

The Main Challenges and Barriers to the Successful “Smart Shipping”

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ABSTRACT: As with the powerful digitalization of the world in the 21st century, maritime affairs, like all other areas, are facing not only new opportunities, but also new big challenges and problems. From the point of view of the development of new technologies, it seems that everything is possible, for example the bringing of so-called "intelligent ships" and "smart ports" into one global system on base of internet of things and big data applications. However, if to look at the matter further, a number of factors and obstacles may appear which could be major threats to the normal functioning of such a system.

While it is clear that systems with such high degree of complexity are even technically vulnerable, it seems to the author of this paper that questions that are no less difficult are in the field of human relations. For example, when ships and ports are becoming more and more "smarter" and need less and less people to intervene in their interactions, who at the end will be responsible for everything that can and definitely will happened at sea or in the port? What about liability of cargo carrier if "carrier" is an autonomous ship without any person on-board during the entire journey? How to ensure cyber security? How to be secured against the risks of so-called artificial intelligence systemic errors?

It is possible that only new non-trivial approaches can lead to acceptable results in this area, but what they may be and whether these approaches are possible at all - these questions are still waiting for answers.

1 INTRODUCTION

At the present day, everyone or almost everyone talks about the fourth (some talks even about fifth) industrial or rather technological (otherwise digital) revolution (Grantham 2016). Indeed, now we experience a stage of development where it seems that there is no limit to the growth of the technological capability of humankind, in other words there is nothing that cannot be achieved through the development of modern technologies.

Shipping is undoubtedly a lot of promising playground for the introduction and implementation of new technologies. In recent years, quite a number

of serious shipping market players have declared that they have seriously addressed the development of so-called "intelligent ships", the main expression of which is remotely controlled and autonomous ships (Cowan 2018). The first autonomous ships are already sailing along the sea, though not very far and, as a rule, along precisely defined shipping lanes, but anyway a precedent has been created (The Beam 2018).

Seaports are also not lagging behind in today's development. The so-called "smart port" concept is widespread, which in turn means the maximum automation of port processes and the application of

new intelligent technologies for the processing of goods and ships in ports (Berns et al. 2017).

In fact, continuous getting separate ships and ports more, more autonomous, and smarter is not a major challenge in shipping today. Thanks to the improvement of information technologies, the rapid growth of the volume and processing speed of the information (big data) and development of internet of things, connection, interaction and exchange of data in global transport systems has become so real as it was possible never before. Such systems may be also referred to as "artificial intelligence", the number of components of which may be huge and these components may be located anywhere in the world, acting simultaneously as a whole and performing coordinated common tasks. It is logical that for goods transportation by sea, such a common system could be called "smart shipping", where ships and ports are connected to one global system and operated in the most optimal way using common algorithms.

At first glance, it seems like a great idea and an impressive breakthrough in the field. For example, wise machines in port can process information coming from other ports, ships, weather services, cargo shippers and other sources, and inform continuously the ships going to the port, what should be their optimal speed and other seagoing characteristics so that they can reach the port in exactly right time and should not wait in order. The intelligence ship, in turn, continually adjusts without human intervention its sailing parameters based on incoming information.

It is clear that it has several positive influences. At present, ships are in many cases flying at full speed to reach the port before the other ships or for a fixed arrival time, burning large amounts of fuel and polluting the environment. Ultimately, however, they may be late or other ships congest the port, and they are forced to stay on the anchorages for waiting, not only once again burning fuel and polluting the environment but wasting time and money. Smart shipping makes it possible fully implementation the just-in-time principle, which is currently not working very well in the shipping.

Undoubtedly, there are important positive factors that author names in following sections, but at the same time there are numerous difficulties and potential threats that can make successful operation of such a system complicated or even unrealistic. They are also described by the author in the SWOT analysis and are analysed in more detail in the following sections.

2 ADVANTAGES AND DISADVANTAGES OF SMART SHIPPING

2.1 Fixing the problem and SWOT analysis

Based on modern information technology solutions, the creation of a unified system of ports and ships, in which components are constantly in communication, transaction and interaction, seems at least theoretically possible in the near future.

