owning country, with cargo shipping capacity accounting for 11.5 % and 10.5% respectively of the global total (see Figure1). For both of them, shipbuilding industry is important business. Japan has maintained a global competitive edge for nearly half a century, occupying the first market share from 1956 to 1999 and accounting for 50% of the world's market at its peak (MLIT, 2017a, p.1; MLIT,2018, p.4). In recent years, with the rise of China and South Korea, the Japan share of the market slipped to the third place (see Figure 2). Chinese shipbuilding industry has undergone substantial development since 1980. By the early 1980s, China's annual shipbuilding productivity was only about 400,000tons, accounting for 1% of that of the world and 1/20 of that of Japan (Hu, 2019). After 1990s, shipbuilding industry was intensively fostered as a strategic industry. It now takes the first place in shipbuilding countries, with newbuilding amount representing 37.2% world market share in 2019 (MIIT, 2019).

Both Japan and China are keen to develop smart ship technologies. Japan put forward 'i-shipping' project, which promotes the full production phase of ship design, building and operation by embracing Information and Communication Technology (ICT)（MLIT, 2016）. China is also actively seeking the automated and autonomous upgrading of the shipbuilding industry which is large in scale yet not strong enough. For example, high-end ships are uncompetitive, and the shipbuilding efficiency is still 1/4 of Japan (MIIT, 2016). Adapting to the technology-driven trends of shipping and relying on new technology and independent innovation to increase productivity efficiency and competitiveness are their mutual aspiration. In addition, both of them are major players in IMO council, among the 10 states with the largest interest in providing international shipping service (IMO, 2019) .

The similar status and strength in maritime industry of the two countries and their common pursuing for technological innovation provide a very interesting opportunity to compare the governmental policies and measures dedicated to the development of smart shipping. Therefore, this paper investigates Japanese and Chinese maritime administrations and aims to answer the following questions: (1) What are the efforts of Japan and China respectively in the competitive and the coordinative domains to promote smart shipping technology development? How the governments incentivize the technical developments? And how they bring together stakeholders to regulate the implementation? (2) What are the differences between the two countries in the public policy context and what implications can be drawn?

To answer these questions, this paper adopts a qualitative case study method and makes international comparison. The analysis draws upon published articles, governmental documents and reports from website, which are secondary resources. Regarding the structure of this paper, the remaining sections starts with a literature review. The following section 3 and section 4 investigates Japanese and Chinese practices respectively as case studies, with focuses on their general strategy, legal and administrative support, working mechanism, infrastructure and information sharing and current developments. Research findings are discussed in Section 5. The comparative case study reveals that both Japan and China attach much importance to the competitive domain. Different political and institutional system, and administration threads as well lead to different policy actions. In the coordinative domain, Japan is doing better than China. Section 6 summarizes the conclusion and policy implication. For future implementation of the smart shipping technology, a proactive and coordinative approach to incorporate the new technology into the regulatory framework is suggested.

Figure 1 Fleet ownership and registration of main economies

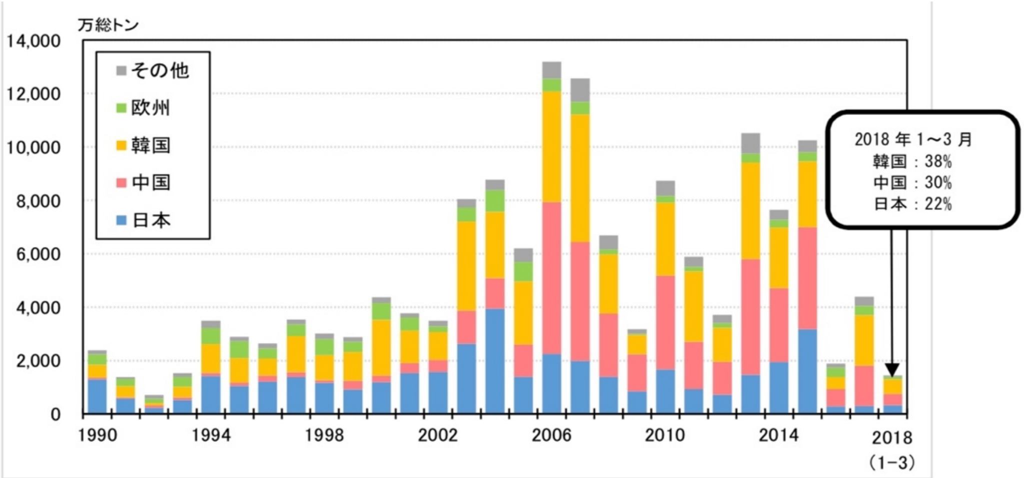
Tonnage
(Thousands of dead-weight tons)

