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The role and applicability of multi-criteria procedures in the function of defining the model for connecting the mainland and islands and islands in between

Ante Mrvica[1], Alen Jugović[2], Mirjana Kovačić[2]

[1] Jadrolinija d.d., Gat Sv. Duje bb, 21000 Split, Croatia
[2] Faculty of Maritime Studies, University of Rijeka, Studentska ulica 2, 51000 Rijeka, Croatia, e-mail: ajugovic@pfri.hr

ABSTRACT

Passenger traffic in the Adriatic is mostly seasonal and takes place during the summer tourist season when the islands are appropriately connected to the mainland by a large number of lines of any ferry or fast ship. Since the islands are generally associated only with the narrow circle of close islands that are in the fairway, interinsular connection is insufficient. The rapid growth of maritime transport does not follow the ports and port infrastructure, and in this part certain difficulties appear. As this is a complex problem of choosing the type and size of vessels with more dominant criteria, a systematic approach to resolving this problem requires the application of methods of multi-criteria analysis. A method of analysis defines the objectives of this work, and based on the stated objectives, defined is the criteria relevant to the selection of the size and type of vessels in the maritime connection of the mainland and islands and between the islands in the Republic of Croatia (Croatia).

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1 Introduction

There are several methods for solving the above problem of choosing the right vessel for the purpose of connecting the mainland and islands and between the islands, from linear programming to modern methods [5] such as multi-criteria decision-making and more. There are many reasons for the growing interest in multi-criteria decision-making, from the knowledge that most of the problems are multi-criteria to the fact that many of the problems that are classically considered as single-criteria can be observed as, and are multi-criteria. Also an important reason for increased interest in multi-criteria decision-making is extraordinary development capabilities, speed, capacity and flexibility of computing machines.

The role and applicability of multi-criteria procedures in the function of defining the model of connecting the mainland and islands and between the islands has not been the subject of analysis. However multi-criteria analysis has been used by many authors [3] in order to select the best path, the appropriate carrier, the means of transport, location and more. The fact is that multi-criteria analysis provides significant help in the decision making process, [11, 12] which for the problem of the model for connecting the mainland and islands and between the islands with regard to the type of vessel is very complex. The complexity of the problem requires a comprehensive view of all conditions, from hydro-meteorological, technical and technological, accommodation and natural, ecological and economic (business efficiency, impact on the environment, investment in the purchase of modern ships with economically acceptable costs), and socio-cultural and more. With the given criteria, the technical and technological constraints of infrastructure for the vessel to maximize the safety of navigation should be considered in order to protect the lives of passengers and crew and their belongings.

2 Evaluation of current research

To date, a great number of analysis and research papers related to the maritime transport of passengers and vehicles have been published [7] along with individual studies for individual ports and harbours, but there are very few studies that would combine this matter. Each county, municipality, city or town made individual plans for certain navigable areas.

The research problem of connecting islands in the Republic of Croatia and given the importance of the same, it can be concluded that there are analyses, studies and partial studies which offer only partial solutions for individual ports, without taking into account other ports which are located in a particular navigation area.

Systematic research in order to define the criteria and selecting the size and type of vessels in maritime transport to connect the mainland and islands and between the islands by using some methods such as surveys, SWOT analysis, Promethee, Gaia, Electra, AHP have not been performed by now.

Analysis of relevant material in connection with maritime connectivity of the mainland and islands and between the islands in Croatia points to a small number of scientific papers. Out of the papers that deal with the maritime connection of the mainland and islands and between the islands in Croatia, the most prominent is the State program to connect islands with the mainland, the islands in between and navigation between the islands, published in 2006 by the Ministry of Sea, Tourism, Transport and Development. [6]

