

**DEVELOPMENT OF MARITIME PILOT
TRAINING AND ASSESSMENT FRAMEWORK
FOR MALAYSIAN PORTS USING KNOWLEDGE,
SKILLS AND ABILITIES (KSA) METHOD**

DOUGLAS CHOONG PIN AUN @ DON

**MASTER OF SCIENCE
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ASSESSMENT FRAMEWORK FOR MALAYSIAN PORTS
USING KNOWLEDGE, SKILLS AND ABILITIES (KSA)
METHOD**

DOUGLAS CHOONG PIN AUN @ DON

**Thesis Submitted in Fulfilment of the Requirement for the
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DEDICATION

This thesis is lovingly dedicated to my mother, whose unwavering support, guidance, and sacrifices have shaped who I am today. Your strength and wisdom have always been my source of inspiration. To my beloved wife, whose love, patience, and encouragement have been my anchor throughout this journey. Thank you for standing by me through every challenge and for believing in me when I doubted myself. To my children, whose smiles and laughter remind me of life's true joy. You are my greatest motivation to strive for excellence and leave a legacy you can be proud of. This work is a testament to the love and strength of family, and I am eternally grateful for each of you.

Abstract of thesis presented to the Senate of Universiti Malaysia Terengganu in fulfilment of the requirements for the degree of Master of Nautical Science

**DEVELOPMENT OF MARITIME PILOT TRAINING AND ASSESSMENT
FRAMEWORK FOR MALAYSIAN PORTS USING KNOWLEDGE, SKILLS
AND ABILITIES (KSA) METHOD**

DOUGLAS CHOONG PIN AUN @ DON

NOV 2024

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PhD**

Co-Supervisor : Encik Hafizi Bin Said

Mohammed Ismail Russtam Suhrab, PhD

School/Institute : Faculty of Maritime Studies

Training and assessment of a maritime pilot is mandatory procedure in Malaysia and most countries prior to issuing pilot license. The Knowledge, Skills and Abilities (KSA) theory explains that knowledge develops one's skills, thus leading to improved abilities. Accordingly, this study determined finds that the KSA approach could be applied in the development of maritime pilot training and assessment conceptual framework for Malaysian maritime pilots. The process commenced by obtaining the maritime pilot training and assessment modules from Pilot Board in Malaysia. The modules are then collated, and items are identified as factors and sub factors of knowledge, skills & abilities. For data collection and filtration purposes, the factors, filtering elements, and filtered model (FFF model) were utilized and consulted by interviewing 5 maritime technical experts who are Malaysian maritime pilots with highest license and management experience. Following this, a measurable Likert scale questionnaire was developed for the survey of this study. Data collection comprised a pilot study and a full survey. In the pilot study, data collected from 10 respondents

comprising of deck watchkeeping officers with minimum of class 3 unlimited voyage license were analyzed for reliability using Cronbach Alpha, whereas in the full survey, the data collected from 85 respondents which consists of Malaysian maritime pilot from selected ports in Malaysia, were initially analyzed with a series of factor analysis including Principal Component Analysis (PCA) using SPSS and continued with Confirmatory Factor Analysis (CFA) and Structural Equation Modelling (SEM), which involved the use of AMOS SPSS. Essentially, data obtained from respondents successfully establishes that KSA approach can be applied to develop Maritime Pilot Training & Assessment framework. Therefore, the factors identified in this study are expected to be utilized during training and assessment programs in preparing future Malaysian maritime pilot trainees and obtain increased competency level in anticipation of growing ship size, heavy ship traffic and other challenges.

Abstrak tesis yang dibentangkan kepada Senat Universiti Malaysia Terengganu bagi memenuhi keperluan untuk Ijazah Sarjana Sains Nautikal

**PEMBANGUNAN KERANGKA LATIHAN DAN PENILAIAN MALIM
KAPAL UNTUK PELABUHAN MALAYSIA MENGGUNAKAN KAEDAH
PENGETAHUAN, KEMAHIRAN DAN KEUPAYAAN (KSA)**

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Latihan dan penilaian seorang malim maritim adalah prosedur wajib di Malaysia dan kebanyakan negara sebelum mengeluarkan lesen pemaliman. Teori Pengetahuan, Kemahiran dan Kebolehan (KSA) menjelaskan bahawa pengetahuan membangunkan kemahiran seseorang, seterusnya membawa kepada peningkatan kebolehan. Sehubungan itu, kajian ini mendapati bahawa pendekatan KSA boleh digunakan dalam pembangunan kerangka konsep latihan dan penilaian malim maritim untuk malim maritim di Malaysia. Proses ini dimulakan dengan mendapatkan modul latihan dan penilaian malim maritim daripada Pilot Board di Malaysia. Modul-modul tersebut kemudian dikumpulkan, dan item-item dikenalpasti sebagai faktor dan subfaktor pengetahuan, kemahiran & kebolehan. Untuk tujuan pengumpulan dan penapisan data, faktor-faktor, elemen penapisan, dan model yang ditapis (model FFF) digunakan dan dirujuk melalui temu bual dengan 5 pakar teknikal maritim yang merupakan malim maritim di Malaysia dengan lesen tertinggi dan mempunyai pengalaman dalam pengurusan. Selepas itu, soal selidik skala Likert yang boleh diukur

dibangunkan untuk tinjauan kajian ini. Pengumpulan data terdiri daripada kajian rintis dan tinjauan penuh. Dalam kajian rintis, data yang dikumpulkan daripada 10 responden yang terdiri daripada pegawai dek dengan minima lesen pelayaran tanpa had kelas 3 dianalisa untuk kebolehpercayaan menggunakan Cronbach Alpha, manakala dalam tinjauan penuh, data yang dikumpulkan daripada 85 responden yang terdiri daripada malim maritim di Malaysia dari pelabuhan terpilih di Malaysia, pada mulanya dianalisis dengan beberapa siri analisis faktor termasuk Analisis Komponen Utama (PCA) menggunakan SPSS dan diteruskan dengan Analisis Faktor Pengesahan (CFA) dan Pemodelan Persamaan Struktur (SEM), yang melibatkan penggunaan AMOS SPSS. Pada asasnya, data yang diperoleh daripada responden berjaya menetapkan bahawa pendekatan KSA boleh digunakan untuk membangunkan kerangka Latihan & Penilaian Jurumudi Maritim. Oleh itu, faktor-faktor yang dikenali dalam kajian ini diharapkan dapat digunakan semasa program latihan dan penilaian dalam menyediakan bakal jurumudi maritim Malaysia dan mencapai tahap kecekapan yang lebih tinggi dalam menghadapi peningkatan saiz kapal, lalu lintas kapal yang berat dan cabaran lain.

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To my beloved family; my mother, whose endless prayers and sacrifices have been my constant source of strength; my wife, whose unwavering love, patience, and encouragement kept me grounded; and my children, whose laughter and joy reminded me of my purpose. Your unconditional love and support have been the cornerstone of my success.

Finally, to my friends, thank you for your encouragement, camaraderie, and sacrifices throughout this journey. Your presence has been a tremendous source of motivation and positivity, for which I am forever grateful.

To all who have played a role in this journey, thank you from the depths of my heart.

APPROVALS

I certify that an Examination Committee has met on 21st NOVEMBER 2024 to conduct the final examination of Douglas Choong Pin Aun @ Don, on his Master of Nautical Science thesis entitled “**Development of maritime pilot training and assessment framework for Malaysian ports using Knowledge, Skills and Abilities (KSA) method**” in accordance with the regulations approved by the Senate of Universiti Malaysia Terengganu. The Committee recommends that the candidate be awarded the relevant degree. The members of the Examination Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UMT or other institutions.



DOUGLAS CHOONG PIN AUN @ DON

Date: 24th JUNE 2025

TABLE OF CONTENTS

	Page
DEDICATION	ii
ABSTRACT	iii
ABSTRAK	v
ACKNOWLEDGEMENTS	vii
APPROVALS	viii
DECLARATION	x
TABLE OF CONTENTS	xi
LIST OF TABLES	xv
LIST OF FIGURES	xviii
LIST OF ABBREVIATIONS	xix
LIST OF APPENDICES	xx
 CHAPTER	
1 INTRODUCTION	1
1.1 Background of study	2
1.1.1 Marine Transportation	2
1.1.2 Shipping in Malaysia	4
1.1.3 Maritime pilotage	9
1.1.4 KSA Approach	13
1.2 Problem Statement	14
1.3 Research Question	17
1.4 Research Objectives	17
1.5 Development of Hypothesis	18
1.6 Significance of study	20
1.7 Scope of study	21
1.8 Limitation of study	21
 2 LITERATURE REVIEW	23
2.1 Introduction to the chapter.	23
2.2 Overview of vessels accident under pilotage	24
2.3 Statistics of vessel accident due to pilotage	24
2.4 Report of Vessel accident due to pilotage from 2019 - 2023	28
2.5 Review on history of maritime pilot training and qualification	34
2.6 Review of Malaysia maritime pilotage	36
2.6.1 Licensing requirement for apprentice	37

2.6.2	Licensing requirement -Penang Port Commission (Source: Penang Port Commission- Pilot Training Scheme).	37
2.6.3	Licencing requirement – Pilotage District of Sungai Udang Port (Source: Pilotage Rules and Procedures, 2018)	39
2.6.4	Licensing requirement – Lembaga Pelabuhan Johor	40
2.7	Maritime pilot training and assessment	41
2.7.1	Recommendations by the IMO A.960	41
2.7.2	Modern technology approach	45
2.8	Malaysia maritime pilot training and assessment	47
2.8.1	Lembaga Pelabuhan Johor	47
2.8.2	Sungai Udang Port Pilotage District	48
2.8.3	Penang Port Commission	52
2.9	KSA Theory	54
2.10	Likert scale set questionnaire	56
2.11	Knowledge, Skills and Abilities	57
2.12	Selecting factors to represent maritime pilot knowledge, skills and abilities	57
2.12.1	Selecting factors to represent maritime pilot knowledge.	59
2.12.2	Selecting factors to represent maritime pilot skills & abilities.	61
2.13	Scoping review	63
2.14	Factors, filtering elements and filtered (FFF) model	64
2.15	Structure Equation Modelling	66
2.16	Conclusion	67
3	METHODOLOGY	70
3.1	Research method	70
3.2	Detailed steps of research methodology	71
3.2.1	Step 1 – Gather pilot training and assessment module	71
3.2.2	Step 2 – Identifying Factor FFF	71
3.2.3	Step 3 – Develop questionnaire for survey.	72
3.2.4	Step 4- Pilot study	73
3.2.5	Step 5- Final survey and data collection	73
3.2.6	Step 6- Factor analysis	74
3.2.7	Step 7- SEM analysis	74
3.2.8	Methodological limitations	75
3.3	Development of Maritime Pilot Knowledge, Skills and Abilities conceptual model and hypotheses.	80
3.4	Selecting factors through scoping review	80
3.4.1	Method	80
3.4.2	Determining the scoping review question	81
3.4.3	Selecting literature	81

4	RESULT AND DISCUSSIONS	83
4.1	Research findings	83
4.2	Preliminary results	84
4.2.1	Identifying maritime pilot training and assessment module in Malaysia	84
4.3	Maritime Pilot Knowledge	85
4.3.1	Preliminary Result on Identifying the factors of Knowledge, Skills and abilities	85
4.3.2	Selection of maritime pilot knowledge factors by maritime experts with reference to FFF model	86
4.3.3	The factors and sub-factors for maritime pilot knowledge	87
4.4	Maritime Pilot Skills	96
4.4.1	Identifying Maritime Pilot skill factors	96
4.4.2	Selection of Maritime Pilot Skills factors by maritime experts with reference to FFF model	98
4.4.3	Skill development process	107
4.5	Maritime Pilot Abilities	108
4.5.1	Identifying the Maritime pilot abilities factors	108
4.5.2	Selection of maritime pilot abilities factors by maritime experts with reference to FFF model	109
4.5.3	Practical applications	117
4.6	Pilot survey	118
4.7	Full survey	120
4.7.1	Full survey empirical results	120
4.7.2	Bias Discussion and Response Pattern Analysis	123
4.8	Factor analysis	124
4.8.1	Knowledge	124
4.8.2	Skills	131
4.8.3	Ability	135
4.8.4	Practical Significance and Industry Implications	141
4.9	Confirmatory Factor Analysis (CFA)	144
4.9.1	Theoretical Framework	145
4.9.2	EFA Summary Results	146
4.9.3	CFA Model Specification	147
4.9.4	Interpretation of the Measurement Models	152
4.9.5	Hypotheses Testing	154
5	CONCLUSION	158
5.1	The research findings	159

5.1.1	Identifying the factors and subfactors pertaining to knowledge, skills, and abilities.	160
5.1.2	Determining correlations between the factors for maritime knowledge, skills and abilities	161
5.2	Research Contribution	163
5.2.1	Research application	163
5.2.2	Global Implications	164
5.2.3	United Nation Sustainable Development Growth programme	164
5.2.4	Verification of current KSA framework	164
5.3	Recommendations for future research	165
5.3.1	Extension of KSA research.	165
5.3.2	Human error in maritime pilotage	165
5.3.3	Assessment of pilot using technology	166
5.3.4	Future Research Directions	166
REFERENCES		168
APPENDICES		175

LIST OF TABLES

Table		Page
1.1	Statistic of accidents from 2014 to 2020 according to type of accident (EMSA, 2021)	5
1.2	Statistic of accidents from 2014 to 2020 according to location of accident (EMSA, 2021)	8
1.3	Statistic of accidents from 2014 to 2020 according to type of accident (Jabatan Laut Malaysia, 2020)	9
2.1	Number of incidents occurred during pilotage (Source: IGP&I, 2020).	25
2.2	Categorization by region of the incidents occurred during pilotage (Source: IGP&I, 2020).	26
2.3	Categorization by nature of incidents occurred during pilotage (Source: IGP&I, 2020).	26
2.4	Accident reports from maritime sources from 2019 to 2023	29
2.5	Class of license and limitations (Source: Pilotage Rules and Procedures, 2018)	39
2.6	Training and assessment requirement for maritime pilots of Sungai Udang Port	49
2.7	Assessment Criteria (Source: Penang Port Commission, Assessment Criteria)	53
2.8	Method of collecting data on KSA measures by previous studies	56
2.9	Level attributes, keywords and example of CLO according to COGNITIVE level	59
3.1	Summary for methodology, timeline, population, sampling adequacy, sampling technique, validation and analysis technique for each stage	78
3.2	Overview of the development of the conceptual model and hypotheses	80
3.3	List of literatures to be reviewed	82
4.1	The list of training and assessment module reviewed.	85

4.2	List of technical experts	86
4.3	Maritime Pilot Knowledge	86
4.4	Summary of acceptance and rejection of Knowledge Factors	90
4.5	Summary of Knowledge Factors and sub-factors.	92
4.6	Maritime Pilot Skills Factors and Sources	96
4.7	Factors and reasons	101
4.8	Summary of Skills Factors and sub-factors.	102
4.9	Maritime Pilot Abilities and sources	108
4.10	Maritime Pilot Abilities factor	113
4.11	Summary of Abilities Factors and sub-factors.	114
4.12	Reliability test, Cronbach's Alpha (α), and KMO-Bartlett test before PCA.	120
4.13	Cronbach's Alpha of Factor Knowledge	125
4.14	Descriptive Statistics on Factor Knowledge	125
4.15	KMO and Bartlett's Test of Factor Knowledge	127
4.16	Pattern Matrix of Factor Knowledge	128
4.17	Component correlation matrix of Factor Knowledge	129
4.18	Cronbach's Alpha of Factor Skill	131
4.19	Descriptive statistics of Factor Skill	131
4.20	KMO and Bartlett's Test of Factor Skill	132
4.21	Pattern Matrix of Factor Skill	132
4.22	Component Correlation Matrix of Factor Skill	133
4.23	Cronbach's alpha of Factor Ability	136
4.24	Descriptive statistics of ability factor	136
4.25	KMO and Bartlett's Test of Factor Ability	137
4.26	Pattern Matrix of Factor Abilities	137
4.27	Component Correlation Matrix of Factor Ability	138
4.28	Factor Loadings for Knowledge, Skills, and Abilities	149

4.29	Composite Reliability (CR) and Average Variance Extracted (AVE) Average Variance Extracted (AVE) and Composite Reliability (CR)	150
4.30	Goodness-of-Fit Indices	151
5.1	The list of training and assessment module were reviewed.	159

LIST OF FIGURES

Figure		Page
1.1	The forecasted development in world seaborne trade, as measured by the tonne-mile transportation work carried out (DNV, 2021b).	3
1.2	Distribution by location of marine casualties and incidents (Source: EMSA, 2021)	7
1.3	Conceptual model for research (N. Hairi et. al., 2019)	20
2.1	Structure of Taxonomy circles	62
2.2	Psychomotor Domain as a Taxonomy Circle	63
2.3	Factors, filtering elements and filtered BT education, Knowledge, Attitude, Behavior (FFF model) (Kamis, 2020)	65
3.1	Research flow	70
3.2	Factors, filtering elements, filtered list model (FFF model)	72
4.1	Generic list of knowledge factors to final filtered using FFF model	88
4.2	Distribution of maritime pilot knowledge factor by maritime experts.	88
4.3	Generic list of Skills factors to final filtered using FFF model	98
4.4	Distribution of maritime pilot skills factor by maritime experts.	99
4.5	Generic list of Abilities factors to final filtered using FFF model	110
4.6	Distribution of maritime pilot abilities factor by maritime experts	111
4.7	Number of respondents from respective ports	121
4.8	Working experience of respondents	122
4.9	Qualification of the respondents	122
4.10	Path Diagram of the KSA Model	148

LIST OF ABBREVIATIONS

BT	Basic Training
CFA	Confirmatory Factor Analysis
COC	Certificate of Competency
EMSA	European Maritime Safety Agency
IMO	International Maritime Organisation
ISM	International Safety Management
JLM	Jabatan Laut Malaysia (Malaysian Marine Department)
KAB	Knowledge Attitude Behaviour
MAIB	Marine Accident Investigation Branch
PCA	Principal Component Analysis
SEM	Structural Equation Modelling
SMCP	Standard Marine Communication Phrase
STCW	International Convention on Standards of Training, Certification, And Watchkeeping for Seafarer

LIST OF APPENDICES

Appendix		Page
1	Questionnaire	175

CHAPTER 1

INTRODUCTION

Estuary navigation, manoeuvring in confined waters, ports or canals demands great nautical skill. Merchant vessels with ever larger dimensions have to be safely guided through narrow waterways, often in heavy traffic. The pilot acts as the partner of the captain coping with the demanding role, which requires long experience as well as specific knowledge of the vessel and the estuary. Within a very short period of time pilots have to acquaint themselves with the characteristics and manoeuvring of an unfamiliar vessel, while taking weather conditions, currents and tides into account, before setting course and giving instructions to sail (IMO, 2000)

The statement above summarizes that effective maritime pilots require exceptional nautical skills, extensive experience, specific knowledge, and the ability to manage demanding roles. Recognizing this, the IMO has issued recommendations for minimum training, certification, and operational procedures for maritime pilots, excluding deep-sea pilots.

