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ENGINE CADETS WITH AND WITHOUT ADDITIONAL TRAINING ON TRAINING VESSEL – COMPETENCES COMPARISON CASE STUDY

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Abstract

In the last decade evolution of the requirements for training and professional competences of ship's crewmembers, including ship engineers can be observed. Despite the implementation of training programs according to IMO requirements in maritime training centres, a different level of competence of young people beginning their professional career on ships in the engine department is observed. The article discusses general conventions, goals, and effects of the "BS Cadet Program" training program, introduced by one of the larger German ship-owner to improve the competencies of crewmembers at the operational level, who will take duties of the watch engineer in the ship engine room soon. General idea of this training program is reducing the time of the path career what is a standard in most shipping companies. Such idea in this program is utilised by directly merging theoretical knowledge with professional practice on special prepared training vessel. The work present also comparison of the acquired knowledge verification results of training participants with the results of engine cadets from last semester of the UMG Faculty of Engineering. The comparison includes computer exercises of Marine equipment and machineries (UNITEST Company – CBT) also genera ship and engine room knowledge checked by written test called "Final Test" carried out on the end of 3 months training.

Keywords*: ship power plant, watch engineer training, marine engineer competences*

1. Introduction

In the last two decades, is observed fast develop of ship's technology. This concerns the development of vessels construction, for example, more optimal hull shapes. In addition, marine equipment installed in the engine room and on board has changed to more efficient but also as more complicated devices. The consequence of this is evolution of the requirements for training and professional competences of ship's crewmembers, including ship engineers. At the same time, economic competition in the global maritime transport market has pushed ship-owners to follow direction of decreasing the number of ship's crewmembers to the necessary minimum required by international regulations. This result of reducing the number of engine room crew has to maintain more and more automated equipment in the ship's engine room. Large automation of machines and mechanisms make possible such reduction for example even by elimination of necessity 24-hour watch keeping, through to the unattended engine room. However, at the same time impose the higher knowledge and skills requirements for people worked there are observed. Furthermore, to strictly technical and professional competences, a very high emphasis is placed now during training or during ship operation on safety issues of staff as well as safe operation of all machineries on board. All shipping companies are obligated to implement Safety Management Systems (SMS) or Quality, Health, Environment Management System (QHEMS), based on ISM Code the aim of such documents is to reduce the risk of various potentially dangerous situations for people, environment, ship or cargo. Each of the crewmember is obliged to familiarize with such a system and apply it during day-to-day work on ship. Such familiarization is not the simple task especially for the young person, due to the volume of such documents, which may cover up to

2,000 pages. Even superficial review, so extensive documentary like SMS even for an experienced crewmember could take a relatively long time. Especially for the young, inexperienced person, who just start career on board of ships the time necessary for familiarization with the SMS will be much longer. In particular, that before sign on, only initial safety training is carried out, usually at the company's office, while further self-training is carried out individually on board, during work-off time. The amount of knowledge and information what a young crewmember has to acquire in a relatively short time makes it cheap but not the best way of efficient training.

The largest ship-owners on the global market also come to such conclusions. It cause that they are looking for other methods to improve the safety and professional competences their crews as well as at the operational and support level.

The ship engineer officers training course is various in the world in terms of the length of training and the content of the training program. For example, even in Poland there are two ways to obtain the rank of engineer officer. In the first case, the educational process includes a course within 4 years of engineering studies (containing about 6 months of on board practice). In the second case, as part of post-secondary school, covers 2.5 years of education (including 12 months of maritime practice).

In maritime education in the world, there are systems similar to the two existing in Poland, more or less comparable to one of them. The times of theoretical and practical training are significantly different for both ways.

Due to the existence of such differences between maritime education centres in the world, the International Maritime Organization (IMO) has developed standards of competence that should be met by every person worked on different positions on the ship. Those competences have to be confirmed by appropriate examinations process by the maritime administration of the country.

