

Ship-Cargo Interface: Concept of Optimization, Using Risk Assessment Methods and Network Data Exchanging Technologies

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ABSTRACT: The idea of the proposed concept is to optimize information exchange between ship managers and potential charterers. There are many attempts to create electronic system for facilitation of information exchange, but all of them are aimed to find solution in particular area: container or oil trade, collecting data on ships or some other Port State Control issues. Existing technical solutions in most cases are not taking into account possibility of data change, which may vary significantly during ship's trip. Moreover, there is no deep analysis of each proposed variant, which can take into account all variable factors. Also – there is no complex solution, applicable to any ship / any cargo. Proposed concept describes the system of electronic data exchange, which assists in decision-making and based on risk assessment of changing scenario in the process of choosing the best solution for fixing the ship.

1 INTRODUCTION

Growing cargo flow all over the world leads to some difficulties, connected to the time of cargo handling, waiting for cargo and some other unexpected delays, like weather conditions or acts of piracy or any other unpredicted delay. Any delay can cause critical problems in the logistic chain, which will lead to financial loss. There are many ideas and procedures, designed for the prevention of such situations, however, they are mainly serve the purpose of reacting for the problem appeared. Moreover, existing methods of information exchange and communication, sometimes, are not guarantee proper level of decision making and delay with taking decision. Another matter – very often the decision is not discussed with all parties of transport process, every stakeholder plays his own game.

There are many negative factors, which affect transport process: unexpected weather changes,

political and war factors, unpredictable situations, ships' traffic, and many others. Among mentioned, we can predict just weather changes, but even this could not be done very accurately, moreover, sometimes, they are not taken into account, not having scientific background.

So, the task of optimization of transport process include at least communication between main stakeholders – ship and cargo owners, per example. Such communication to be fulfilled in the real time mode with constant prognosis of the future development of the situation.

Nowadays we have some projects, aimed to find the solution for better cooperation and coordination between stakeholders: "Pronto" system, testing now in the port of Rotterdam, allows to trace the situation in the real time mode. According to the information from designers, this system uses public data, distributed by port and ship, data of AIS system, and, also – prognosis of artificial intellect systems. The

specific of this system is an attempt to unify standards of development of such systems (in particular – standards of draft, fairways, and other similar standards, developed by International Harbourmasters Association). This gives the great opportunities, however, “Pronto” does not operate cargo data [4].

Actually, the idea of automation of cargo transportation process is not new: fertilizers’ transporting optimization system was developed in Australia in 1999. This project is still interesting because the designers took into account not only accurate planning of the ships’ schedules, but financial aspects as well: the cost of the cargo and freight of the ship. They considered data on presence of empty space in the warehouses, presence of the cargo and presence of the proper tonnage in the market. Proposed programme gave an opportunity to pay attention to the prognosis of fertilisers’ cost (which is variable in Australia, depending on the season, weather forecast, and many other factors) and to the freight prognosis. Finally, the developed programme allowed Customers to optimize ships’ schedules on yearly basis, but also to minimize freight rates [2].

Container optimization systems are also have wide application. They usually take into account financial aspects of particular container line. Such systems can arrange optimal ports’ rotation (taking into account presence of loaded and empty containers in each port, distance between ports, bunkering facilities in the ports, presence of bunker on board of each particular ship, and many other factors). They also can calculate optimal bay plan, ship’s stability, and many other details [3]. As disadvantage of such systems, could be mentioned narrow targeting in the frames of particular “container” tasks.

Naturally, tanker fleet was also in need of the similar optimization system. Proposed programmes give the opportunity for preparing ship’s call in advance. Financial aspects, connected to laytime, freight price and it’s changes, are taken into account [5]. Again, the main disadvantage of such systems is concentration on the particular problems of tanker fleet, which are very important, but very specific, which not allow to expand positive experience for the dry fleet as well.

Moreover, the whole port digitalization does not look fantastic nowadays. We know the project of Hexagon Company on implementing multifunctional digital technologies in the port of Lisboa. This is not only optimization of paperwork (which might be considered quite simple in our time), but systems of analysing the situation in the real time mode and visualization of the most important processes, which allows to many stakeholders to take their decisions at the same time, avoiding delay [7].

The other example – the product, proposed by Kazakhstan Company “KTZ Express”. They can operate not only digital documents, but scanned copies as well (including Cargo Manifests and Bills of Lading). Moreover, this Company implements blockchain technologies in the frames of Transcaspien way, which allows to make all paperwork in the electronic format [1].