Therefore, this study aims to review the training and assessment modules currently implemented by Pilot Boards or port operators for maritime pilot trainees in Malaysia. The scope of the review is to assess whether the existing training and assessment methods provided for trainee pilots in Malaysia can be enhanced to better prepare future maritime pilot trainees to confront the emerging challenges in pilotage.

The literature review underscores the necessity for a more effective and systematic approach to training and assessing Malaysian maritime pilots, ensuring the enhanced development of their foundational knowledge, skills, and abilities.

Consequently, this study will embrace the Knowledge, Skills, and Abilities (KSA) approach and formulate a framework that can be utilized to craft future training and assessment modules.

This chapter delineates the background of the study, its problem statement, research questions, objectives, significance, scope, and limitations.

1.1 Background of study

1.1.1 Marine Transportation

Throughout history, people and goods have moved between continents and across oceans by sea. Marine transportation can effectively and efficiently move almost any goods, though the advent of air travel proved preferable for perishable and high-value goods (Schnurr & Walker, 2019). Marine transportation drives 80–90% global trade, moving over 10 billion tonnes of containers, solid and liquid bulk cargo across the world's oceans annually (Schnurr & Walker, 2019).

According to DNV (2021), Between 2018 and 2050, seaborne trade grows 35% (Figure 1.1), as transportation demand outweighs efficiency improvements in almost all shipping segments. Most of the increase in shipping will occur in the coming decades, as seaborne trade rises 29% by 2035. After the mid-2030s, there will be limited growth in most segments, with seaborne trade plateauing at 80,000 billion tonne-miles in 2050.

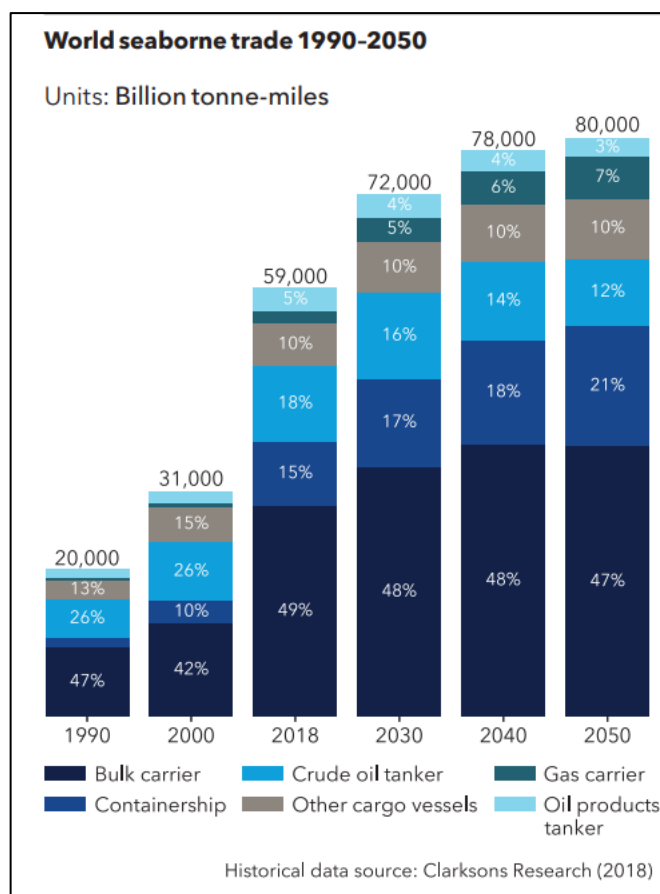


Figure 1.1 The forecasted development in world seaborne trade, as measured by the tonne-mile transportation work carried out (DNV, 2021b).

Container and gas trades are projected to maintain robust growth through 2050. Container shipping is forecasted to surge by 90% between 2018 and 2050, driven by economic expansion primarily outside the OECD and the ongoing containerization of manufactured goods. Notably, regions like the Indian Subcontinent and Sub-Saharan Africa are expected to witness over a three-fold increase in their exports and imports of manufactured goods. The gas trade is set to more than triple by 2050, benefiting from heightened demand in net importing regions (DNV, 2021).

UNCTAD (2024) projects maritime trade to grow by 2% in 2024, driven by strong demand for major commodities like iron ore, coal, grain, oil, and containerized goods. Containerized trade is expected to rebound by 3.5%, up from 0.3% in 2023, supported by easing economic challenges, improved global economic trends, and increased liquefied natural gas exports from countries such as Russia and the U.S.

Between 2025 and 2029, maritime trade is forecasted to grow at an average annual rate of 2.4%, with containerized trade increasing by 2.7%. Growth will be fueled by technological advancements, cleaner energy transitions, and infrastructure development, though risks like the war in Ukraine, geopolitical tensions, and economic uncertainties could pose challenges (UNCTAD, 2024).

Global trade recovery is expected, particularly in major Asian economies and sectors like green energy and AI-related products. Potential U.S. interest rate cuts and a weaker dollar may enhance trade competitiveness, alongside moderating inflation and improved economic stability (UNCTAD, 2024).

1.1.2 Shipping in Malaysia

As per the Malaysia Shipping Masterplan 2017-2022, statistics reveal the significant reliance of the Malaysian economy on shipping, with 98.4% of Malaysian commercial activities conducted by sea in 2016, amounting to RM 1.48 trillion in total trade (MOT Malaysia, 2017). Malaysia ranks 3rd in ASEAN and 24th globally in terms of tonnage measurement, boasting a total deadweight tonnage of 9,612,000 as of 2016 (MOT Malaysia, 2017).

The Eleventh Malaysia Plan (11MP), spanning from 2016 to 2020, addressed Malaysia's developmental trajectory beyond 2020, projecting the country's gross domestic product (GDP) to soar to RM2.6 trillion by 2030 from RM1.4 trillion in 2020. Malaysia's GDP per capita is anticipated to double to RM117,260 in 2030 compared to RM54,890 in 2020 (MOT Malaysia, 2017), thereby indirectly escalating the volume of merchant vessels entering and leaving ports annually.

The maritime industry in Malaysia is a significant contributor to the country's GDP, accounting for about 40%. More than 90% of Malaysia's exports are shipped by sea, with Malaysian ports experiencing an average trade growth of three (3) percent in compound cargo throughput over the last decade. In response to this growth, Port Klang, Malaysia's largest port, plans to augment its capacity by 50% to 30 million

twenty-foot equivalent units (TEUs) per annum by 2040. Similarly, the Port of Tanjung Pelepas (PTP) in Johor is underway with the development of a new berth, set to add 3.5 million TEUs to its current capacity by 2025 (MIDA, 2021). Projections from the Eleventh Malaysia Plan and reports by MIDA (2023) strongly indicate that the volume and size of vessels will continue to increase. With the projection of shipping industry to rise globally as well as in Malaysia in terms of its volume and positive impact to its economic, so does the challenges face by the shipping operators especially the ship navigators as the increase of vessel in volume and size means more constraint area in navigation waters. Mohamed Fazlee, U.S. et. al., (2023) suggested that the rapid growth in fleet size and ship size may lead to an increase in maritime accidents.

Table 1.1 shows type of accidents onboard vessel from 1st January 2014 to 31st December 2020. The navigational casualties, constituted by collision, contact and grounding/stranding, represent 43% of all casualty events. The main casualty event over 2014-2019 is “Loss of control – Loss of propulsion power”. It is the only casualty event that increased continuously since 2014, until a 12.6% decrease in 2020 (EMSA, 2021)

Table 1.1 Statistic of accidents from 2014 to 2020 according to type of accident (EMSA, 2021)

	2014	2015	2016	2017	2018	2019	2020	Total
Loss of control - Loss of propulsion power	372	374	471	506	552	662	579	3516
Contact	391	402	356	421	377	365	364	2676
Damage / loss of equipment	289	365	358	309	343	315	331	2310
Grounding/ stranding	325	328	290	292	302	249	219	2005
Collision	333	297	320	293	282	292	186	2003

	2014	2015	2016	2017	2018	2019	2020	Total
Fire/ Explosion	159	170	133	132	136	131	119	980
Loss of control - Loss of directional control	78	92	83	110	76	87	92	616
Loss of control - Loss of containment	76	60	70	67	68	46	62	449
Loss of control - Loss of electrical power	61	49	47	65	59	66	51	398
Flooding / Foundering	63	60	43	63	35	47	42	353
Capsizing/ Listing	11	14	7	14	17	19	5	87
Hull failure	6	15	21	5	4	4	3	58
Loss of control - Other	1	1	12	4	5	0	1	24
Missing	0	0	1	1	1	2	1	6
Total	2163	2227	2212	2282	2257	2285	2055	15481

Figure 2.16: Distribution by location of marine casualties and incidents

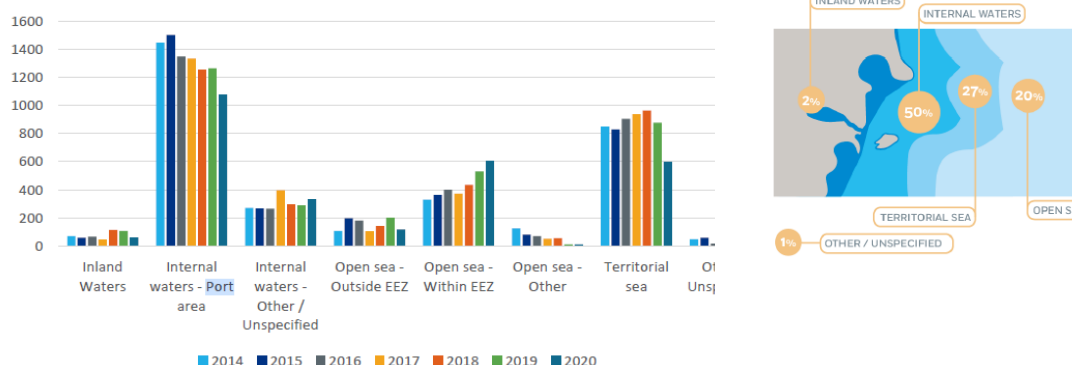


Figure 1.2 Distribution by location of marine casualties and incidents (Source: EMSA, 2021)

Internal waters are the location where more than half of the casualties take place. The sub-category port area represented 41.5% of all accidents. However, accidents in port areas continued decreasing since 2015. At the same time, the increase of casualties in open seas also continued, and almost doubled over the period. (EMSA, 2021). Nevertheless, the volume of accidents remains high.

The executive summary by ECIMP stated that the year 2020 appeared to have been a positive year considering the decrease or stabilisation of most of the indicators, such as the number of occurrences, ships lost, fatalities or injuries. However, consequences of COVID pandemic are very likely to have affected the area of marine casualties and incidents, taking into consideration its significant impact on shipping in 2020 reduced traffic in general, cruise ships and ferries activities heavily disrupted, etc.

Above statements shows that there is a correlation between the decrease of accident cases towards the reduced traffic density. Therefore, looking at the forecast of growth in shipping, numbers of accidents are expected to increase due to the expected increase of traffic density.

Table 1.2 Statistic of accidents from 2014 to 2020 according to location of accident (EMSA, 2021)

		2014	2015	2016	2017	2018	2019	2020	Total
Internal waters	-	1449	1504	1351	1351	1257	1266	1081	9245
Port area									
Territorial sea		850	830	907	938	964	878	599	5966
Open sea - Within EEZ		329	363	399	371	434	531	606	3033
Internal waters	-	271	266	265	396	296	290	334	2118
Other / Unspecified									
Open sea - Outside EEZ		107	196	180	105	142	200	117	1047
Inland waters		69	58	66	46	113	106	59	517
Open sea - Other		125	81	69	50	55	10	11	401
Other / Unspecified		47	58	15	21	12	22	30	205
Grand Total		3247	3356	3252	326	3273	3303	2837	22532

Table 1.3 provides generic types of accidents onboard vessel in Malaysian waters from 1st January 2014 to 31st December 2020 which is derived from Jabatan Laut Malaysia statistics. The data is not focused on accidents during pilotage because former records specific to accidents during pilotage in Malaysian waters is not available.

Table 1.3 shows the navigational casualties, constituted by collision, contact and grounding/stranding, represent 54.3% of all casualty events. The main casualty event over 2014-2020 is “Collision/contact “ with a total of 197 incidents.

Table 1.3 Statistic of accidents from 2014 to 2020 according to type of accident (Jabatan Laut Malaysia, 2020)

	2014	2015	2016	2017	2018	2019	2020	Total
Collision/ Contact	17	23	21	31	15	47	43	197
Sink/ Foundering	11	12	17	28	7	13	5	93
Incident (Missing/Flooded/ Cargo/Drifting/ Etc)	7	10	11	11	8	6	12	65
Grounding	6	11	5	21	5	5	5	58
On fire	2	5	4	4	5	4	6	30
Capsized	0	2	4	4	1	1	2	14
Man overboard	0	3	5	1	2	2	0	13
Total	43	66	67	100	43	78	73	

1.1.3 Maritime pilotage

Since the early days of marine navigation, vessels entering or leaving port, or navigating other hazardous waters, have been guided by pilots possessing a thorough knowledge of local currents, tides, rocks, shoals, weather, and other conditions. The skill and care of the pilot are vitally important for the safe passage of vessels, for the safety of lives and cargo, and as means to protect the port and the marine environment. Today, as in the past, vessels normally are required by maritime countries to engage independent marine pilots when entering or leaving ports or piloting waters. Piloting demands more than guiding a passage through a particular waterway; it requires a diverse mix of navigation and shiphandling skills (Armstrong, 1980; Hofstee, 1991; MacElrevey, 1988; Plummer, 1966, National Research Council, 1994). Pilots with local knowledge have been employed on board ships for centuries to guide vessels into or out of port safely- or whenever navigation may be considered hazardous,

particularly when a shipmaster is unfamiliar with the area (International Maritime Organization, 2019)

Marine Pilot is an individual who operates from an organized pilot association or group and is licensed by a governing authority (federal, state, or local authority empowered by a state) to provide pilotage services over specific waters or routes. May provide some or a combination of bar, harbour, river, and docking pilotage services (National Research Council, 1994).

Qualified pilots are usually employed by the local port or maritime administration and provide their services to ships for a fee, calculated in relation to the ship's tonnage, draught or other criteria. The importance of employing qualified pilots in approaches to ports and other areas where specialized local knowledge is required was formally recognized by IMO in 1968, when the Organization adopted Assembly resolution A.159(ES.IV) Recommendation on Pilotage. The resolution recommends Governments organize pilotage services where they would be likely to prove more effective than other measures and to define the ships and classes of ships for which employment of a pilot would be mandatory (International Maritime Organization, 2019).