2. The aim of the training program

Despite the implementation of training programs according to IMO requirements in maritime training centres, a different level of competence of young people beginning their professional career on ships in the engine department is observed. Because of such observation, some of the international ship-owners wanting to provide better prepared staff to work on their vessels they organize own education or training centres for ship crewmembers. One of the possible solutions is signing contracts by ship-owners with external training centres. The second is the foundation of own training centres, where crewmembers of sea-going vessels are trained from the sailor, the cook to the deck and engine officers. Examples of the second approach to training are one of the world's largest ship owners "Maersk" (Denmark), which trains crews in their centres around the world, or smaller ship-owner "MOL" (Japan), having training centres only in their country. Another of the large ship owners "Schulte Group" (Germany) has training centres in 5 countries around the world (Cyprus, China, India, Philippines, Poland). This ship-owner has two standard vessels specially adapted for the training of cadets as well. One of this ship is used for the training of young, unexperienced, future officers for deck department. The second vessels are dedicated for the training of engine and electrician cadets as part of the "BS-Cadet training program" (BS – Bernard Schulte). Such a rarely utilized form of training ship engineers on the operational level is aimed to increasing their professional competences so that they are faster and better prepared to take responsibilities on watch engine room.

3. „BS-Cadet training program"

The Schulte Group (BS Group) is a global ship-owner and ship operator, coming from a family-owned company from Hamburg (Germany). Currently, the company manages over 750 vessels including about 160 as a property. The group employs around 16.000 seafarers in all positions and about 1,500 people working on shore. Such a large number of vessels require providing the right

number of people to work for as well as their proper training. In or-der to ensure the steadiness of managed vessels operation, which number in-creases from year to year, as well as to improve the training of young officers this company decided to build and adapt to the carrying out of training tasks in basic standards two container vessels with a capacity of 5600 TEU. These ships are typically container vessels on permanent shipping line similar to other sister vessels, sailing between the ports of Asia, Africa and South America. The element that distinguishes them from the other sister ships is additional deck in superstructure. On this deck are located 4 additional cabins for 8 cadets, 2 cabins for instructors and a classroom.

For appropriate usage of these vessels, BS Company elaborate dedicated training program. This program includes the scope of requirements for engineers on operational level established by IMO in the STCW 79/95 convention. The general idea of this training program is reducing the time of the path career what is a standard in most shipping companies. Such idea in this program is utilised by directly merging theoretical knowledge with professional practice. During the training, the classes are carried out on the ship in the form of theoretic lecture or practical exercises and practical tasks in engine room at the same day. This enables the future engineers to gain greater professional competence in relation to the traditional path career. Fig. 1 presents the standard path career of engineer officers at BS and the path career of the participant of the "BS-Cadet training program".

Candidates to this program are recruit among the best students in different maritime schools. Recruitment is carried out directly in maritime schools or by using internet communicators (e.g. Skype) by a person from the HR department of the BS Company. The recent groups of cadets qualified for this pro-gram came from the following countries: Philippines, Indonesia, Myanmar, Ghana, as well as individual people from China or Sierra Leone.

Cadets selected in the recruitment process signed the employment agreement. On the basis of such a contract, everyone cadet after completing this training program with a positive result, as well as after completing maritime education and obtaining the engineer officer on watch, they have employment at BS company.

The "BS-Cadet training program" has been developed as a combination of theoretical and practical training. In connection with this, the plan of standard day is divided into two parts: theoretical (from morning to dinner – 4h) and practical (from lunch to dinner – 4h). In practice, the instructor who supervises training on a ship decides which part of the program is implemented for each day or time. The day plan can be adapted ad-hoc to the operating conditions of the engine room or vessel so as to involve cadets in the most interesting, planned or routine tasks or operations as well as those that appear unexpectedly like failures. To present possibly wide range of situations and problems, appear in carrier of ship engineer officers.

The training program covers a number of subjects included in IMO standards established in STCW Convention for operational level. Some of the topics are discussed as separate points in the training program (directly), i.e. marine piston engines, marine boilers, ship machinery and equipment, etc. Other issues from STCW standards do not exist in the training program separately but they are discussed as part of the other subjects (indirectly). In example, elements of thermodynamics can be found in marine boilers and steam system as well as refrigeration and air conditioning. The issue of environmental protection occurs during discussing many subjects in particularly operating fluids such fuel, oils and lubricants or else marine machineries such sewage treatment plants, oily water separators, etc.

