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IAMU SECTION ARTICLE

Analysis of types of competences in MET of deck officers

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Abstract

Technological development on board ships creates new challenges for the crew. Developing trends on board ships (e.g. extending decision-making capabilities in various control units, increased number of different measuring sensors, extensive redundancy of critical systems on board) change the way processes on them are carried out. Consequently, the crew has to master new competences or upgrade the already existing ones. Therefore, some competences will probably become obsolete. In this paper, the authors draw attention to MET of deck officers. The main goal of the research that lasted for 2 years was to determine the presence of different types of competences in MET of deck officers. The process of gaining competences prescribed by IMO Model Courses 7.01 and 7.03, study programmes of Croatian higher MET institutions, non-formal education programmes, i.e. short courses on board LNG carriers and cruise ships were analysed in the paper. Research methods used in the paper were interview, questionnaire and document analysis. Interview and questionnaire were used for gathering data on short courses for LNG carriers and cruise ships. Document analysis was used when classifying competences gained through MET programmes based on only IMO Model Courses and the programmes that go beyond IMO Model Courses, i.e. short courses on board LNG carriers and cruise ships. Taking into consideration the results of the research, the authors have suggested the so-called process approach to interrelate the processes on board ships with required competences.

Keywords STCW · Higher MET institutions · Competences · Process approach

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1 Introduction

Technological development has a strong impact on maritime industry (Maritime 2050 2019). New, functional organization on board a ship has changed the role of the crew. Due to evolving technologies, the role of the crew is becoming extremely complex (Pourzanjani and Ali 2008). Besides, an increased digitalisation and automation on board and in maritime industry in general, require more advanced technical knowledge and expertise than in the past times (The Maritime Executive 2020). Therefore, a modification of competences needed for jobs on board is necessary (Cicek et al. 2019). In other words, technological development requires changes in MET (Oksavik et al. 2020). As pointed out by Rayner, "... competence is not forever. Changes in policy, procedures, regulations, technology and equipment, business goals and objectives, all mean that workplace performance standards need to be modified and updated. And new standards must be developed for new job functions that may arise from the changes" (Ryaner 2019).

There is a wide range of different definitions of competences in the analysed literature. Two approaches or definitions can be pointed out. The first approach according to which competences are a combination of knowledge, understanding and skills (Caena 2011) and the second one according to which competences are a combination of knowledge, skills and attitude (Wahba 2013). According to STCW Convention, competences consist of knowledge, understanding and proficiency.

Competences described in the STCW Convention refer mostly to ships that were commonly trading at the times the Convention's rules were adopted. At that time, the process of maintaining and upgrading the required competences was relatively simple, and was usually done by attending a few short courses or a specific on board training. In maritime industry, these programmes can be divided into the following categories: the ones prescribed by STCW Convention, and the ones required by shipping companies (Gundić et al. 2016). Nowadays however, in view of technological differences among various ship types and trades, competences are not easily transferrable, thus, attending short courses is not enough, especially for technologically advanced ships (e.g. LNG ships or cruise ships).

STCW Convention prescribes mostly professional competences. However, if we take into consideration that maritime industry has become extremely complex and global recently, we can conclude that professional competences are not enough for its proper functioning. Present-day crew should be able to work in a team, solve problems, analyse more information simultaneously, think critically, etc. (Oksavik et al. 2020). It is expected that leadership, ethics, human relations skills, multicultural/diversity awareness, teamwork, etc. (Michael et al. 2019) will have the key role in the process of globalisation and technological development on board a ship.

It is important to emphasize that the seafarers' trainings focus is on acquisition of hands-on practical skills. During the academic education, the emphasis is placed on the development of analytical and critical thinking skills (Manuel 2017). However, it is still unknown to what extent different types of competences are present in programmes of academic education and seafarers' training.

Therefore, we have tried to determine to what extent different types of competences are present in IMO Model Courses for deck officers, in study programmes and in short courses on board LNG carriers and cruise ships. IMO Model Courses 7.01—*Master*

and Chief Mate and 7.03—*Officer in Charge of Navigational Watch* were analysed in order to compare types of competences acquired at institutions whose programmes are based on minimum standards, and the institutions that go beyond standards. The analysis of a study programme for deck officers was made in order to determine to what extent the programme goes beyond minimum standards. Short courses, carried out at training centres which are the result of the shipping companies and maritime industry's demands, were analysed as well. Courses help the crew to acquire new competences and/or to upgrade the already existing ones needed on specific types of ships and/or their equipment. Courses' contents differ depending on the type of the ship, its cargo, and navigation through certain areas, ships' equipment and demands of a company. The basis of the analysis of the types of competences, shipping companies look for, were short courses for LNG carriers and cruise ships.