If such a system could be created, it would undoubtedly be a very complex system influenced by huge amount of factors. Even finding and listing all these factors would be a difficult task, not to mention reliably identifying the positive and negative effects of all these factors and the consequences of these effects. In any case, it is not possible to do so to the full in the context of this paper. Nevertheless, the author tries to define some most obvious positive and negative factors of the system in the first approach. These factors are presented in the form of a SWOT analysis; after the strengths and weaknesses, the author identifies the main threats to the system, while also mentioning the opportunities that such a system functioning may bring. The author also discusses what measures or solutions can be applied to eliminate or at least alleviate the negative impacts.

Strengths

- 1 For the ship owners - optimal timing of arrival to each port, cargo and other operations in port, departure from port; this leading to a significant reduction or even zeroing of waiting time on the anchorages.
- 2 For the cargo shippers and consignees – maximum use of direct variant in loading/unloading of vessels.
- 3 For the port owners - a significant reduction of port congestions (ideally not at all), minimization of the amount and capacity of port warehouses.
- 4 For the consumers - more goods in shops at lower prices.

Weaknesses

- 1 The ultimate complexity of the system.
- 2 Need to coordinate simultaneously the personal needs and interests of very lots of stakeholders.

Opportunities

- 1 In the context of ships: a) an optimal trip time that can be always be optimized, b) minimum fuel consumption, c) minimizing environmental damage.
- 2 In the context of cargo shippers and consignees as well as consumers: a) minimization of good storage costs, b) the goods reach the consumer faster – keeping the best quality of goods for the consumer.
- 3 In the context of ports: (a) lower costs for the exploitation and maintenance of waiting areas for ships, (b) significant reduction of costs for medium- and long-term warehouses.

Threats

- 1 Because of the extreme complexity of the system, it can be easily vulnerable and unstable.
- 2 It is extremely difficult to create sufficiently reliable and flexible algorithms for optimal system management in all possible situations.
- 3 Collapse of the system due to the influence of external factors.
- 4 Collapse of the system due to the occurrence and accumulation of internal disturbances.
- 5 Complete disappearance of human control over a system with such high degree of autonomy.
- 6 Inefficient energy consumption in whole system.
- 7 Ship owners are reluctant to accept high-risk innovations.

8 The ineffectiveness of the insurance system.

2.2 System reliability and efficiency

2.2.1 Systemic errors and possible instability

Simpler objects can be operated locally and it can be done by people but consider that human control is largely intuitive. Human thinks linearly, it is not applicable for more complex objects and systems (Langhe et al. 2017). The more complex the system is, the more complex its connections and needs are, so the requirement of efficiency is more complicated to perform. Linear models work in small-localized systems only. The operation models of more complex systems are non-linear, the system must work reliably in a wider area, which means that the system should ideally be free of disruptions, i.e. maximum efficient.

From the other side, while becoming very effective, the system becomes proportionally very vulnerable, a small internal mistake or external impact can lead to system break up like avalanche. This means that the system must be enough robust at the same time, but there is a contradiction here, which is very difficult or even impossible to overcome: efficiency and robustness take place in opposite directions, the more efficient the system, the less robust it is and vice versa. It is dangerous to put efficiency at the forefront, almost the only valuable thing. Efficiency is always at the expense of robustness. If in a maximally efficient system a permanent disturbance occurs that could not be resisted at the right moment, the whole system will move in the direction of the disturbance and its impact may increase exponentially. As example may be hacker attack that could not be responded to at the right moment and eliminated or minimizing timely; in this case, the system goes out of control, disturbances/ inconsistencies grow exponentially, so the cost of maximum efficiency of the global system is the probability of a global collapse of the system. There should be a balance between efficiency and robustness.

Apart from non-linearity, the object-relatedness plays a major role. The connections affect each other, the number and nature of the connections determine the functioning of the system; the more these links are, the more unstable the system. Development of information technology - more memory, faster processors, more and faster data exchange, etc. - leads to that the robustness decreases, the risk of system collapse increases. Separate elements are copied multiple times, but the artificial world becomes more and more undefined.

Undoubtedly, the global smart shipping system is subject to the principles and laws of automatic control theory. Theoretically, the control system is a system with a number of free parameters or variables that operator can influence. For this operator needs to have buttons, levers, etc. that he can change the behaviour of the system in the desired direction (e.g. that the ship would move along the desired trajectory). The automatic control system takes over the function of operation by using predetermined algorithms.

