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CONTRIBUTION TO THE DEVELOPMENT OF THE MODEL OF MANAGING REAMBULATION IN PORTS

ABSTRACT

Maritime safety information[1] are also presented in the information content of marine charts and navigational publications. From the navigation safety point it is important that during navigation ships are aware of all maritime safety information important for navigation in ports they are intending to use. Information content of marine charts and navigational publications show the real situation. The real situation is partially dynamic and changing. In order to monitor the changes hydrographic organizations collect data about them. The data are collected by hydrographic survey[2] and by reambulation[3].

Ports are classified in a special category of hydrographic survey[4]. Therefore, applying new methods and technologies in the development of the system of managing reambulation in ports is proposed. In order to develop such a system further analysis is made of:

- *data to be collected,*
- *necessary technical and technological equipment, and*
- *planned activities of hydrographic organisations.*

KEY WORDS

ports, information, reambulation

1. DATA TO BE COLLECTED

The data to be collected in reambulation refer to short term, long term and static data which are shown as information content of sea charts and navigational publications. The influence of short term data as updating data to accuracy is the greatest because of the frequency of their change. The updating data obtained in reambulation are numerous and varied. Each item of information content of sea charts and navigational publications is not equally important for the safety of navigation. Therefore, during reambulation, it is necessary to determine navigational significance (K_n) of an item or a group of data. The criteria for determining navigational significance for the safety of navigation and the procedure of reambulation are:

- the type of reambulation applied to th area whose data are examined,
- the properties of an item or a group of data referring to the safety of navigation, and
- depths.

The first criterion refers to the categories of reambulation. They are used to determine the significance of an item or a group of data of the entire area.

The second criterion refers to more accurate determining of the significance of the properties of an item or a group of data of the researched area relating to the safety of navigation.

The third exceptionally important criterion is the depth, which, as in the hydrographic survey, refers to depths over and under 100m.

In order to distinguish the values of navigational significance of the data, which is important in making decisions during reambulation, it is necessary to establish the range of values of navigational significance as follows:

- unimportant (1),
- less important (2),
- important (3),
- medium important 4),
- very important (5) and
- extremely important (6).

Grade unimportant (1) is given to the areas of special, first, second and third category of reambulation, when the properties of the data are not vital for the

safety of navigation or when they are out of all categories of reambulation.

Grade less important (2) is given to the areas of the third category of reambulation when the properties of the data are vital for the safety of navigation and when the depths are over 100 m.

Grade important (3) is given to the areas of the third category of reambulation when the properties of the data are vital for the safety of navigation and when the depths are under 100 m.

Grade medium important (4) is given to the areas of the second category of reambulation when the properties of the data are vital for the safety of navigation and when the depths are over 100 m.

Grade very important (5) is given to the areas of the second category of reambulation when the properties of the data are vital for the safety of navigation and when the depths are under 100 m.

Grade extremely important (6) is given to the areas of the first category of reambulation or to special areas when the properties of the data are vital for the safety of navigation.

For easy reference of algorithm of determining navigational significance of an entity (Fig. 1), instead of the term properties of the data the term properties of the entity is used. Each entity of a sea chart and/or navigational publication is determined by one or more data, like: position, depth, height and other properties of the sea, for which the term property of the entity is used. Reambulation confirms the changes in the state of the entity. Possible results of the change of the entity are the change of the state (P) to any extent or maintaining of the same (known) state (S). It cannot be known if there were any changes and to what extent. Sea charts and navigational publications have their lifetime. It can be assumed that over time the possibility of change of entity grows. Therefore it is necessary to determine numerically the effect of time on the possibility of changes.

This is determined by defining the possibility of the change of the state of entity (V_p). It equals the product of multiplication of the navigational significance (K_n) and the age of the last data (t). This is the time which passed from the day (or year) of a hydrographic survey or reambulation to the day (or year) of the planned reambulation.

$$V_p = K_n \cdot t \qquad (1.1.)$$

It is obvious that the possibility of change of the state of an entity is greater with longer time from the last data (hydrographic survey or reambulation).