It is also necessary to mention one of the most useful platforms for ship Owners and Charterers: “Shipnext”. This system allows to the participants to find the best solution, most suitable for the particular ship and particular cargo, taking into account many factors, including specific of fleet and specific of cargoes. Tracking of cargo is also available in the system, same as producing of electronic Bill of Lading, as well as wide database of ships and ports. Close integration with financial institutions and other service providers gives the possibility to make the next step – integrated system, based on block-chain technologies [6].

There are also some programmes existing, which allow automatic search of cargoes and available tonnage for these cargoes. However, all mentioned systems do not have an opportunity to predict the development of the situation. Moreover, sometimes the decision taking process becomes even more difficult because of data overload. They facilitate work and mutual cooperation of the stakeholders, however there is always room for improvement.

2 SHIP’S OWNER – CHARTERER RELATIONS

Probably while transporting goods by sea, the main relations, affecting all other aspects, are relations between “Ship”, means “Ship Owner” and “Cargo”, means “Cargo Owner” or “Charterer”.

We can consider as a “Ship’s Owner” not only the owner of the ship himself, but all persons, acting on behalf of him: Master of the ship, Ship’s operator/manager, agent and many other persons, acting on behalf of the owner, and who are in need of updated information.

If we are talking about “Cargo Owners” (“Charterers”), we can consider also charterer’s agents, or any other persons, acting on behalf of cargo owners.

Let us look how we can assist in the cooperation and relations of “Ship” and “Cargo” parts of the sea transport process at least on the first stage of their relations – cargo search. There are several players at this stage: Ship Owners, Charterers, Brokers, Insurance Companies and some other minor players (which we will not take into consideration at this moment, because the principle of their collaboration with the system is the same).

Imagine, we have several Ship Owners (see figure 1) – Owner 1, Owner 2 and Owner 3. Every of these Companies has several ships, some of them will be open for charter soon. The ship are various by types, size, age and other particulars.

On the other hand, there are several Chartering Companies – Charterer 1, Charterer 2 and Charterer 3. Each of them needs to transport the cargo of various nature, quality and quantity.

We have also several Brokers as the mediators – Broker 1, Broker 2 and Broker 3. The task of the Broker is to find the optimal variant ship/cargo, which will be the most efficient from economical point of view, keeping in mind also safety aspects of course.

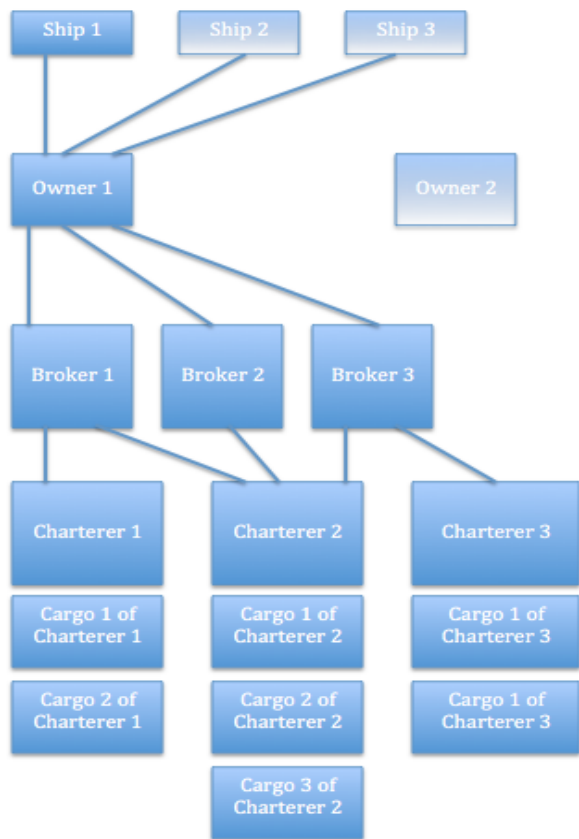


Figure 1 Example of connections while searching the cargo

We have created this diagram as a simple example of possible connections between stakeholders. In reality they are much more sophisticated, to achieve a good result necessary to analyse all possible variants. Let us look through the process of searching cargo for just one ship by one owner, which have 3 brokers. These 3 brokers are in contact with 3 Charterers (Charterer 2 is in contact with all 3 brokers on various conditions).