It is clear that the human brain is capable of processing information with sufficient efficiency only to certain volumes of information; for larger volumes and for faster processing this function must inevitably be transferred to machines or computers. At the same time, computers do not think off something themselves; they are operating according to the algorithms created, at least initially, by the same imperfect people. At one point, probably, the machines themselves can also take on the improvement of the algorithms, making the system more independent and self-evolving, but the algorithms for the development of its algorithms will still thought out and written by people. At the same time, however, a system that constantly evolving and becoming more independent is becoming less and less under the control of the humans, which may not only have advantages but also disadvantages.

It is well known from the theory of automated systems that the more complex the system, the greater the probability of errors and disturbances in the system (Chavaillaz 2016). The more complicated the system is, the more disturbances of a random nature, i.e. uncertainty, is inherent in a complex system; it is a constitutive feature of such systems. This fact cannot be eliminated by any Meta system; it can be improved a little here and there, but randomness is generated into complex systems. Even the thoughtful complication of the system inevitably leads to the additional uncertainties or unsteadiness. The individual elements can be almost perfect, the randomness of the whole system consisting of them is the inevitable because laws of mathematics. It cannot be eliminated by any means; it must be accepted.

It is imperative that errors occur in complex systems (Redundancy... 2018). The principle of duplication of critical elements, known from the theory of automated systems, only works to a certain degree of complexity: at one point, the duplication system becomes as complex as the basic system or even more complex and in turn requires duplication... etc. In other words, when attempting to build control mechanisms into the system, these mechanisms, beginning from a certain degree of complexity, can prove to be as complex as the systems themselves and these control mechanisms themselves become complex systems, which means that they in turn need control mechanisms.

One logical way to make the system more reliable is to simplify the system, i.e. to reduce the number of its components and connections, and the complexity of the tasks set, what ultimately causes the simplicity of the algorithms. Here, however, too much simplified system may become ineffective, in other words, simplifying the systems may set the limits; it must always be monitored whether the system is still fulfilling the purpose for which it is created.

Another way to make the system more reliable is to make the system layered, i.e. to apply the principle of independent management levels. In other words, the system is formatted not from a big amount of separate components, but from several local systems, between which these components are divided. These local systems are much simpler and contain significantly fewer components and connections, while being relatively independent and better

protected from the effects of interference at other levels of the system. The bottleneck of such a system is communication between layers and maintaining the efficiency of the entire system.

2.2.2 Possible impact of external factors

Speaking of the systems with high degree of complexity that the smart shipping system undoubtedly is, one cannot overlook the potential negative impact of some powerful external factors on the system. Two of these external factors deserve to be mentioned first: problems with system power supply, i.e. electricity and consequently Internet connectivity and problems with unauthorized malicious intrusion into system (hacking). It is clear that the impact of these factors on the whole system and, consequently, on its individual components can be devastating.

The global loss of electricity can be caused by human errors or malevolence as well as by one of the so-called cosmic factors: big meteorite, powerful solar prominence, cosmic radiation, and the like. It should be borne in mind here that, as the prerequisite for impeccable functioning of the smart shipping system is the undisturbed work of the global internet network. There is no need for the meteorite or the solar wind particles to reach the ground of Earth and cause widespread destruction here; it is enough to destroy a certain number of satellites. Providing preventive measures against such possible natural phenomena is rather difficult, if not impossible; in any case, the humankind is not able to prevent or control these events now, as well as to implement any effective measures to mitigate their impacts.

For smart shipping is clear that in case of such events, the ships at sea are the most vulnerable, first autonomous and, largely, remotely controlled, as they are most likely can lose communication within managing network. In order to prevent or at least partially mitigate the catastrophic consequences of the events described, the relative autonomy of the vessels' own energy sources and the maximum protection of computer systems must be respected, as well as the ability of on-board computer systems to successfully solve local navigation and other vitally necessary tasks if all interactions and information exchange with management levels will be lost.

The hacking of the system or its elements is, in the author's opinion, a more relevant and serious external source of potential problems for a smart shipping system. The events of recent years show that the number and extent of unauthorized entry into computer systems are growing rapidly, and they are leading to increasingly severe consequences. It should be mentioned here that the purpose of hackers may not always be to attack a particular ship or ships, it may be an intention to use computational capabilities, which is potentially enabled by the Internet of Things, where all elements of the system are connected through the so-called the cloud. This kind of hacking is also dangerous, because in some cases, for example, in an emergency, a power of calculation might be missing to make a quick decision.