2 Defining criteria for the selection of the size and type of vessel

To maintain a regular service on a given sea route, it should be defined whether it is seasonal or whole-year navigation. To maintain the line of a classic passenger ship, Ro-Ro, combined catamaran or a passenger catamaran, other than to define the capacity of the ship, it is also important to choose the type of ship that will maintain a certain line. This may change the application of multi-criteria analysis [2] in a way that after analysing all the factors, the process of determining each criteria and sub-criteria is carried out in order to select the size and type of the vessel and to determine certain restrictions. Determining the type of ship depending on the relation of the journey is defined by the regulations on construction and the regulations on navigation on the waterway and the period of navigation which is defined by the Ministry of Sea, Transport and Infrastructure. The ship, depending on its size, structure, devices and equipment, and other technical requirements defined in the regulations and the performed technical supervision can navigate in areas of one of these categories of navigation: [10, 9] long navigation, long coastal navigation, small coastal navigation, coastal navigation of the Adriatic sea, national navigation, national coastal navigation, national coastal navigation, local navigation.

For classification purposes of passenger ships in domestic voyages, the following sea regions are determined [10, 9]:

– *Sea REGION B* – internal waters and territorial sea of the Republic of Croatian in which a passenger ship in national navigation cannot in any case distance itself more than 20m from the shore where people in danger at sea can be safely accessed during high tide level;
– *Sea REGION C* – internal waters and territorial sea of the Republic of Croatian in which a passenger ship in national navigation cannot in any case distance itself more than 15 meters from the place of refuge, nor more than 5 meters from the beach which people in danger at sea can securely access during the mid-tide and that meet additional requirements:
– *Sea REGION D* – internal waters and territorial sea in which the Croatian passenger ship in national navigation cannot in any case distance itself more than 6 M from the place of refuge, nor more than 3 m from the shore where people in danger at sea can securely access during the mid-tide which area meets additional requirements. In order to meet the requirements for navigation in the specified category, it is necessary to implement technical rules for the construction of passenger ships, and required are adequate equipment owned by the vessels for the specified category of navigation.

The following are important factors in selecting the size and type of ship: weather conditions, the size of the ship and the type of ship, the ship's power, frequency of the line and accommodation at the port on the island. In addition and almost as important are the alternative ports of call and adequate staff managing the ship, but the influence of market opportunities in selecting the size of the ship should not be ignored either. [1]

3 The criteria for selecting the size and type of vessel for the purpose of maritime connecting of the land and islands and between the islands in the Republic of Croatia

In addition to research factors in selecting the size and type of vessel for the purpose of maritime connecting of the mainland and islands and between the islands in Croatia, during 2012/2013 conducted was a comprehensive study of criteria for making a general model of selecting the size and type of vessel. [8]

In 2012 a targeted questionnaire was composed which included a larger number of experts of various fields related to the subject. Thematically, the questions were related to the specific problems of the maritime connecting of the mainland and islands and between the islands in Croatia, and were designed in a way that experts with their answers and suggestions provide relevant evaluations.

3.1 Contents, goals and research methods

The questionnaire was composed of general information and two questionnaires which could be thematically grouped in the following manner:

– Personal information
– Input parameters for multi-criteria analysis
– Evaluating individual criteria

– Evaluating groups of criteria.

The questionnaire was composed in the Croatian language, and interviewed were experts from Croatia and other European countries who have knowledge and experience related to the subject of research. The data collected by the questionnaire enabled the definition of the criteria and sub-criteria for the selection of the size and type of vessel for the purpose of the maritime connection of the mainland and islands and between the islands in the Republic of Croatia and the development of a general model using the selected methodology of multi-criteria analysis.

The content of research (Table 1) can be divided into themes:

- o input parameters for multi-criteria analysis – proposal of criteria and sub-criteria, grouped into five major groups for each type of ship as follows: classic passenger boat, catamaran, Ro-Ro ship, combined catamaran
- o Groups of criteria – a proposal of five groups of criteria for their evaluation and defining their weight.

Followed is a display of the implemented research.

Methods of research:

- o experts were contacted personally by telephone, email and mail
- o with the attempt of achieving cooperation with American and Spanish experts, there was no response regarding possible cooperation
- o while analysing the responses, it was noticed that a total of 15 responses arrived, or 33% of the total 45 included, 15 from Croatia
- o in gathering the date, only the method of self-filling out was used. The subjects filled out the questionnaire alone and by their own free will.