Economy of ownership (Ranked by tonnage owned)	Flag of registration (Ranked by tonnage registered)							
	Panama	Marshall Islands	Liberia	China, Hong Kong SAR	Singapore	Malta	China	World
Greece	25 642	71 339	76 272	1 191	2 175	65 774	0	**349 195**
Japan	134 705	11 944	14 686	2 990	7 408	491	0	**225 121**
China	20 898	2 485	3 365	75 268	4 656	2 687	90 930	**206 301**
Singapore	9 377	7 455	12 064	6 845	71 287	889	52	**121 486**
China, Hong Kong SAR	9 458	2 736	6 215	72 311	3 613	307	192	**98 128**
Germany	865	7 694	36 396	1 316	3 690	7 707	34	**96 532**
Korea, Republic of	34 917	24 553	1 682	1 219	10	183	0	**76 702**
Norway	3 105	5 941	4 141	6 185	2 781	1 328	0	**61 115**
United States of America	1 186	27 091	6 876	3 325	183	377	0	**58 382**
Bermuda	2 628	17 346	3 757	7 403	1 077	266	0	**58 232**
World	**332 809**	**245 745**	**243 112**	**198 686**	**129 363**	**110 653**	**91 499**	1 962 582

Sources: UNCTADstat (UNCTAD, 2019a); Clarksons Research.
Note: Commercial ships of 1000 gt and above; beginning-of-year figures.

Source: UNCTAD. Handbook of Statistics 2019-Maritime transport

Figure 2 Flow of the world's new ship orders



Japan China Korea Europe others

Source: MLIT 2018. Report for Deepening Productivity Revolution of Maritime Industry. p.4

2 Literature review

The majority of the existing literature relates to technical development. In recent years, with the increasingly maturity of technologies, autonomous ships appear to move closer to real-world implementation, and there are growing research interest into the concrete challenges that autonomous ships will face. Some authors discuss legal challenges and barriers (Van Hooydonk, 2014; Karils, 2018; Lafte et al. 2018; Kominanos, 2018,). It is generally agreed that the autonomous ships, like other ships, should comply with the current rules and regulations governing shipping. And the existing maritime law and regulations need necessary and extensive amendments to legally shield and technically assure the autonomous ship concept.

Other authors focus on safety and risk management challenges. Wróbel et al apply a safety assessment framework based on what-if analysis over a hundred of maritime accident reports. The results reveal that unmanned vessels would perform better in reducing likelihood of accidents than mitigating its consequences (2017, pp.163-165). Wahlstrom et al. (2014, pp.1040-1044) and Mallam et al. (2020, pp.337-339) study on the challenges for transferring the role of human involved in the safety management. Goerlandt (2020, pp.5-9) explores the risk characteristics for the 4 degrees of autonomy of MASS and draw implications for the recommended risk governance strategies in approaching MASS development and implementation.

Economic benefits are researched by several authors. Kretschmann et al. (2017, pp.80-84) produce hypothetical cost analyses and suggest that autonomous ships might not be more costly than conventional ships. Ghaderi (2018, pp.158-171) applies crew costs modeling in short sea shipping and shows that autonomous technologies are viable to the challenges that the shipping industry is facing in terms of crew costs and skill shortage. Furthermore, the potential business models for autonomous ships (Munim, 2019), shipping service model (Chen and Ni, 2019) and seafarers education against the background of smart shipping (Lušić et al., 2019) have been analyzed and discussed.