2 Literature review

Competences are usually defined as the ability to do something successfully or efficiently (Mulder 2014) or as a dynamic combination of knowledge, understanding and skills (Caena 2011; STCW Convention 2010). However, according to some authors, competences consist of not only knowledge, understanding and skills, but of attitudes as well (DeSeCo, O.E.C.D. 2005; Nanzhao 2005; Wahba 2013).

Traditional education places an emphasis on the process of acquiring knowledge, whereas, competence based education emphasises the process of acquiring competences (Gruppen et al. 2016). Competence-based educational programmes need to specify and explain in detail all the types of competences that should be acquired upon completion of a programme (Sánchez and Ruiz 2008).

The literature offers various classifications of competences. Some authors differ core and functional competences (OECD 2014); some differ functional, foundational and organizational competences (Guide for Writing Functional Competencies 2005); some differ generic and specific competences (Tuning educational structures in Europe 2010; Biesma et al. 2008). A classification of competences stated at Global Maritime Professional, Body of Knowledge from 2019 is important for maritime professions. It differs the following competences: foundational knowledge and skills, academic skills, professional-technical skills and professional-soft skills (Michael et al. 2019). It is of utmost importance to mention Skillsea project's classification of competences from 2020. According to its report, the goal is to map relevant skill needs and competences required in maritime industry (Zec et al. 2020). In the same report, competences are classified into transitional (generic) skills, professional skills, sector-specific skills and cross-sectoral skills. Similar classification can be noticed in the European Classification of Competences, Qualifications and Occupations, which differs transversal competences, cross-sectoral competences, sector-specific competences and occupation-specific competences (ESCO 2019). Taking into consideration all the abovementioned, the classification used in this research differs professional, generic and other competences (sector-specific, cross-sectoral).

In maritime industry, professional competences are prescribed in STCW Convention. Every institution involved in formal education of deck officers at management level, has to offer minimum standards prescribed by STCW Convention in their study

programmes. Competence standards that have to be met by seafarers are defined in STCW Convention; however, it is not unusual that most countries have gone well beyond them. IAMU Haiphong Statement from 2016, recommended that study programmes should offer educational outcomes that go beyond minimum standards prescribed by STCW Convention in order to prepare students, the future seafarers for rapidly changing industry (IAMU Haiphong Statement 2016).

In contrast to professional competences, the literature offers various terms, definitions and classifications of generic competences. Therefore, one can come across the following terms used for generic competences: basic competences, key competences, core competences, etc. Furthermore, the analysed literature also offers various definitions of generic competences, which very frequently depend on the scientific discipline they are defined in. Generic competences are defined as transferable, multipurpose knowledge, understanding and skills that an individual acquires and develops in different ways and in different situations (Fung et al. 2007). As a result of the employers' needs and expectations, and rapid development of technology, generic competences have become one of the major preconditions for the future employment (Australian Chamber of Commerce and Industry 2002). On the international market, the employers are searching for a highly competent employee whose generic competences are more important than the professional ones (Richens and McClain 2000). They are searching not only for the employees with highly developed professional competences but for those who have generic competences as well. They are searching for the employees who can work in a team, fix problems, be flexible, take initiative, multitask and analyse more information simultaneously (NCVER 2003). Economically speaking, generic competences increase competitiveness, efficiency and productivity (Young and Chapman 2010).

Apart from various terms and definitions, the literature also offers various classifications of generic competences. American Society for Training and Development has defined, in the late 1980s, six competences necessary for the success in a working environment (Young and Chapman 2010): writing and arithmetic, speaking and presenting, problem solving, setting goals, resolving conflicts and leading teams. According to Redondo Duarte, generic competences are efficient communication, ability to adapt to new situations, teamwork, applying knowledge and skills, self-learning, leadership, entrepreneurial spirit, understanding global social, historical and economic politics (Redondo Duarte et al. 2015). Male and Chapman have defined the following generic competences: efficient communication, identifying problems, systematic approach, work in a multidisciplinary and multicultural environment, team leadership, team work, professional and ethical responsibility etc. (Male and Chapman 2005).

As far as maritime industry is concerned, more and more attention has been given to generic competences recently. IAMU 2018 conducted a research with a scope to determine competences requested of a future seafarers: teamwork, adaptability, flexibility, communication, leadership, critical thinking (Cicek et al. 2019).

3 Methodology

The main goal of our research was to determine to what extent various competences have been present in STCW Convention, in correlated study programmes, and in short

courses. The research itself lasted for 2 years. The presence of professional, generic, and other competences was estimated. For better understanding, simple specific examples of joint application of different types of competences in different tasks on board ship are shown in Table 1.