Time period for the implementation of the questionnaire was during the year 2013, and the sample covered 45 experts and solely experts who with their knowledge and experience and activities were connected with maritime transport and navigation.

3.2 Analysis of input parameters for multi-criteria analysis – criteria and sub-criteria

Previous experience in the evaluation of selecting the appropriate size and type of vessel justified the convenience of using the method of multi-criteria analysis since it allowed the evaluation of all aspects of the problem through different criteria. The problem of choosing the right vessel was presented in a way that it systematically analysed all the factors that were relevant to solving the problems of selecting the size and type of vessel for inter-insular connection. Factors analysed in such a way were grouped according to importance where the parameters were defined which could be identified as the criteria for selecting the size and type of vessel. The importance of each criteria on the basis of expert evaluation was defined by its weight, which is important of each individual criteria in the group factors.

Because of the complexity of research and lack of statistical data, the burden of data collection was on the researcher. [8] In the above study, experts were included for particular issues in order for the results of the research to be objective, acceptable and enforceable. Due to this, in the part of the research related to the evaluation of criteria and sub-criteria, 15 of the 45 invited experts participated. Taking into account the difficulty of engaging experts, the questionnaire is regarded as significant, despite the low turnout of experts. The experts were suggested criteria and sub-criteria were they were to consider and define the content of each criteria in the total amount (100%) and determine their individual value (weight) according to their own opinion for each type of vessel individually, passenger ship, Ro-Ro ship, catamaran passenger and catamaran combined. The procedure to input the evaluations included a few steps:

– **Step 1:** Each of the proposed criteria should have added to it the appropriate (percent) of weight value, the total sum must be 100% (%A + %B + %C + %D + %E =100%), or to suggest other criteria (Table 2). The

Table 1 Research parameters, subject profiles

Research parameters	
Goal of the research	Defining the criteria and sub-criteria relevant for the selection of the size and type of vessel for the purpose of the maritime connecting of the mainland and islands and between the islands in the Republic of Croatia, to evaluate the defined criteria, rank it by the importance of the proposed individual criteria, rank it by the importance of the proposed group of criteria and to propose other criteria or sub-criteria in accordance with personal judgement
Time period	2012./2013
Sample – scope	Experts from Croatia
Sample – size	45 subjects
Research instrument	Questionnaire composed in the Croatian language, doc version for sending by email and a version for personal filling out
Method self-filling out by the subjects	
Subject profiles	
Country of origin	Croatia – 15
Level of education	10 experts with university degree, the remaining with college degree

Source: Authors

value is to be determined according to the meaning of each criteria for the rational maritime connecting of the mainland and islands and between the islands in Croatia, in accordance with the purposes of research.

– **Step 2:** Each of the proposed sub-criteria should have added to it the appropriate weight value, where the total sum must correspond to the weight value of the leading criteria (example %A1 + %A2 = %A or %B1 + %B2 + %B3 = %B). The value was to be determined according to the meaning of each criteria for the rational maritime connection of the mainland and islands and between the islands in Croatia, in accordance with the purposes of research.

  In this case, experts were invited to suggest other criteria and approaches to their evaluation if they did not agree with the proposed sub-criteria.

– **Step 3:** For each of the identified sub-criteria it was necessary to determine the condition of the maximum or minimum. This means if the impact of sub-criteria of importance is maximum or minimum. For example, fuel costs are sub-criteria which have great importance and even when it comes to defining the maximum and minimum it must have a minimum condition, because the goal is to pass a certain distance while minimizing fuel consumption or with a ship that has lower fuel consumption.

The stated criteria as well as others that can be identified during the analysis represent the information basis that allows the decision-maker a choice among several solutions (Table 2). Such a set analytical system is an open type and it is possible to make basic changes and updates to the basic criteria relating to the choice of the size and type of vessel. The changes regard the possibility of changing the weight of criteria which defines the guidelines that belong to policy management, and give greater weight to those criteria that have greater importance in terms of the management of the interinsular connection as a system.

