IJSSR International Journal of Social Service and Research
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Vol. 04, No. 06, June 2024
e-ISSN: 2807-8691 | p-ISSN: 2807-839X

RESHAPING CURRICULUM OF INDONESIAN MARITIME EDUCATION AND TRAINING

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Keywords
Reshape, curriculum, maritime education and training

ABSTRACT
Maritime education and training are pivotal for the development and operation of autonomous ships and green port era, encompassing areas such as safety, economic advantages, legal frameworks, cybersecurity, and operational efficiency. The author aims to develop robust and resilience curriculum for future generation which is a combination of well developed STCW (Standard of Training & Certification of Watchkeeping) and Indonesia Educational Standards through literature review and applying a well-designed guidance from the Indonesian Ministry of Education. The research contribution lies in the development of an integrated curriculum that aligns international maritime standards with national educational requirements, using a systematic approach informed by literature and official educational guidance. The data then compared with some MET's curriculum and the results are proven to be aligned with every limitation set up by International Standards and Indonesian National Education Standards.

INTRODUCTION

The rapid advancement of science, technology, engineering and math (STEM) has greatly influenced the development and characteristics of shipping and maritime technology and has had consequences on human resources who operate and manage ships, including the science of navigation which tends to be eroded by the modernization of navigation tools while if we think that if we the navigation itself conduced inefficiently, it will cost of revenue losses to the stakeholder (Hobbs, 1981). So, it is very necessary to improve the ability of human resources related to the operation of ships in navigation science including aspects of mastery of knowledge, work abilities, attitudes and values, general skills and special skills (Emad & Ghosh, 2023) and also accommodate the Indonesian Workforce Framework (KKNI) and National Standard (SN-DIKTI). In line with the development of science and technology in the field of maritime and human resource, needs that are more specific according to the field of work and the specifications of maritime resources competencies need to be adjusted to the technology used in certain fields of work (Çelik et al., 2019).

https://doi.org/10.XXXXX/ijssr.xxxx.xx

In its early days, vocational higher education was intended to bridge (interface) between Engineers and Operators. Vocational higher education has not specifically answered the challenges of today's developing nation (Oviawe et al., 2017). Vocational higher education takes a role in producing competent graduates with qualifications that match the challenges faced by the Indonesian nation. Vocational higher education can precisely identify needs in their environment and prepare a learning process that ensures graduates can answer these challenges. Furthermore, vocational higher education graduates must redefine the role in the constellation of higher education in Indonesia which currently includes Universities, Institutes, Colleges, Vocational higher education, Academies, and a new addition, namely Community Academies. Vocational higher education graduates at universities/academies and polytechnics should be encouraged not only to be able to "work", as this role has now been taken over by Community Academies. The profile orientation of vocational higher education graduates needs to be reorganized and refined to include a posture as a "job creator" who is "aware" and "understands" the excellence of their region (Kemendikbud, 2016).

In the foreseeable future, MASS developer and researcher realized that to pushing boundaries in Autonomous Surface Vessel (ASV) they must invent some “bridge” which is an onshore operator who conduct any related navigational control, perception and decision making (Song et al., 2023). The onshore operator is a human being who able to forecast any risk related to operation of ASV and able to solve any problem related to the operation of ASV from departure until arrival at port. As regulated by IMO, MASS had four degrees of automation, which is the second and third degree still needing human involvement. In doing so, much research published and focusing on the main issue, which is Bridging Human-AI Interaction (before entering fully autonomous ship). The focus on MASS is to put minimal risk in collision prevention (by applying industry proven systematic like COLREG) and trajectories selection which based on ship’s motion of a ship. All data should be calculated and stored in huge database processed by machine learning technology. Until now, the reliable interface between subsystem and stable operation logic still in the process of making (Aristotelis et al., 2018). Maritime Autonomous Navigation Decision – Making System (MAN-DS) which is a system that will bridge between Navigation Perception System (NPS) and Ship Autonomous Control System (SACS). The NPS is like perception machine learning that operates from various layer of inputs or information on the bridge based on current situation of any MASS facing. The perception will then process into decision making layer where all various information analysed and projected into action. That process required some decision-making system which the author propose. After the decision being made and action is taken, the control system then responsible for converting navigation decisions into more specific control instructions to achieve precise control of ship navigation (Shaobo et al., 2023). All research that mentioned above is implemented to a real ship and performed successfully. The reliable interface that continuously share data and jointly support the entire navigation process needs to be think about in any further research related to MASS in any degrees. That reliable interface is called “digital twin”. While digital twin technology still in the process, many researchers also develop abundance of method of data-processing using various algorithm (Kim et al., 2023). Facing that challenge, MET in Indonesia should consider preparing human resources that able to apprehend and understand not only technology but also have navigational background.