The existing literature mainly focus on technical development and discussion on the legal, safety and security, economic and societal implications. The role of societal actors has been discussed in the context of risk governance (Goerlandt，2020). Some studies present concepts and research projects of autonomous vessels in leading countries, e.g. Norway and Finland (Rodseth, 2017, pp.8-10; Valdez Banda et al., 2019, pp.2-4). However, to the best of the author's knowledge, there has not been a focused analysis on the government's regulatory and policy action concerning smart shipping development, nor a comparative study between countries. The smart shipping is an issue in the future of maritime transport, which is inseparable with the efforts of the governments. The technological innovation, regulatory framework and governmental administration have been referred in the above literature, but these studies appear less focused on what the governments are doing to incentivize R & D, modify standards, laws and convention, and bring together all stakeholders' groups to enable a technological transition. Against this background, the paper intends to open up the discussion on the governments' actions by highlighting Japan and China's practices.

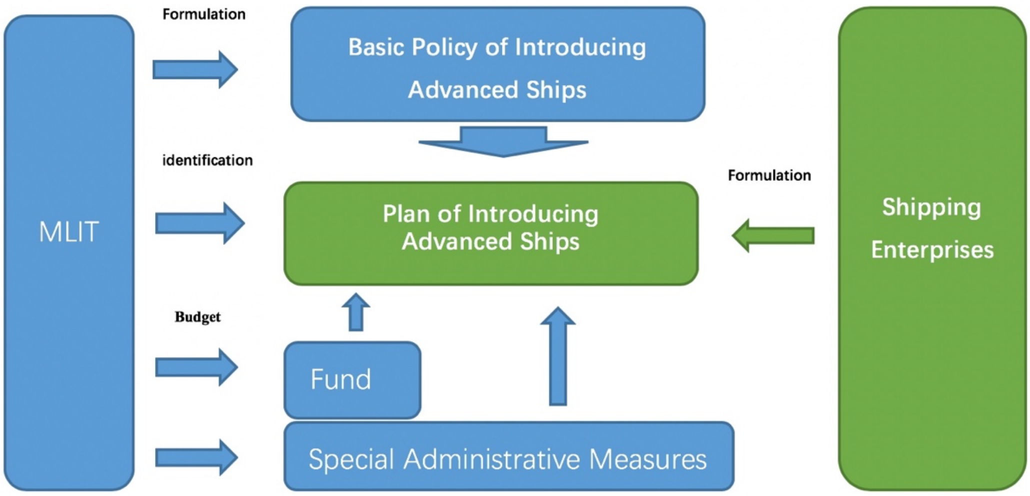
3 Japan's practices

3.1 Administrative and legal support

In order to advance the i-shipping project, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) has established an innovative shipbuilding technology R&D grant system in 2016 for enterprises and organizations that are committed to developing and utilizing LoT (Internet of Things) and big data to improve shipbuilding efficiency. Up to 1/2 of the R&D spending can be subsidized. Further, the MLIT has introduced the promotion of 'advanced ships' to current law and regulations. Advanced ships refer to the LoT application ships which promote shipping efficiency and safety, and the alternative fuel ships that reduce environment burden. In 2017, the "Maritime Transport Law" has been revised with "Basic Policy of Introducing Advanced Ships" included (MLIT, 2017 b). Apart from grants for the R & D of advanced ships，special supporting measures of administrative procedures have been formulated（see Figure 3）.

In addition, there is a Transportation R & D Promotions System, which provide research funds through MLIT commissioned policy research projects. The MLIT releases annual research theme and calls for applicants. Base on competition, those whose research proposal is adopted by the MLIT get the project and funds. This could be a source of financial support for researching smart shipping.