2.3 Possible solutions

2.3.1 Partitioning the system into relatively autonomous parts

According to EMSA, as of the end of 2017, the world merchant fleet consisted of 56,963 vessels with a gross tonnage of over 500 GT (The world...2018). Only the major sea and inland ports number, through which 99% of the world's maritime trade takes place, are 835, but there are additionally thousands of smaller ports; in total more than 8,000 ports and harbours there are in the world (Seaports...2019). Therefore, a worldwide global smart shipping system that would include even only larger cargo ports and merchant ships that are continuously in constant interaction and interconnection, and that is constantly coordinated by the central artificial intelligence, would contain a huge number of components and links between them. It is clear that such a system would be too complicated and therefore too vulnerable and unstable.

To make the system described above less complicated taking it in use only partially may be recommended. Randomly reducing the number of actors involved seems to be a useless act, because in this case, the system loses, completely or largely, the unique benefits listed in section 2.1. Such a system seems to be effective only if all actors in the field (in this case shipping) are actively involved. Nonetheless, the author is trying to suggest some solutions that, if not solving the problems arising of system's complexity then at least make the system more realistic.

One of way to make the system more reliable is to make the system layered, i.e. to apply the principle of independent management levels. In the case of smart shipping, the indispensable condition of system stratification is the relative independence of each layer. There may be two approaches here. The first is the specialization according to the type of goods, e.g. the entire world's container ports/terminals and container ships can be connected to one network. Another example of such a system would be a system of crude oil terminals and tankers. These systems should be sufficiently autonomous to maintain the benefits of a smart shipping network, it should be ensured that in the first case no goods other than containerized goods pass through these ports and no ships other than container ships go there, i.e. this system would be both global (worldwide) and autonomous (containers only). The same principle should be applied for crude oil terminals and tankers as well as for any other similar variants.

As of January 2018, there were more than 6,000 active container ships and 7244 crude oil tankers (World...2019). Although these numbers are also high, it is clear that the complexity of such different systems is, of course, much smaller and thus reliability is significantly higher than would be in the case of a global system. However, the problem with this solution may be the unwillingness of the port owners to be so narrowly specialized, or to meet the requirement of processing only one type of goods in the port, which will largely eliminate for them the advantage of free choice of suitable business developments. From other side, if the interactivity between these autonomous systems is indispensable,

the question arises of how to combine the "independent" layers into one whole system and who or what is controlling and operating the co-ordination between these layers?

Another option may be the separate systems based on a territorial feature: e.g. sea freights within a certain area, where the vessels carrying the goods never leave the boundaries of some geographical area and travel between certain (probably relatively small) ports. However, it is more difficult to achieve a high degree of autonomy for such variants because probably ships from other regions or those carrying other types of cargo will call this ports being inevitably in the role of the system's external disturbances. However, for feeder container lines, at least theoretically, is possible, for example, within the European region. At the same time, such a transport system cannot be enough autonomous, because the containers they carry arrive either from ocean lines or from other modes of transport. Ideally, all these external agents inevitably have to be implemented into system, which ultimately does not allow the system to be sufficiently simplified.

2.3.2 *Semi-autonomy ship - 3M and MP concepts*

In Section 2.2.1, we talked about the fact that the human brain thinks and processes information in a linear manner, and takes decisions largely intuitively, which some people may define as a primitive way of thinking. Being excited about the rapid development of information technology, humanity tends to overestimate its efficiency and perfection, considering that the key to success in any field lies in the speed of information processing and the capacity of information being processed. The common belief is that powerful quantum computers can handle everything. Is it ever everywhere and always true?

Overestimation of technical solutions and blind beliefs to them have also occurred in the past, including at sea. For example, in the first half of the last century, problems with the taking in use radars on ships could be mentioned. Initially, the common phenomenon was the resistance and distrust of older masters and other seafarers against new technical solutions because "the human eyes are still king". However, as time passed, the pendulum moved in the opposite direction and in some cases, the shipmasters encountered a "blind belief" in the technique, e.g. sailing with full-speed in thick fog and high traffic areas. Some major accidents at sea have taken place because the ship's officers trusted the radar too much, although the information obtained from it was incorrect or misinterpreted. As example, a collision between "Andrea Doria" and "Stockholm" in 1956 may be named. (Andrews 2016)

In previous sections, the author described problems related to the occurrence of random errors in ultra-complicated systems. Nevertheless, even if it would be possible to avoid these errors with some technological techniques or eliminate them at an early stage, it is not certain that the system will work hard and the result will always be the best. As is well known, the basic principle of the even most complex computer systems is to answer questions or respond to emerging situations, with only two responses "yes" or "no" or, in computer language, "one" or "zero". It

can be said that the accuracy and quality of a computational result depends not on how fast and how much the computer answers these "yes" and "no", but on whether these answers are always correct and ultimately lead to optimal decisions and solutions.