Because the presented course is only additional/supplementary element of training so, the BS-Cadet training program does not cover all the elements required by STCW standards. For the same reasons the topics, scope of particular subjects does not include a detailed discussion of a given issue, but only a short form of that. The training is focused on the most important theoretical aspects and a wider practical and operational aspect with particular emphasis on specific technical solutions installed on the training vessel.

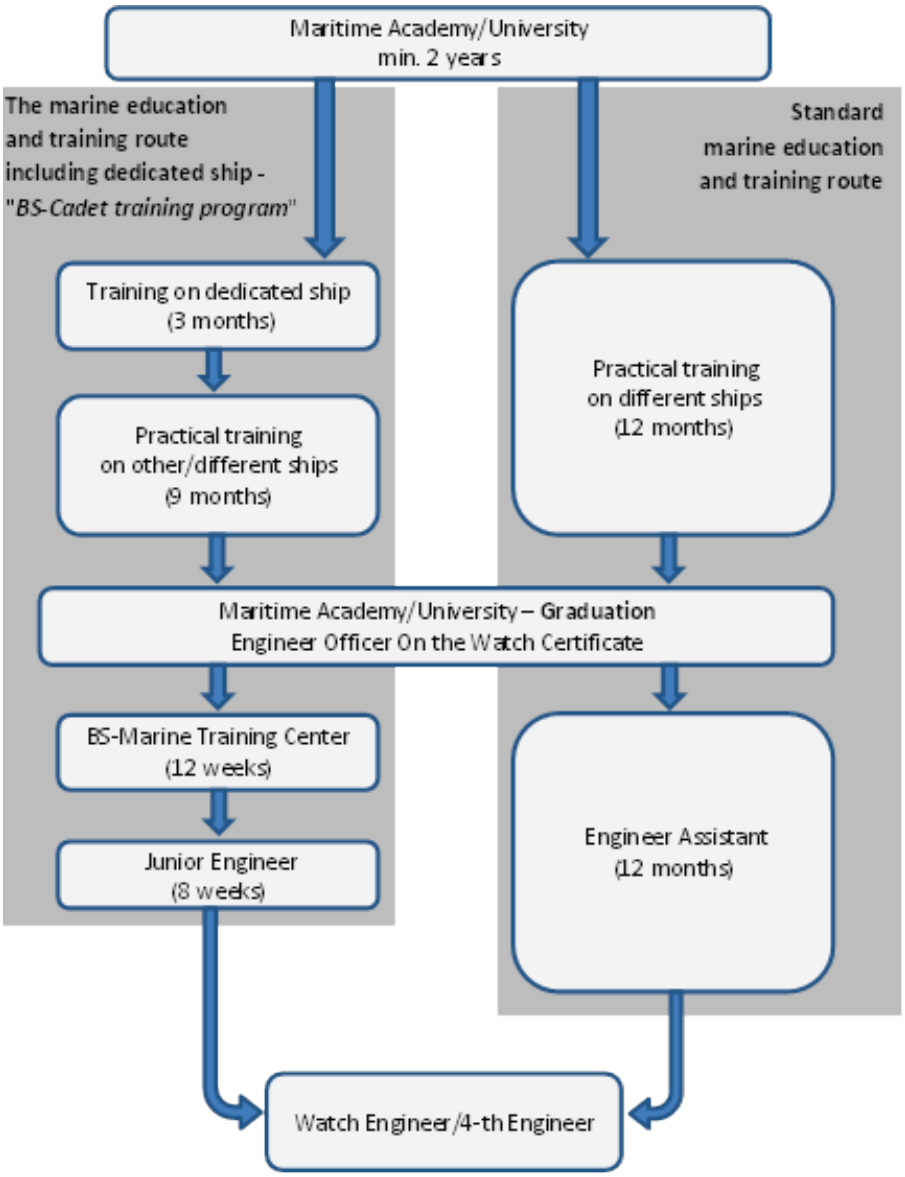

Fig. 1. Comparison of standard career path of the Engine Cadet to the career path with participation in "BS-Cadet training program"

Table 1 presents the approximate time designed to particular issues during the program proposed by the program's author. In practice the instructor have autonomy to determine the time devoted to the issues – adapting this to the necessities depending on the operational situation of the ship and engine room.