Figure 3 Japanese system of promoting advanced Ships



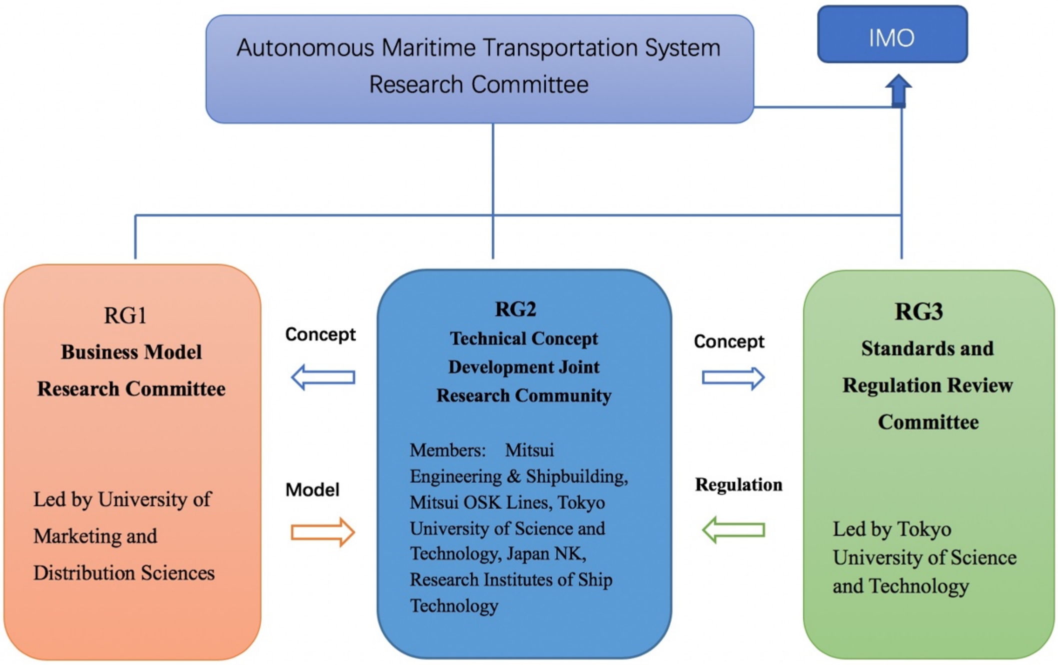
Source: Compiled by the author based on MLIT, 2018, Report for Deepening Productivity Revolution of Maritime Industry. p.12

3.2 Working mechanism

MLIT, Class NK and the Japan Ship Technology Research Association (JSTRA) are major actors. Although in independent status, they make joint efforts to promote maritime industry, shipping safety and environmental protection. MLIT is the government agency in charge of the maritime industry and water transport administration. Class NK is a third-party ship classification society which undertakes ship surveys and focuses on the developing relevant rules, procedures and guidance. While JSTRA is a representative research association gathering various members from ship industry, academics, institutes and public institutions, which carries out R&D projects based on industrial needs and government commission.

In 2017, JSTRA established the research committee of autonomous maritime transportation system, under which discussions, review and research on autonomous ship's business model, technological concept, standard and regulatory design activities are conducted in 3 sub research groups. The structure and the internal relations of the committee are shown in the Figure 4. The project of RG2 was commissioned by MLIT in 2017 and funded by the Transportation R & D Promotions System. JSTRA provides a platform for the government, industry, university and research institutes working together to promote the R&D of autonomous maritime transportation system and scoping exercise of relevant standards and regulations.

Figure 4 Research Committee of Autonomous Maritime Transportation



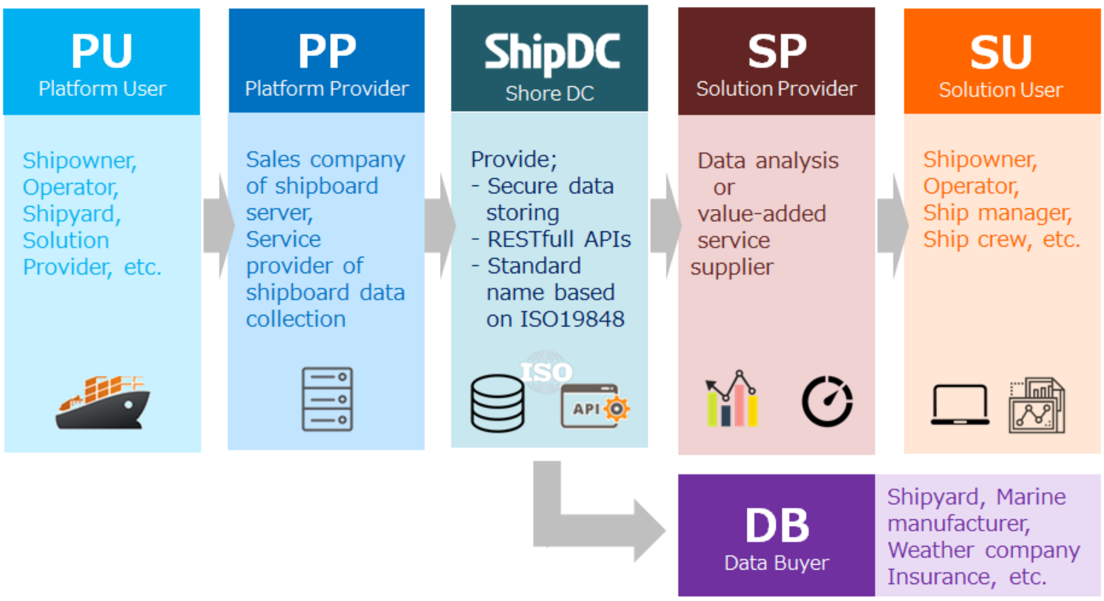
Source: Compiled by the author based on MLIT, 2018, Report for Deepening Productivity Revolution of Maritime Industry. p.24

