The Future Competences of the Marine Engineer

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ABSTRACT

The maritime industry is undergoing a transformation and it seems that there are different perspectives within the field regarding important future scenarios. Consequently, it is likely that the competence profile of the marine engineer will also transform in order to meet future demands. This study finds that, in the future, the maritime industry will be in need of a marine engineer who is a practice-oriented problem-solver with advanced competences in management, innovation, process understanding, maintenance and digitalisation. Furthermore, personal competences such as curiosity, independence and resilience will be in demand. In order to accommodate the prospective competence demand of the maritime industry, three suggestions have been made:

1. *An increased focus on the areas of digitalisation and innovation;*
2. *Utilisation of continuing education to enhance the competences of the marine engineer;*
3. *Regulatory efforts to maintain and expand the flexibility of the educational system, to support the changing demands.*

1 INTRODUCTION

Since the Viking era, the Danish people have associated the maritime industry with economic growth. As technological development changes the field, the necessary competences of the crew is bound to change as well. In 2017, Danish Shipping (trade and employer organisation) conducted their half-yearly status report, which also included questions concerning future competences in seafaring. The report asked 26 leaders, representing 79 % of the Danish merchant fleet, which competences would be in particularly demand within the next five years [1]. Tradesmanship and commercial understanding rated high on the list, while more traditional competences in management and technical understanding were rated lower, despite it being at the core of the skills of the marine engineer education today. The point of departure in this study is to explore, whether the current mandatory requirements are in alignment with the maritime stakeholders and their scenarios of the future demand for competences. The maritime field is a global industry, influenced by rapid technological development and there are many qualified notions as to which competences a marine engineer must possess in the future. The competition in the field is fierce and companies are cutting costs to survive. The provision of a proper pool of maritime competences and skill-set is a vital part of successful maritime business. This study explores the fit between the prospective competence need as viewed by the industry and the requirements in the current Danish Ministerial Order no. 1348 of Bachelor in Technology Management and Marine Engineering.

In the following section, a detailed description of the methods and materials are presented. In section 3, the observations are outlined followed by a discussion in section 4. Finally, section 5 contains recommendations based on the findings.

2 METHODS AND DATA

In the study, we apply the SOLO-taxonomic requirements (Structure of the Observed Learning Outcome) for each subject area in the current Ministerial order of the Danish bachelor's degree in marine engineering. The SOLO taxonomy structures and separates levels of understanding and learning outcome into cumulative degrees of complexity [2]. This allows for a comparative analysis of the fit between the current educational competences and prospective expectations of the competence demand in marine engineering held by the maritime industry.

The Ministerial order no. 1348 of Bachelor in Technology Management and Marine Engineering uses *knowledge*, *skills* and *competences* to segregate the levels of understanding. The table shows the eight subject areas defined in the current Ministerial order and the required level of understanding according to the SOLO taxonomy.

Table 1. Ministerial order no. 1348 – SOLO classification of subjects

Level	**Ministerial order – Subject areas**	**Verb from SOLO**
0 Pre-structural	Incompetence	Fail, miss point
1 Uni-structural	*"Account for principles of the composition of machine- process and electrical plants[…]."* • *Innovation*	Identify, name, follow simple procedure
2 Multi-structural	*"Conduct measurements on machine-process and electrical plants."* • *Craftsmanship*	Combine, describe, perform serial skills, list
3 Relational	*"Fault-finding on machine- process and electrical plants"* • *Management* • *Communication* • *Maintenance* • *Business Economics* • *Automation* • *Process Understanding*	Analyse, apply, argue, compare, contrast, relate
4 Extended abstraction	Generalised in new domain	Create, formulate, generate, reflect, theorise

Generally, *knowledge* demands are at a uni-structural level, while *skills* are at a multi-structural level. Lastly, *competences* are at a relational level. The Bachelor in Technology Management and Marine Engineering is at the sixth level of the Danish Qualification Framework for Higher Education, with Masters and PhD degrees at levels seven and eight. Hence, no subject area requirements for marine engineering are found at the extended abstraction level.