In 2023, research conducted in Germany and find that as of right now, operators operating in a VTS are qualified marine professionals and adhere to both unique national regulations as well as international principles from captains or navigating officers with experience. To obtain candidates for a position in a VTS Centre must possess the minimal STCW requirement for officers who keep watch. Most operators have officers with more than a year of experience in watchkeeping, either Captains or Chief Officer. Given this requirement, VTS Candidates receive training using the VTS model course V-103 by the IALA. Besides theoretical training providing the basics of international and national legal frameworks, rules and regulations, operators are also trained in practical operation in simulator courses, get a theoretical knowledge of the national maritime industry and law related to the job. The finding suggests that even today, VTS operation and training are still highly traditional and grounded in real-world application. As the study had revealed, most of the participants continue to view their time at sea as the key qualification for employment in a VTS (Janssen et al., 2023).

In Green Port domain, green ports, also referred to as eco-ports, are dedicated to reducing their environmental impact by minimizing their ecological footprint, curbing greenhouse gas emissions, safeguarding marine ecosystems, and advocating for the adoption of renewable energy sources (Lin et al., 2022). Marketing strategies for green ports are explored in detail, highlighting the significance of promoting environmental consciousness among port stakeholders and customers for sustainable growth and development (Lam & Li, 2019). Additionally, green port strategies implemented in developed coastal countries offer valuable lessons for the sustainable development path of other nations, as exemplified by a case study in Vietnam (Nguyen et al., 2022). Evaluating and governing green development practices in ports are crucial for ensuring the effective implementation of sustainability initiatives, which is evident in a seaport case in China (Hua et al., 2020). Several research papers present innovative approaches for evaluating and forecasting the competitiveness and sustainability of green ports. Machine learning methods are utilized to predict energy consumption and enhance energy efficiency in port operations, contributing to a greener and more environmentally friendly maritime industry (Wang et al., 2023). The concept of a circular economy is explored in the context of green port implementation in Indonesia, emphasizing the importance of sustainable practices and resource utilization (Gurning & Tangkau, 2022).

Maritime education and training are pivotal for the development and operation of autonomous ships. As the maritime industry transitions towards autonomous vessel operations, it is essential to predict the changes necessary for seafarer education and training in the era of Maritime Autonomous Surface Ships (MASS) (Jo et al., 2020). The introduction of autonomous ships is expected to reduce maritime accidents and enhance safety by minimizing human involvement, emphasizing the need for training and education to adapt to this new technology (Liu et al., 2020). With predictions of both seafarers and non-seafarers being involved in the critical operations of autonomous vessels, it is imperative to identify key maritime stakeholders and investigate their beliefs and perceptions on the training requirements of the future shore-based operators (Emad & Ghosh, 2023). Furthermore, autonomous ships must provide significant economic, environmental, safety, and interoperability advantages for a transition to autonomy to be feasible, highlighting the importance of comprehensive education and training in these areas (Kurt & Aymelek, 2022). The maritime industry is on the brink of a paradigm shift, and regulations and training need to be implemented before the industry can progress towards autonomous vessel operations (Chan et al., 2022). Autonomous ships aim to improve the safety and efficiency of maritime operations while preventing the exposure of the ship crew to on-board hazards, emphasizing the need for specialized education and training in safety protocols and hazard prevention (Chaal et al., 2020). The development of autonomous ships is at an advanced stage, and researchers believe that autonomous shipping will help reduce mishaps by eliminating navigation problems and the burden of fatigue, which have been established as primary human error factors associated with crewed ships (Osaloni & Ayeni, 2022). The International Maritime Organization (IMO) has recognized the importance of creating the international legal regime for autonomous vessels, emphasizing the need for education and training in the legal and regulatory aspects of autonomous shipping (Vio & Brdar, 2022). Additionally, maritime cybersecurity is critical as autonomous ships are being developed, highlighting the need for specialized training in cybersecurity for autonomous vessels (McGillivary, 2018). In conclusion, the role of maritime education and training in autonomous ships and green port era are multifaceted, encompassing areas such as safety, economic advantages, legal frameworks, cybersecurity, and operational efficiency.