The Maritime Pilot is also regarded as a highly specialized adviser to the shipping industry with specific local and regional knowledge. He advises Masters and/or bridge teams in the conduct of safe navigation of all kinds of vessels in confined, restricted pilotage waters near the coast and into ports, estuaries and fairways. (Maritime M., 2021). The pilot acts as the partner of the captain coping with this demanding role, which requires long experience as well as specific knowledge of the vessel and the estuary. Within a short period of the time pilots have to acquaint themselves with the characteristics and manoeuvring of an unfamiliar vessel, while taking weather conditions, currents and tides into account, before setting course and giving instructions to sail (IMPA, 2004, IMO,2004).

Piloting is largely a visually dependant activity involving a continuous series of actions and reactions to the transit situation. Most of the essential navigational tasks

are performed by the pilot's use of visual sightings of navigational aids and prominent landmarks. Vessel control, or track-keeping actions, are taken to maintain a known course or to move the vessel from its present position to a desired position. In order to process this visually-acquired data, a pilot needs knowledge, i.e., cognitive representations which are used to represent data (Wallace W.A & Grabowski M, 1993).

There is growing concern over the professional development of pilots, especially those who direct and control the movements of tankers, and over the qualifications of licensed operators and pilots of coastwise towing vessels, especially tank barges. Programs for acquisition of theoretical knowledge and entry-level navigation and piloting skills range from training provided through accredited undergraduate programs at maritime academies to apprenticeships and on-the-job training (National Research Council, 1994).

IMO even noted that each pilotage area needs highly specialized experience and local knowledge on the part of the pilot during the Convention on the International Maritime Organization concerning the functions of the Assembly in relation to regulations and guidelines concerning maritime safety and the prevention and control of marine pollution from ships.

The expertise needed to serve as a marine pilot includes basic maritime theoretical knowledge and practical skills; local knowledge (such as routes, traffic conditions, seasonal variations); shiphandling skills; familiarity with technically advanced equipment; and the ability to assess the capabilities of masters, mates, and bridge personnel and to interact effectively with them. On the-job training usually consists of progressive advancement in knowledge about routes and categories of ships (National Research Council, 1994).

There are initiatives done by European pilots whereby they collaborated in developing a framework named CERTIPILOT, which focuses on the recognition of pilots' qualifications acquired through vocational training; specifically, through the application of the European Credits system for Vocational Training (ECVET) and the

European Qualification Framework (EQF) to the vocational training undertaken by Maritime Pilots. More specifically, CERTIPILOT provides a qualification for Maritime Pilots who wish to specialise in emergency manoeuvring and risk prevention in ports. The qualification is based on the competences that Maritime Pilots need to strengthen and links them with the existing training available.

A similar effort was also done in Australia through on of their CPA which is NSW Maritime. They developed NSW MARINE PILOTAGE CODE (106) through the combined efforts of NSW marine pilots; the NSW Australian Maritime Officers Union Marine Pilots Working Group; marine pilots of the Sydney Ports Corporation, Newcastle Port Corporation, and Port Kembla Port Corporation or their subsidiaries; NSW Maritime and the New South Wales Port Corporations. The Code provides comprehensive explanation on requirement for licencing and certification of pilot and the standards that are required to be adhered by the pilots which includes training and assessment required to obtain Pilots license.

For the American maritime pilots, their trainings and developments are organized by The American Pilots' Association. The association adopts the recommendation set by IMO resolution A.960. However, they also developed resolutions, guidelines and best practices manual for the benefit of the pilots in their association.

The typical state-licensed pilot in the U.S. is the most highly trained mariner in the world. Pilots have either extensive deep-sea or tug experience before they enter pilot training programs or they go through a lengthy (four to seven years) apprenticeship program. In addition to extensive prior experience or detailed instruction in basic shiphandling, pilot trainees undergo long periods of route specific training under the guidance of experienced pilots. This hands-on training is supplemented with the latest in classroom instruction and simulator training. Once a pilot receives a license, he or she undergoes regular continuing training, including training in bridge resource management for pilots, emergency shiphandling, and new navigation technology, as well as other types of instruction and practice on full mission bridge simulators and manned models. Each state pilot is expected to be comfortable

with the latest in navigation technology and ships' systems (American pilots association, 2015)

1.1.4 KSA Approach

In the pursuit to improve maritime pilot training and assessment for Malaysian pilots, this study explores knowledge, skills and abilities (KSA) theory as proposed by (Hunter & Hunter, 1984; Reilly & Chao, 1982; Schmitt, Gooding, Noe & Kirsch, 1984, Stevens & Campion, 1994) stating that the history of success in the prediction of job performance has been much better with KSA based Systems. This statement is also supported by (Wang, N. et. al., 2005) stating that it is often the KSA required for performing the tasks, rather than the job tasks themselves, which are tested by licensure and certification exams.

The implementation of KSA theory has been studied in a number of areas for decades, such as the aviation (Walters J. M., 2002), education technology (Kang Y. & Ritzhaupt A.D, 2015), accounting (Palmer, K.N., 2004), human resources (Stevens S.J. & Campion M.J., 1994), medication, IT, engineering, hospitality management (Cetin, G., 2016), Agriculture workforce (Erickson et. Al(2018). To be specific, Walters, J.M. (2002) in his pilot proficiency audit of KSAs stated that a complete air-carrier safety program must provide reliable data in all pilot performance categories; knowledge, skills, and abilities. In his study, he suggested changes to pilot training syllabi and techniques as well as hiring practices. Kang Y. & Ritzhaupt A.D (2015) conducted research to identify competencies of an educational technologist via a job announcement analysis. They managed to derive 150 knowledge, skill and ability statements from the job analysis themselves based on a conceptual framework.

Therefore, this study aims to develop a maritime training and assessment framework by using KSAs method for Malaysian Pilots. IMO resolution A.960 and modules from Malaysian pilot boards will be the basis of this study which is relevant to the knowledge, skills and abilities method.

1.2 Problem Statement

Table 2.1 shows accidents during pilotage from 1999 to 2020, with a total of 1,046 incidents, highlighting that such occurrences remain persistent. The average cost per incident, amounting to \$1,741,545, underscores the significant financial impact of these accidents, warranting serious attention. Table 1.3 provides data on accidents reported in Malaysian waters. Although the table is not specific to accidents during pilotage, it reveals that 54.3% of the reported incidents are attributed to navigational casualties, including collisions, contacts, and grounding/stranding. These types of accidents are similar to and closely related to those occurring during pilotage.

When accidents occur whilst vessel is under pilotage, the cause is generally a collective under-performance of the bridge team and it is also recognized that the ship's masters and officers will also have played a part (IGP&I, 2019).

Based on the above statement, Nuutinen, M., and Norros L. (2009) has identified that part of the reason of accidents occurrence is due to tension in pilotage operation. In their article describing the development of a new core task analysis-based method for accident analysis, they also analysed the evolution of piloting practices and tensions of the piloting system (adopted from Engeström (1987)) and has identified nine tensions in pilotage operation which were stated below:

1. The capacity and conditions of the fairways and the traffic system are not able to fulfil the increasing demands for safety, productivity and quality in society in every situation.
2. Reducing the safety margin (bigger ships) for navigation in coastal fairways calls for technically mediated navigation and supports the development of a new, cooperative piloting practice on the bridge. An increase in the interaction with other actors in the traffic system could also be facilitated.
3. The strength of the current piloting practice is in skill-based adaptability. The practice does not include communication and cooperation amongst the bridge crew to such a degree that the current demands require.

4. The current piloting practice cannot efficiently take advantage of the existing navigation technology, and the technology is not being developed according to the demands of the piloting task.
5. The practical responsibility and power relations (based on professional skills) between the master and the pilot are in contradiction with those enacted in the law. This does not manifest itself until the situation demands it.
6. The sources of the pilots' expert identity seem to be strongly in individual skills and his/her own experience and responsibility, which get even stronger when the demands of the situation increase. Cooperation is not included in the conception of expertise or the construction of professional identity. The reduction in peer support (resulting from the fact that the time used at pilot stations has been reduced) can prevent the construction of a new kind of identity when, e.g. the observations on the changes in the core task are not shared.
7. Authority control and supervision do not create sufficient conditions for the situational execution of piloting. Creating support for piloting has been left as the individual pilots' responsibility.
8. The training of pilots cannot efficiently fulfil the pressures for development. The problems are the deficient theoretical teaching in connection with practical training and the missing basic education on route planning and use of technologies.
9. The demands of piloting are not taken into account in designing the navigation technology on the ships. The demands of piloting should be part of the validation and verification criteria.

Summary of above statements shows that part of the reason for the tensions are due to the growth in shipping industry and is supported by the statement from Maritime, M., (2021) that the maritime pilot operates in a challenging environment where vessels are becoming larger, and shipping lanes and waterways are becoming increasingly crowded. The statement was also supported by Demirci, S. E., et. al., (2023) stating that the enormous growth of the capacity and number of ships during the last decade have led to congested marine traffic in narrow canals, straits, rivers,

and ports. Growing ship sizes and increasing traffic are two of the most significant issues in sustainable transportation, as they increase the risk of maritime accidents, especially when navigating confined waters.

Another aspect of the statement emphasizes the need for highly skilled pilots to mitigate tensions during pilotage, ultimately minimizing the risk of accidents that could lead to loss of life, property damage, and harm to the marine environment.

IMO committed to enhancing maritime safety and safeguarding the marine environment, acknowledges the critical role of training and certification in maritime pilotage. Consequently, it has adopted Resolution A960, which provides recommendations on training, certification, and operational procedures for maritime pilots, excluding deep-sea pilots. The IMO urges governments to promptly implement these recommendations to ensure the highest standards of safety and environmental protection.

Although IMO recognizes that high standards of pilotage services already established in many states, there is limited academic research on maritime pilot training. Demirci, et al., (2023) stated that, although losses caused by accidents that occur in areas where pilotage is mandatory are a crucial issue, little study has been done on the subject. Nuutinen, M., and Norros L. (2009) previously also stated that, In general, there are only a few studies focusing on sea pilotage.

A few studies aimed at increasing a pilot's competence have been conducted. For example, Ernstsén, J. and Nazir S. (2020). developed a tool called the computer-aided performance assessment (CAPA) to better assess a pilot's performance during pilotage simulations. Kalulu (2018) compared and contrasted Namibia's maritime training and certification system against those of Denmark and international standards and practices. However, limited studies have been conducted on maritime pilot training and assessment modules.

Therefore, there has yet to be a study on Malaysian pilot training and assessment with regard to its effectiveness as tested by the KSA model.

Hence, the main objective of this research is to highlight the relationship between knowledge and skills, which will lead to the positive development of a maritime pilot's abilities. To achieve this primary objective, the research questions and objectives should be established:

1.3 Research Question

RQ1. What are the availability of training and assessment modules for maritime pilots in Malaysian ports, and what pilot training and assessment that is recommended by the IMO?

RQ2. What are the statistically significant factors and sub-factors that influence maritime pilot knowledge, skills, and abilities within the maritime pilot training modules and IMO Resolution A.960.

RQ3. What are the correlations among the measurable factors representing knowledge, skills, and abilities?

1.4 Research Objectives

Based on the research questions, the research objectives are as follows:

RO1. To examine the current training and assessment modules used by Malaysian pilots including recommendation by IMO Resolution A.960 in relation to maritime knowledge, skills and abilities.

RO2. To identify the factors and subfactors pertaining to maritime knowledge, skills, and abilities.

RO3. To determine the correlation value between the factors for maritime knowledge, skills and abilities.

1.5 Development of Hypothesis

Several methods have been employed in the study of maritime education. For example, Kamis (2020) examined basic training on seafarers' safety using the Knowledge, Attitudes, and Behaviour (KAB) approach. Demirci S.E. et al. (2023) analyzed the causal relationships of marine accidents during ship navigation under pilotage using the DEMATEL approach. Kalulu (2018) investigated maritime training and certification by comparing the standards between Denmark and Namibia. The KSA (Knowledge, Skills, and Attitudes) method is widely used in fields such as aviation education, nursing education, management, and others (see Chapter 1.1.4). However, there are limited studies in maritime education that apply the KSA approach.

To address this gap, this study aims to introduce the KSA framework into maritime education. Specifically, it builds upon the KSA approach proposed by Hairi N. et al. (2019). While their study is not directly related to maritime education, particularly in training and assessment for maritime pilots, it explores the domains and elements that form competency-based learning objectives focused on enhancing graduates' employability. This study ultimately proposes a comprehensive conceptual framework for graduate employability and competency-based learning objectives, which could serve as a guide for universities in designing curricula that better prepare graduates for their employability.

Hairi N. et. al., (2019) states that 'competency' refers to the ability to practice or apply related skills, knowledge, and abilities to accomplish critical tasks in a defined workplace setting (Figure 1.3). In this study, 'competency' was taken to have the same meaning as 'ability'. Therefore, 'abilities' can replace 'competencies'.

In this study's context, 'knowledge' refers to the information and understanding a pilot should possess to develop their skills and abilities to conduct safer pilotage operations.

Hence, the following hypotheses are proposed:

Hypothesis 1 (H1): Maritime pilotage knowledge positively affects maritime pilotage skills. This relationship can be both mediated and moderated as follows:

H1a: Maritime pilotage knowledge enhances maritime pilotage skills through the mediating effect of training opportunities. (More knowledge leads to greater access to training, which in turn improves skills.)

H1b: The relationship between maritime pilotage knowledge and skills is moderated by the effectiveness of education and instructional quality. (The extent to which knowledge translates into skills depends on the quality of education and training materials.)

Hypothesis 2 (H2): Maritime pilotage skills positively affect maritime pilotage abilities. This relationship can be both mediated and moderated as follows:

H2a: Maritime pilotage skills enhance maritime pilotage abilities through the mediating effect of decision-making competence. (As technical skills improve, pilots develop better decision-making abilities, which enhance overall maritime pilotage performance.)

H2b: The relationship between maritime pilotage skills and abilities is moderated by situational awareness and problem-solving capacity. (The extent to which technical skills improve abilities depends on the pilot's ability to assess situations and solve complex problems effectively.)

Hypothesis 3 (H3): Maritime pilotage knowledge positively affects maritime pilotage abilities. This relationship can be both mediated and moderated as follows:

H3a: Maritime pilotage knowledge enhances maritime pilotage abilities through the mediating effect of decision-making competence. (Greater knowledge equips pilots

with better decision-making skills, which in turn improves their overall pilotage abilities.)

H3b: The relationship between maritime pilotage knowledge and abilities is moderated by practical experience and situational awareness. (The extent to which knowledge enhances abilities depends on the pilot's hands-on experience and ability to assess and respond to real-world maritime conditions.)

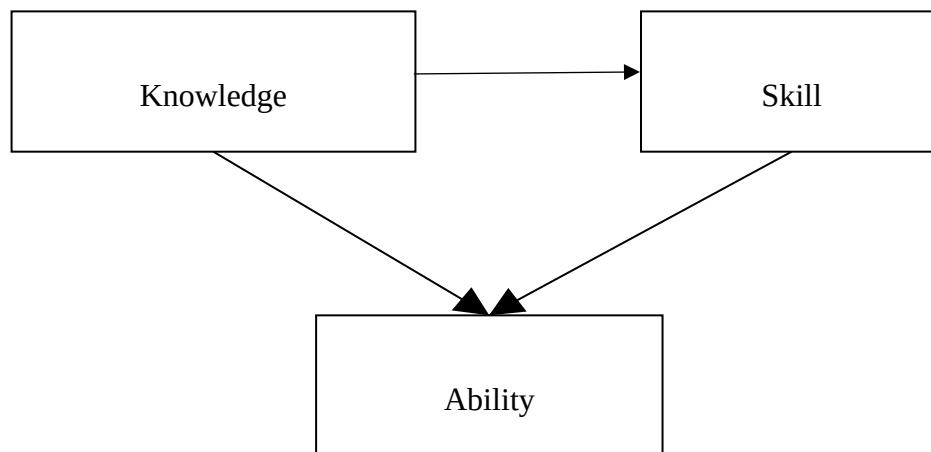


Figure 1.3 Conceptual model for research (N. Hairi et. al., 2019)

1.6 Significance of study

The primary objective of this study is to assess whether the existing training and assessment module in Malaysia can be systematically refined into a comprehensive training and assessment framework using the KSA method. Additionally, the study will provide recommendations for training and assessment in alignment with IMO Resolution A.960.

The research is anticipated to bolster the groundwork for future pilots produced for ports adopting the KSA training and assessment framework as the foundation for their modules. The KSA framework offers a systematic approach to training and assessing Malaysian maritime pilots, enhancing their preparedness for the challenges

they may encounter. This, in turn, better prepares future Malaysian maritime pilots to confront challenges ahead.

Moreover, given the limited research conducted on the training and assessment modules for Malaysian maritime pilots, the Malaysia Marine Department and JPDS could consider adopting the KSA framework and advocating for its implementation across all Pilot Boards in Malaysia.