In order to get a richer understanding of the complex nature of the maritime industry's prospective competence demand we chose a qualitative strategy and performed interviews with maritime stakeholders. The Danish maritime industry was sorted into the following three segments:

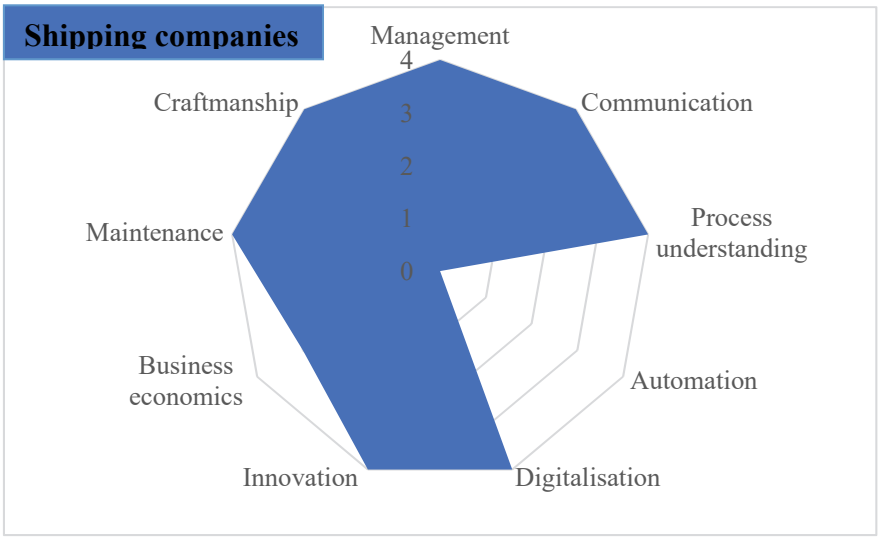
1. Companies which directly operate at sea, such as shipping companies or offshore companies;
2. Support companies such as engine builders, ship agencies or development companies;
3. Regulatory institutions, unions and educational institutions.

Danish harbours, shipyards and drilling was excluded in the study, due to the timeframe of the study In order to explore the maritime stakeholders' beliefs about the competence demand in 10 years' time, a total of 20 executives from the three segments was selected and invited to participate as informants in the study. Out of the 20 executives, 14 accepted the invitation. The informants were selected based on their leading position in the Danish maritime industry. Prior to participation, an informant analysis was performed stating the informant's role in answering the research question, and their background or possible personal agenda [2]. The data was collected via interviews during the fourth quarter of 2018.

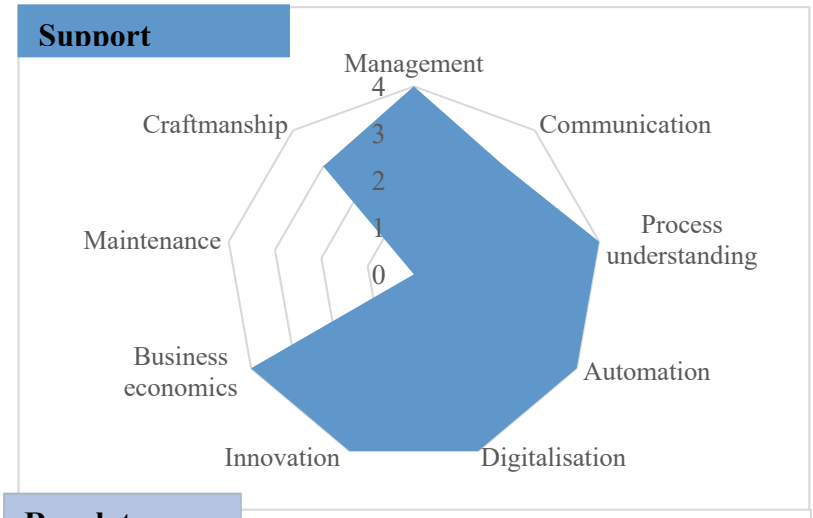
The interviews were transcribed and all statements of significance were coded and categorised, ensuring that all conclusions drawn from the gathered material were empirically founded. Thus, all interviews have been coded against all categories, including subcategories. To analyse the interviews, five categories were established: The background of the informant, future maritime engineer competences, the informant's motivation for mentioning a competence, the external conditions of the Danish maritime industry and personal qualifications. In order to classify at what level the informant believed a specific competence would be required, the SOLO taxonomy was applied. After finalising the rating of the competence requirement for each informant, the rating results were validated by the informants.