Usually, the process of the cargo/ship search begins from the mutual evaluation of Brokers and Charterers on one side and Brokers and Owners – on another side. Naturally, for the most of the Companies, which are long time in the market, and knows the abilities of potential stakeholders, this is not necessary, because of long time connections, proved quality of service and long term contracts (however, it is not always true). If we assume that we have companies, which are completely unknown to each other (it is quite often situation), thus we have to use risk assessment methods for making decision making process more grounded. It seems this will be better for all stakeholders.

So, we have for the each segment of this scheme some certain set of parameters, which should be assessed from the potential risk point of view:

For the Ship Owner: how long the Company operates the ships, presence of Safety Management System, number of ships, their types, flags, trading area, specific of construction (availability of cranes per example), positive Port State Control history and many other factors.

For the Charterer: how long the Company is on the market, history of fixes, cargoes in possession of the Company, usual ports of loading and discharging,

size of the Company, proposed freight rate and others.

For Broker: experience, number of fixings per year, cargoes and ships, normally operated by this broker, announced broker's commission, and is this broker works on ship's or cargo side.

For insurance Company: work experience, if the Company P&I Club member, main Clients, if they had insurance cases, insurance payments and level of insurance coverage, cargoes and fleet, usual for the particular company.

Let us make risk assessment on behalf of Ship first. It is clear, the decision of choosing cargo is to be taken by Ship Owner, but the specific of the particular ship to be taken into account before taking a decision (such as, per example, if Chief Officer does not hold the Polar Waters Certificate – if the cargo bounded for polar area).

2.1 Data involved on Ship's (Ship Owner's) side while searching cargo

Basic data: ship's type; size of the ship (deadweight and cargo capacity); speed; date/place when the ship will be available for new employment; present position; list of cargo, allowed for transporting by the ship; specific of construction; trading area; any existing limitations on construction, trading area, crew complement and/or qualification; other important data.

Data to be analysed with the help of risk assessment system are mainly connected to the evaluation of level of trust to every of available freight brokers: how long this particular broker operates in the chartering market; reputation; number of fixes for the last year; if any problematic fixes happened; if the broker operates on ship or cargo side; how long this broker cooperates with particular Charterer, which propose cargo; Broker's commission; if the freight proposal has the signs of circular from the market.

At this stage it is possible to adjust the system in the following way: to commence the next stage after choosing the best broker only. But in the real conditions of the real market, it seems not feasible, thus seems better to make general risk assessment, taking into account all data available, as following:

- level of trust to Charterers, which have cargo proposals: how long time this particular Charterer operates in the market; size of the company; core business; last fixes' information; if non-payment of freight ever happened; usual cargoes; ports of loading and ports of destination.
- information about the cargo itself: proposed freight level; cargo, quantity of cargo, specific of cargo (like specific of cargo operations, transporting, etc.); cost of cargo; specific of the ship for the particular cargo (for example availability of cranes, size of cargo holds and hatches, etc.); proposed Charter Party; proposed freight payment conditions; dates of cargo readiness; place of cargo storage; name of the port of loading, specific of the port of loading, cargo handling rates; name of the port of discharging, specific of the port of discharging, cargo handling rates; notice of

- readiness tendering conditions; dispatch/demurrage conditions.
- other information, concerning proposed charter: necessity to refill ship's store during voyage planned; if it is necessary to pass canals; navigational safety aspects and hazards on the route; usual weather condition on the route; weather forecast for the dates of the voyage; possible delays on the route and in the ports of loading/discharging; length of the route; possibility to find next employment for the ship after fulfilling proposed voyage; if proposed charter (route and/or cargo) could affect next employment of the ship; necessity of the crew change during voyage; cargo insurance conditions.

Owner can take the decision on choosing proper charter variant.

Proposed algorithm will work if it will be applied to all proposals – not only circulars from the market, but to analysis of proposals of existing trustful partners. This will allow to avoid any mistakes and to choose really best proposal.

On the other side, broker and charterer might not have exclusive long-term agreements with each other, so the same cargo could be proposed by various brokers. In order to avoid mistakes in such situation, it is necessary to make separate analysis and risk assessment for each proposal (all the chain must be analysed: broker- charterer-cargo). The same could be recommended for the situation when different charterers propose similar cargo of almost similar quality and quantity.

The remark to be made here: in most cases broker does not disclose the name of the charterer, when making proposal, thus we have to evaluate broker more carefully. Evaluation of charterer to be done on the stage of fixation in this case (but this does not mean it is not necessary to evaluate charterer at all!)