1.7 Scope of study

This research focuses on the development of maritime training and assessment framework using KSA approach. The scope of this study covers only on Malaysian maritime pilots and current Malaysian training and assessment modules. In this study, a survey was conducted to collect data from seven ports across Malaysia over a three-month period, from 1st January 2023 to 31st March 2023. Questionnaires were distributed to current Malaysian maritime pilots operating in these seven ports, which included Tawau Port, Labuan Port, Bintulu Port, Pasir Gudang Port, Sungai Udang Port, and Penang Port. The training and assessment models were sourced from the Pilotage District of Sungai Udang Port, Johor Port Authority, and Penang Port Commission.

1.8 Limitation of study

The scarcity of research and modules concerning maritime pilot training and assessments poses challenges in finding references. Moreover, this study focuses solely on three latent variables which is Knowledge, Skills and Abilities, potentially overlooking other relevant factors. The limited While the findings may be applicable to other countries due to similarities in training, assessment, and duties, the survey is restricted to Malaysian maritime pilots.

As the objective is to develop a training and assessment framework for Malaysian pilots, respondents are limited to current Malaysian maritime pilots and the Pilot Board in Malaysia. Time constraints also pose a limitation, as maritime pilots often work irregular and demanding schedules, including long hours and on-call duties. These factors leave them with limited time to participate in non-mandatory activities, such as completing surveys, even when the topic is related to their profession.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction to the chapter.

This chapter reviews all the literature that is required to support the study. It began with reviewing statistics on marine accidents during pilotage operations and investigating their causes.

In answering to the statement by IMO recognizing the importance of training and certification in maritime pilotage to promote maritime safety and promote the environment, this study continued by reviewing the current training and licensing standards enforced by the Pilot boards in Malaysia. The review includes the requirement set by various Pilot Boards for becoming a trainee pilot and continues with the training time and examinations that a trainee or apprentice must comply in order to obtain their pilot licences.

It is important to highlight that the contemporary pilot training and assessment methodology employed by most ports in Malaysia is based on the recommendations of IMO Resolution A.960. However, several ports have developed their own modules to enhance the training and assessment of maritime pilots under their jurisdiction. This study, therefore, reviews the training and assessment recommendations outlined in IMO Resolution A.960, as well as the modules prepared by various Pilot Boards in Malaysia.

The study then continues the exploration of several theories to find which is the most suitable to be applied for maritime pilot training and assessment. KSA theory

was found to be most suitable as the history of success in the prediction of job performance has been much better with KSA based Systems (Hunter & Hunter, 1984; Reilly & Chao, 1982; Schmitt, Gooding, Noe & Kirsch, 1984). The relation between pilot training and assessment modules with KSA was also explored and found that very limited study has been conducted.

The study then reviews the theoretical model by Hairi, N., et. al., (2019) in order to develop a conceptual model. Therefore, observe variables or factors need to be identified to represent latent variables. While searching for the best method to gather factors, this study has found out that the scoping review technique with references to the PRISMA model (The Joanna Briggs Institute, 2015; Kamis, 2020) can be utilized for this purposed.

This study also reviews FFF model which can be used to help the author to filter only related factors to the study (Kumar & Dange, 2012; Kamis, 2020).

2.2 Overview of vessels accident under pilotage

The first step in this review was to gather statistics and records of vessel accidents under pilotage operation to support problem statements found. By analysing these data, it is possible to gain insights into the factors that contribute to accidents and evaluate their impacts (Marino, M. et. al, 2023)

2.3 Statistics of vessel accident due to pilotage

Statistics was taken from IGP&I which was based on vessel claims for Protection and Indemnity (P&I) funds of above USD 100,000.00 involving vessels under pilotage from year 1999 to 2019. Statistics show that there was a total of 1,046 incidents in which pilot error either caused or contributed to those events. The total cost of those incidents was over USD 1.82 billion. On average, this represents 52 incidents per year, or one per week (IGP&I, 2020).

Incident statistics for the years between 1999-2018 are shown in Table 2.1, however, since the data for 2019 are limited, they are not included in the table.

Table 2.1 Number of incidents occurred during pilotage (Source: IGP&I, 2020).

Year	No. of Incidents	Total Cost	Average Cost Per Incident
1999	33	\$21,761,748	\$659,447
2000	47	\$35,371,471	\$752,584
2001	70	\$51,090,973	\$729,871
2002	52	\$41,662,008	\$801,192
2003	56	\$106,305,096	\$1,898,305
2004	59	\$76,596,850	\$1,298,252
2005	46	\$39,563,866	\$860,084
2006	54	\$112,306,540	\$2,079,751
2007	57	\$306,538,481	\$5,377,868
2008	57	\$50,811,280	\$891,426
2009	38	\$149,212,660	\$3,926,649
2010	32	\$70,436,063	\$2,201,127
2011	59	\$76,077,997	\$1,271,310
2012	74	\$130,646,688	\$1,765,496
2013	42	\$107,118,832	\$2,550,448
2014	79	\$144,241,993	\$1,825,848
2015	70	\$134,125,800	\$1,916,083
2016	42	\$66,593,613	\$1,585,562
2017	45	\$42,425,808	\$942,796
2018	34	\$58,769,271	\$1,728,507
Totals	1,046	\$1,821,657,039	\$1,741,545

Table 2.2 shows the highest incident reported is from Asia with 365 incidents followed by North America with 202 incidents. Europe came on third with 194 incidents followed by Africa with 119 incidents. South America and Oceania reported the least incidents with 106 and 21. The total cost of those incidents was over USD 1.82 billion. This averages to 52 incidents per year or one per week.

Table 2.2 Categorization by region of the incidents occurred during pilotage (Source: IGP&I, 2020).

Region	No. of Incidents
Asia	365
North America	202
Europe	194
Africa	119
South America	106
Oceania	21
Total	1,046

The types of accidents during pilotage were either during Navigation, Vessel went aground, collision with other vessels or Allision and Fix and floating objects (FFO). Allision and FFO contributes to the highest number of incidents which is 60% with the highest value of claims amounting to USD 1.15 billion. Whilst the overall cost is substantial, the number of incidents is however very small in comparison with the overall number of acts of pilotage undertaken every year (IGP&I, 2020).

Table 2.3 Categorization by nature of incidents occurred during pilotage (Source: IGP&I, 2020).

Category	No. of Incidents	Approx. Value US\$	% of No.	% of Value
Allision/FFO	630	1,148,762,868	60%	63%
Collision	327	479,620,178	31%	26%
Grounding	81	190,532,761	8%	10%

Category	No. of Incidents	Approx. Value US\$	% of No.	% of Value
Navigation	8	2,741,232	1%	1%
Total	1,046	1,821,657,039		

In the categorisation of the incidents in Table 2.2, Allision and Fixed and Floating Objects (FFO) denotes damage to a structure other than a vessel. This includes damage to docks, fenders, bridges, cranes and other similar structures. As may be expected given the fact that a pilot is generally onboard a vessel to assist with its arrival at or departure from a berth, incidents in the Allision/FFO category constitute the majority – 60% of the total. Collision denotes contact with another vessel, and this constitutes the next most frequent category of incident – 31% of the total. Groundings represented approximately 8% of the total incidents. The Navigational category denotes incidents where there has been no physical contact with the vessel - typically damages arising from the wash of a vessel. These incidents constituted approximately 1% of the total. There is some correlation within each category with reference to the percentages of the totals for each category by number of incidents and their value. It is notable however that there is a slight adverse skew for the Allision/FFO and Grounding categories with those incidents being proportionately more costly.

In the conclusion response to the incidents, report in (IGP&I, 2020) states that the berthing of larger vessels has been identified as the area of focus for their future work. This is because the severity of three incidents in year 2019 which involve contacts between container vessels and gantry cranes. There were even additionally two more incidents of similar nature notified to the IG Pool for the 2020 underwriting year.

Increase in traffic density was also highlighted in the report based on the timeline of incidents for the top four ports which is Houston, Singapore, Antwerp & New Orleans. The year with the greatest frequency was 2014 in Singapore when there were 7 incidents, the majority of which (4) were collisions with other vessels compared to 28 of those years where there was only one incident (IGP&I, 2020).

IMPA has also been closely following the incidents involving large container ships and has made submissions on this topic to the IMO's Sub-Committee on Implementation of IMO Instruments. These seek an expert review of relevant Marine Safety Investigation Reports on such incidents with a view to identifying measures that will improve operational safety and enhance safe berthing procedures. See submission III 6/4/4 dated 25 April 2019 – Annex III. (IGP&I, 2020)

2.4 Report of Vessel accident due to pilotage from 2019 - 2023

Table 2.4. shows the report of vessel accident during pilotage from 2019 to 2023 of which was collected from various maritime sources. This is to investigate vessel accident under pilotage in recent years and to study the cause of accident. The report includes the summary of incidents which explains the cause of accident that is related to pilot performance during operation. Table concludes that vessel accident during pilotage operations continues to occur with attention to larger vessels especially the grounding of CV. Ever Given at Suez Canal causing damage of 1billion USD.

Table 2.4 Accident reports from maritime sources from 2019 to 2023

No.	Date	Location	Summary of Incident	Source
1.	28 Jan 2019	Vancouver, Canada	Container vessel Ever Summit hit a crane while being piloted. The report says the pilot sent incorrect orders to two tugs assisting the ship into berth, and a lack of standardized communications between the pilot, ship's crew and tug captains compounded the problem.	https://bc.ctvnews.ca/vessel-s-collision-with-crane-at-vancouver-port-sheds-light-on-terminal-s-infrastructure-tsb-report-1.5176680
2.	12 Feb 2019	Puerto Rico	NTSB said the probable cause of the crash was a lack of coordination and communication between the master and the pilot caused passenger vessel NORWEIGIAN EPIC crash to the harbour	https://www.tradewindsnews.com/law/legal-dispute-rages-in-puerto-rico-crash-of-norwegian-cruise-line-ship/2-1-961875
3.	10 Mar 2019	Norfolk, USA	Decision to navigate through a bridge that was poorly aligned with the channel with an unfamiliar towing vessel in high water and strong current causing towing vessel RIVERS WILSON to come in contact with Norfolk Southern Railway Bridge.	https://maritime-executive.com/article/towing-accident-pilot-had-incomplete-understanding-of-the-current
4.	29 Mar 2019	Mississippi, USA	The NTSB determines that the probable cause of the collision of the heavy lift vessel HAWK with a docked barge and the destroyer DELBERT D BLACK was the speed at which the conning pilot was operating the HAWK while attempting to turn and anchor in a shipyard basin.	https://safety4sea.com/wp-content/uploads/2020/02/NTSB-Collision-of-Heavy-Lift-Vessel-Hawk-with-Unnamed-Barge-and-Destroyer-Delbert-D-Black-2020_02.pdf

No.	Date	Location	Summary of Incident	Source
5.	10 May 2019	Houston Channel, USA	The LNG carrier 'GENESIS RIVER' collided with a 297-foot-long tank barge being pushed ahead by the 69-foot-long towing vessel 'VOYAGER', spilling petrochemical cargo into the Houston Ship Channel and capsizing a barge. NTSB issued an investigation report, identifying the Genesis River pilot's decision to transit at sea speed, out of manoeuvring mode, as key cause of the incident. Cost of damage was 3.2 mil USD while cost for cleaning up was USD 12.3 mil. USD	https://safety4sea.com/ntsb-investigation-houston-ship-channel-collision-attributed-to-speed/
6.	16 May 2019	Lower Mississippi, USA	The NTSB found that the likely cause of the incident was "poor bridge resource management and miscommunication between the pilot and the master of AMERICAN LIBERTY, which led to the bridge team's delay in carrying out an engine order and caused a delay in the vessel attaining sufficient speed to conduct an undocking manoeuvre in high river conditions." NTSB investigators added that a decision to release assist tugs too early was likely a contributing factor to the multi-vessel collision.	https://www.waterwaysjournal.net/2021/01/12/ntsb-releases-report-on-may-2019-ship-collision-on-lower-mississippi-river/
7.	16 Dec 2019	Washington, north of Bellingham, USA	NTSB reported LPG Levant was coming in too fast and at too steep an angle when it crashed into a wharf at Cherry Point.	https://www.kuow.org/stories/speed-small-tank-led-to-oil-tanker-crash-inquiry-finds

No.	Date	Location	Summary of Incident	Source
8.	14 Jan 2020	Gavelson, Texas, USA	“Investigators determined the probable cause of the collision was the captain of the PAPPY’S PRIDE’S outbound course toward the ship channel, which created a close quarters situation in restricted visibility. Contributing to the collision was the lack of communication from the captain of the Pappy’s Pride,” the NTSB concluded.	https://www.nationalfisherman.com/gulf-south-atlantic/ntsb-faults-lack-of-communication-in-fatal-texas-collision
9.	26 Jan 2020	Mississippi River, USA	NTSB has identified two pilots’ insufficient radio communication and inaccurate AIS info related to tow size as the probable cause of fatal collision between a two towing vessels between the COOPERATIVE SPIRIT and RC CREPPEL, the latter of which capsized with four crewmembers on board.	https://gcaptain.com/ntsb-insufficient-communication-inaccurate-ais-caused-fatal-collision-between-towing-vessels-on-lower-mississippi/
10.	23 Mar 2021	Suez Canal, Egypt	20,000 Teu EVER GIVEN aground due to communication breakdown, high speed of 12-13kts and strong wind. Causing damage of 1Billion USD. Took 6 days to retrieve vessel	https://gcaptain.com/ever-given-report-highlights-suez-canal-pilots-role-in-grounding/
11.	25 Nov 2021	Port Neches, Texas, USA	LPG carrier, ARES GAS collided with outermost of two harbour tugs moored alongside no.1 loading dock due to pilot reducing vessel speed causing vessel to reduce rudder effectiveness.	https://safety4sea.com/ntsb-investigation-pilots-decision-to-reduce-vessels-speed-caused-loss-of-rudder-effectiveness/
12.	14 Apr 2022	Houston Ship Channel. USA	CV. MSC AQUARIUS collided with harbour tug due to excessive speed(9.7knots) while tug is fast at centre lead causing damage to vessel totalled more than USD 900,000 and 1,000 gallons of gear oil released from the damage	https://www.marineinsight.com/shipping-news/excessive-speed-leads-to-tugboat-collision-with-container-ship/

No.	Date	Location	Summary of Incident	Source
13.	26 May 2022	Falmouth, Jamaica	Tourism Minister Edmund Bartlett says Thursday's crash of the Royal Caribbean HARMONY OF THE SEAS vessel into the dock at the wharf in Falmouth in Trelawny was caused by pilot error	https://jamaica-gleaner.com/article/news/20220527/pilot-error-cited-vessel-crash-falmouth-wharf-bartlett#google_vignette
14.	21 Aug 2022	Sabine passage, Texas, USA	Cargo ship DAMGRACHT (18,143dwt) collided with AP REVELIN (38,700dwt) due to high speed and loss of propulsion power	https://maritime-executive.com/article/engine-shutdown-due-to-false-alarm-caused-collision-with-3-4m-in-damages
15.	8 Oct 2022	Demerara Harbour bridge (DHB), Guyana	Bridge team overreliance on pilot incorrect navigational direction caused allision of the vessel MT TRADEWIND PASSION with the DHB resulted in extensive damages to critical components of the bridge as a consequence of which the bridge was rendered inoperable, and serious physical injuries were sustained by an employee of the DHB Corporation.	https://mopw.gov.gy/sites/default/files/documents/FINAL%20BOI%20REPORT%202022.pdf
16.	20 Mar 2023	Port of Kao Hsiung, Taiwan	74,000 tonne container vessel HYUNDAI TOKYO failed to slow down and collided with the wharf causing damage to terminal facilities.	https://www.porttechnology.org/news/boxship-hits-pier-at-port-of-kaohsiung/
17.	Mar 2023	Panama Canal, Panama	Container vessel OOCL UTAH experienced near collision due to excessive speed	https://theloadstar.com/near-collision-in-panama-canal-shows-an-accident-is-waiting-to-happen/

No.	Date	Location	Summary of Incident	Source
18.	10 Jul 2023	San Francisco, USA	Cruise ship RUBY PRINCESS collided with pier.	https://maritime-executive.com/article/docking-accident-damages-hull-of-princess-ruby-princess
19.	6 Dec 2023	Suez Canal, Egypt	CV. MV. ONE ORPHEUS rudder malfunction and knocked into a bridge causing 6 ships to delay	https://timesofindia.indiatimes.com/world/middle-east/cargo-ship-breaks-down-in-egypts-suez-canal-and-crashes-into-a-bridge/articleshow/105791283.cms?from=mdr
20.	26 Mar 2024	Baltimore's Francis Scott Key Bridge	MV Dali collided with Baltimore's Francis Scott Key Bridge due to momentary loss of propulsion causing destruction to bridge and many casualties.	https://www.todayonline.com/singapore/mpa-singapore-flagged-vessel-collision-baltimore-bridge-collapse-2391441

2.5 Review on history of maritime pilot training and qualification

The earliest training and qualifications for maritime pilot was adopted on 19 November 1981 by Inter-Governmental Maritime Consultative Organization (IMCO) Resolution A.485(XII) Training, Qualifications and Operational Procedures for Maritime Pilots other than Deep-Sea Pilots.