The participants' learning progress control of knowledge passed during the training took place through weekly written tests. These tests were usually carried out on Sunday before midday or on Saturday afternoon. It gives the time before weekly test to make knowledge review for cadets. Each test was preceded by a short review of knowledge from the last week as well as an addition and obligatory, common group review carried out by the cadets themselves the day before the test. Typical test had a form of multi-chosen test with few additional questions where cadets had to provide your own answer (open questions). At the end of the whole course, a final test was carried out. Final test included all issues covered during the 3 months training pro-gram. The results of this final tests show the knowledge acquire by the cadets. As well as compared the finale test results to the results of weeks for individual cadet shows indicatively what progresses have been made by individually in acquiring knowledge.

Tab. 1. List of issues implemented to the "BS-Cadet training program" with the assignment of an approximate time designated

No.	Subjects	Number of dedicated days
1.	Safety and ship familiarization, location and identification of all Engine Room machinery	5
2.	Main Engine	8
3.	Generator Engine	5
4.	Boilers and feed water system	2
5.	Pumps	2
6.	Air Compressors	2
7.	Purifiers	3
8.	Steering Gear	1
9.	Ballast and Bilge System	2
10.	Sea Water Cooling System	2
11.	Fresh and Sanitary Water System; Fresh Water Generator	1
12.	Lubricating Oil and associated filtration, transfer systems	2
13.	Generation and Distribution of Electricity	3
14.	Engine room Crane and lifting Devices	1
15.	Fuel Storage, Handling ,Filtration and Transfer System	3
16.	Sewage Treatment Plant	1
17.	Incinerator and Oily Bilge separator	2
18.	Emergency, Safety and Fire Fighting equipment	3
19.	Life Boat Engine and other systems	2
20.	Deck Machinery: Winches, Gangway, Cranes, Davits, etc.	2
21.	Familiarization with Bridge and Equipment	1
22.	Electrical, Pneum. and Hydrau. Automation basic components	3
23.	Refrigeration and air conditioning	3
	Sum	**59**

4. BSM and UMG engine cadets – comparison of certain engineer competence

In spite of the training programs in maritime education centres compliant with IMO standards, there is observed that young people starting their professional career on ships in the engine department represent a varied level of competence. Due to the difficulty of defining objective criteria for assessing the competences of young engineers or way to verification of those competences, this article presents a test results comparison of the same computer exercises (CBT – Computer Based Training). Such exercises are delivered to marine educational centres by among others UNITEST company. These exercises are carried out as part of the training program in Gdynia Maritime University (UMG), as well as in BS-Cadet training program. These exercises cover issues in the subject of Machinery and Ship Equipment (pumps, air compressors, purifiers, steering gear, sewage treatment plant, incinerator, oily bilge separator, etc.).

In addition, for comparative purposes, final test results of the BS-Cadet training program have been compared with the same test results carried out for the students group from last semester of UMG Marine Faculty students. This test covered the scope of issues from both the ship's engine room and ship-general aspects, such as human and environmental safety, fire protection, etc.

For comparison, selected/exemplary results of 4 groups of engine cadets participating in the BS-Cadet training program in 2012-2015 and 3 groups of UMG students from 2015-2017 were

used. Both BS-Cadet training program participants as well as UMG students used the training package of UNITEST programs – CBT's. The results achieved from different tests are presented in Tab. 2 and in graphical form in Fig. 2. The numbers presents averaged value of results calculated for different training groups.