In addition, experts are invited to fill in the table in relation to the problem of rationalizing the maritime connection of the mainland and islands and between the islands in Croatia where five specific criteria are considered (attributes, characteristics) for their ranking and determining the weight by (Table 3): institutional, hydro-meteorological, technical and technological, economic and socio-cultural.

In order to determine the weight (importance) of the criteria, the experts have compared and ranked five chosen criteria with evaluations from 1 to 5. With that, evaluation 1 represents the highest rank, followed by evaluation 2 and so on, up to evaluation 5 which represents the lowest rank.

Table 2 Input parameters for multi-criteria analysis

Label	Criteria/sub-criteria	%	min/max
A	**Institutional (STCW, Solas)**	15	
A1	(5) Sailing on open sea more than 6 M all year	10	max
A2	(6) Sailing within sea waters in the season	5	max
B	**Hydro-meteorological**	30	
B1	Height of waves and wind speed	20	max
B2	Number of days line not working – Reliability of line maintenance	10	max
C	**Technical – technological**	20	
C1	Travelling speed (economic)	4	min
C2	Passenger capacity	4	min
C3	Vehicle capacity	3	min
C4	Passenger and vehicle capacity	5	min
C5	Draft of the ship	2	max
C6	Port infrastructure (Length of the operative coast, area for stationary vehicles)	2	min
D	**Economic**	25	
D1	Procurement price of ship (new or used)	6	max
D2	Fuel usage	5	max
D3	Price of ticket	3	min
D4	State support (subsidies)	4	max
D5	Time of navigation	3	min
D6	Length of navigation route	4	max
E	**Social-cultural**	10	
E1	Direct use	4	max
E2	Indirect use	2	max
E3	Sustainable development of the island	4	max
Total		100	

Source: Authors

Table 3 Input parameters for multi-criteria analysis

Group of the criteria	A	B	C	D	E
Evaluation (1 – 5)					

Source: Authors

For some criteria (or for all), the appropriate qualitative evaluations can be defined which are transferred to quantative values with the application of the appropriate linear scale, from 0-10, or with evaluations which are poor, medium and good. The criteria is characterized by two characteristics: [4]

– They can be type maximization or minimization
– Most frequently they are not of the same significance and usually they are given the appropriate weight coefficient.

The questionnaire required an expert evaluation of the importance of individual criteria from 0 to 100 and sub-criteria within specified criteria. It is important to note that the weight of the sub-criteria is global, or the sum of the weight of sub-criteria within the criteria gives a global weight to the criteria.

Also, already in the very process of expert evaluation, the weight of the criteria is normalized by the total possible sum (100), which to a large extent facilitated further analysis. Results of evaluations defined in this way are given in Tables 4, 5, 6, 7.