Following forms could be proposed for the risk assessment of main factors (Owner's point of view). Of course, each form to be developed according to particular company's standards, needs and experience.

In case of absence of information on problematic fixings in the both tables above, some average level might be accepted (5 per example). If there is information about more than 10 problematic fixings – it seems better not to cooperate with such company at all.

2.2 Risk assessment

From the commercial point of view risk is economical category, therefore it is logical to provide most of data in monetary form (wherever it is possible) – this will simplify analysis and decision making process. However, there are many factors, which are difficult for monetary assessment. Sometimes it is really impossible. Such factors recommended providing in digital form (10 points scale). It is clear, that some factors hard to put in digital format too (like core business of the company, per example). In such situation the best solution is to take into account the importance of every particular parameter and to make correction after some time (on obtaining some experience). It is necessary to keep in mind that every parameter (from mentioned above) affects the final financial result, even if it is indirect influence. Basing on the results of the analysis (risk assessment), the

Table 1. Risk assessment of the broker

Coefficient of importance	Parameter	Min evaluation (0)	Max evaluation (10)	Financial evaluation
50-1	Lifetime	New company	100 years	
50-2	Reputation	Bad or no info	Very good	
50-3	Time of cooperation with "Ship"	No	10 years	
50-4	Fixings	No	100 fixings	
50-5	Problematic fixings	10	No	
50-6	Time of cooperation with Charterer	No	10 years	
50-7	Broker acts onside of	Ship	Cargo	
50-8	Operates by cargoes	Unusual for "Ship"	Usual for "Ship"	
50-9	Is the proposal circular from the market?	Yes	No	
...
50-n	Commission			Amount

Table 2. Risk assessment of the Charterer

Coefficient of importance	Parameter	Min evaluation (0)	Max evaluation (10)	Financial evaluation
50-1	Lifetime	New company	100 years	
50-2	Reputation	Bad or no info	Very good	
50-3	Size of the Company	Small	Very large	
50-4	Proposed cargo	Unusual for this Company	Usual for this Company	
50-5	Time of cooperation with "Ship"	No	10 years	
50-6	Fixings	No	100 fixings	
50-7	Problematic fixings	10	No	
50-8	Unpaid freight	Several cases	No	
50-9	Time of cooperation with Broker	No	10 years	
50-10	Operates with cargoes	Unusual for "Ship"	Usual for "Ship"	
50-11	Is the proposal circular from the market?	Yes	No	
...
50-n	Freight			Amount

Table 3. Risk assessment of the Cargo

Coefficient of importance	Parameter	Min evaluation (0)	Max evaluation (10)	Financial evaluation
50-1	Freight			Amount
50-2	Cargo specific	Very sophisticated transporting	Very simple transporting	
50-3	Cost	Very expensive	Very cheap	Amount
50-4	Is additional equipment necessary	Yes	No	
50-5	Charter	Non-Standard	Standard	Calculation of time of
50-6	Charter conditions	Many difficult	No difficult conditions	
50-7	Readiness of cargo	Long waiting time	Cargo is ready	
50-8	Location of cargo	Far from ship's place	At the ship's place	Calculation of expenses for additional trip
50-9	Rate of cargo handling	Slow handling	Fast handling	Calculation of time of waiting when the cargo operations idling
50-10	NOR conditions	Tough conditions	Usual conditions	Calculation of expenses if conditions would not met
...
50-n	Dispatch/Demurrage	Tough conditions	Usual conditions	Calculation of expenses if conditions would not met

Table 4. Other information – risk assessment

Coefficient of importance	Parameter	Min evaluation (0)	Max evaluation (10)	Financial evaluation
50-1	Stores refilling	Necessary	Not necessary	Calculation of expenses for additional port call
50-2	Passing canals			Calculation of cost
50-3	Navigation on the route	Many hazards	No hazards	Calculation of expenses in case of navigational accident with probability calculation
50-4	Traffic on the route	Tough	Small traffic	Calculation of expenses in case of collision with probability calculation
50-5	Risk of pirate attack	Big	No risk	Calculation of expenses in case of attack with probability calculation
50-6	Military operations	High probability	Low probability	Calculation of expenses in case of attack with probability calculation
50-7	Usual weather on the route fixings	Very bad	Good	Calculation of expenses in case of storm with probability calculation
50-8	Weather forecast for the dates of voyage	Very bad	Good	Calculation of expenses in case of storm and expenses for deviation from route
50-9	Other delays on the route	High probability	Low probability	Calculation of expenses in case of delay with probability calculation
50-10	Delays in the ports (inspections, etc.)	High probability	Low probability	Calculation of expenses in case of attack with probability calculation
50-11	Length of the route	Very long	Short	Calculation of expenses for fuel, etc.
50-12	Possibility of the next fix in the port of discharging	Low probability	High probability	Calculation of probability of the next fix
50-13	Is it necessary to prepare the ship for cargo	Yes, a lot of work	No	Calculation of expenses for ship's preparation
50-14	Crew change	Necessary	Not necessary	Calculation of expenses for crew change
...
50-n	Insurance conditions	Not so good	Good	Calculation of expenses, taking into account possible additional insurance