The author aims to develop robust and resilience curriculum for future generation which is a combination of well developed STCW (Standard of Training & Certification of Watchkeeping) and

Indonesia Educational Standards through literature review and applying a well-designed guidance from the Indonesian Ministry of Education. The research contribution lies in the development of an integrated curriculum that aligns international maritime standards with national educational requirements, using a systematic approach informed by literature and official educational guidance.

METHODS

The research method uses systematic review. This method will identify what the researcher has written about subjects or topics that are done selectively (Kosztyán, 2021). The goal is to obtain summary of existing scientific literature and produce reports comprehensive about the current position of science related to specific topics such as STCW, IMO Model Courses, IAMU Body of Knowledge and Indonesian National Education Standards. The data then compared with some MET's curriculum and the results are proven to be aligned with every limitation set up by International Standards (STCW, IMO Model Courses) and Indonesian National Education Standards.

RESULTS

Indonesia's Ministry of Education and Culture already announced recent policy regarding National Education Standard. It simplified the standard domain and giving huge opportunity and flexibility to all Higher Education / Universities / Institutes / Polytechnics to implement and embedded skill and knowledge that needed for the future and required by the industry or government. This opportunity must be acknowledged as soon as possible by all Indonesian MET by implementing all curriculum review they made recently including all program related to "freedom of learning or campus freedom". The Industry/Factory-Academy relationship must be established, international student exchange program, research program and any other related activities in academic field must be implemented to achieve each MET's goals based on their vision and mission. Current MET in Indonesia is divided by two, between adhered to the Ministry of Education from the perspective of the Diploma Program and Ministry of Transportation from the perspective of Proficiency and Competency according to STCW. Question may arise in the future regarding how all MET implemented those goal to their curriculum.

New Proposed Approach of Body of Knowledge

Indonesia's Ministry of Education and Culture already announced recent policy regarding National Education Standard. It simplified the standard domain and giving huge opportunity and flexibility to all Higher Education / Universities / Institutes / Polytechnics to implement and embedded skill and knowledge that needed for the future and required by the industry or government. This opportunity must be acknowledged as soon as possible by all Indonesian MET by implementing all curriculum review they made recently including all program related to "freedom of learning or campus freedom". The Industry/Factory-Academy relationship must be established, international student exchange program, research program and any other related activities in academic field must be implemented to achieve each MET's goals based on their vision and mission. Current MET in Indonesia is divided by two, between adhered to the Ministry of Education from the perspective of the Diploma Program and Ministry of Transportation from the perspective of Proficiency and Competency according to STCW. Question may arise in the future regarding how all MET implemented those goal to their curriculum. To achieve this, first thing they must make a mutual perception in Body of Knowledge. The below proposed approachis for Nautical Study Program in Diploma III and it is also possible to implement it to Diploma IV (since both have the same output as navigational officer competence certificate). The same method is possible to be implemented for engineering and shipping departmentHere presented BoK from the International Association of Maritime University (IAMU) published back in 2019:

Table 1. Body of Knowledge

No.	Body of Knowledge
a.	Foundational Knowledge and Skills
1)	Mathematics
2)	Natural (physical) sciences
3)	General humanities and social sciences
4)	English language and maritime communication
5)	Computing and informatics
6)	Physical and mental fitness
b.	Academic Skills
1)	Problem recognition/solving
2)	Critical thinking
3)	Academic research
4)	Contemporary global issues
c.	Professional – Technical Skills – Example for Nautical:
1)	Technical competencies as per international requirements (STCW)
a)	Terrestrial and coastal navigation
b)	Celestial Navigation
c)	Electronics navigation system
d)	Compass and steering system
e)	Meteorology
f)	Collision regulation and watchkeeping for officer
g)	Emergency procedures and SAR
h)	Maritime English
i)	Visual communication
j)	Ship maneuvering and handling
k)	Seamanship
l)	Cargo handling and stowage include cargo space inspection and reporting
m)	Environment awareness and pollution prevention
n)	Ship construction and stability
o)	Basic knowledge of IMO convention – Maritime Law
p)	Deck machinery and equipment
q)	Ship machineries
2)	Risk assessment and management
3)	Situational awareness, preparedness and response
4)	Technological awareness (job-specific)
5)	Maritime law, policy and governance
d.	Professional – Soft Skills
1)	Technological awareness (global)
2)	Leadership, teamwork and discipline
3)	Effective (interpersonal) communication
4)	Sustainable development
5)	Human resource management
6)	Cultural/diversity awareness and sensitivity
7)	Progressive mindset and lifelong learning
8)	Environmental awareness, sustainability and stewardship
9)	Decision-making and proactivity

10)	Mentorship
11)	Professionalism & Ethical Responsibility

COMPETENCE 1.1	Plan and Conduct a Passage and Determine Position

1.1.1 CELESTIAL NAVIGATION

Textbooks: T8, T9

Teaching aids: A1, A4, A13, A14, A17, A21, A23, A24, A25, A26

Required performance:

1.1 Solar system (4 hours)

- describes the composition and dimensions of the solar system
- names inferior and superior planets
- describes the earth's elliptical orbit, and states approximate perihelion and aphelion distances and dates
- explains the eccentricity of the earth's orbit
- describes the inclination of the earth's axis to the plane of the orbit and the stability of the axis (ignoring precession) and its effect on the seasons
- states the dates of the solstices and equinoxes
- explains the concept of the earth's axial rotation giving day and night
- explains the varying length of daylight through the year
- explains daylight and darkness conditions in various latitudes at the solstices and equinoxes
- describes the significance of the tropics of Cancer and Capricorn and of the Arctic and Antarctic Circles

Figure 1. Excerpt from IMO Model Course

From above BoK, all MET should then breakdown the IMO Model Course (figure 1) and weighted them according to the BoK which refers to domain in Bloom's taxonomy to get credits in every semester as shown below table:

Table 2. Core Curriculum

No.	Subject	BoK	Depth		
			Cognitive	**Affective**	**Psychomotor**
a.	Foundational Knowledge and Skills				
1.	Religion Education	General humanities and social sciences	Applying 3	-	-
2.	Citizenship	General humanities and social sciences	Applying 3	-	-
3.	Indonesian Language	General humanities and social sciences	Applying 3	-	-
4.	Pancasila	General humanities and social sciences	Applying 3	-	-
		Cultural/diversity awareness and sensitivity	Applying 3	Valuing (Understanding & Acting) 3	-
5.	Safety Culture	General humanities and social sciences	Applying 3	-	-
		Progressive mindset and lifelong learning	Understanding 2	Valuing (Understanding & Acting)	-

				3	
		Critical thinking	Understanding 2	Valuing (Understanding & Acting) 3	-
		Situational awareness, preparedness and response	Applying 3	Valuing (Understanding & Acting) 3	-
6.	Social Psychology	General humanities and social sciences	Applying 3	-	-
		Progressive mindset and lifelong learning	Understanding 2	Valuing (Understanding & Acting) 3	-
		Critical thinking	Understanding 2	Valuing (Understanding & Acting) 3	-
		Situational awareness, preparedness and response	Applying 3	Valuing (Understanding & Acting) 3	-
7.	Applied Mathematics	Mathematics	Applying 3	Valuing (Understanding & Acting) 3	-
8.	Applied Physics	Natural (physical) sciences	Applying 3	-	-
9.	Maritime English	English language and maritime communication	Applying 3	-	-
10.	Technology	Computing and informatics	Applying 3	-	-
		Contemporary global issues	Understanding 2	Valuing (Understanding & Acting) 3	-
		Technological awareness (job-specific)	Applying 3	Valuing (Understanding & Acting) 3	
		Technological awareness (global perspectives)	Applying 3	Valuing (Understanding & Acting) 3	-
BK			55	33	-
b.	Academic Skills (Skill Akademik)				