A list of topics that should be included in course syllabus are listed for every competence defined in IMO Model Courses.

Conceptual framework of the analysis:

According to their content, topics are classified into the ones needed for acquiring professional competences, generic competences or other competences.

1. Basic assumptions:

   a) If the content of the topic is focused only on standard on board procedures, that topic is considered to be the one needed for acquiring professional competences
   b) If the content of the topic is focused on transferable, multipurpose knowledge, understanding and skills that can be used in different situations, that topic is considered to be the one needed for acquiring generic competences
   c) If the content of the topic is not focused only on standard on board procedures and can be used in other sectors, that topic is considered to be the one needed for acquiring other competences

2. Classification of topics in IMO Model Courses, study programmes and short courses for LNG Carriers and cruise ships:

   a) Topics in IMO Model Courses are divided into group of topics, subcategories and categories. The term categories refers to ship's departments. The term subcategories refers to competences within ship's departments. The term group of topics implies more topics present within one competence whereas a topic is just one topic within a group of topics. The example of such a classification is shown in the Table 2. A group of topics referring to *Carriage of Dangerous, Hazardous and Harmful Cargoes* was used in the example. These topics are a

Table 1 Examples of joint application of different types of competences on board ship

Task	Generic	Professional	Other
Boarding a pilot	Teamwork effective communication Work in multidisciplinary and multicultural teams	Manoeuvre and handle a ship in all conditions (manoeuvres when approaching pilot stations and embarking or disembarking pilots)	Competences regarding weather forecast and oceanographic conditions
Investigation of the cause of injuries and preparation of injury and illness reports	Leadership Teamwork Effective communication Decision-making Problem Solving	Organize and manage the provision of medical care on board	Competences regarding first aid and medical care

Table 2 Competence classification example

Competence classification in IMO Model Course			
Topic	Professional	Generic	Other
Shifting of bulk cargo by reducing an excessively high GM.	X		
Appropriate action to take in emergency and medical first aid situations involving dangerous goods			X
Effective communication with the port authority		X	
Competence classification in a study programme			
Topic	Professional	Generic	Other
Ship's pharmacy	X		
Composition and texture of the human body			X
Competence classification in short courses programmes			
Topic	Professional	Generic	Other
Team development		X	
Bridge watch keeping	X		

part of the subcategory called *Carriage of Dangerous Cargo*, which is a part of the category called *Cargo Handling and Stowage at the Management Level;*

b) Topics of the 3-year-long undergraduate study programme for deck officers were analysed for every course separately. Therefore, curricula were analysed as well. There were 15 courses during the first year, 14 during the second and 13, out of which seven were obligatory and six optional, during the third year. Topic classification was shown on the example of the course called *Maritime Medicine and Medicine for Seafarers* (Table 2).

c) Programmes of short courses for LNG carriers and cruise ships defined by companies were analysed in order to determine a presence of various competences in the courses. A programme called *SMS Bridge Resource Management* has exemplified competence classification in short courses' programmes. The programme is a part of the short courses required for LNG carriers (Table 2).

3. Percentages of the type of competences in categories, subcategories, group of topics and topics have been estimated on the basis of the proportion between the total number of topics and the number of topics that refer to each type of the competence.

The research was divided in two phases. The ratio of various competences in STCW Convention, in correlated study programmes, and in short courses was analysed in the first phase. The STCW Convention's analysis was based on the IMO Model Course 7.01(IMO Model Course 7.01 2014) and 7.03 (IMO Model Course 7.03 2014). STCW Convention prescribes competences needed to perform jobs at management level. Knowledge, understanding and proficiency, prescribed for every competence, can be found in column 2 of the table A-II/2. The Convention does not contain a detailed syllabus for acquiring competences. A detailed syllabus for masters and deck officers is written in the IMO Model Courses 7.01 and 7.03. That is the reason why STCW

Convention and IMO Model Courses 7.01 and 7.03 were analysed in this paper. MET institutions' teaching staff has been advised to use IMO Model courses when organizing and introducing new courses or updating the existing ones. Part C of IMO Model Courses gives a detailed teaching syllabus and lists all the topics that should be contained in a programme, for every competence defined in the Convention.

The analysis of undergraduate study programmes was based on a study programme in Croatia. Short courses' analysis was based on 57 programmes required by companies managing 188 LNG carriers, and on 41 programmes required by 12 companies managing 161 cruise ships. The analysis presented in the research had included programmes required for crew members navigating LNG carriers and cruise ships. These two types of vessels were chosen because of their specialized equipment and a high rate of implementation of new systems needed for safe operations. Since there are no agreed international standards, programmes differ in duration, content, and reasons as why shipping companies require them.