3.3 Infrastructure support and data sharing

Smart ship utilizes onboard and shore-based application services to achieve optimum ship operation. In order to support these application services to access ship equipment data easily and enhance more application services development, Japan launched Smart Ship Application Platform Project (SSAP) in 2012. It is a joint industry project supported by Japan Ship Machinery and Equipment Association (JSMEA) and Class NK, with 27 members from industry and research institutes participated in (Ando, 2014). As an E-navigation testbed, the SSAP project is succeed in establishing infrastructure that promotes onboard and shore data transmission and service. Moreover, it proposes two ISO formats. Standardized format and protocol enhance further application development. In addition, image of shore data center was introduced. Big data becomes increasingly important in digitization and automatization of maritime industry, and the integration of individually managed data is necessary for further data utilization. To this end, Class NK founded the Ship Data Center Company (Ship DC) in December 2015. As a foundation for the big data of ships, the Ship DC manages the accumulation and storage of operational data and offer it to the users. In this way, the unitarily managed data can be used at a low cost and maximize opportunities for big data utilization throughout the entire maritime industry.

On the basis of previous work, SSAP2 project started from 2015, with an aim to design and to implement an open platform for supporting Ship IoT service development and operation. SSAP2 works closely with Ship Data Center to create opportunities for a new maritime cluster in the digital age.

Figure 5 Roles of the stakeholders of Ship DC



Source: Ship Data Center Co.,Ltd.
Retrieved from: http://www.shipdatacenter.com/en/index.html

3.4 Road map

Facing the new model of shipping that will be brought by the development of autonomous ships, Japan adopts a phased method to introduce and test the autonomous ships aligning with technological advances and the society's demand. The general road map is divided into 3 phrases based on the autonomy levels. At present, Japan is taking technological advancement and adjustment of standards and regulations as a two-pronged drive. On the one hand, technological R&D and experiment in the competitive domain is encouraged and supported; on the other hand, reviewing and revising standards and regulations for the practical use of autonomous ships is underway. To participant in and lead IMO discussion on MASS is taken as a strategic direction, nevertheless, regulatory scoping exercise not only focus on international conventions, but also domestic regulations.

4 China's practices

4.1 Top-level design

Boasting world manufacturing hub, though, the whole Chinese manufacturing industry is situated in middle and low-end stage. In order to construct China into a world manufacturing power and technology power, the State Council has released two strategic plans, in which high-tech ships and smart shipping are included. First is an industrial plan calling for enormous Chinese government assistance to 10 industries.[1] Second is an AI development plan proposing to develop emerging AI industry and smart social governance.[2]

In order to carry out the two national plans, the Ministry of Industry and Information Technology (MIIT) and the Ministry of Transport (MoT) released their ministerial-level plans respectively.[3] The A*ction Plan of Developing Autonomous Ships* issued by MIIT aims to make the top-level design of China's autonomous ship development and preliminarily establish the standard system within 3 years (MIIT, 2018, p.3). The *Guidance on the Development of Smart Shipping*, issued by MoT, also proposes to finish smart shipping development top-level design by the end of 2020 (MoT, 2019, p.4). These documents provide macro guidance to develop autonomous ship industry and smart shipping service. According to these two documents, the specific roadmap is still under development.