Table 4 Input evaluations of experts for passenger ships

Passenger ship criteria/sub-criteria	%	min/max	Experts														
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A. Institutional (STCW, SOLAS)	15		15	0	10	10	15	15	15	15	15	15	15	15	15	15	15
A1. Sailing on open seas more than 6 M all year	10	max	9	0	4	4	6	9	10	5	4	10	10	5	6	10	9
A2. Sailing within sea waters in the season	5	max	6	0	6	6	9	6	5	10	11	5	5	10	9	5	6
B. Hydro-meteorological	30		30	16	30	30	30	20	30	30	30	30	30	30	30	30	30
B1. Height of waves and wind speed	10	max	7	2	8	8	6	9	9	3	6	20	7	9	2	15	7
B2. Number of days line not working	10	max	14	1	2	2	14	2	1	2	2	7	3	1	10	10	14
B3. Reliability of line maintenance	10	max	9	13	20	20	10	9	20	25	22	3	20	20	18	5	9
C. Technical-technological	20		20	30	30	30	20	20	20	20	20	20	20	20	20	20	20
C1. Sailing speed (economic)	4	min	8	4	4	4	4	5	4	5	5	4	4	6	5	7	8
C2. Passenger capacity	5	min	6	10	10	10	5	7	10	10	9	7	10	10	9	9	6
C3. Vehicle capacity	4	min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C4. Draft of ship	5	max	2	8	8	8	2	6	4	3	5	5	4	1	5	2	2
C5. Port infrastructure (Length of operative coast, area for stationary vehicles	2	min	4	8	8	8	9	2	2	2	1	4	2	3	1	2	4
D. Economic	25		25	30	30	30	25	25	25	25	25	22	25	20	17	20	25
D1. Procurement price of ship (new or used)	6	max	6	5	5	5	6	6	5	7	5	5	5	5	5	6	6
D2. Fuel consumption	6	max	5	7	7	7	4	4	10	8	7	5	8	8	4	4	5
D3. Price of ticket	3	min	3	2	2	2	3	3	5	5	7	4	4	2	3	2	3
D4. State support (subsidies)	4	max	4	4	4	4	4	4	2	1	4	2	1	1	2	4	4
D5. Time of sailing	4	min	5	6	6	6	5	6	2	2	1	4	6	2	2	2	5
D6. Length of sailing route	2	max	2	6	6	6	3	2	1	2	1	2	1	2	1	2	2
E. Social-cultural	10		10	25	10	10	10	11	10	10	10	10	10	10	10	10	10
E1. Direct use	4	max	4	5	2	2	3	6	2	3	3	1	4	3	4	4	4
E2. Indirect use	2	max	2	5	3	3	2	2	2	2	2	1	2	1	3	2	2
E3. Sustainable island development	4	max	4	15	5	5	5	3	6	5	5	8	4	6	3	4	4

Source: Authors

Table 5 Input evaluations of experts for Ro-Ro ships

RO-RO ship criteria/sub-criteria	%	min/ max	Experts														
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
A. Institutional (STCW, SOLAS)	15		10	0	10	10	15	15	15	15	15	15	15	15	15	15	15
A1. Sailing on open seas more than 6 M all year	10	max	4	0	4	4	6	9	9	5	5	10	10	5	5	9	9
A2. Sailing within sea waters in the season	5	max	6	0	6	6	9	6	6	10	10	5	5	10	10	6	6
B. Hydro-meteorological	30		30	16	30	30	30	20	30	30	30	30	30	30	30	30	30
B1. Height of waves and wind speed	10	max	8	2	8	8	6	8	7	3	7	20	6	9	2	15	7
B2. Number of days line not working	10	max	2	1	2	2	14	3	3	2	3	7	4	1	10	10	14
B3. Reliability of line maintenance	10	max	20	13	20	20	10	9	20	25	20	3	20	20	18	5	9
C. Technical-technological	20		20	30	30	30	20	19	20	20	20	20	20	20	20	20	20
C1. Sailing speed (economic)	4	min	4	2	2	2	4	5	3	5	5	4	4	5	5	4	7
C2. Passenger capacity	5	min	4	6	6	6	5	6	8	8	8	5	6	7	3	6	4
C3. Vehicle capacity	4	min	3	6	6	6	5	5	3	3	3	3	3	3	4	5	3
C4. Draft of ship	5	max	6	8	8	8	2	1	4	3	2	6	4	3	5	2	2
C5. Port infrastructure (Length of operative coast, Area for stationary vehicles	2	min	3	8	8	8	4	2	2	1	2	2	3	2	3	3	4
D. Economic	25		30	30	30	29	25	25	25	25	25	22	25	20	20	20	25
D1. Procurement price of ship (new or used)	6	max	10	5	5	5	6	7	5	7	5	5	6	5	5	6	6
D2. Fuel consumption	6	max	10	7	7	7	4	4	10	8	7	5	8	8	5	4	5
D3. Price of ticket	3	min	5	5	5	5	3	2	5	5	6	4	2	2	4	2	3
D4. State support (subsidies)	4	max	2	5	5	5	4	4	2	1	5	2	1	1	3	4	4
D5. Time of sailing	4	min	2	4	4	4	5	6	2	1	1	4	7	1	2	2	5
D6. Length of sailing route	2	max	1	4	4	3	3	2	1	3	1	2	1	3	1	2	2
E. Social-cultural	10		10	25	10	10	10	10	10	10	10	8	13	10	10	10	10
E1. Direct use	4	max	2	5	2	2	2	6	3	3	1	2	3	3	4	5	4
E2. Indirect use	2	max	3	5	3	3	2	2	2	2	1	2	4	2	3	3	2
E3. Sustainable island development	4	max	5	15	5	5	6	2	5	5	8	4	6	5	3	2	4