Based on the results of the first phase of the research, a total amount of time needed to acquire various competences was estimated, and became the second phase of the research. The total amount of time needed to acquire competences was estimated in the following way:

$$\text{Total amount of time needed to acquire competencies} = \text{ratio of the type of competence} \times \text{total number of hours}$$

Total amount of time needed to acquire professional competences (TPC), generic competences (TGC) and other competences (TOC) was estimated.

Limitation of this analysis:

A part of the short programmes' contents was not available for the research. Contents and duration of eight programmes were not determined so they were not analysed.

4 Results of the research

4.1 IMO Model Courses 7.01 and 7.03

The analysis of competences, prescribed by STCW Convention, was based on the analysis of the respective IMO Model Courses 7.01 and 7.03. IMO Model Courses specify topics that are supposed to be a part of the curricula for a particular competence. In STCW Convention though, competences are determined according to ship's operations (functions) at operational and management level. These results are shown in Figs. 1, 2, 3 and 4.

Detailed Teaching Syllabus is divided into three sections in IMO Model Courses 7.03 and 7.01: *Navigation at the Operational/Management Level, Cargo Handling and Stowage at the Operational/Management Level and Controlling the Operation of the Ship and Care for Persons on Board at the Operational/Management Level.*

Section *Navigation at the Operational/Management Level* refers to acquiring competences needed for safe coastal and ocean navigation. Its topics aim at acquiring

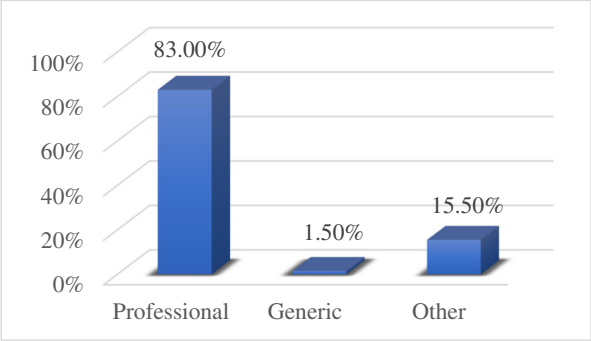

Fig. 1 Presence of various competences in IMO Model Course 7.01

professional competences. Topics referring to acquiring generic competences are minimally represented and refer mostly to efficient communication. Topics that aim at acquiring other competences refer to forecast weather and oceanographic conditions. The examples of such topics are weather conditions, meteorological systems, and ice.

Section *Cargo Handling and Stowage* aims almost entirely at acquiring professional competences. Generic competences are minimally represented again. Some of the topics referring to acquiring generic competences are effective communication between a ship and a terminal, communication with port and regulatory authorities, etc. Topics that aim at acquiring other competences are represented only in the section referring to carriage of dangerous, hazardous and harmful cargoes. The examples of such topics are classes of dangerous goods, medical first aid, etc.

Professional competences are mostly represented in the section called *Controlling the Operation of the Ship and Care for Persons on board*. That is, most of the topics aim at acquiring professional competences. However, a presence of generic competences in this section is far greater than in other sections. Some of the topics needed to acquire generic competences are theories in cultural awareness and cross cultural communication, managing crews of different cultures, and effectiveness of training methods that can be adopted for training. Topics that aim at acquiring other competences are represented only in the section referring to control trim, stability and stress. The examples of such topics are corrosion and corrosion of metals.

The results of the research show that IMO Model Courses' topics refer mostly to acquiring professional competences. Partially present are the topics that refer to