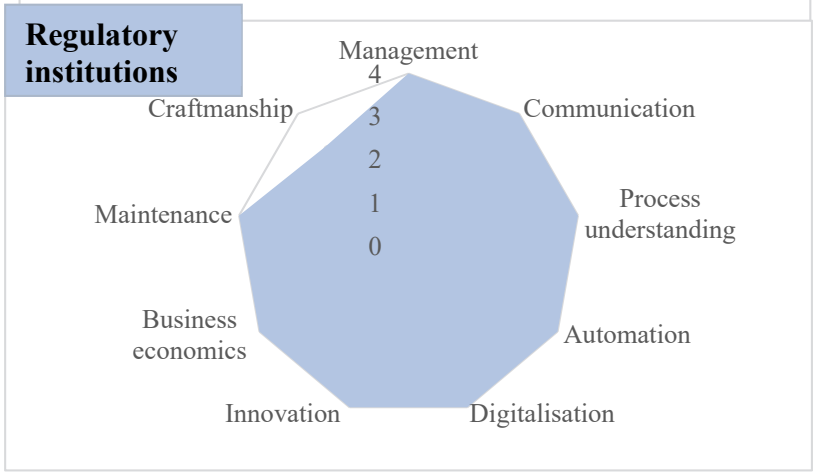
3 FINDINGS – THE MARITIME STAKEHOLDER'S EXPECTATIONS

The competence radar is based on the informant's competence demand, which is analysed using SOLO. It is illustrated as a radar with the subject areas from the Ministerial order. Digitalisation has been added even though it is not a mandatory requirement in the Ministerial order today, but many informants have requested future competences in that field.



The informants from the shipping companies, valued craftsmanship more than the other segments of the maritime industry in Denmark. Furthermore, none of the five informants from the shipping companies mentioned automation, which is surprising given the global discussion on autonomous vessels.

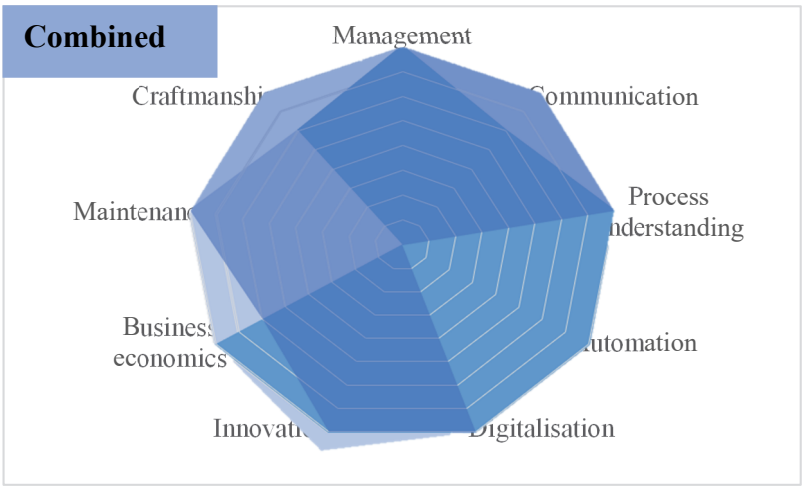




In contrast, the support companies all mention automation, but none of them focussed on maintenance. Where the shipping companies requested that the marine engineers were able to use craftsmanship to solve problems of a practical nature, the support companies have requested craftsmanship at a multi-structural level, which is lower than the shipping companies.

The regulatory institutions generally request a more advanced level of understanding in all the subject areas, especially innovation. Two out of six informants requested innovation at an extended abstraction level as they requested that marine engineers be able to create new solutions using innovation.

When all the competence radars are combined, it becomes clear that the maritime industry in Denmark requests competences at a relational level within all subject areas. The marine engineer should have a wide range of competences relevant for several maritime functions - both onshore and offshore, in the future as well.



The subject areas where most informants have requested competences at the relational level are **management, innovation, process understanding and maintenance**. Innovation is requested at a higher level than required according to the current Ministerial order. Furthermore, 8 out of 14 informants requested competences outside the subject areas of the ministerial order: competences such as curiosity, independence and maturity.