Source: Authors

Table 6 Input evaluations for passenger catamaran

Passenger katamaran criteria/sub-criteria	%	min/ max	Experts														
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
A. Institutional (STCW, SOLAS)	15		10	0	10	10	15	15	15	15	15	13	15	15	15	15	15
A1. Sailing on open seas more than 6 M all year	10	max	3	0	3	3	5	8	7	7	6	8	6	6	5	7	8
A2. Sailing within sea waters in the season	5	max	7	0	7	7	10	7	8	8	9	5	9	9	10	8	7
B. Hydro-meteorological	30		30	30	30	30	30	30	30	30	30	20	30	20	30	30	30
B1. Height of waves and wind speed	10	max	5	7	5	5	5	10	9	2	5	5	8	4	7	15	4
B2. Number of days line not working	10	max	5	8	5	5	19	13	6	8	10	8	12	6	8	10	19
B3. Reliability of line maintenance	10	max	20	15	20	20	6	7	15	20	15	7	10	10	15	5	7
C. Technical-technological	20		20	25	20	20	20	20	20	20	20	20	18	20	20	20	20
C1. Sailing speed (economic)	4	min	9	13	9	9	6	8	10	7	9	5	8	10	9	10	9
C2. Passenger capacity	5	min	9	5	9	9	4	6	8	10	9	7	6	10	9	7	6
C3. Vehicle capacity	4	min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C4. Draft of ship	5	max	1	2	1	1	1	2	1	1	1	6	2	0	1	1	2
C5. Port infrastructure (Length of operative coast, Area for stationary vehicles	2	min	1	5	1	1	9	4	1	2	1	2	2	0	1	2	3
D. Economic	25		30	15	15	15	25	27	25	25	24	22	24	25	23	24	25
D1. Procurement price of ship (new or used)	6	max	10	2	2	2	6	6	7	4	5	5	5	5	6	5	6
D2. Fuel consumption	6	max	10	5	5	5	5	6	8	9	8	5	10	9	6	5	6
D3. Price of ticket	3	min	5	3	3	3	3	6	5	5	5	4	2	4	4	3	5
D4. State support (subsidies)	4	max	3	1	1	1	4	4	3	2	2	4	3	2	4	4	4
D5. Time of sailing	4	min	1	3	3	3	5	3	1	4	2	2	2	4	1	5	2
D6. Length of sailing route	2	max	1	1	1	1	2	2	1	1	2	2	2	1	2	2	2
E. Social-cultural	10		10	40	10	10	9	10	10	10	10	10	13	10	10	10	10
E1. Direct use	4	max	2	10	2	2	2	6	2	3	1	4	2	3	3	4	4
E2. Indirect use	2	max	3	10	3	3	2	2	2	2	1	2	4	1	3	2	2
E3. Sustainable island development	4	max	5	20	5	5	5	2	6	5	8	4	7	6	4	4	4