The resolution recommends on minimum standards for training and qualification as well as operational procedure of maritime pilots which is explained in Appendix 1 and 2 of the resolution. IMCO urges Governments to give effect to these recommendations as soon as possible and stated that the content of training and certification or licensing standards is the responsibility of the competent authority.

Appendix 1 of Resolution A.485(XII) explains the assessment of the experience, qualifications and suitability of an applicant for certification or licensing as a maritime pilot and responsibility of each competent authority and should be left to their discretion. Appendix 1 also includes Syllabus for Pilotage Certification or Licensing which explains applicants should be able to demonstrate that they have the knowledge factors of the following:

1. Limits of local pilotage areas.
2. International Regulations for Preventing Collisions at Sea, 1972, and also such other national and local navigational safety and pollution prevention rules as may apply in the area.
3. Systems of buoyage used in the area.
4. Characteristics of the lights and their angles of visibility and the fog signals, racons and radio-beacons in use in the area.
5. Names, positions and characteristics of the lightvessels; buoys, beacons, structures and other marks in the area.
6. Names and characteristics of the channels, shoals, headlands and points in the area.
7. Proper courses and distances in the area.

8. Traffic separation schemes, ship traffic services and similar ship traffic management systems in the area.
9. Depths of water throughout the area, including tidal effects and similar factors.
10. General set, rate, rise and duration of the tides and use of the tide tables for the area.
11. Anchorages in the area.
12. Bridge equipment and aids to navigation.
13. Use and limitations of radar and automatic radar plotting aids (ARPA), and radar plotting.
14. Communications and availability of navigational information.
15. Systems of radio navigational warning broadcasts in the area and the type of information likely to be included.
16. Manoeuvring behaviour of the types of ships expected to be piloted, and the limitations imposed by particular propulsion and steering systems.
17. Factors affecting ship performance such as wind, current, tide, channel configuration, water depth, bottom, bank and ship interaction.
18. Use and limitation of tugs.
19. The English language to a standard adequate to enable the pilot to express himself clearly in his communications.
20. Any other knowledge that the competent authority considers necessary.

In the United States, general requirements for pilot certification and licensing are set by statute. Applicants must demonstrate "the requisite general knowledge and skill" and proficient use of aids to navigation, and they must have "sufficient experience to evidence ability to handle any vessel of the type and size which the applicant may be authorized to pilot" (U.S.C. Annotated, 1990, Section 7101; National Research Council, 1994). For example, in South Carolina The apprentice is graded every 6 months by tutor pilots on procedures, skill, communications, and attitude; the apprentice must receive a minimum grade of 3.2 on a 4.0 scale from a majority of

tutors. (Final Regulation, Commissioners of Pilotage, Port of Charleston, Chapter 136; National Research Council, 1994).

2.6 Review of Malaysia maritime pilotage

Pilot board / Competent pilotage authority

Maritime pilotage in Malaysia is governed by the Marine Department of Malaysia under Ministry of Transport Malaysia in compliance to Part XII – Pilotage (Pilot Boards and Licensing of Pilots) of the Merchant Shipping Ordinance 1952 for pilots of West Malaysia and Merchant Shipping Ordinance 1960 for state of Sabah and Sarawak.

A Pilot Board shall be appointed by the Minister for any area which the Minister, by notification in the Gazette, constitutes a pilotage district (Malaysia Shipping Ordinance, 2017). Similar to the recommendation of IMO A960, whereby Pilot Board are named as Competent Pilotage Authority.

The Pilot Board is required by the ministry to setup a committee which consists of the port officer who shall be president of the board and not less than two nor more than four other persons appointed by the minister. The Pilot Board shall have the control and supervision of all pilots on the register of the Pilot Board and, subject to the Ordinance, the power of granting, cancelling, withdrawing and endorsing pilotage licenses and of suspending, dismissing and reprimanding pilots licensed by it, or of taking such less severe disciplinary action as it deems expedient (Malaysia Shipping Ordinance, 2017).

The Ministry also sanctions every Pilot Board to fix the number of licenses issued to pilots and no new license shall be granted so long as the number of pilots so fixed are present at or near the pilotage district in the execution of their duties as pilot (Malaysia Shipping Ordinance, 2017).

Regarding pilot licensing, every Pilot Board provides a certain requirement need to be complied by candidate applying to be pilot for the pilotage district. Should the requirements are met and vacancy has occurred, candidate can be approved to join as an apprentice pilot whereby he is required to comply with the training requirements especially onboard training whereby he shall company any licensed pilot on all occasions when such pilot is engaged in or seeking pilotage or berthing work, and such pilot shall answer to the best of his knowledge and experience any question upon matters concerning pilotage or berthing work.

The Pilot Board then will examine the nominated candidate, and on being satisfied as to his fitness and competency may grant him a license to act as a pilot in the pilotage district.

2.6.1 Licensing requirement for apprentice

The requirement for apprentice maritime pilot are set by the Pilot Board of the district. Pilot board in Malaysia are Johor Port Authority, Port Klang Authority, Kuantan Port Authority, Penang Port Commission, Bintulu Port Authority, Sabah Ports and Harbours Department (JPDS) and Sungai Udang Port Sdn. Bhd.

2.6.2 Licensing requirement -Penang Port Commission (Source: Penang Port Commission- Pilot Training Scheme).

Entry requirements require candidates to possess a valid certificate of competency (Deck) of the following grades or equivalent:

- Master $\geq$ 3000 GT unlimited voyage;
- Chief Mate $\geq$ 3000 GT unlimited voyage;
- Officer in charge of a navigational watch with at least 12 (twelve) month watchkeeping experience;

- Master $\geq$ 3000 GT near coastal trade voyage.

The qualified candidate will initially obtain Stage 1 Restricted pilot license and can work his way up to Unrestricted pilot license. For stage 1 restricted license, holders are licensed to perform pilotage services for vessels of up to 122 metres LOA to or from anchorages and buoys only. The restrictions are being reduced as the stages of license increase and for the final stage which is Unrestricted pilot license, pilot can perform pilotage services for vessels of unlimited size within the Compulsory Pilotage District of Penang Port.

Apprentice pilot then has to undertake a training regime that is required by the commission as shown below;

Stage 1 Restricted Pilot License

An apprentice pilot shall complete at least 3 (three) months on the job training with licensed pilots of higher grade comprising of:

- A minimum of 120 movements of vessels inbound and outbound via North Channel;
- A minimum of 6 movements of vessels inbound and outbound via South Channel.
- In addition, an apprentice pilot shall complete at least 1 movement via South Channel every month onboard pilot boat for familiarization;
- A minimum of 20 movements onboard various existing harbour tugs to witness the berthing and unberthing of vessels; and
- 50% of on the job training shall be performed during hours of darkness i.e. 1900 hours to 0700 hours.
- Upon completion of the on the job training, they are required to undergo at least 2 (two) practical pilotage assessment that is to be assessed by the Head, Marine

- Services of licensed operator or any other approved person.
- The candidate may be required to undergo a written examination prior to attend the oral examination.
- The candidate must possess a valid certificate of ECDIS.
- (Electronic Chart Display & Information System) which to be submitted during the oral examination.

Upon completion of above training, the apprentice pilot is then required to sit for orals and written examinations before the stage 1 restricted license is being issued to the pilot.

2.6.3 Licencing requirement – Pilotage District of Sungai Udang Port (Source: Pilotage Rules and Procedures, 2018)

For a new joining pilot, the candidate must possess a COC class 1 (Master of 3000GT or more unlimited trade voyage) as approved by the director of marine. Candidate must also be medically fit as approved by the pilotage board. Candidate from other pilot district may also join with the minimum requirement of COC Class 3 and 10 years pilotage experience.

Table 2.5 Class of license and limitations (Source: Pilotage Rules and Procedures, 2018)

Class of license	Limitation
Class UR SPM Endorsed	License to pilot ships for operation at Single Point Mooring (SPM)
Class UR	License to pilot ships above 80,000 DWT
Class A	License to pilot ships up to 80,000 DWT
Class B	License to pilot ships up to 50,000 DWT
Class C	License to pilot ships up to 10,000 DWT

Table 2.5 shows that the qualified candidate will initially obtain Class C license and can work his way up to Class UR SPM endorsed. For example, Class C, the candidate will be eligible for the examination on acquiring a minimum of:

- 100 movements on vessels up to 10,000 DWT.
- A minimum of 20 anchoring movements.
- Minimum training period is 6 months.
- 1 week attachment with different tugs operating in Sungai Udang Port.

The apprentice pilot shall also undergo ship simulation training with at least 10 different scenarios training where 2 of it are on VLCC.

Upon completion of all training, apprentice pilot will be assed by UR license pilot for at least 2 berthing manoeuvres and 2 unberthing manoeuvres and report the candidates capability. Candidate will also be examined in written and orals. Upon completion of required training and having successfully passed the written and oral examinations, the Pilotage board will grant the candidate the pilotage license of its class.

2.6.4 Licensing requirement – Lembaga Pelabuhan Johor

Entry requirements require candidates to possess a valid certificate of competency (Deck) of the following grades or equivalent:

- Master $\geq$ 3000 GT unlimited voyage;
- Chief Mate $\geq$ 3000 GT unlimited voyage;
- Officer in charge of a navigational watch with at least 12 (twelve) month watchkeeping experience.

The qualified candidate will initially obtain Class C license and can work his way up to Class B, A2, A1 then finally A license. For Class C, the candidate will be eligible for the examination on acquiring a minimum of:

- Not less than 6 months as trainee pilot
- 240 movements consists of 40% night movement(Inclusive 100 movements of $\leq 125\text{m}$ LOA vessel size.
- Practical assessment: 2 in/ 2 out
- STS training including bunkering and lightering(10)

However, if the apprentice pilot has the license of Master $\geq 3000\text{GT}$ U.V with 1 year of command experience, the eligibility for examination are :

- Not less than 3 months as trainee pilot
- 120 movements consists of 40% night movement(Inclusive 50 movements of $\leq 125\text{m}$ LOA vessel size.
- Practical assessment: 2 in/ 2 out
- STS training including bunkering and lightering(10)

The practical assessments are to be performed in the presence of a member of the pilotage committee or its representative. Written examination will also be conducted by the Technical committee with passing marks of 70%.

2.7 Maritime pilot training and assessment

2.7.1 Recommendations by the IMO A.960

The International Maritime Organization (IMO) is the United Nations specialized agency with responsibility for the safety and security of shipping and the prevention of marine and atmospheric pollution by ships. As a specialized agency of the United Nations, IMO is the global standard-setting authority for the safety, security and environmental performance of international shipping. Its main role is to create a

regulatory framework for the shipping industry that is fair and effective, universally adopted and universally implemented. In other words, its role is to create a level playing field so that ship operators cannot address their financial issues by simply cutting corners and compromising on safety, security and environmental performance. This approach also encourages innovation and efficiency. IMO measures cover all aspects of international shipping – including ship design, construction, equipment, manning, operation and disposal – to ensure that this vital sector remains safe, environmentally sound, energy efficient and secure (International Maritime Organization, 2019)

Since pilotage operation plays a crucial part in ensuring safety and security of shipping, the IMO Resolution A.960(23) was adopted on the 5th December 2003 during IMO 23rd assembly providing recommendations on training and certification and on operational procedures for maritime pilots other than deep-sea pilots.

The IMO resolution A.960(23) states that CPA is responsible for training and certification or licensing standards for pilots operating in ports of the designated district.

The IMO resolution A.960(23) recommends that every pilot should be trained in bridge resource management with an emphasis on the exchange of information that is essential to a safe transit. This training should include a requirement for the pilot to assess particular situations and to conduct an exchange of information with the master and/or officer in charge of navigational watch. Maintaining an effective working relationship between the pilot and the bridge team in both routine and emergency conditions should be covered in training. Emergency conditions should include loss of steering, loss of propulsion, and failures of radar, vital systems and automation, in a narrow channel or fairway.

The Initial and continuing training in the master-pilot information exchange should also cover: (Source: IMO Resolution A.960, 2004)

1. regulatory requirements governing the exchange;
2. recognition of language, cultural, psychological and physiological impediments to effective communication and interaction and techniques for overcoming these impediments; and
3. best practices in the specific pilotage area.

CPA are also encouraged to provide updating and refresher training conducted for certified or licensed pilots to ensure the continuation of their proficiency and updating of their knowledge, and could include the following (Source: IMO Resolution A.960, 2004);

1. courses to improve proficiency in the English language where necessary;
2. sessions to enhance the ability to communicate with local authorities and other vessels in the area;
3. meetings with local authorities and other responsible agencies to envisage emergency situations and contingency plans;
4. refresher or renewal courses in bridge resource management for pilots to facilitate communication and information exchange between the pilot and the master and to increase efficiency on the bridge.
5. simulation exercises, which may include radar training and emergency shiphandling procedures;
6. courses in shiphandling training centres using manned models;
7. seminars on new bridge equipment with special regard to navigation aids;
8. sessions to discuss relevant issues connected with the pilotage service including laws, rules and regulations particular to the pilotage area;
9. personal safety training;
10. techniques for personal survival at sea; and
11. emergency first aid, including cardio-pulmonary resuscitation (CPR) and hypothermia remediation.

For assessment, each applicant for a pilot certificate or license should demonstrate that he or she has necessary knowledge of the following (Source: IMO Resolution A.960, 2004)

1. limits of local pilotage areas;
2. International Regulations for Preventing Collisions at Sea, 1972 as amended, and also such other national and local navigational safety and pollution prevention rules as may apply in the area;
3. system of buoyage in the area;
4. characteristics of the lights and their angles of visibility and the fog signals, racons and radio beacons and other electronic aids in use in the area;
5. names, positions and characteristics of the light vessels, buoys, beacons, structures and other marks in the area;
6. names and characteristics of the channels, shoals, headlands and points in the area;
7. bridge and similar obstruction limitations including air draughts;
8. depths of water throughout the area, including tidal effects and similar factors;
9. general set, rate, rise and duration of the tides and use of the tide tables and real-time and current data systems, if available, for the area;
10. proper courses and distances in the area;
11. anchorages in the area;
12. shiphandling for piloting, anchoring, berthing and unberthing, manoeuvring with and without tugs, and emergency situations;
13. communications and availability of navigational information;
14. systems of radio navigational warning broadcasts in the area and the type of information likely to be included;
15. traffic separation schemes, vessel traffic services and similar vessel management systems in the area;

16. bridge equipment and navigational aids;
17. use of radar and other electronic devices; their limitations and capabilities as navigation and collision avoidance aids;
18. manoeuvring behaviour of the types of ships expected to be piloted and the limitations imposed by particular propulsion and steering systems;
19. factors affecting ship performance such as wind, current, tide, channel configuration, water depth, bottom, bank and ship interaction including squat;
20. use and limitation of various types of tugs;
21. the English language to a standard adequate to enable the pilot to express communications clearly;
22. IMO Standard Marine Communication Phrases;
23. IMO Code for the investigation of marine casualties and incidents;
24. Master-Pilot Relationship, Pilot Card, operational procedures;
25. pollution prevention;
26. emergency and contingency plans for the area;
27. safe embarking and disembarking procedures; and
28. any other relevant knowledge considered necessary.

2.7.2 Modern technology approach

Modern technology has significantly transformed maritime pilotage, particularly through the integration of advanced simulation training. This approach enhances the proficiency and safety of maritime pilots by providing realistic, controlled environments for skill development.

Over the past four decades, ship navigation has seen substantial technological progress. Innovations such as electronic chart displays, automatic identification systems, and integrated bridge systems have become integral to pilotage operations.

These tools assist pilots in making informed decisions, thereby improving the safety and efficiency of maritime navigation (clearseas.(n.d.)).

Nowadays, simulation centers play a crucial role in modern maritime training. Facilities like the Maritime Professional Training's S.M.A.R.T. Center offer state-of-the-art simulators that replicate various maritime scenarios. These centers provide pilots with hands-on experience in ship handling, navigation, and emergency response without the risks associated with real-world training

Similarly, the Maritime Pilots Institute offers integrated training programs that combine classroom instruction with both manned model and simulator exercises. This comprehensive approach ensures that pilots are well-prepared for the complexities of modern maritime operations.

The adoption of advanced technologies and simulation-based training has several implications for the maritime industry:

Enhanced Safety: Pilots can practice complex maneuvers and emergency procedures in a controlled environment, reducing the likelihood of accidents during actual operations.

Operational Efficiency: Familiarity with the latest navigation technologies enables pilots to make more informed decisions, leading to smoother and more efficient vessel movements.