However, always achieving this best result is not so clear. When deciding whether to answer "yes" or "no" in each case, the computer is guided by the algorithm provided to it. It is assumed that the algorithm is more perfect, the more initial data is processed putting it together, i.e. the application of so-called Big Data processing principles. Here, however, two potential threats can occur.

First, are these big data "big" enough? Whether in process of compiling the algorithm and collecting the data all the facts, factors, impacts important for programming of behaviour models are taken into account. Returning to the idea of "smart shipping", it is feared that, in its operation, this amount of essential data is so large and unnoticed that not all possible situations can be pre-programmed. Particularly, it becomes vague when factors related to human's behaviour come into game, which in many cases cannot be predicted and programmed.

Another place of uncertainty is that the basic principle of data processing is statistical analysis. Moreover, the "bigger" the data, the more likely it is that the averaged results will become not enough reliable. Even more so when a human has the opportunity to influence the system. Predicting people's behaviour because of statistical data analysis may not be very reliable, what kind of phenomenon economy scientists know well. While one hundred people have behaved in a particular way in a particular situation, statistical analysis suggests that one hundred first person with almost 100% probability behaves exactly the same way. However, this is not the case for people. The one hundred first person can unexpectedly do something about the opposite, and the strangest thing is that he may not be able to explain later why he did just that. The computer processes a large number of similar cases, their solutions, and the consequences, and calculates statistically what is most likely to follow in one case or another and what would be the most appropriate next step. However, even with the biggest, nearly 100% probability, solutions are just statistics and there is no guarantee that the next similar event will not be interrupted by a random factor, whether it is the human error or malicious activity. Thus, these methods can never be one hundred percent confident when it comes to making decisions and putting them into action only by artificial intelligence.

The author concludes that although at first sight the possibility of human intervention in the work of a global or very large port/ship network is not desirable due to the unpredictable impact of the human factor, the total exclusion of a human from the system may be even more dangerous. If the system is completely out of human control, the coincidence of many negative effects is possible, and if human cannot intervene or even has not idea of what is really happening, the risk of serious consequences cannot be ruled out.

For example, it is possible, at least theoretically, that the computer may not have an unambiguous "yes" or "no" response in a particular case; the answer tends to be "don't know". However, the computer work principle does not see such an option, and the "yes" or "no" response must be achieved in any case. In this case, it is not excluded to exhaust energy resources, and even to collapse the computer or the entire system. Here is a simple example: two ships have to go to the storm shelter harbour to escape from the hurricane. The system calculates the best options and it turns out that both ships should go to the same nearest port, but there is free space only for one there. The information background in the system for both ships is equal and how the computer can make the choice? When a human could take the power to make decisions at this point, he or she will make a decision, either intuitively, as stated above, or by applying purely psychological and social qualities that the computer will not have anyway.

It seems to the author that for a smart shipping global system, the optimal ship would be an intermediate variant of a fully manned and autonomous ship, the so-called semi-autonomy ship. There may be two possible options here.

The conditional name of the first option could be 3M (three masters) and it is the most suitable for use on deep-sea lines. Artificial intelligence, which connects ports and ships to one system, continuously collects a large amount of data, processes them with a quantum computer speed, and outputs according to algorithms optimal operation parameters for system in whole and for each single ship as well. Ship's crewmembers keep things under control and are ready and able to intervene if needed. Artificial intelligence also does not turn out to be intervening by crewmembers, but is always helping them with all its power.

For every single ship, this means that it should have at least three people on board throughout the voyage, who keep watch on board like usually, but will not interfere in the normal operation of the ship as an autonomous unit. At the same time, they are always aware of the situation and are able to assess the situation and the need for intervention. If such a need arises, for example in an emergency, they will take control of the ship. This means, among other things, that these people are excellent ICT specialists, at the same time well trained, and experienced seafarers (with the captains' qualifications). It is because "three masters".