Source: Authors

Table 7 Input evaluations of experts for passenger catamaran

Combined catamaran criteria/sub-criteria	%	min/ max	Experts														
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
A. Institutional (STCW, SOLAS)	15		10	0	10	10	15	15	15	15	15	12	15	15	15	15	15
A1. Sailing on open seas More than 6 M all year	10	max	3	0	3	3	5	8	7	8	6	7	6	6	5	7	8
A2. Sailing within sea waters In the season	5	max	7	0	7	7	10	7	8	7	9	5	9	9	10	8	7
B. Hydro-meteorological	30		30	30	30	30	30	30	30	30	30	20	30	20	30	30	30
B1. Height of waves and wind speed	10	max	5	7	5	5	5	10	10	1	5	5	5	5	10	15	4
B2. Number of days line not working	10	max	5	8	5	5	19	13	10	9	10	7	15	5	10	7	19
B3. Reliability of line maintenance	10	max	20	15	20	20	6	7	10	20	15	8	10	10	10	8	7
C. Technical-technological	20		20	25	20	20	20	20	20	20	20	20	20	20	20	20	20
C1. Sailing speed (economic)	4	min	9	8	9	9	6	8	9	10	8	5	8	8	8	7	7
C2. Passenger capacity	5	min	4	5	4	4	4	5	6	6	8	6	6	3	8	5	6
C3. Vehicle capacity	4	min	3	3	3	3	4	3	2	1	2	4	1	3	1	4	4
C4. Draft of ship	5	max	1	2	1	1	1	1	2	1	1	2	2	4	1	1	1
C5. Port infrastructure (Length of operative coast, Area for stationary vehicles	2	min	3	7	3	3	5	3	1	2	1	3	3	2	2	3	2
D. Economic	25		30	25	25	25	25	25	25	25	25	22	25	25	26	25	27
D1. Procurement price of ship (new or used)	6	max	10	5	5	5	6	7	8	4	6	5	6	5	7	6	6
D2. Fuel consumption	6	max	10	5	5	5	5	6	8	9	8	5	10	9	7	5	6
D3. Price of ticket	3	min	5	5	5	5	3	3	4	5	5	4	2	4	4	3	5
D4. State support (subsidies)	4	max	3	1	1	1	4	4	3	2	2	4	3	2	5	4	4
D5. Time of sailing	4	min	1	5	5	5	5	3	1	3	2	2	2	3	1	5	4
D6. Length of sailing route	2	max	1	4	4	4	2	2	1	2	2	2	2	2	2	2	2
E. Social-cultural	10		10	20	10	10	10	9	10	10	10	6	13	10	10	10	10
E1. Direct use	4	max	2	7	2	2	2	6	3	3	1	2	3	3	2	5	4
E2. Indirect use	2	max	3	7	3	3	2	2	2	2	1	2	4	2	3	3	2
E3. Sustainable island development	4	max	5	6	5	5	6	1	5	5	8	2	6	5	5	2	4

Source: Authors

After examining the evaluation of experts, observed were differences in certain criteria which is understandable given the structure and career orientation of the experts.

The paper set the strategic goal of sustainable development of islands which implies a sub-objectives, selection criteria and alternative choices. The development of the general model of the study included five groups of criteria, namely: institutional, hydro-meteorological technical and technological, economic and socio-cultural. The most significant and highest-ranking criteria in the majority of experts were the hydro-meteorological criteria due to the conditions on a particular waterway as well as the annual period in which the navigation takes place. Other criteria, such as economic and technological were evaluated at approximate values. Results expectedly indicated that the appropriate choice of vessels is the combined catamaran or a passenger catamaran, which is in agreement with the demands that are put before this type of vessel.

4 Conclusion

The connection between the islands is still not functional and the organization of it does not meet the demand in Croatia for the local population nor other users. The current connection is mainly for speed boats or catamarans and to the islands which are located on the waterway which is held by individual lines. At the same time, one of the tasks of maritime passenger traffic is to maintain it continuously or to temporarily connect the islands with the mainland or between the islands. Good connection between the island and the mainland is the main feature for the survival of the population on the islands.

Determining the type of ship, depending on the route of the maritime journey, is challenging and complex. As this is a complex problem of selecting the type and size of vessels with more dominant criteria, the paper set the strategic goal of sustainable development of the islands. Data collected by the survey enabled the definition of the criteria and sub-criteria for the selection of the size and type of vessel for the purpose of a maritime connection between the mainland and islands and between the islands in the Republic of Croatia and the development of a general model using the selected methodology of multi-criteria analysis.

Examining the implementation of the model of selecting the size and type of vessels using the multi-criteria analysis is the subject of further research of the author.

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