Standardized Training: Simulation centers provide a consistent training platform, ensuring that all pilots receive uniform instruction and assessment.

In conclusion, the integration of modern technology and simulation-based training is pivotal in advancing maritime pilotage. These developments not only enhance the skills and competencies of pilots but also contribute to the overall safety and efficiency of maritime operations.

2.8 Malaysia maritime pilot training and assessment

IMO was established to adopt legislation and Governments are responsible for implementing them. When a government accepts an IMO Convention it agrees to make it part of its own national law and to enforce it just like any other law (International Maritime Organization, 2019)

Malaysia has been a member of the IMO since 1971 and was successfully elected as a Council Member under Category C since 2005 (Ministry of Transport Malaysia, 2024). Malaysia has been re-elected to the International Maritime Organisation (IMO) Council under Category C for the 2024-2025 term, marking Malaysia's victory for the 10th consecutive time.

Therefore, as a member state Malaysia plays part in implementing of IMO Resolution A.960(23) Recommendations on training and certification and on operational procedures for maritime pilots other than deep-sea pilot.

Training and assessment modules were collected from several pilot boards in Malaysia namely Lembaga Pelabuhan Johor, Penang Port Commission and Sungai Udang Port Pilotage District.

2.8.1 Lembaga Pelabuhan Johor

Lembaga Pelabuhan Johor require all apprentice to go through trainings set by the Pilot Board. Apart from onboard training, additional trainings are listed into training matrix which includes induction training, bridge resource management, ECDIS, IMO codes and convention, Ship handling simulation, liquid cargo handling simulation, engine simulation, advance ship handling simulation, ship stability and ship construction, ISPS code awareness, marine facility security officer, port state control and inspection, marine accident investigation, risk assessment and job safety analysis, GMDSS refresher, ARPA and radar navigation.

During onboard assessment, a pilot's evaluation report checklist is used to assess the pilot. The assessments include; (Source: Lembaga Pelabuhan Johor, Pilot's evaluation report).

- Radio communications with various control towers and personnel on vessel movements, traffic density and conditions.
- The knowledge on the type of tugs usage, engine power, limitation including efficient utilization of boat.
- For Bridge resource management, preparation on pre-arrival exchange with master on passage planning, decision making and situational awareness including ability to interact with master in case of contingencies and emergency procedures will also be accessed.
- Knowledge on local rules, regulations, guidelines and procedures concerning navigation of vessel as per local and international rules.
- Knowledge on current, tide, weather, wind, latest port and canal development, buoys and navigational marks and meteorological.
- Knowledge on vessel manoeuvring characteristics, turning circle, lateral thrust and stopping distance- hydrodynamic conditions.
- Knowledge on usage of ships inertia systems during berthing/unberthing.

2.8.2 Sungai Udang Port Pilotage District

Sungai Udang Pilot Board requires trainee to have a minimum training period of 6 months. The training includes attending simulator courses and onboard training. During the training period, trainees will be trained based on the Appendix 1 of the Sungai Udang Port Pilotage Rules and Procedures which is Sungai Udang Port Pilotage Syllabus.

The trainer or examiner must ensure that the trainee pilot acquire the knowledge, understanding and proficiency of the appendix to consider him as

competent. The ability of the trainee pilot can be evaluated in the following method;
(Source: Final revision Sungai Udang Port Pilotage Rules and Procedures, 2018)

1. Approved in service experience
2. Approved training ship experience.
3. Approved simulator training where appropriate.
4. Assessment through written, oral & practical examination.

Table 2.6 shows the training and assessment requirements for maritime pilots for Sungai Udang Port. The competency required by the trainee pilot includes

Table 2.6 Training and assessment requirement for maritime pilots of Sungai Udang Port

Competency	Criteria for evaluating competence
Principle Ship Handling and Manoeuvring	Able to define, implement, facilitate for safe operation and safety of navigation on: 1) The effect of displacement, draft, trim, list speed and under keel clearance on turning circles and stopping distance. 2) The effect of wind (windage area) and current on ship handling. 3) The effect of Squat, shallow water and similar effects. 4) Ship's engine-types of engine and their character i.e. turbine and motor. 5) Type of propeller /rudder and their effect to ship handling.
Practical Ship Handling and Manoeuvring	Able to define, implement, facilitate for safe operation and safety of navigation on: 1) Handling ship in rivers, estuaries, and restricted waters having regard to the effects of current, wind and restricted water on helm order. 2) Manoeuvring in shallow water, including reduction in UKC caused by squat, rolling and pitching.

Competency	Criteria for evaluating competence
	3) Interaction between passing ships and nearby banks i.e. 'Hydrodynamic Interaction. 4) Ability to adjust course and speed to maintain safety of navigation. 5) Berthing and unberthing in various conditions of wind, tide and current with and without tug. 6) Ship and tug interaction. 7) Use of propulsion and manoeuvring systems. 8) Choice of anchorage, anchoring with one or two anchors in limited anchorages and factors involved in determining the length of anchor cable to be used. 9) Ability to determine the manoeuvring and propulsion characteristics of common types of ships with special reference to stopping distances and turning circles at various drafts and speeds 10) Clearing a fouled hawse, beaching and refloating a vessel. 11) Pilot Information Exchange 12) Radar and ARPA including parallel indexing
Respond to emergency	Able to identify, act and lead an unplanned event or emergency and manoeuvring of the ship and in accordance with contingency plans and appropriate for: 1. Emergency Manoeuvres Appreciation of the procedures to be followed during emergency such as; • Man overboard. • Steering Failure. • Engine Failure. • Sinking Vessel. • Fouled Propeller. • Pollution Incident. 2. Role of On Scene Commander in the event of an emergency involving the various cargoes handled in port and port Emergency Response Plan.
Ascertain stability of the vessel.	Able to define, implement, facilitate for safe ship operation on:

Competency	Criteria for evaluating competence
Local Knowledge and Navigational aids within Port Limits (lights, characteristic and shapes)	1) Fundamentals of watertight integrity. 2) Knowledge of stability, trim and stress including Free Surface Effect, its and how to minimize it including action taken 3) Stiff and tender vessel and causes of such conditions. 4) Free surface effect on stability of ship. Able to define, implement and facilitate for safe operation and safety of navigation in relation to: 1) Local Knowledge : · Limits of pilotage area · Knowledge of various anchorages within the port limit and their position · TSS and other schemes in the area. · Name and characteristic of the channel, shoals headlands and ports in the area. · Emergency and contingency plans for the area. 2) Navigational Aids · System of buoyage in the area. · Name, position and characteristics of the buoys, beacons structures and other marks in the area. · Knowledge of the position of the buoys, beacons and lighthouses within the port including their type, shape, colour, top marks if any and light characteristics of the navigational aids and mooring system of the buoys.
Tides & Tidal Streams	Able to define, implement and facilitate for safe operations and safety of navigation in relation to Tides, Tidal Streams and Meteorology Knowledge of : 1) Level which soundings on charts are reduced to 2) Contents of the Malaysian Tide Table.

Competency	Criteria for evaluating competence
	3) Stations to refer to for predictions and able to calculate the height of tide at any time and or time the tide reaches specific height. 4) Rate and direction of current at various locations during spring and neap tide. 5) Areas where turbulence may be experienced and the effects this has on the vessel. 6) General set, rate rise and duration of the tides and use of the tide table and real-time and current data system for the area. 7) Interpret weather reports, bulletins and weather facimile charts.
Communications Transmit and receive information effectively.	Able to define, implement, facilitate for safe operation on: 1) Flag, light and sound signaling. 2) VHF channels which various stations are keeping watch on and channels allocated to areas of pilotage. 3) Basic features of the GMDSS and VTS system.
Depth and Distance Sufficient depth for safe navigation.	Able to define, implement and facilitate safe operations in relation to: 1) Depth of water at each berth channel and anchorage including tidal effects and similar factors. 2) Maximum allowable draft on each berth, Under Keel clearance and rate of siltation. 3) Program berthing and unberthing. 4) Courses and distances in the area

2.8.3 Penang Port Commission

An apprentice pilot shall complete at least 3 (three) month on the job training with licensed pilots of higher grade as required in the Penang Port Commission, Pilot Training Scheme. Upon completion of training, apprentice pilot are required to

undergo at least 2 (two) practical pilotage assessment that is to be assessed by the Head, Marine.

The assessment will be evaluated based on table 2.7.

Table 2.7 Assessment Criteria (Source: Penang Port Commission, Assessment Criteria)

No	Description	Marks
1	Planning an act of pilotage	
	- Acquiring relevant data to facilitate the act of pilotage - Preparing the port underway - Re-assessing the plan and modify necessary	/10
2	Embarking and Disembarking	
	- Preparing for pilot transfer - Transferring the pilot underway - Transferring a pilot when not underway	/10
3	Assessing standards on the piloted vessel	
	- Evaluating the conduct of vessel prior to boarding - Assessing the vessel's condition and evaluating the crew - Evaluating and responding to deficiencies	/10
4	Co-operating with the bridge team and functioning within it	
	- Exchanging relevant information - Assessing the bridge team's capabilities - Integrating with the bridge team	/10
5	Liaising and communicating within the port	
	- Communicating by radio - Communicating by other means - Co-operating with other port team's members	/10
6	Transiting with pilotage District	
	- Determining the vessel's position - Monitoring the vessel's progress - Navigating vessel	/10

No	Description	Marks
7	Manoeuvring vessels in harbour and their approach • Handling different type and size of vessel • Manoeuvring in different locations and conditions • Working with tugs • Arriving at departing from berth, buoys, mooring and anchorage	/10
8	Reacting and responding to problems and emergency situation • Assisting in the management of ship-board malfunctions and problems • Dealing with emergencies • Facilitating problem-solving	/10
9	Managing personal and professional conduct and development • Maintaining professional standards • Improving personnel performance	/10
10	Self Confident • Demonstrating self confident • Always confident with action taken	/10
TOTAL		/100

2.9 KSA Theory

KSAs are knowledge, skills, and abilities that a person must possess to perform the duties of his or her position (Sam Houston State University, 2022). The implementation of (KSAs) has been studied in numerous areas for decades, including in aviation industry for aviation pilots. To be specific, Walters, J. M. (2002) in his study observed 62 flight officers and graded 74 knowledge, skills and abilities performance variables and produced a report describing specific knowledge, skills and abilities required for successful performance task required of students in United States Air Force pilot training. Walters, J. M. (2002) The goal was to produce a scientific description of the job required of pilot training candidates in terms of underlying knowledge, skill, and ability for use in the development of content and balance of future pilot selection instruments.

When hiring a candidate for a job, (KSAs) are general descriptions of minimum qualifying competencies within a trade or career (Johnson, Lenartowicz, & Apud, 2006; Glassman et. al, 2015). An employee's match with the job KSAs is an important hiring criterion since training employees without the right mix will cost the organization additional training dollars (Kristof-Brown, 2000; Moy & Lam, 2004; Neistadt, & Murphy, 2009 ; Glassman et. al 2015). Although education, certification and experience (ECE) is important in hiring criterion. However, understanding the relationship between ECE and KSAs is paramount to understanding the right mix of KSAs within the aviation industry because KSAs not only influence hiring decisions, but they also drive retention decisions (Shawn, Kim, and Jitendra, 2014; Glassman et. al, 2015).

KSAs are also used to develop test items as described by Wang et. al., (2005) in his study of using KSAs in developing licensure and certifications examinations, presented a framework to describe the important role of KSAs in the process of test development, including linking job task survey results to the test content outline, transferring job task weights to test specifications, and applying the results to the development and classification of the test items and finally, the impact of using KSAs in the development of test specifications on two diverse profession. Namely, nursing certification and real estate licensure programme.

A summary of the literature review on KSA reveals its extensive utilization across various fields, particularly in the aviation industry, where it plays a critical role in pilot training, assessment, and performance evaluation. In aviation, KSA frameworks are widely recognized for their effectiveness in identifying competencies, enhancing safety protocols, and improving operational efficiency. However, despite its proven benefits in aviation and other industries, the application of KSA in the maritime field appears to be notably absent. This lack of implementation underscores a significant gap, suggesting that the maritime sector has yet to fully explore and leverage the potential of KSA frameworks for the training, assessment, and development of maritime professionals, such as pilots and crew members. Addressing this gap could lead to substantial improvements in safety standards, operational performance, and overall competency in the maritime industry.

Although other method is researched on its application for development of maritime pilot training and assessment framework. For example, Knowledge, attitude and behaviour (KAB) was found to be relatable as KAB theory explains that knowledge enhances one's attitude, leading to improved behaviour (Kamis, 2020). However, studies done by (Kamis, 2020) shows that KAB method focuses on improvement of behaviour whereas KSAs focuses on improvement of competency.

2.10 Likert scale set questionnaire

Questionnaires with a Likert-type scale are usually used to measure knowledge, attitude, and behaviour (James M. Walters, 2002; Driskill, 2001; Aaron glassman, 2015). This study used the same method to measure Maritime KSAs.

Table 2.8 Method of collecting data on KSA measures by previous studies

Authors	Sample	Knowledge measure	Skills measure	Abilities measure
Glassman et. al., (2015) aviation	45 aviation professionals	Likert-type self-report scale	Likert-type self-report scale	Likert-type self-report scale
Walters M.J. (2002) aviation	62 flight officers	Likert-type self-report scale	Likert-type self-report scale	Likert-type self-report scale
Driskill et. al., (2001) aviation	159 Instructor/student	Likert-type self-report scale	Likert-type self-report scale	Likert-type self-report scale
O'neill T. et. al., (2015) Teamwork	268 Job candidates	Likert-type self-report scale	Likert-type self-report scale	Likert-type self-report scale
Kay C. et. al., (2014) Lodging management	184 respondents	Likert-type self-report scale	Likert-type self-report scale	Likert-type self-report scale
Mcclough A. et. al., (2003) Teamwork selection	227 under-graduates	Likert-type self-report scale	Likert-type self-report scale	Likert-type self-report scale

2.11 Knowledge, Skills and Abilities

Knowledge is an understanding of information that you get by experience or study about a subject, either known by one person or by people generally (Cambridge Dictionary, 2018b). It is the state of knowing about or being familiar with something (Cambridge Dictionary, 2018b).

Knowledge refers to the subjects, topics, and items of information that an employee should know at the time he or she is hired or moved into the job. Knowledge represents bodies of information that are applied directly to the performance of work functions (Sam Houston State University, 2022).

Skill is the ability to do an activity or job well, especially because you have practised it (Cambridge Dictionary, 2018b). Skill is a particular ability that you develop through training and experience and that is useful in a job (Cambridge Dictionary, 2018b).

Skills refers to technical or manual proficiencies which are usually learned or acquired through training (Sam Houston State University, 2022).

Ability is the physical or mental power or skill needed to do something (Cambridge Dictionary, 2018b).

Abilities is the present demonstrable capacity to apply several knowledge and skills simultaneously in order to complete a task or perform an observable behavior (Sam Houston State University, 2022).

2.12 Selecting factors to represent maritime pilot knowledge, skills and abilities

A maritime pilot needs knowledge, i.e., cognitive representations which are used to interpret data (Grabowski and Wallace, 1993). Three types of knowledge are

necessary for piloting: local knowledge, trans-specific knowledge, and knowledge of shiphandling (Huffner, 1978, National Research Council, 1994).

And at most times, maritime pilots require combination of knowledge & skills to competently execute tasks during pilotage operation. For example, Grabowski and Wallace (1993) stated that manoeuvring and collision avoidance require both perceptual and motor skills, and cognitive abilities to apply the rules of the road in the context of the particular harbour.

Aviation operations and maintenance require several interrelated human and machine components, which require practice, immersion and the ability to apply knowledge and demonstrate skills and ability. 'Applying' in the aviation context refers to situations where learned material is used, applied or demonstrated skills transfer of combined cognitive and psychomotor objectives (Brown, L.J., 2020).

Discussions during the 1948 convention of the American Psychological Association, bloom spearheaded a group of educators who eventually overtook the ambitious task of classifying educational goals and objectives with the intention of developing a method of classification of thinking behaviours that were believed to be important in the processes of learning. (Forehand, M., 2011) Eventually the framework became a taxonomy of three domains namely The cognitive (knowledge based domain), The affective (attitudinal based domain and The psychomotor (skill based domain).

The taxonomy was eventually named Bloom's taxonomy and has been used by educators and examiners. While it should be noted that other educational taxonomies and hierarchical systems have been developed, it is Bloom's Taxonomy which remains, even after nearly fifty years, the de-facto standard (Forehand, M., 2011).

Till present also, educators and researchers are developing new method of Intended learning outcome (ILO) for their research or universities. For example, Brown, L.J., (2019) created learning outcomes based on Blooms' Taxonomy which

clearly define knowledge, skills or ability students should possess after completing the training module or course as using Blooms' Taxonomy in the cognitive domain, learning objectives can be refined to create more meaningful student outcomes and mapped to reflect expected student assessment goals.