For example, if the situation with the storm shelter port described above has arisen and the artificial intelligence is unable to decide, or it is necessary to avoid collision of two ships, violating the COLREG rules or even directing the ship to ground what the artificial intelligence algorithm does not provide in any case, masters on different vessels will communicate directly with each other and take decisions in a coordinated manner using, of course, the maximum help provided by artificial intelligence. The AI could, for example, quickly analyse all circumstances, offer grounding place with optimum conditions, quickly calculate the minimum dangerous end speed and even manage process of grounding but the final decision must remain to the master.

Otherwise, an artificial intelligence in which two or more contradictory commands begin to fight may eventually end up or overload the ship's energy system, causing it to turn off. Maybe, the only possible solution here that there is a person who at one point decides to ignore all the moments of logic and rationality and does it intuitively. Of course, artificial intelligence can spend a lot of energy and computational power on finding a "logical" solution that runs counter to human intuitive decisions, but is it always the best? It can be compared to the well-known (though rather fictional) situation in cosmology where you go through the wormhole, not using long time-space journeys.

Man thinks linearly, but maybe just in such moments such a "direct go" is essential? Sometimes with his linear thinking, man can be more effective in solving local problems than artificial intelligence with its complex mathematical solutions. If the system is very effective, even a small system error can bring the system to a standstill. System efficiency vs. human simplicity somewhere is a golden centre, as always.

The second option semi-autonomy is called MP (master-pilot) and it would be a part-time vessel crewing. This option would be better suited for shorter lines and feeder line services where the autonomous part of the journey goes along relatively safe shipping fairways with quite well predictable weather and vessel traffic conditions. Ship diversions from the programmed route are minimal (ideally not at all), and the ship sails as autonomous through this part. During this time, there are no crewmembers on board (indispensable condition is that artificial intelligence is fine and can handle). Upon arrival at the boundary of pilotage or high-risk traffic areas, a person who can be called master and pilot simultaneously, arrives on board and takes over the control over ship. It does not necessarily mean that he will immediately intervene in the process of navigating the ship, but he is ready to do it at any moment. The master-pilot will remain responsible for the ship throughout her stay in the port and will take part in the departure of the vessel from the port and pilotage area. This person must also have good ICT education and excellence knowledge, skills and experience in seafaring that means ship master level.

From the point of view of the ship-owner and the owners of the goods on board, the 3M concept has one undoubted advantage over fully autonomous and semi-autonomy (MP concept) ships, even over remote-controlled ships. This is the fact that throughout the voyage there are real persons on board who are responsible for the ship and the goods. These abovementioned three masters are responsible jointly and severally. Of course, many efforts has to be made to develop legal regulations that also take into account the responsibility of artificial intelligence or more correctly speaking the responsibility of the people who have developed the algorithms that manage the artificial intelligence or who operate it. Nevertheless, it should be much easier for 3M concept than for ship in full-autonomous passage, where it is still unclear what legal principles a ship operated by an artificial intelligence should follow.

On the other hand, the 3M concept also has a big deficiency for the ship owner. One of the greatest

advantages in case of an autonomous ship, where there is no one people on board during the whole voyage, that the equipment and systems of the ship may be greatly simplified. There is no longer a requirement for the obligatory living and working conditions for the crew and, that is even more importantly, the owners do not have to spend money on wages and maintenance of the crewmembers on-board. Thus, the autonomous ship's construction and operational costs may be significantly reduced. However, if even one (in this case three) people are on board all the time at sea, then all the systems that ensure the safety of human life and normal living conditions must be developed on the ship: the presence of fresh water and washing water, living cabins and their heating and ventilation systems, life-saving equipment, cooking facilities, etc. In summary, there is no big difference in such kind of costs depending on how many people on board - three or thirteen.

2.4 *Deviation in economic philosophy and social psychology*

Because the idea of smart shipping is global in nature and shipping is an integral part of the economy of the world, the author is forced to look at the economic paradigms and principles of functioning of today's society and even touch human nature. The author is trying to reconcile the principles of smart shipping and the market economy and must admit that it does not come out very well.

Almost 250 years ago, the Scottish scientist A. Smith came out with his economic theory in the book "An inquiry into the nature and causes of the wealth of nations", in which he postulates that the foundations of a modern liberal economy to this day. Smith found that the source of wealth is any effective work, and that the best incentive for a person to act is self-interest, i.e. the profit of a private entrepreneur is the basis of collective prosperity and well-being, in other words, human greed is good and a driving force. "The profits from the production must be reinvested in the expansion of production," said Smith; that is the well-known nowadays saying "money must make money". In order not to collapse, the market economy must constantly grow and be based on competition between market players. (McCreadie 2009)

Speaking of the feasibility of developing a global smart shipping system and its realism, it should be stated that its key word is "cooperation" rather than "competition". This in turn means that participants in the system should be tuned not only at earning personal profits, but be prepared even to give up some part of this in order to achieve though long-term but well targeted goals. For this, however, a broader vision is needed, the ability to strategically think not only about building up the plans of one's own company and even a changing a person's natural qualities. Unfortunately, the latter seems particularly unrealistic.