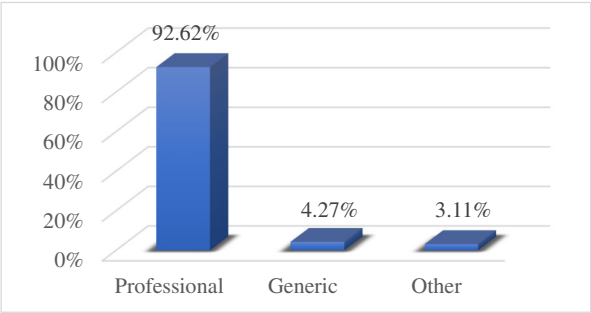

Fig. 2 Presence of various competences in IMO Model Course 7.03

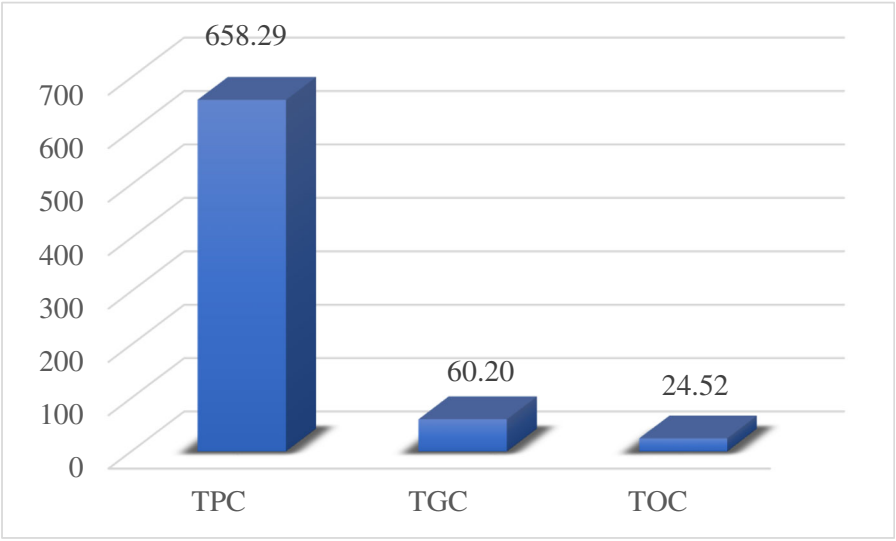

Fig. 3 Total amount of time [hrs] needed to acquire various competences in IMO Model Course 7.01

acquiring generic competences. Competences in question are mostly team work, team management, time management, decision-making, identification and problem solving, effective communication, work in multidisciplinary and multicultural environment, teaching and evaluation.

There is a significant disproportion between the time needed to acquire professional and the time needed to acquire generic competences. Topics that refer to acquiring sectoral and cross-sectoral competences are present to a lesser extent. They are present mostly in subcategories called *Carriage of Dangerous Goods, Forecast Weather and Oceanographic Conditions*.

4.2 The undergraduate study programme

In order to determine the presence of various competences, the undergraduate study programme "*Nautical Studies and Maritime Transport Technology*", delivered in Croatia, was analysed. The results are shown in Figs. 5 and 6.

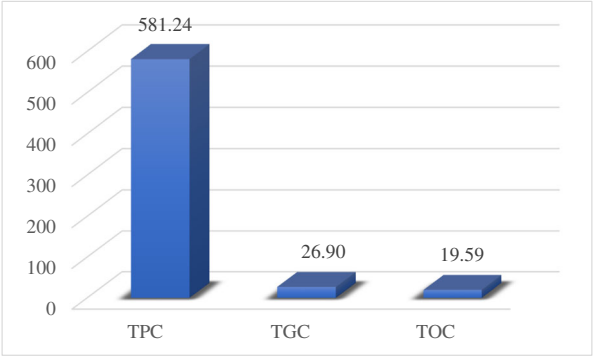

Fig. 4 Total amount of time [hrs] needed to acquire various competences in IMO Model Course 7.03

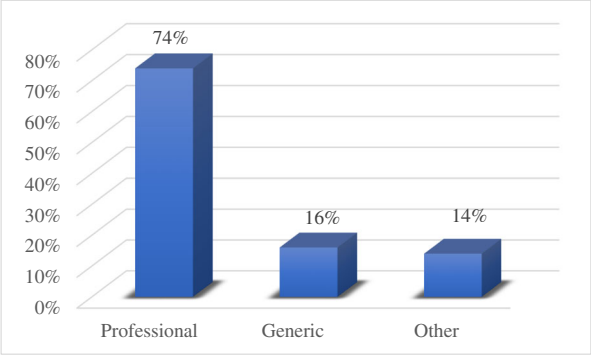

Fig. 5 Presence of various competences in the undergraduate programme

The programme is based on IMO Model Courses, and it includes all the professional competences needed for jobs at management level. According to the research, generic competences are present in the following courses: Maritime English 1, Maritime English 2, Maritime English 3, Maritime English 4, Mathematics 1, Mathematics 2 and Applied Computer Technology. Generic competences are minimally present in other courses. Sectoral and cross-sectoral competences are mostly present in the following courses: Physics, Fundamentals of Electrical Engineering, Maritime Public Law, Marine Environment Protection and Maritime Meteorology and Oceanography. Sectoral and cross-sectoral competences are present in the additional courses of the 5th and 6th semesters.

The total amount of time needed to acquire generic competences is far greater than as prescribed by IMO Model Courses. It can be concluded that the analysed study programme includes more generic competences than the programmes based exclusively on IMO Model Courses.