Tab. 2. Results of CBT exercises assessments achieved by BS-Cadet cadets and UMG students

Marine pumps	Marine compressors	Stearing Gear	Controlable Pitch Propeller	Fresh Water Gen. AQUA	Sewage Tratment Plant	Marine Hydraulic Systems	Alfa Laval S-type Separat.	Westfalia Separator	OilyWater Separator	Average value	Nationality	Year
1	2	3	4	5	6	7	8	9	10	11		
81%	79%	86%	68%	90%	60%	88%	75%	79%	81%	**79%**	Philipines	2012
54%	65%	71%	40%	70%	49%	64%	68%	65%	64%	**61%**	Indonesia 1	2013
61%	79%	79%	63%	91%	91%	74%	86%	65%	76%	**77%**	Indonesia 2	2014
71%	86%	80%	53%	81%	73%	70%	74%	75%	71%	**73%**	Ghana	2015
67%	**77%**	**79%**	**56%**	**83%**	**68%**	**74%**	**76%**	**71%**	**73%**	**72%**	Aver. BS-Cadets ...	
81%	80%	67%	70%	71%	77%	71%	76%	49%	72%	**71%**	Poland 1	2015
74%	78%	96%	89%	89%	71%	75%	84%	75%	76%	**81%**	Poland 2	2016
83%	69%	74%	51%	76%	74%	64%	71%	59%	69%	**69%**	Poland 3	2017
79%	**75%**	**79%**	**70%**	**79%**	**74%**	**70%**	**77%**	**61%**	**72%**	**74%**	Aver. UMG stud.	

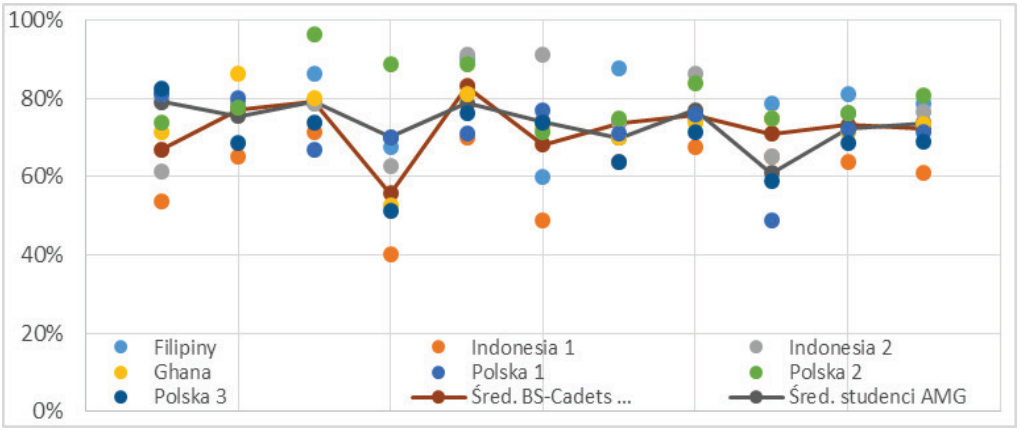

Fig. 2. Results of CBT exercises assessments achieved by BS-Cadet cadets and GMA students

For the purpose of this article Additional simile of competence, wider ex-tent than Machinery and Ship Equipment CBT's was made by comparison the results of the final test of BS cadets and UMG students.

Table 3 presents summary results of the "Final test" carried out for six groups of cadets of different nationalities and two groups of last semester of UMG Marine engineering faculty students.

It should be noted that while knowledge of the issues presented during the CBT exercises described earlier concerned specified machines and engine room equipment but these are common on the ships. The "Final Test" contains a certain number of questions concern specific of the training vessel as well as the details implemented in BS-Cadet training program. The factors determined such details are among the others: it is a container vessel; the main propulsion engine

is a large power unit (49.000 kW) electronically controlled, etc. The questions considered the specific of training vessel were an additional difficulty for UMG students. They performed marine practical training on the significantly different ships to the training vessel. That certainly affected the test results they obtained.