To achieve better results of the risk assessment, we need to assign priority to each parameter. For this purpose, we have to rate them in the sequence of decreasing priority, means the most important parameters to be the first. It is clear that very company will choose own sequence of priorities: for one company main priority could be the freight rate, for other – long term contract with famous and reputable company. We've chosen 50 minus sequence number of the parameter as a coefficient of importance of the parameter. Of course 50 is not compulsory, it is

chosen assuming that total number of such parameters will not be more than 50 in any case. Usually, it is less, than 50, but we have to have some spare numbers for the situation, if new parameters will appear. Moreover, such approach will give an opportunity to the user to make some "break" between parameters (for example, in Table 1 time of cooperation with the "Ship" might be much more important for the Owner, than next parameter (number of fixings in our case), thus Owner can assign coefficient 50-3=47 for the time

of cooperation and 50-6=44 – for the number of fixings, thus coefficients 46 and 45 would be absent).

From time to time Owner can change mentioned coefficients, basing on the experience and particular policy of the Company, it's strategy and tactical tasks. Such changes to be reflected in calculations.

When all lines of the tables above will be filled in, the simple sum of the data to be calculated (monetary figures to be calculated separately, of course). Finally, the bigger result we would have, the better variant we choose. This task could be fulfilled manually, when we have just one ship, and just one or two cargoes proposed. But even in this case, we have quite big number of variable data – like different possible routes, different bunkering places, changeable weather conditions, etc. So, even for very simple task better to use special programme. We are not talking about analysing of all possible variants and combinations, which might appear (See Figure 1 – it is not most difficult situation, which could be).

Methods of the risk assessment are not simple, they are variable and definitely would be different not only for the each factor (Broker, Charterer, Cargo, Other factors), but for the particular parameters. For some of them (like number of problematic fixings or risk of pirate attack) statistic analysis is applicable; for others – might work just expert assessment (for example – reputation of the company). In some cases Markov chain or Monte Carlo method application will be suggested. Moreover, some of the parameters allow several methods (statistic and expert assessment) – it is on decision of particular Ship Owner to decide which method to choose.

Another problem – possible correlation of the parameters, which will require building up scenario tree and detailed analysis of each possible way of situation development, including extraordinary situations.

All various methods require various mathematic approach, which will give us quite sophisticated model, description of which is out of the frames of the present article.

3 CONCLUSIONS

Our idea is to handle the task of cargo search, using risk assessment, with artificial intellect systems, which could be trained before on big number of typical situations, proposing to the Owner the best solution. Moreover, current abilities of IT technologies allow automatic transmission of weather data (per example) to the system with automatic calculation of

probability of storms and possible damage. Also – programme allows calculating several variants of future job (various routs per example), proposing to Owner's decision maker all possible variants of the situation development for all proposals. Of course, the decision to agree or not (or which proposal to choose) still remains on human – the final decision could be not optimal from the financial point of view or from the point of view of formal logic: nowadays manager should have the opportunity to take risky decisions with the aim to achieve long term (or postponed) profit. Therefore programme has to show to manager all calculation results, including negative. Other task to be fulfilled – to remind to the manager all similar decisions, their logic and their results. This will allow learning on mistakes.

It is clear, that for the optimization of cargo search, it is necessary to analyse the future agreement on cargo carriage from both sides – from the side of the "Ship" (as we did above), but also from the side of "Cargo". This algorithm will be different a bit from the previous one (different data, first of all). But the result will be the optimal correlation of the ships and cargoes for them, taking into account economical factors for the all participants of sea transporting process.

Implementation of proposed concept will allow fixing the ships in the real time mode with optimal results.

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