2.12.1 Selecting factors to represent maritime pilot knowledge.

Bloom et. al., (1956) bloom's taxonomy explains that cognitive domain consists of knowledge, comprehension, application, analysis, synthesis and evaluation. The cognitive domain includes those objectives which deal with the recall and recognition of knowledge and the development of intellectual abilities and skills (Bloom et. al., 1956).

Table 2.9 shows the definition and application of Bloom's taxonomy derived from University Malaysia Terengganu- Outcome Based Education handbook for lecturer's use.

Table 2.9 Level attributes, keywords and example of CLO according to COGNITIVE level

Cognitive Level	Level Attributes	Keywords	Example of CLO
C1 Knowledge	Rote memorisation, recognition, or recall of facts.	Fine, define, label, describe, memorize, locate, recognize, identify, record name, tell, list, recite, select, relate	Define the basic of electrical quantities and laws in dc and ac system.
C2 Comprehension	Understanding what the facts mean.	Convert, transform, examples, match, restate, paraphrase, change, rewrite, give, express, illustrate, extend, generalize, summarize, interpret, compare, explain, predict	Explain and summarise the working culture of professional engineers in society and organization.

Cognitive Level	Level Attributes	Keywords	Example of CLO
C3 Application	Correct use of the facts, rules, or ideas.	Use, apply, change, solve, choose, sketch, modify, make, dramatize, discover, classify, prepare, show, produce, construct, paint, demonstrate, illustrate.	Apply the appropriate assembly language for microprocessor (8086) and microcontroller (PIC).
C4 Analysis	Breaking down information into component parts.	Analyze, classify, survey, separate, distinguish, infer, categorize, subdivide, inquire, differentiate, probe, attributes, investigate, select, experiment, point out, compare, contrast	Investigate power factor problems that arise during the utilisation of electrical energy.
C5 Synthesis	Combining parts to make a new whole.	Plan, role-play, compose, invert, hypothesis, design, revise, construct, develop, collect, predict, formulate, create, organize, originate, combine, arrange	Compose systematically engineering problems and their solutions using appropriate hardware or software.
C6 Evaluation	Judging the value or worth of information or ideas.	Appraise, deduce, critique, defend, recommend, conclude, decide, critique, defend, recommend, conclude, decide, criticize, evaluate, consider, weight, judge, support, rate	Evaluate the power factor problems that arise during the utilisation of electrical energy

Bloom's taxonomy is used to evaluate learning outcomes of a student based on cognitive levels and level of attributes by applying the keywords suggested in Bloom's Taxonomy. A search of the World Wide Web will yield clear evidence that Bloom's Taxonomy has been applied to a variety of situations(Forehand M., 2011).

For example, local knowledge is a key requisite of the profession which makes a maritime pilot a professional who is strictly bound to his area of operation(Maritime. M., 2021). Therefore, a maritime pilot require memorization,

recognition and recall facts of local knowledge which are the attributes that can be observed in cognitive level 1 of Bloom's taxonomy cognitive domain.

Therefore, factors that can be used to develop a set of questionnaires to measure maritime pilot knowledge can be found from Bloom's taxonomy of cognitive domain.

2.12.2 Selecting factors to represent maritime pilot skills & abilities.

Atkinson, S.P. (2013) developed taxonomy circles for visualization of the possibilities of intended learning outcomes (ILO), which are adaptation from (Anderson & Karthwohl, 2001) Cognitive Domain, (Karthwohl et. al., 1999) Affective domain and and (Dave, 1967) for Psychomotor Domain. Atkinson, S.P. (2013) states that the taxonomy circles demonstrates a comprehensive and coherent approach to ILOs across all domains, with visualization to enable faculty to engage with potentially complex conceptual relationships, could support both effective design processes and enable future adaptive learning scenarios and student-centred learning planning tools.

Figure 2.1. Each circular representation has the higher-level terms at the centre, proto-verbs, derived from pre-existing taxonomies with some adaptation. Surrounding these is a series of active verbs that articulate actions an individual might undertake to generate evidence of their ability to represent the proto-verb. The final outer circle suggests the means by which a student might provide evidence of their having demonstrated successfully a particular active-verb, and hence proto-verb (Atkinson, S.P. 2013).

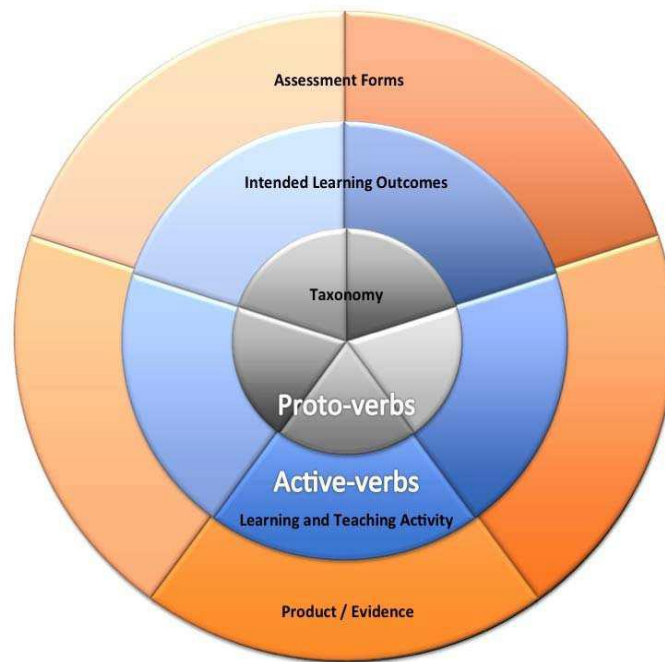


Figure 2.1 Structure of Taxonomy circles

Figure 2.2 describes Psychomotor Domain which is an example of the taxonomy circles developed by Atkinson, S.P. (2013). Whereby the inner circle represents the taxonomy of psychomotor domain. Surrounding these taxonomies are intended learning outcomes from a student while the outermost circle represents the forms of assessment which suits each elements of psychomotor domain.

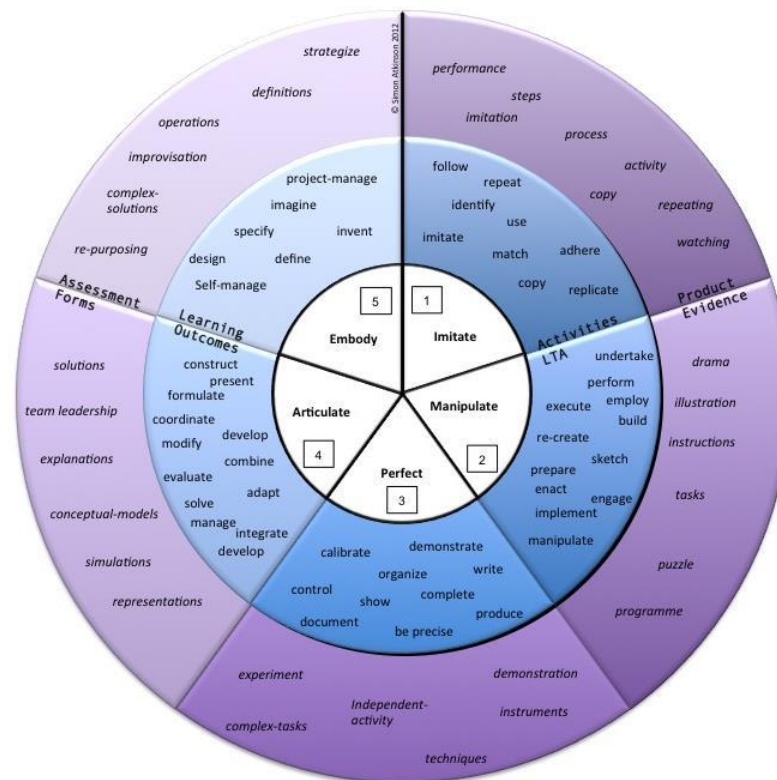


Figure 2.2 Psychomotor Domain as a Taxonomy Circle

Therefore, factors that can be used to develop a set of questionnaires to measure maritime pilot skill and abilities can be found from Atkinson, S.P. (2013) taxonomy circles.

2.13 Scoping review

Scoping review is one of the literature review techniques aiming at broadly defined research questions but carried out systematically (The Joanna Briggs Institute, 2015; Kamis, 2020). As opposed to systematic literature reviews (SLR) that focuses on the quality of a study, the scoping review framework collects, maps, and summarizes the literature based on a specified subject and aims to categorize all current studies on a topic paying little mind to their quality (Arksey & O'Malley, 2005; Kamis, 2020). As there are limited literature regarding maritime pilot KSA, scoping review is therefore found suitable for this research method.

Furthermore, the criteria of the study review are developed at the selection stage and involved all types of study (Arksey & O'Malley, 2005; The Joanna Briggs Institute, 2015; Kamis, 2020). Accordingly, the data are extracted according to key issues and themes (Arksey & O'Malley, 2005; Kamis, 2020).

Scoping reviews require wide-ranging and organized exploration of the literature to maximize analysis and reduce preference (Arksey & O'Malley, 2005; Kamis, 2020). Common reasons for conducting a scoping study include, but not limited to (The Joanna Briggs Institute, 2015; Kamis, 2020):

- a. Study the scope, variety, and nature of research activity.
- b. Determine the value of undertaking a full systematic review (e.g., do any studies exist?).
- c. Summarise and publish research results.
- d. Pinpoint gaps in the current body of literature.

2.14 Factors, filtering elements and filtered (FFF) model

This study needed a model to be used in order to filter some factors into the scope of maritime science. Several models were considered in this process, including the ETL Model (Extract-Transform-Load), whereby researchers initially extract and collect raw data from multiple sources. They then transform the data by cleaning, processing, and structuring it for analysis, and finally load the transformed data for reporting or further use. Another model under consideration was the DECIDE Model (Define, Explore, Consider, Identify, Decide, Evaluate).

However, this study has identified the FFF Model as the most suitable model, as it was previously utilized in a study on identifying factors for BT education, knowledge, attitude, and behavior (Kamis, 2020). The FFF Model was chosen because it has been successfully applied in the field of maritime science, where the filtering

elements were established through a combination of literature review and expert references in the maritime field (Kamis, 2020).

FFF model by (Kamis, 2020) talks about the factors that affect BT education, knowledge, attitude and behavior. It is used to filter the factors with the help of field experts to ensure that the factors met the research criteria (Kamis, 2020). The gathered factors were filtered by the FFF model so that it is personalized to measure only shipboard safety, and the selection of factors based on the FFF model was carried out by maritime technical experts (Kamis, 2020). Then, the development of a survey questionnaire based on the selected factors was carried out (Kamis, 2020). This model can be utilized to ensure that the factor selection fits the scope of this study.

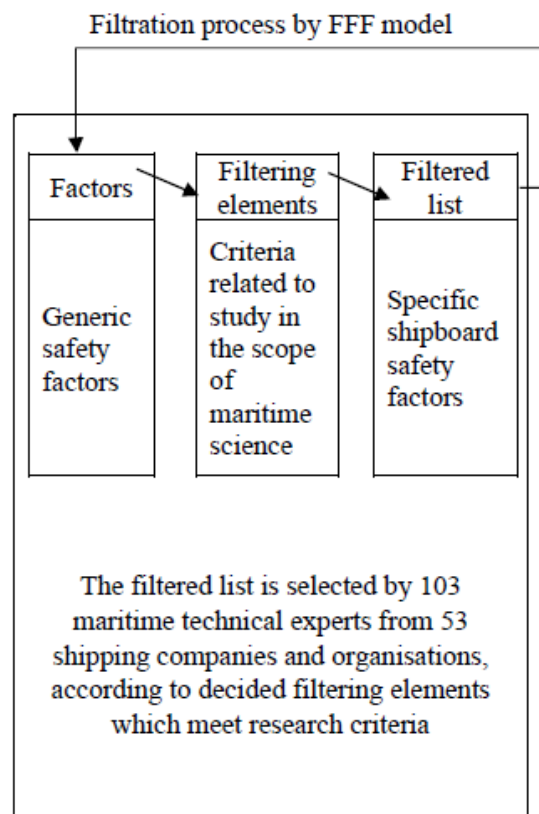


Figure 2.3 Factors, filtering elements and filtered BT education, Knowledge, Attitude, Behavior (FFF model) (Kamis, 2020)

2.15 Structure Equation Modelling

Several SEM approaches were considered in this study. Amongst are AMOS, SPSS, LISREL and R.

AMOS SPSS is known for its user-friendly graphical interface, which allows researchers to perform SEM without extensive coding knowledge. Unlike R, which requires proficiency in programming languages such as R syntax and the lavaan package, AMOS provides a drag-and-drop functionality that simplifies model specification and interpretation. This feature reduces the learning curve, making it an ideal choice for researchers who may not have advanced programming skills.

Since this research involves statistical analyses beyond SEM, including descriptive statistics, hypothesis testing, and regression analysis, the integration of AMOS with SPSS is highly beneficial. SPSS is widely used in social sciences and business research, and having AMOS as an extension ensures seamless data transfer, reducing the likelihood of errors in data handling. In contrast, LISREL requires a separate interface and often involves syntax-based commands, which can be more challenging to manage alongside SPSS.

While LISREL is a pioneer in SEM and offers robust capabilities, it relies heavily on syntax and requires a steeper learning curve compared to AMOS. AMOS, on the other hand, provides comprehensive modeling tools, including Confirmatory Factor Analysis (CFA), path analysis, and mediation/moderation analysis, all within an intuitive interface. This makes it an excellent choice for efficiently building and testing theoretical models.

One of AMOS's most significant advantages is its ability to visually represent models using a graphical user interface. This feature enhances the clarity of SEM models, making them easier to communicate in research presentations and publications. While R (lavaan) and LISREL also support SEM, they lack a built-in graphical modeling tool, requiring additional software or coding for visualization.

AMOS streamlines the SEM process by automating many aspects of model specification and estimation. Compared to R, where extensive scripting is necessary, AMOS allows for quicker modifications and refinements. This efficiency is crucial in academic research, where iterative testing of models is often required.

Based on these considerations, AMOS SPSS is the most suitable choice for this study. Its ease of use, integration with SPSS, graphical modeling capabilities, and efficiency in SEM make it a practical and effective tool. While LISREL and R have their own strengths, AMOS provides the best balance between functionality and accessibility, allowing me to conduct rigorous statistical analysis without the need for extensive programming knowledge.

2.16 Conclusion

Statistics show that there was a total of 1,046 incidents in which pilot error either caused or contributed to those events. The total cost of those incidents was over USD 1.82 billion. On average, this represents 52 incidents per year, or one per week (IGP&I, 2020).

Whilst the number of incidents is however small in comparison with the overall number of acts of pilotage undertaken every year, the overall cost is substantial. The average cost per incident was calculated at USD 1.74 million.

Statistic also shows that 630 out of 1046 incidents was caused by allision/FFO which covers 60% of the number of incidents with the value of USD 1.15 billion. Although it is expected given the fact that a pilot is generally onboard a vessel during berthing/unberthing, it shows continuation of trend. In the conclusion response to the incidents, report in (IGP&I, 2019) states that the berthing of larger vessels has been identified as the area of focus for their future work. This is because the severity of three incidents in year 2019 which involve contacts between container vessels and gantry cranes. There were even additionally two more incidents of similar nature notified to the IG Pool for the 2020 underwriting year (IGP&I, 2019).

Demirci, S. E. et al., (2023) stated that the expansion of ship sizes and heavy traffic poses significant challenges to sustainable transportation, increasing the risk of marine accidents, particularly in confined waters was supported by the report from (IGP&I, 2019) stating that the increase in traffic density was also highlighted in the report based on the timeline of incidents for the top four ports which is Houston, Singapore, Antwerp & New Orleans. The year with the greatest frequency was 2014 in Singapore when there were 7 incidents, the majority of which (4) were collisions with other vessels compared to 28 of those years where there was only one incident.

IMPA has also been closely following the incidents involving large container ships and has made submissions on this topic to the IMO's Sub-Committee on Implementation of IMO Instruments (IGP&I, 2019). Incidents involving large container ships continues to occur with the recent incident whereby CV. Ever Given of 400m LOA went aground at Suez Canal causing damage of USD 1 billion on the 23rd of March 2021(Schuler M., 2023), CV MSC Aquarius of 300m LOA, collided with harbour tug on the 14th April 2022(National Transport Safety Board, 2023), CV Hyundai Tokyo of 303.83m LOA collision with wharf on the 20th March 2023(Rakin R., 2023), CV. MV One Orpheus of 336m LOA, knocked into a bridge (Hope A., 2023) and CV Dali of 300m knocked and collapsed Baltimore's Francis Scott Key Bridge(Konrad J., 2024).