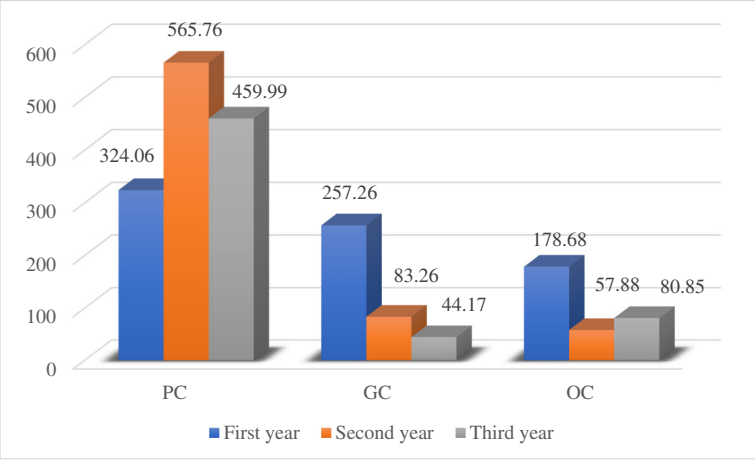

Fig. 6 Time needed to acquire various competences during the undergraduate study programme "Nautical Studies and Maritime Transport Technology"

4.3 Short courses for LNG carriers and cruise ships

Duration in days, not hours, is generally prescribed for short courses. In other words, 96 out of 98 short courses analysed in this research, had the duration prescribed in number of days, not hours. That is the reason why total number of hours for every short course is based on the prescribed number of days. Days were turned into hours by multiplying the number of days by 8 since it may be assumed that each day consists of 8 h of lectures. Contents and topics prescribed for every short course were analysed upon determining the total number of hours for each of them. The results are shown in Figs. 7, 8, 9 and 10.

The research has shown that majority of time, for both types of ships, is spent on acquiring professional competences. Although these two types of ships are very different, there are also some similarities:

1 The amount of time needed to acquire professional competences in categories: voyage planning, communication and people management is the same.
2 Topics that refer to ship manouvering make the majority of topics in the category voyage planning.
3 A significant amount of time is spent on acquiring additional generic competences in the category communication and team management.
4 Topics that refer to team work, team management and decision-making make the majority of topics in the category communication and team management.

5 Discussion and recommendations

Due to rapid development of technology, it is almost impossible to expect the IMO Model Courses and study programmes to comprise all the professional competences needed on board. It is to be expected that a part of professional competences will always be acquired through short courses.

As opposed to professional competences, the application of generic competences needed on board should not be that frequent. That means that generic competences

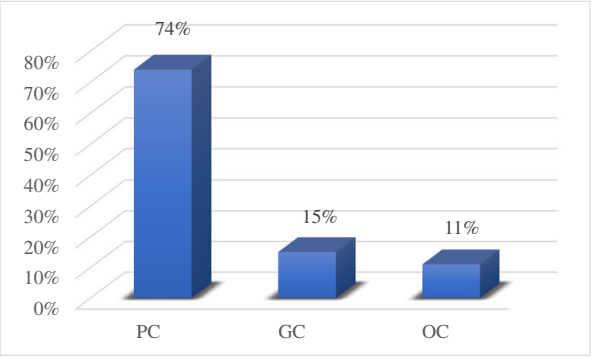

Fig. 7 Presence of various competences in short courses for LNG carriers

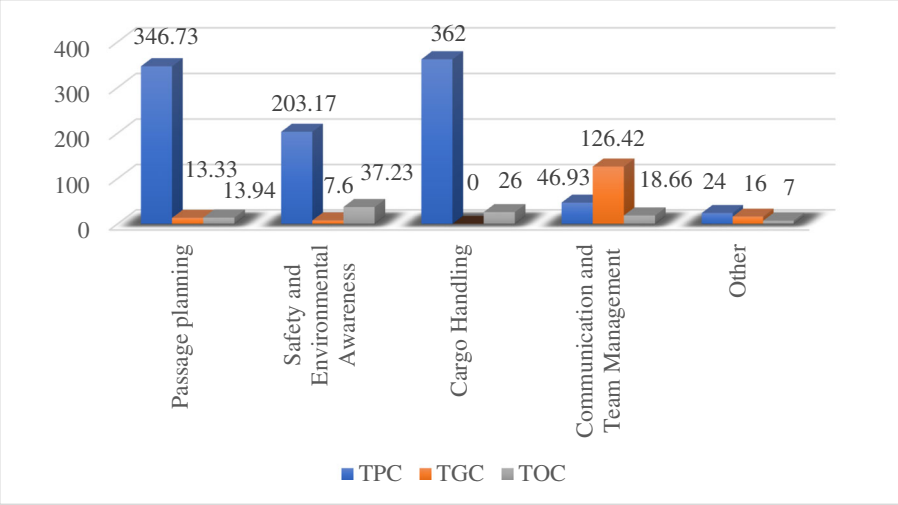

Fig. 8 Total amount of time [hrs] needed to acquire various competences in short courses for LNG carriers

needed for jobs on board should mostly be included in IMO Model Courses and academic education.