Tab. 3. Results comparison of Final test achieved by BS-Cadet cadets and GMA students

No.	Year	Nationality	Average for Final test	Average	Deviation from the average
1	2012	Philipines	69.0%	72.6%	3.6%
2	2013	Indonesia 1	76.9%		4.3%
3	2014	Indonesia 2	74.6%		1.9%
4	2014	Myanmar	73.0%		0.4%
5	2015	Ghana 1	70.0%		2.6%
6	2016	Ghana 2	72.1%		0.5%
7	2018	Poland 1	48.1%	----	24.5%
8	2019	Poland 2	39.5%	----	33.1%

Table 3 presents also the comparison of the average values of "Final test" results achieved by the aforementioned groups. The "Average" column shows the average value (72.6%) of the "Final Test" for all presented nationalities participating in the training under the BS-Cadet program. The "Deviation from Average" column represents the difference between the mean value for all cadet groups and the value obtained by each group. In two last rows of that column presents deviation of results achieved by polish-tested groups to aver-age of whole other nationalities.

As can be seen in Tab. 3 the average result – about 72% presents the "good" (author's assessment) assimilation of theoretical and practical knowledge provided during the training. The deviation from the mean value for BS cadets is not a large and ranges from -3.6% to + 4.3%, which may indicate a similar level of training. It should be noticed that present's average value for group only. The individual deviations were much higher and reached even +/- 20% for each cadet.

Relatively weak "Final test" results of two "Polish" groups (only 48.1% or 33.1%) of the conducted in a group of several dozen volunteers of UMG students arise mainly due to the specific of some questions in the test. As well as difficulties in understanding some questions due to English language, (this fact was reported by students after writing the test).

Due to the completely different mode of education and especially practical training the above does not allow to draw explicit conclusions from a direct comparison of the Final test results of UMG students and BS cadets. For better assessment of those groups, competences the test should be less detailed due to specific of training vessel. However, the Final test does not exceed be-yond the standard marine engineer knowledge.

5. Summary

Presented in the article a program of additional training for young engine cadets implemented in one of the largest shipping companies allows to better preparation and development of future employees. The training with this pro-gram review the knowledge acquired during education as well as introduces elements of training in BS company internal procedures of quality management systems in force on the ships.

Considering the fact that the program has been operating since 2011 (8 years) has not been suspended or closed so far. The vast majority of ship engineers employed that time at the operational level was participants of this program. It can be concluded that the program brings positive results and is profitable in the long term.

The level of competences readiness of young engine cadets to work in the engine room at the operational level just after graduation and having only a compulsory practical training is relatively

weak, regardless of the type or place of study. Such a program definitely improves the competences of young people to undertake professional duties in the engine room but though certainly not to an exhaustively.

Comparison of the results achieved by different groups of engine cadets (different nationalities, different stages of education) shows that the theoretical knowledge before gaining experience is at a similar level – the differences are not significant. However, it can be observed that both practical and especially theoretical knowledge is not complete. This is shown by the results of individual CBT exercises as well as the final test (approximately 72% on average). The questions in these tests included issues that were in the syllabuses, which individually all cadets passed during study time on shore before joining the BS-Cadet training program or UMG students before graduation. In addition, a significant factor influencing the achieved results of both BS cadets and UMG students was the fact that all tests were carried out in English but the individual of English skill level was very different (from weak groups, such as cadets from Indonesia or UMG students (basic level) to a group of Ghana cadets where English is an official education language).

Currently, ship-owner BS Group employs 181 engine officers on the operational and management level, from about 200 engine cadets who passed through additional training under the BS-Cadet program on a dedicated ship. These are 13-second engineers, 71 third engineers and 97 fourth engineers, what is close to 90% of the whole cadets participating in the program in 2011-2017. Such a high percentage may also be one of the arguments that such pro-gram brings benefits to the ship-owner.

According to the author's high competence ratings of experienced engineers who are UMG graduates is observed. However, other factors such:

– despite the, the larger financial expectations on the positions of operational and management level,
– increasing the quality of marine education and training in countries that were not significant nations among crews of sea-going vessels recently (i.e. Ghana, Myanmar, etc.),
– additional training organized by ship-owners themselves,

They contribute that the difference in competitiveness of AMG cadets and graduates on the labour market in the maritime industry decrease recently. This leads to difficulties in finding a ship-owner to complete the maritime practical training necessary to complete marine education and get the officer engineer on the watch certificate. All this makes it difficult to get the necessary professional experience to start a professional career.

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