4.2 Working mechanism

In terms of standardization and regulatory administration, two ministries engage with smart shipping technology: MIIT and MoT. The Ship Division under the Equipment Department of the MIIT is responsible for ship industry administration. Under the MoT, CCS (China Classification Society) provides classification service and statutory surveys to ships; whilst MSA (Maritime Safety Administration) is in charge of the shipping safety administration. In the technologic innovation and development domain , the Ministry of Finance (MoF) and the Ministry of Science and Technology（MoST）are sources of finical support. In addition, the governments at local level can make policies to incentivize science and technologic innovation of local enterprises. The relations of these governmental agencies are shown in figure 6. Within the spheres of these government agencies' responsibility, state-own enterprises, private enterprises,

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[1] *"Made in China 2025"* , issued in 2015, is the first 10-year national plan for upgrading China's manufacturing. Marine engineering equipment and high-tech ships is listed as one of the 10 key industries.

[2] *"Development Planning for a New Generation of Artificial Intelligence"* , issued in 2017, lists intelligent transportation tools as emerging AI industry that should be vigorously developed, and smart transportation as one of the directions of promoting smart social governance.

[3] MIIT issued the *Action Plan of developing autonomous ships (2019-2021)* in December 2018. MOT issued the *Guidance on the Development of Smart Shipping in* May 2019.

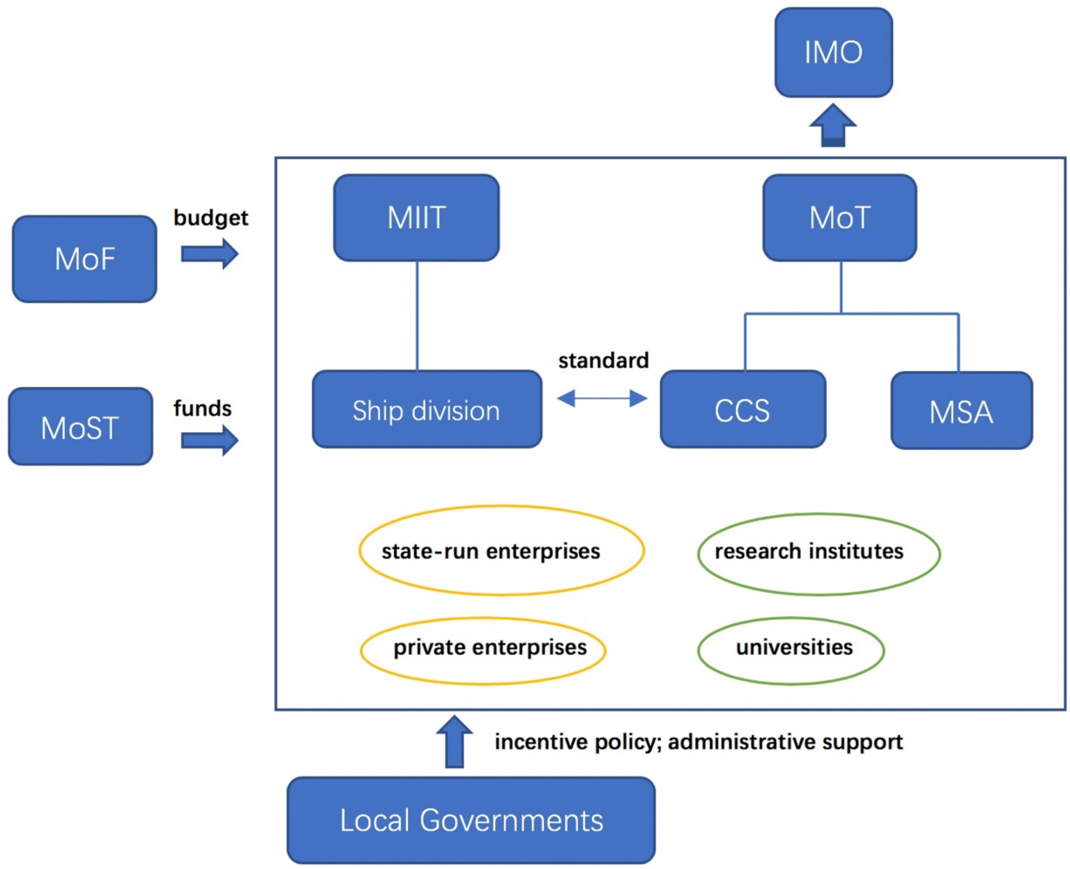
universities and research institutions form cooperative relationships to support industrial development and governmental administration.