Thus, the possibility of change of the state of entity becomes the probability of the change shown as the linear function of time:

$$P_i(t) = \{f(K_n, t), K_n = 1...6,\ t \geq 0...n\} \qquad (1.2.)$$

In other words, determining of the possibility of the change of the state of entity is also influenced by the type of data which refer to the entity. Thus, the possibility of change is greater at short-term data, and smaller at static data. Since during reambulation mostly short-term data are collected, the effect of the type of data need not be calculated. In case of application of navigational significance (K_n) and the possibility of change of the state of the entity (V_p) in the processes of hydrographic organizations referring to hydrographic survey, it is necessary to take into consideration all the entities of information content of sea charts and navigational publications. Using the possibilities of change of the state of entity (V_p) priorities in hydrographic survey can be determined.

Information content of sea charts and navigational publications includes the data which are permanently or frequently checked, as well as the data which are not checked before a new hydrographic survey. The first category includes for instance, lights, signs of sea routes, instructions for navigation, various warnings, etc. The second category of data refers to coastline, and the depths, which, despite the changes, are not controlled frequently enough. The possibility of change of the state of entity (V_p) is one of the tools or means in preparing or making decision in reambulation to which priority has to be given.

According to the proposed algorithm it may be concluded that ports are classified in the area of special reambulation category. The data about them, according to their importance, should be constantly verified.

2. EQUIPMENT

During reambulation the following equipment is needed:

- for positioning,
- for measuring depths, heights and distances,
- for other measurements, and
- for transportation.

Positioning is connected to all measurements in reambulation. In reambulation the accuracy of navigational systems for positioning is important: expected accuracy (the accuracy of measuring radio navigational system compared to the read value of the same geodesic date) and repetitive accuracy (the accuracy with which the user can refer to the previously measured position measured by the same system). The time of the control measuring is not known in advance. Availability of the system has to be as long as possible, preferably permanent. However, it is possible that satellite navigational systems are available, but some users do not dispose of the main element of the system. During reambulation the updating data in all maritime areas of navigation are collected. Thus, navigation system for reambulation should have world range. Reambulation is performed on site by a reambulator.

Navigational system has to satisfy the condition of work autonomy. The autonomy refers to power source, their capacity and the possibility to charge them. Transportability is also a condition set because