Sectoral and cross-sectoral competences are minimally present in additional programmes prescribed by shipping companies. These results are acceptable since the abovementioned programmes are the result of companies' needs and demands for competences needed for jobs on board.

Competences, as defined in STCW Convention, refer only to a person, without analysing his/her surroundings. The term *surroundings* stands for processes on board ships. These processes are complex and consist of organizational units,[1] tools and devices.

The existing process of determining required competences refers only to a person without analysing his/her surroundings or the devices and tools he or she uses in the processes. To determine required competences more precisely, it is necessary to analyse the working environment. This means that competences should be linked up with working processes on board ships (navigation; loading and unloading of the cargo; safety, security and environmental standards; maintenance). In addition, competences should also be linked up with tools and devices used on board ships. The recommendation to fill in this gap is to use process approach.

The process approach (Fig. 1) implies the recognition of process elements that determine complexity of a process (Fig. 11):

1. Subprocesses (if they exist)
2. Organizational units
3. Actions
4. Decisions
5. Executors

[1] An organizational unit implies a person, or a group of people who participate in a process, as it may be appropriate.

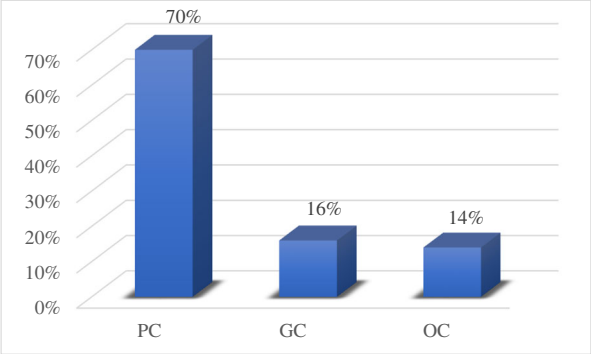

Fig. 9 Presence of various competences in short courses for cruise ships

Every on board process can be divided into one or more subprocesses. Furthermore, actions and decisions have to be determined for a successful implementation of a subprocess. Each action consists of one or more tasks and can have one or more executors. Apart from actions, decisions have to be defined as well and they can also have one or more executors. Executors can be crew members or devices. If it were possible to determine which actions and decisions are executed and defined by the crew and which by a device, it would be possible to determine the role of the crew members and their competences needed to perform actions, execute tasks and make decisions.

In this way, a continuous monitoring of changes in processes on board would be ensured, which is not possible by the approach used today. Monitoring of changes would also ensure easier identification of needed competences, which should be in accordance with technological development on board ships.

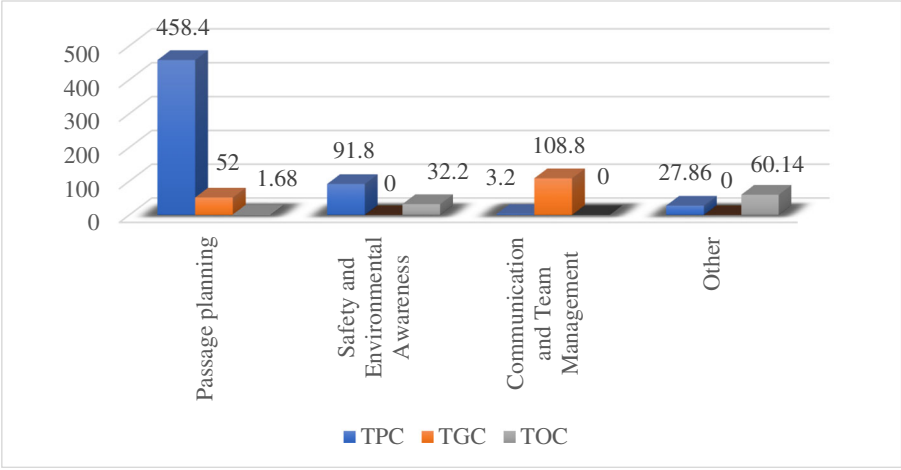

Fig. 10 Total amount of time (h) needed to acquire various competences in short courses for cruise ships