4.3 Administrative and policy support

Regarding administrative and policy support, the extant *Measures for the Administration of the Certification of High-tech Enterprises* is the only solid policy that can incentivize the private enterprises. Qualified enterprises that belong the high-tech domain supported by the country can enjoy preferential tax policies. In 2016 the *Measures* was revised, and intelligent transport technology and high-tech ship building technology were included in the supporting list（MoST, 2016, p.69）. At the local level, the governments can formulate similar incentive measures, mainly preferential tax, rent allowance, office and land etc. These measures differ from area to area and are general for all technological companies. Local industrial layout matters. Smart shipping technological enterprises are more likely to be supported by the government in areas that focus on developing marine economy, such as Zhuhai and Qingdao.

More direct government investment come from technological project funds and budgetary allocations. Since smart shipping technology is proposed by the national strategy, MoST and local science and technology departments add relative projects to its annual released Application Guidance for Key Technological Projects. MIIT also gets budgetary allocations to set up special projects e.g. Smart Ship 1.0 Project. Enterprises, universities and research institutions can apply for the project funds, which is similar with the Japanese Transportation R & D Promotions System but conducted in Chinese national system. Competitive applicants gain the funds, which are usually state-own enterprises and institutions or local leading private enterprises. For private enterprises, especially middle and small companies, the existing policies do not provide clear guidance and solid support.

Figure 6 Chinese system of supporting smart shipping technology



Sources: Made by the author.

4.4 Regulatory efforts

Standard formulation of autonomous ships and review of existing laws and regulation are carried out by the ship division of MIIT, CCS and MSA according to their responsibilities. MSA takes charge of IMO regulatory scoping exercise (RSE), whilst CCS and MIIT lead the review and formulation of technical norms and industrial standard respectively. At present, CCS has released several guidance on autonomous ships survey. MIIT is organizing stakeholders from the industry, universities and research institutes to develop the *Guide to the Construction of Autonomous Ship Standard System*. These three governmental departments have cooperation in participating in IMO affairs. On the side of MoT, most of the current regulatory work is driven by IMO RSE discussion, thus the scoping excises on domestic regulation have not yet been discussed. At IMO level, the progress remains slow, as the decision-making is based on consensus of member states.

4.5 Infrastructure and information sharing

As a large ship building and shipping country, China has some digital foundation in ship industry, port facilities, maritime administration, and navigation supporting. These areas are moving towards higher level of intelligentization separately. The trend of smart shipping is to form digitalized and smart networks for integration of all shipping elements, including ships, harbors, supervision, navigation support and shipping service. A problem is that these areas are at different levels of development and not quite coordinated. The current infrastructure is still insufficient to support smart shipping development. Further, China has yet to establish a digitalized database or open platform for information sharing for all parties due to concerns of standardization, stability and coverage. The Chinese governments adopts a pilot study approach to promote smart shipping at local level, starting from areas with good infrastructure foundation.

In the field of industry, MIIT has promoted to form industrial alliance to bridge the government and enterprises, connect industry-university-research institutions, and enhance information sharing and industrial cooperation. Various alliances have already been founded, for example, China Smart Ship Innovation Alliance, Unmanned Ship Industry innovation and Development Alliance. By joint efforts of alliance members, it is expected to build the industrial chain, reduce cost and risks in R&D, and improve the innovation and competitiveness of the whole industry.

5 Findings from Japan-China Comparison

Due to different political and institutional system, industrial and economic situation, and thread of governmental management, Japan and China show different characteristics in developing smart shipping technology. In general, Japanese policies are more targeting at maritime industry, focusing on improving the productivity and economic benefits (MLIT, 2016). While the Chinese government makes a top-down deployment for the transformation and upgrading of the whole manufacturing industry (State Council, 2015). Driven by the national strategy, Chinese supporting measures are embedded into the general science and technological policy system.