It is by no means certain that stakeholders (ship owners, port owners, merchants, buyers) will be all ready to join the smart shipping systems immediately. There are, of course, very innovative entrepreneurs,

but generally, they tend to be more conservative in their mass. In his article, M. Stopford gives examples of how long the revolutionary changes in shipping in recent centuries have taken. For example, the total transfer from sea-going sailing vessels to steamboats took over a hundred years, the final conquest of the world by containers over fifty. It was not that entrepreneurs did not understand the benefits of innovations, but rather that the revolutionary changes required a radical reorganization of the entire shipping industry. (Stopford 2015) In other words, in order for the innovations to work effectively, more or less everyone in the industry would have to embrace them. So what about smart shipping? In this case, the necessary changes need to be even more drastic and broader, meaning that the smart shipping revolution will be by nature the most total and comprehensive. However, the author dares to be in deeply doubt that a quick and painless transition is possible.

In recent decades, many scientists and experts have concluded that the mainstream economic model is unsustainable in long-term perspective, first due to its unstoppable wasteful nature and its destructive impact on the environment. A number of economists have also come up with other economic theories, but the modern economic system based on the continuous growth of the economy, chasing of personal benefits and ruthless competition, has not been influenced by them on a global scale. The point is that the economy is not so much the result of models developed in the offices of scientists, but of the collective consciousness that is the amount of what happens in everyone's head.

Shipping as a part of global economy is no exception. Today, a very large number of very different goods are transported by ships, for example, in the year 2017 there were ca 10,7 billion tons of cargo transported by ships (United...2018), a significant part of which is food products, both as raw materials and as finished product. At the same time, studies show that near 25% of the final product of the food industry never reaches the final consumer (Kummu et al 2012), but taking into account the losses at the consumption stage, a number of so-called waste foods rises to around 40% (Kuldna 2016). According to market economy laws, goods move where there is greater purchasing power, not where they are needed, but where they are already more than enough. As a result, a big part of them ends up on waste ground, getting there either directly from shops or from customers' homes.

The sad story is that if to apply smart shipping to an existing economic system, it amplifies not only positive but also negative effects of it. This means that smart ships will increasingly carry more and more goods with greater efficiency and lower costs, including, largely, the "waste ground" as the final destination. May it be instead the right goal to reduce the volumes of goods transported, while at the same time making their destination more efficient, ideally to lost nothing and providing that everything will be reach the right place at the right time? Thanks to technological developments, it is possible for the first time in human history, at least theoretically. When artificial intelligence that manage smart shipping will be able to obtain complete additional information from wholesalers and retailers, government agencies,

etc., up to the end consumers' home refrigerators (the Internet of Things), it can calculate at every moment what goods where to and how much should go. It is an ideal picture and requires the transformation of all the basic economic paradigms, the most difficult of which is not only to embrace the principles and beliefs of the business community, but also of the whole consumer society, which is of course quite hard to believe.

3 CONCLUSIONS

The author of this publication is convinced that the advent of digital shipping to the world's seas is inevitable as a troublesome and full of setbacks, this journey would not be. However, even a brief overview made in this article shows that there are a number of different risk factors and obstacles that make it difficult to do.

The author has placed the main threats described in the article in the rankings firstly by their probability and complexity, and secondly the severity of the consequences. The ranking came out like this:

- 1 Human factor
 - Unauthorized malicious intrusion into system (hacking);
 - The lack of readiness of entrepreneurs to contribute to the system;
 - The imperfection of the leading global economic model and human qualities;
- 2 Internal disturbances and faults in the system as a super complex system;
- 3 Effects of external factors (natural forces such as cosmic impacts).

The influence of external factors is placed in the last place, despite the fact that their consequences can be very serious. This has been done because the probability of these events is low.

To avoid mistakes that may be fatal to the system or parts of that, the effects and factors described in this article, and many others that were not reflected or mentioned quite briefly, certainly need serious further research and analysis.

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