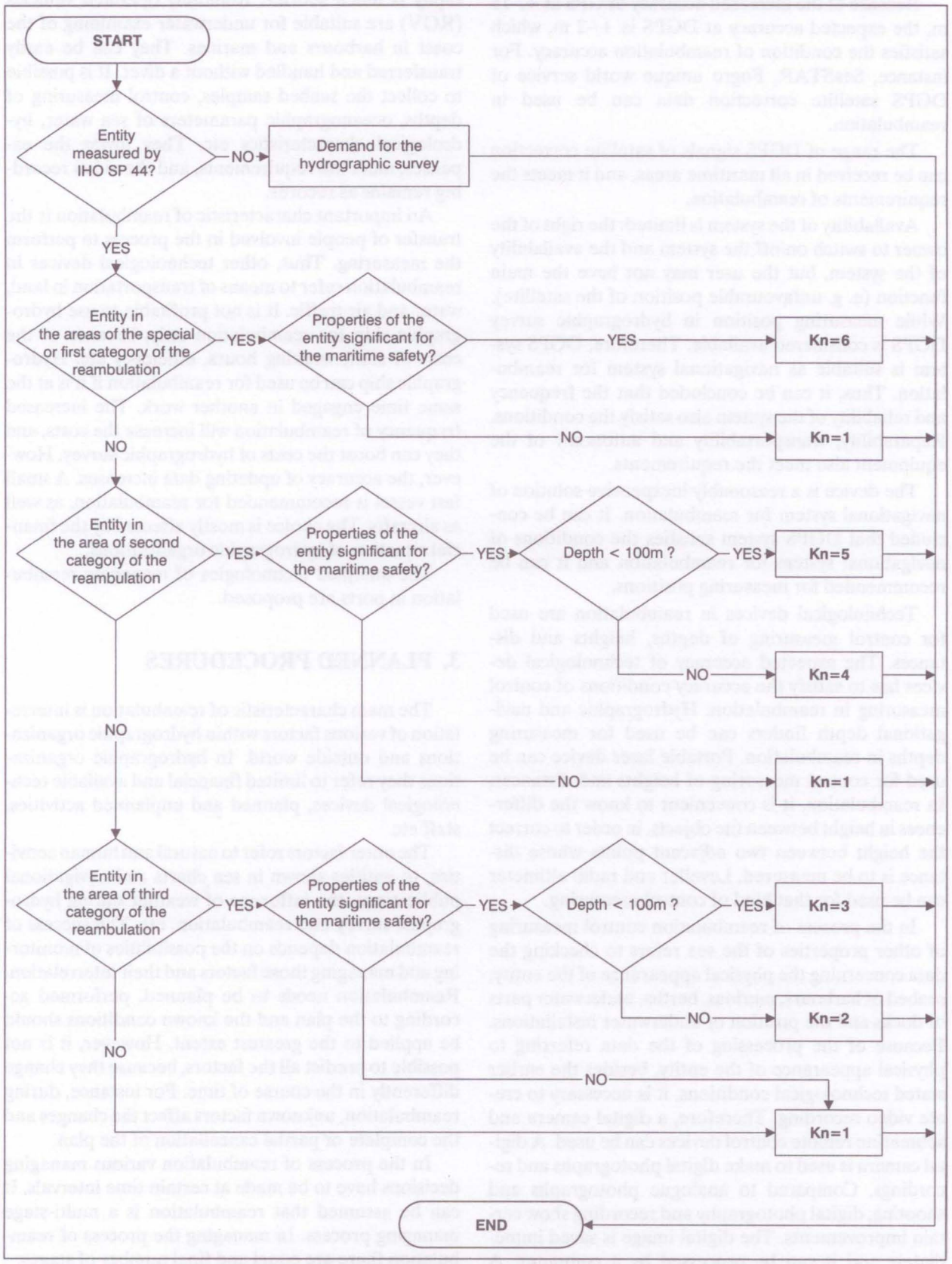

Figure 1 - Algorithm of determining navigational significance of an entity

of the site work. The instrument for reading the output values of navigational system has to be portable.

Because of the increased accuracy of GPS at +/-15 m, the expected accuracy at DGPS is +/-2 m, which satisfies the condition of reambulation accuracy. For instance, SeaSTAR, Fugro unique world service of DGPS satellite correction data can be used in reambulation.

The range of DGPS signals of satellite correction can be received in all maritime areas, and it meets the requirements of reambulation.

Availability of the system is limited: the right of the owner to switch on/off the system and the availability of the system, but the user may not have the main function (e. g. unfavourable position of the satellite). While measuring position in hydrographic survey DGPS is considered available. Therefore, DGPS system is suitable as navigational system for reambulation. Thus, it can be concluded that the frequency and reliability of the system also satisfy the conditions. Reparability, transportability and autonomy of the equipment also meet the requirements.

The device is a reasonably inexpensive solution of navigational system for reambulation. It can be concluded that DGPS system satisfies the conditions of navigational system for reambulation and it can be recommended for measuring positions.

Technological devices in reambulation are used for control measuring of depths, heights and distances. The expected accuracy of technological devices has to satisfy the accuracy conditions of control measuring in reambulation. Hydrographic and navigational depth finders can be used for measuring depths in reambulation. Portable laser device can be used for control measuring of heights and distances. In reambulation, it is convenient to know the differences in height between the objects, in order to correct the height between two adjacent points whose distance is to be measured. Leveller and radio altimeter can be used for that kind of control measuring.

In the process of reambulation control measuring of other properties of the sea refers to checking the data concerning the physical appearance of the entity, seabed of harbours, marinas, berths, underwater parts of docks and the position of underwater installations. Because of the processing of the data referring to physical appearance of the entity, besides the earlier stated technological conditions, it is necessary to create video recording. Therefore, a digital camera and submarine remote control devices can be used. A digital camera is used to make digital photographs and recordings. Compared to analogue photographs and shooting, digital photography and recording show certain improvements. The digital image is saved immediately and it can be processed by a computer. A reambulator can immediately see the results of their work, notice the errors and correct them. The time between the moment of shooting and a finished photography is much shorter. Remotely operated vehicles (ROV) are suitable for underwater examining of the coast in harbours and marinas. They can be easily transferred and handled without a diver. It is possible to collect the seabed samples, control measuring of depths, oceanographic parameters of sea water, hydrological characteristics etc. They lower the expenses, meet the requirements, and the video recording remains as records.