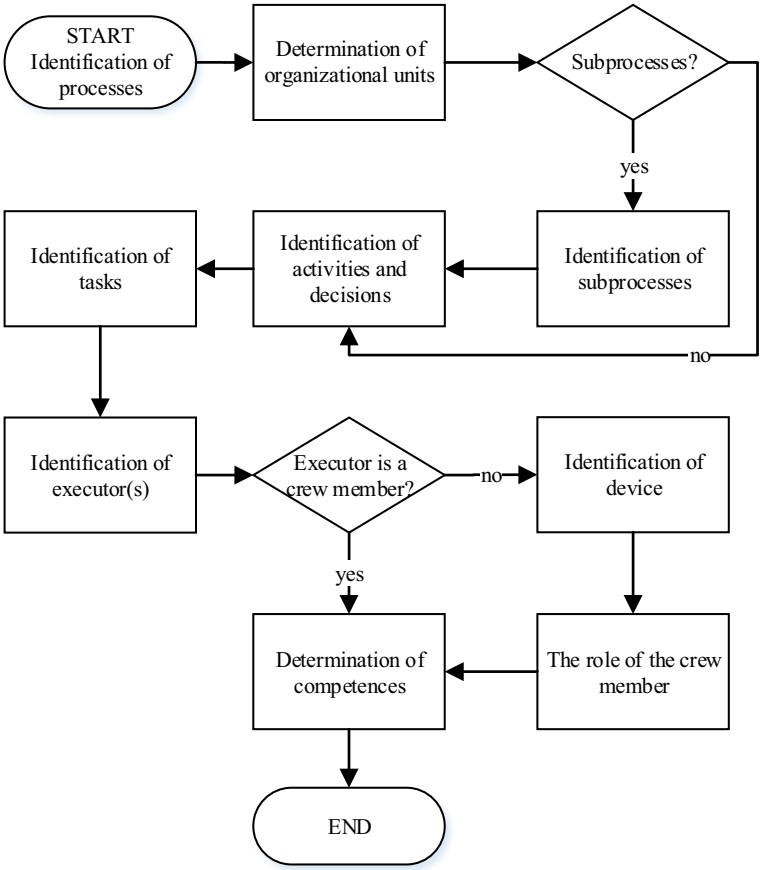

Fig. 11 Process approach for determining competences (Gundić et al. 2019)

6 Conclusion

The analysis of IMO Model Courses 7.01 and 7.03 has shown that most of their topics aim at acquiring professional competences. Topics needed to acquire generic competences refer to the following generic competences: team work, team management, decision-making, effective communication and collaboration in multidisciplinary and multicultural teams. A study programme contains all the topics defined by IMO Model Courses. Most of these topics refer to acquiring generic and other competences. They refer mostly to acquiring the following generic competences: effective communication, problem solving, teamwork, team management, decision-making, time management, collaboration in multidisciplinary and multicultural teams. On the other hand, topics that refer to acquiring other competences belong mostly to the field of law, meteorology, medical first aid, physics, electrical engineering and protection of the environment. Short courses aim at acquiring professional competences, i.e. competences needed for specialised jobs on LNG carriers and cruise ships. It is reasonable to assume that a part of the competences needed for highly specialised jobs on some type of ships will continue to be acquired through short courses in the future. The topics that aim at

acquiring generic competences refer mostly to the following generic competences: team work, team management, decision-making and effective communication. Topics that refer to acquiring other competences are minimally represented in short courses.

It can be concluded that topics included in IMO Model Courses, study programmes and short courses, that aim at acquiring generic competences refer mostly to the same or almost the same generic competences. It is important to emphasise that the abovementioned competences are not isolated in STCW Convection or IMO Model Courses. They are a part of professional competences. Therefore, these competences should be recognized and described more precisely in STCW Convention and IMO Model Courses. Furthermore, the number of topics needed to acquire generic competences and the time needed to acquire them should be increased in the IMO Model Courses.

All the involved parties, especially MET institutions, should participate in the process of interrelating competences with the tasks on board ships as well as in the process of determining generic competences needed for jobs on board. In that respect, IAMU, as the most important association of the prominent MET institutions, has already made an important step forward in determining needed generic competences through IAMU Hiphong Statement and Global Maritime Professional Body of Knowledge. For this very purpose, process approach could be used in the future to interrelate competences with associated processes. Process approach could be used to identify if presently drafted competences comply with working processes on board modern ships, if competences prescribed by STCW Convention should be upgraded, if there are any new competences that should be developed and if there are any competences that are becoming obsolete.

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