From the perspective of working mechanism, Japan is more coordinated than China. Japan Maritime Bureau under MLIT manage both maritime industry and water transportation, which enable it to arrange and coordinate government affairs as a whole. In addition, JSTRA and Class CK play a supporting role in uniting the industry, government agencies, universities and research institutes. In China’s case, given its vast size and institutional system, the ship industry and shipping administration are responsible by MIIT and MoT respectively. Making policies of promoting science and technology innovation is confined to MoST and local governments. The fragmentation in these governmental agencies lead to the situation that autonomous ship and smart shipping development is a highlight，but being advanced in different domains and areas separately.

From the perspective of legal and administrative support, different political systems of the two countries produce different policies and measures. Japan pays more attention to legalization of supporting policies and the market plays a bigger role. While China relies on the national strategies to support key industries and its current measures are more conductive to competitive enterprises, universities and research institutes, most of them are state-own, which reflects the Chinese threads of gathering advantages and strength to reach the national strategic goals.

In the field of infrastructure and information sharing, Japan started earlier and has a good foundation. The SSAP projects and Ship DC promote onboard-shore integration and data sharing, which makes data distribution a cooperative domain and help focus on competitive fields such as data-driven innovation and the development of new services (MLIT, 2018, pp.24-25). China's development remains unbalanced and uncoordinated. Although pilot ports, cities or enterprises gain much attention and backing (MIIT, 2018, p.7; MoT, 2019, p.10), constructing digitalized and standardized infrastructure and open platform for information sharing of all parties are needed.

Regarding future development, Japan is at the forefront of smart shipping technology. The coordinated working mechanism, synchronous advance of technical development and standardization & regulatory development, as well as the industrial and infrastructure foundation create opportunities to competitiveness enhancement and future smart shipping implementation. China is in the process of transforming to the direction of high-end ship industry and shipping service, with more focus on the competitive domain. National strategy allows for huge investment in this field. Also, the centralized system help mobilize and integrate resource. Some of the big ports and enterprises are taking the lead. However, in the long run, technological breakthrough, infrastructure supporting, and the coordination and cooperation of all stakeholder groups are essential. Lack of inter-governmental and central-local coordination could delay national plans. Further, there is a question mark over whether the close relationships between the government and state-own enterprises can give birth to original and core technical innovation.

6 Conclusion and Future Considerations

This paper presents a comparative study of Japan and China in the process for developing smart shipping technology. The realization of smart shipping concept is largely dependent on technical development and an associated legal and regulatory framework. Meanwhile, the large-scale disruptive changes require infrastructure support and wider cooperation with diverse stakeholder groups. The governmental efforts play an important role in both the competitive and coordinative domains. The contribution of this paper is threefold. First, it contributes a governmental administration perspective for the development of smart shipping technology. Second, it is informative in unfolding the practices of Japan and China. Third, the study can provide policy implications for smart shipping administration.

By analyzing the Japanese and Chinese practices, this paper finds both Japan and China attach much importance to the competitive domain. The fundamental differences in policy actions derive from different political and institutional system, and administration threads as well. It is difficult to judge whose practices will help to win the technological leadership. Nevertheless, in the coordinative field, the discussion above has shown that Japan is doing better than China. In terms of overall strategy, working mechanism, infrastructure support and information sharing, Japan obviously demonstrates strategic design in uniting industrial, academic, and regulatory efforts, and coordinating domestic and international regulatory activities, as well as short-term and long-term planning. Whilst China, though with a grand strategy, is still in the initial edge of formulating road map, with the governmental agencies currently focusing on their own short-term goals.

The smart shipping operation require not only technological innovation and associated standards and regulatory modifications, but also the acceptance of the governments, maritime industry and the public. As technology advances, there will be growing discussion and integration in socio-technical and socio-economic spheres. There are still many uncertainties. Facing both opportunities and challenges, for the government actors, this paper suggests a proactive and coordinative approach to incorporate new technology into the regulatory framework, making efforts to give full play of potentials from various stakeholder groups so as to address the future challenges appropriately through regulatory and policy actions.

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