12.	Research & Statistics	Problem recognition/solving	Applying 3	Valuing (Understanding & Acting) 3	-
		Critical thinking	Understanding 2	Valuing (Understanding & Acting) 3	-
		Academic research	Applying 3	Valuing (Understanding & Acting) 3	-
		Contemporary global issues	Understanding 2	Valuing (Understanding & Acting) 3	-
BK			10	12	
c.	Professional – Technical Skills				
13.	Terrestrial Navigation	Terrestrial and coastal navigation	Applying 3	Valuing (Understanding & Acting) 3	Guided Response 3
14.	Celestial Navigation	Celestial Navigation			
15.	Electronic Navigation	Electronics navigation system			
16.	Steering System & Compasses	Compasses and steering system			
17.	Ship Weather Routing	Meteorology			
18.	Colreg	Collision regulation and watchkeeping for officer			
19.	Emergency Procedures & SAR	Emergency procedures and SAR			
20.	Maritime English	Maritime english			
21.	Visual Comm	Visual communication			
22.	Ship handling	Ship manoeuvering and handling			
23.	Seamanship	Seamanship			
24.	Cargo Handling	Cargo handling and stowage include cargo space inspection and reporting			
25.	Stability & Construction	Ship construction and stability			
26.	Ship Equipment	Deck machinery and equipment			

27.	Ship Machineries	Ship machineries			
28.	Environmental Awareness	Environment awareness and pollution prevention	Applying 3	Valuing (Understanding & Acting) 3	Guided Response 3
		Sustainable development	Understanding 2	Responding 2	-
		Environmental awareness, sustainability and stewardship – Soft Skill	Applying 3	Organizing Personal Value System 4	-
29.	Maritime Law	Basic knowledge of IMO convention	Applying 3	Valuing (Understanding & Acting) 3	Guided Response 3
		Maritime law, policy and governance	Understanding 2	-	-
Total BK			58	57	51

Table 3. Co-curricular

No.	Cocurricular	BoK	Depth		
			Cognitive	**Affective**	**Psychomotor**
a.	Cocurricular - Professional – Technical Skills				
1.	Leadership & Teamwork – Onboards Life Simulation	Risk assessment and management	Applying 3	Valuing (Understanding & Acting) 3	-
		Leadership, teamwork and discipline	Applying 3	Valuing (Understanding & Acting) 3	-
		Effective (interpersonal) communication	Applying 3	Valuing (Understanding & Acting) 3	-
		Human resource management – Soft Skill	Understanding 2	Valuing (Understanding & Acting) 3	-
		Cultural/diversity awareness and sensitivity - Soft Skill	Applying 3	Valuing (Understanding & Acting) 3	-
		Decision-making and proactivity – Soft Skill	Applying 3	Receiving 1	-

No.	Cocurricular	BoK	Depth		
			Cognitive	Affective	Psychomotor
		Mentorship – Soft Skill	Understanding 2	Responding 2	-
		Professionalism & Ethical Responsibility – Soft Skill	Understanding 2	Valuing (Understanding & Acting) 3	-
BK			21	21	

Table 4. Extracurricular

No.	Extracurricular	BoK	Depth		
			Cognitive	Affective	Psychomotor
a.	Foundational Knowledge and Skills				
1.	Extracurricular (Athletics, Soccer, Basketball, Volleyball, Sailing, Swimming, Diving, etc)	Physical and mental fitness	Applying 3	Internalizing value system (adopting behaviour) 5	-
	BK		3	5	

New Semester Credts

As depicted on above matrix, the weighted BoK is measured based on depth of the subject given according to Bloom's Taxonomy and in line with the IMO Model Course. In this case, IMO MC 7.03 is used. After the breakdown and weighting process is complete, then we can easily measure the semester's credit as follow:

Table 5. Weighted Core Curriculum

No.	Subject	Weighted BoK		Weighted Subject (Bm)		Credits	
		T (Co+Af)	P (Psy)	T	P	T	P
a.	Foundational Knowledge and Skills						
1.	Religion Education	3	-	3	-	(3/240) x 120 = 1.5 (1)	
2.	Citizenship	3	-	3	-	1	
3.	Indonesian Language	3	-	3	-	1	
4.	Pancasila	9	-	9	-	4.5 = 4	
5.	Safety Culture	19	-	19	-	9.5 = 9	
6.	Social Psychology	19	-	19	-	9	
7.	Applied Mathematics	6	-	6	-	3	
8.	Applied Physics	3	-	3	-	1	
9.	Maritime English	3	-	3	-	1	

10.	Technology & Computer Information	20	-	20	-	10	
	Total	88	-	52	-	40	-
b.	*Academic Skills*						
12.	Research & Statistic Methodology	22	-	22	-	10	-
	Total	22	-	22	-	10	-
c.	*Professional – Technical Skills*						
13.	*Terrestrial Navigation*	6	3	6	3	3	(3/240) x 120 = 1.5 (1)
14.	*Celestial Navigation*	6	3	6	3	3	1
15.	*Electronic Navigation*	6	3	6	3	3	1
16.	*Steering System & Compasses*	6	3	6	3	3	1
17.	*Meteorology / Ship Routing*	6	3	6	3	3	1
18.	*Colreg*	6	3	6	3	3	1
19.	*Emergency Procedures & SAR*	6	3	6	3	3	1
20.	*Maritime English*	6	3	6	3	3	1
21.	*Visual Communication*	6	3	6	3	3	1
22.	*Ship Handling*	6	3	6	3	3	1
23.	*Seamanship*	6	3	6	3	3	1
24.	*Cargo Handling*	6	3	6	3	3	1
25.	*Ship Stability & Construction*	6	3	6	3	3	1
26.	*Ship Equipment*	6	3	6	3	3	1
27.	*Ship Machinery*	6	3	6	3	3	1
28.	*Environmental Awareness*	17	3	17	3	8	1
29.	*Maritime Law*	8	3	8	3	4	1
	Total	115	51	115	51	*27*	*17*
	Total Bm			*189*	*51*		
	Total Credit					*77*	*17*

Table 6. Weighted Cocurricular

No.	Subject	Weighted BoK		Weighted Subject (Bm)		Credits	
		T (Co+Af)	P (Psy)	T	P	T	P
a.	*Foundational Knowledge and Skills*						
1.	*Leadership & Teamwork – Onboards Life Simulation*	42	-	42	-	(42/240) x 120 = 21	(Onboards life simulation in Campus)

Table 7. Weighted Extracurricular

No.	Subject	Weighted BoK		Weighted Subject (Bm)		Credits	
		T (Co+Af)	P (Psy)	T	P	T	P
a.	Extracurricular Foundational Knowledge and Skills						
1.	Extracurricular (Athletics, Soccer, Basketball, Volleyball, Sailing, Swimming, Diving, etc)	8	-	8	-	(8/240) x 120 = 3.3 (3)	

Example for Subject:

Religion Education Subject – the weighted BoK is 3 (based on cognitive depth).

- The weighted BoK then added to become weighted Bm (Subject's Weight)
- Weighted Bm (which is 3) then added to formula 3/240 x 120. Where 240 is assumed total Bm Weight (which is the same value as assumed, 240) and 120 is assumed credits.

Example for Cocurricular:

- MET in Indonesia that administered by Ministry of Transportation adopted Boarding School. To fill the gap after the students finishes their classroom activities, they implement a simulation of onboard's life (look out duties, fire and security patrol, etc).
- This are the breakthrough to quantified procedures and activities after students finishes their class. The simulation begins at 16.00 and finish at 08.00 the next morning. The simulation will be discussed furthermore in future article

CONCLUSION

A well-designed curriculum requires a systematic approach to information from MET's vision, mission, BoK, IMO Model Course, National Regulations, and International Regulations. Credits are based on each hour of the IMO Model Course, converted to Indonesia National Credit, and related knowledge in MASS and Green Port, including information technology and environmental awareness. Implementing these curriculums and a digital campus environment will broaden MET's role and enable it to compete with other universities in STEM fields like China, Korea, and Japan. Collaboration is needed to create future generations using technology in MASS and Green Port.

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