An important characteristic of reambulation is the transfer of people involved in the process to perform the measuring. Thus, other technological devices in reambulation refer to means of transportation in land, water and air traffic. It is not profitable to use hydrographic ship for reambulation only, because of the costs of staff, working hours, efficiency etc. Hydrographic ship can be used for reambulation if it is at the same time engaged in another work. The increased frequency of reambulation will increase the costs, and they can boost the costs of hydrographic survey. However, the accuracy of updating data increases. A small fast vessel is recommended for reambulation, as well as aircrafts. The choice is mostly affected by the financial situation of hydrographic organizations.

The analysed technologies of managing reambulation in ports are proposed.

3. PLANNED PROCEDURES

The main characteristic of reambulation is interrelation of various factors within hydrographic organizations and outside world. In hydrographic organizations they refer to limited financial and available technological devices, planned and unplanned activities, staff etc.

The outer factors refer to natural and human activities, to entities shown in sea charts and navigational publications, the influence of weather during hydrographic survey and reambulation, etc. The success of reambulation depends on the possibilities of monitoring and managing those factors and their interrelation. Reambulation needs to be planned, performed according to the plan and the known conditions should be applied to the greatest extent. However, it is not possible to predict all the factors, because they change differently in the course of time. For instance, during reambulation, unknown factors affect the changes and the complete or partial cancellation of the plan.

In the process of reambulation various managing decisions have to be made at certain time intervals. It can be assumed that reambulation is a multi-stage managing process. In managing the process of reambulation there are equal and final number of stages:

– starting (p_1),

- planning (p_2), and
- realization (p_3).

For easy reference, specially analyzed various and numerous values, and their changes which affect each stage of reambulation have not been presented (p_1, p_2 i p_3) in this paper to the *Hrvatski hidrografski institute-HHI* [1]. Reambulation can be presented as a function (R) which can change and depends on the stages shown in the model:

$$R = f(p_1, p_2, p_3) \quad (3.1.)$$

However, in the process of reambulation taken as a multi-stage managing process, not all the factors which affect planning and decision-making in various stages of reambulation can be completely identified and monitored. The process of decision-making is also affected by following limitation factors:

- current stage of applied technologies in regular processesf hydrographic organizations,
- comparatively low level of production and use of electronic sea chartsand navigational publications,
- comparatively high level of production and use of paper sea charts andnavigational publications, and
- the level of participation of persons in regular processes of hydrographic organizations.

In the model of managing reambulation in ports it is necessary to determine the continuous process of collecting maritime safety information. In this way the occupation of hydrographic organisations is selecting ports in which it is necessary to manage reambulation, monitoring the managing and maintaining the system.

4. CONCLUSION

It has to be concluded that no technology is so good that it could not be improved. Technology changes fast and it is not easy to estimate the real effects.

In developing the model of managing reambulation in ports it is necessary to apply the algorithm approach to the data to be collected. Also, the necessary technical and technological equipment in accordance with the proposed planning of activities of hydrographic organisations should be used.

It is estimated that the INTERNET is also useful, as it would facilitate the permanent and automatic reambulation in ports. [3].

Finally, it has to be pointed out that the reliability and accuracy of maritime safety data contained in sea charts and navigational publications are of immeasurable importance for the safety of navigation [4].

It is also estimated that the application of the proposed approach will support the development of the system of automatic reambulation in ports. It is expected that its application will increase the safety of navigation in ports.

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SAŽETAK

Pomorske sigurnosne informacije[1] se između ostalog prikazuju informacijskim sadržajem pomorskih karata i navigacijskih publikacija. Sa razine sigurnosti plovidbe drži se važnim brodovima u plovidbi u svakom trenutku poznavati pomorske sigurnosne informacije važne za navigaciju u lukama koje namjeravaju koristiti. Informacijskim sadržajem pomorskih karata i navigacijskih publikacija prikazuje se stvarnost. Stvarnost je dijelom dinamičke i promjenjive prirode. U cilju praćenja promjena hidrografske organizacije prikupljaju podatke o njima. Ti podaci se prikupljaju hidrografskom izmjerom[2] i reambulacijom[3].

Luke se svrstavaju u posebnu kategoriju hidrografskog premjera[4]. Stoga se i predlaže primjena novih metoda i tehnologija u razvoju sustava upravljanja reambulacijom u lukama. U cilju razvoja takvog sustava dalje se analiziraju:

- *podaci koje valja prikupljati,*
- *potrebna tehničko/tehnološka oprema i*
- *planirane djelatnosti hidrografskih organizacija.*

KLJUČNE RIJEČI

luke, informacije, reambulacija

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