4 DISCUSSION

In the following section, the results from the competence radars will be compared with the informant's position in the Danish maritime industry, and the differences will be explored to elaborate on the competence requirement throughout the field.

In order to fully understand the competence requirements, it is essential to also know which reality the informants are exposed to – what scenarios they see in the future. Generally, there are two scenarios: a traditional future, where ship designs won't change. The ships that were build ten years ago will need to be operated ten years from today. A reality where the market leaders are the companies who can bring the running costs down. The shipping companies are the primary proponents of this scenario. The other scenario is the technological, where the important factor is being first with new technology. It is mostly the support companies and a couple of the regulatory institutions which propose a future where technological development and legislative changes will shape the need for a different mix of competences. The stakeholders' beliefs about the future is especially important when it comes to the question of whether the marine engineer should be a craftsman or an academic, or somewhere in between.

The shipping company's orientation towards a practice-oriented marine engineer is supported by the assumption that the operation and maintenance of the ship will not change much in 10 years' time. The general direction for the shipping companies also leans towards more green innovation, and process optimisation because the modern world, and especially the shipping industry, have a significant focus on that area, and the assumption for the group shows that this focus will only grow in the future.

The group of support companies' assumption for the future revolves around being the first with new solutions and products. They need to develop and implement new technology which requires the ability to innovate. This relates to this group's demand for a higher level of digitalisation and automation, but also a high demand for business understanding at a multi-structural level. In this segment the marine engineer is perceived as an academic, broadly speaking. The informants conceptualise innovation in two different ways. Either as optimisation in the everyday operation of the vessel, or as the creation of new products or solutions. Either way, all informants request that marine engineers apply competence in innovation at a day-to-day basis.

To sum up, all of the future competences required by the informants are included in the current Ministerial order of the Bachelor in Technology Management and Marine Engineering, apart from the areas of innovation and digitalisation, and personal competences. The informants request a higher level of understanding within the subject of innovation than the ministerial order is securing today. Digitalisation as a subject area is not included in the current ministerial order, which makes it optional for educational institutions to include it in their curriculum. Furthermore, it was observed that, despite the word digitalisation was used frequently, the meaning of the word differed. Some believe that digitalisation will bring insight to the operation of ships, while others speak of digitalisation as knowing how to set up workstations. Either way, competences in digitalisation were mentioned by 8 out of 14 informants which suggest that in some shape or form, digital competence will be of relevance in any future scenario. Other competences mentioned are the personal competences which are difficult to place under a subject area in the current ministerial order. These competences were mostly requested by employers who sought curiosity and

independence in their marine engineers. The wanted personal competences are not specifically secured in the ministerial order, which means that they, too, are left in the hands of the educational institutions.

The marine engineer education is legislated by the Danish government and in accordance with the international STCW Convention. It is an advantage that the education is partly legislated by an international convention, due to comparability, but it also means that changes cannot be implemented as fast. Whether the informants believe that their business model will operate with traditional or the technological ships in the future, many believe that the future will be more complex than it is today. This may warrant a change in the content of the education. If changing the education system is a slow process, the change in the demand of future competences, will need to be provided by continuing education. In 2006, the marine engineer education became a Bachelor's degree, which then opened the door for further education. Despite this, there is no culture of further education within the marine engineer field, nor many options for further education. If the future competences requirements are to be met, there must be an increased focus on flexibility in the educational system.

5 CONCLUSION

The maritime industry is undergoing a transformation which influences the demand for specific competences as well. The study suggests that management, innovation, process understanding, maintenance and digitalisation are competences which will be in demand in the future. These five subjects are the areas which most informants have requested competences in. Based on the informants' beliefs about the future – traditional or technological - the marine engineer needs to be competent as a craftsman and a manager and be able to innovate through optimisation or by creating new solutions. In order to accommodate these demands, the following three suggestions are proposed:

1. *An increased focus on the areas of digitalisation and innovation;*
2. *Utilisation of continuing education to enhance the competences of the marine engineer;*
3. *Regulatory efforts to maintain and expand the flexibility of the educational system, to support the changing demands.*

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