The IMO Noted that since each pilotage area needs highly specialized experience and local knowledge on the part of the pilot, IMO does not intend to become involved with either the certification or licensing of pilots or the systems of pilotage practised in various States (IMO, 2004). IMO also recognizes the high standards of pilotage services already established in many States and the need for these standards to be maintained (IMO, 2004) and despite recommendation from IMO Resolution A960- Recommendations on training and certification and operational procedures for maritime pilots other than deep-sea pilots. Notwithstanding advancement in training and technology, it is nonetheless likely that there will continue to be incidents of loss or damage that arise with vessels under pilotage (IGP&I, 2019)

As seen in the literature review, Pilot boards in Malaysia have established their pilotage requirement and several have developed their training and assessment modules. However, the requirements including training and assessment module varies from each Pilot boards. Furthermore, some training and assessment modules does not fully adapt the recommendations by IMO A960.

Therefore, evaluation of these training and assessment modules are necessary. Notably, no studies have been conducted in Malaysia on developing maritime pilot training and assessment modules by adapting KSA method. For this reason, this present study aims to illustrate how a systematic framework of training and assessment could provide sufficient maritime pilot knowledge which could lead to positive development in maritime pilot skills and abilities. This relationship would eventually improve maritime pilot competency during pilotage operation.

Based on review of the related literature, evaluation of maritime pilot knowledge, skills and abilities can be achieved by Likert scale questionnaire that can be developed by identifying factors to represent the KSAs (Glassman et. al., 2015; Walters M.J., 2002; Driskill et. al., 2002).

The Malaysian training and assessment modules contain various factors which may or may not relate to pilotage operation. Scoping review technique (The Joanna Briggs Institute, 2015) will be applied to the process of gathering factors of maritime knowledge, skills and abilities. Since not all factors in the maritime training and assessment module are suitable for pilotage operation, factors will be filtered using FFF model to enable to select the key factors only. Then, with references to the filtering elements, series of interviews was conducted with a maritime technical expert to choose the factors (Kamis, 2020). The factors selected by them should include only factors that represent maritime pilot knowledge, skills and abilities. Once all factors namely maritime pilot knowledge, skill and abilities were identified, Likert scale questionnaire will be developed to obtain data. Then the relationship between maritime pilot knowledge, skills and abilities using PCA and SEM analyses.

CHAPTER 3

METHODOLOGY

3.1 Research method

The flow chart of research activities is shown in Figure 3.1

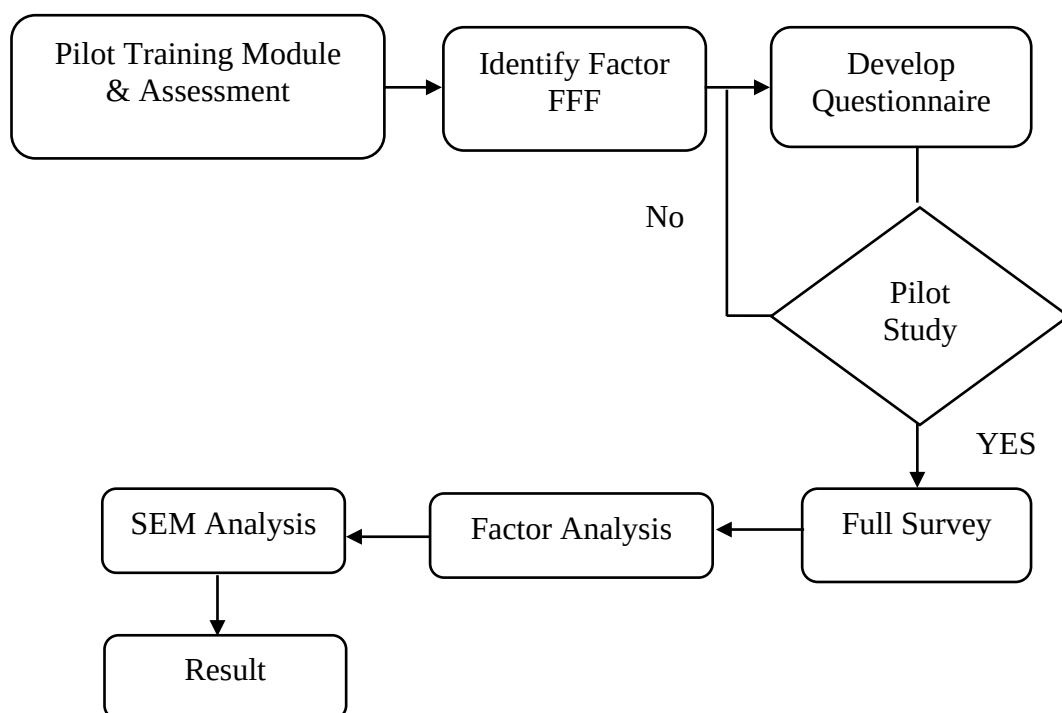


Figure 3.1 Research flow

3.2 Detailed steps of research methodology

3.2.1 Step 1 – Gather pilot training and assessment module

To ensure that the assessment of the latent variables is possible, the step 1 is to obtain the pilot training and assessment modules from 3 Pilot Boards in Malaysia, namely Lembaga Pelabuhan Johor, Penang Port Commission and Pilotage District of Sungai Udang. The relevant documents were obtained by interview with the responsible division in the port on pilotage.

Factors that can represent all three latent variables, were also taken from IMO Resolution A.960- Recommendations on training and certification and operational procedures for maritime pilots other than deep-sea pilots.

Step 2 - Identifying factors for maritime pilot knowledge, skills and abilities.

3.2.2 Step 2 – Identifying Factor FFF

Step 2 is to gather factors, subfactors and items related to maritime pilot knowledge, skills and abilities which were identified using related modules and IMO resolution A.960. All the identified factors were then listed under the generic list. Subsequently, the second step of the second stage was to establish the filtering elements to filter factors of relevance to the study. Here, the adapted FFF model is developed accordingly (Kumar & Dange, 2012; Kamis, 2020). The filtering elements were ascertained by combining the literature review and referring to maritime technical experts by using cognitive interviewing method. Cognitive interviewing is one of the most widely used methods, refers to a set of techniques (e.g., think aloud protocols, verbal probes) that enable a researcher to deeply analyze how respondents understand the survey questions they are to answer (Tourangeau et al., 2000, Ryan k. et. al., 2012) Meanwhile, the third stage for this particular step filtered the factors identified according to the established filtering elements by using the FFF model.

To be specific, several models were implemented, namely, factors, filtering elements, and filtered models (FFF model) (Kumar & Dange, 2012). Moreover, the filtering elements were established through a combination of literature review and reference to the experts in the maritime field (Kamis, 2020).

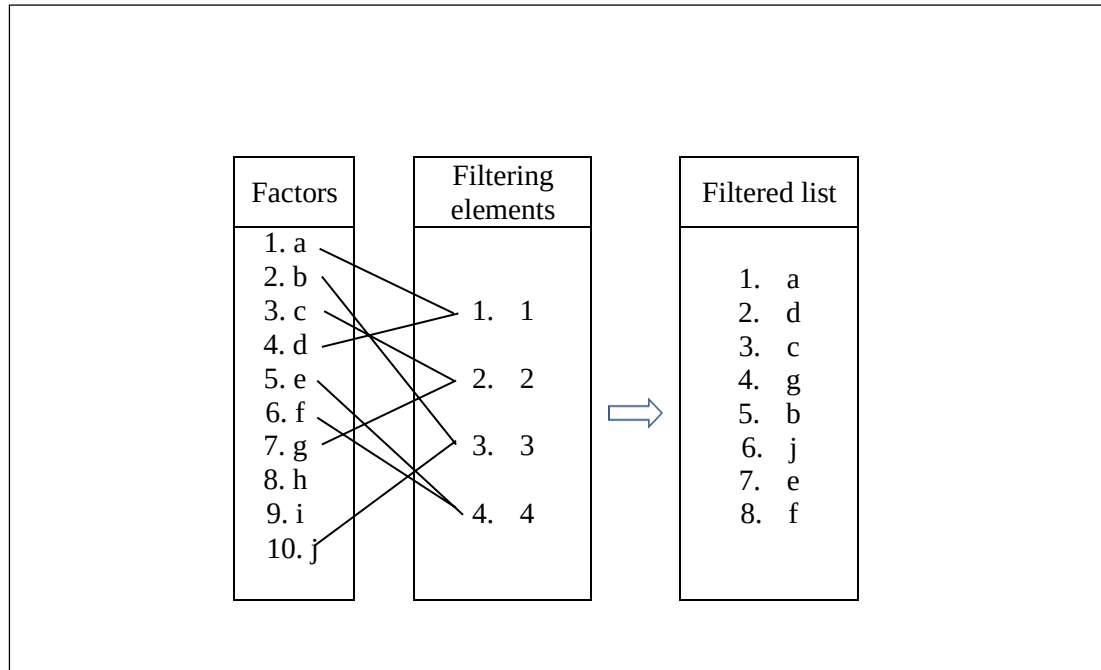


Figure 3.2 Factors, filtering elements, filtered list model (FFF model)

3.2.3 Step 3 – Develop questionnaire for survey.

A set of questionnaires was developed and distributed for pilot study. The developed questionnaire were adapted from existing study by Kamis (2020) with reference to the selected factors by maritime technical experts in second stage. Cognitive interviewing was used to develop the questionnaire by interviewing 5 maritime technical experts to identify factors, subfactors and items that can be considered relevant to pilot tasks during pilotage operation. All interviewed maritime experts are holding Class 1 Deck, Master Mariner licensed by Marine Department of Malaysia and full pilot license licensed from their respective Pilot Board. These maritime experts also hold the position of either manager, head of department or owner of the pilotage company or port operator. In this study, the 6-point Likert scale was selected as it would yield a definite response. Furthermore, the 6-point scale analysis

was in support of the requirement for factor analysis, which necessitated a 4-point scale at the very least. As such, the higher points of the Likert scale, the better suitability of the ordinal data for factor analysis purposes (Piaw, 2009). Research Ethics

This survey was conducted in accordance with ethical research standards to ensure the integrity of the research process and respect for participants' rights. Given the nature of the survey and the data collected, no personally identifiable or sensitive information was required, ensuring that participants' privacy remained fully protected. Participants were informed about the study's purpose, objectives, and voluntary nature. This information was provided at the beginning of the survey, ensuring participants were aware of their rights, including the option to decline participation without any repercussions. Explicit consent was implied by participants' decision to complete and submit the survey.

3.2.4 Step 4- Pilot study

Step 4 is to conduct a pilot study on the questionnaire developed. The questionnaire will be given to 10 deck officers carrying minimum of Certificate of Competency Class 3 from different companies and types of vessels. Results received from the respondent were analysed to produce the reliability analysis Cronbach Alpha. If result of Cronbach Alpha achieves minimum 0.7, then a full survey can be proceeded.

3.2.5 Step 5- Final survey and data collection

Step 5 involves conducting a full survey. The survey was carried out at selected ports in Malaysia, namely Penang Port, Port of Sungai Udang, Pasir Gudang Port, Kertih Port, Bintulu Port, Labuan Port, and Tawau Port. The survey period lasted three months, from 1st April 2023 to 30th June 2023. The survey method involved distributing a multiple-choice questionnaire via Google Forms. Responses from the pilots were timely and collected within the survey period. There were no significant

changes in their daily operations or any incidents during this time that could have influenced the pilots' responses. A total of 85 out of 105 pilots participated in the survey, meeting the sample size requirements as per Krejcie and Morgan's (1970) table (Krejcie & Morgan, 1970; Piaw, 2011). The breakdown of pilot participation is as follows: Pasir Gudang Pilots – 32, Bintulu Pilots – 17, Penang Pilots – 13, Sungai Udang Pilots – 8, Tawau Pilots – 5, Labuan Pilots – 5, and Kertih Pilots – 5.

3.2.6 Step 6- Factor analysis

Step 6 is to conduct a series of data analysis using SPSS software to each and all factor to determine the underlying factors and correlation between factors to develop the framework. The first data analysis was Cronbach's Alpha to measure the internal consistency reliability of a set of items in a questionnaire or survey (Taber, 2018). The second data analysis was frequency analysis to produce mean score and linguistic value for each question. Frequency analysis is a statistical method used to analyse the distribution of a variable in a dataset. The third data analysis was KMO Test to assess the appropriateness of using factor analysis on the data set. The fourth data analysis was Bartlett' test of sphericity to determine whether a set of variables in a dataset are correlated with each other. The fifth data analysis was Principal Component Analysis with Promax rotation to identify the underlying factors or dimensions that explain the correlations among a set of variables.

3.2.7 Step 7- SEM analysis

SEM consists of confirmatory factor analysis (CFA) and path model (Piaw, 2009). CFA is a procedure used to test the hypotheses through statistical means to identify the commonality among variables. (Hoyle, 2000; Kamis, 2020). CFA role is to test hypotheses in relation to developed variables and conceptual models.

Meanwhile, Structural Equation Modelling (SEM) aims to provide a quantitative test of a conceptual model involving various natures of models to

determine the relationship between the observed variables through path analysis (Schumacker & Lomax, 2010; Kamis, 2020). In this study, path analysis was used to identify a relation between maritime pilot knowledge, skills and abilities. It also determined to what extent the conceptual model is supported by the sample data (Schumacker & Lomax, 2010; Kamis, 2020).

Structural equation modelling is a multivariate statistical analysis procedure used to examine structural relationships. This method is the mixture of multiple regression analysis and factor analysis, and it is used to analyse the structural relationship between latent constructs (unobserved variables) and measured variables (observe variables) (Schumacker & Lomax, 2010; Kamis 2020). Accordingly, as Structural Equation Modelling (SEM) aims to provide a quantitative test of a conceptual model, it involves various natures of the model to determine the relationship between the observed variables (Schumacker & Lomax, 2010; Kamis, 2020). Most researchers prefer this method because it estimates the various and interconnected dependency in a single analysis.

Although SEM has limitations, including large sample size requirements, sensitivity to data normality, complexity in interpretation, reliance on fit indices, measurement challenges, difficulty in establishing causality, and resource intensity, researchers can mitigate their impact by ensuring adequate sample sizes, validating measurement tools, and carefully interpreting results within the theoretical context.

Another form of SEM analysis that was considered is Partial Least Square (PLS-SEM). However, it's a variance-based SEM technique suitable for smaller sample sizes and predictive modelling and is usually used for exploratory research or when theory is less developed.

3.2.8 Methodological limitations

This study faced several methodological limitations that may have influenced the findings. Potential biases and methodological constraints arose despite efforts to

design a robust and systematic research approach. These limitations are discussed in detail below, along with the measures taken to address them.

One significant source of potential bias is related to the sampling process. The study focused exclusively on maritime pilots from seven Malaysian ports, including Penang Port, Port of Sungai Udang, Pasir Gudang Port, Kertih Port, Bintulu Port, Labuan Port, and Tawau Port. While this ensured regional representation, the findings may not fully apply to maritime pilots operating in regions with differing operational contexts and pilotage standards. Furthermore, the self-reported nature of the survey data introduces the possibility of response bias. Participants might have provided socially desirable responses rather than accurate reflections of their actual knowledge, skills, and abilities, potentially impacting the validity of the findings.

The cognitive interviewing process, which involved consultations with five maritime technical experts, was another area where biases may have occurred. These experts, selected based on their high qualifications, brought significant expertise to the study. However, their limited number may have excluded other valuable perspectives, potentially constraining the breadth of factors identified. Additionally, observer bias may have influenced the cognitive interviewing process, as the researchers' interpretations of participants' verbal responses might have introduced subjectivity, even with standardized protocols.

Methodological constraints were also evident in the study design and data collection process. The cross-sectional nature of the study, which collected data at a single point in time, limits the ability to establish causal relationships among maritime pilot knowledge, skills, and abilities. The reliance on existing training and assessment modules from three Malaysian pilot boards and the International Maritime Organization's Resolution A.960 provided a strong foundation but may not have captured the practical variations or evolving standards in pilotage practices across different ports.

The sample size for the pilot study, which involved ten deck officers, was relatively small. While this provided initial insights into the survey's reliability, a

larger pilot sample would have been more effective for robust validation. Similarly, the main survey's use of Google Forms for data collection may have excluded some participants due to limited internet access or unfamiliarity with digital tools, potentially affecting the representativeness of the data. Although the Cronbach's Alpha analysis confirmed the internal consistency of the survey items, self-reported responses may not fully reflect the participants' actual performance, further highlighting the limitations of self-reported data.

The use of Structural Equation Modelling (SEM) added complexity to the analysis. SEM relies on strict assumptions, such as data normality and sufficient sample size. While the study's sample of 85 participants met the minimum requirements based on Krejcie and Morgan's sample size table, it may still be on the lower end for complex SEM analyses. This could potentially affect the robustness and reliability of the results.

To mitigate these challenges, several measures were implemented. The inclusion of diverse ports in the sampling design ensured a broader representation of maritime pilots within Malaysia. Cognitive interviewing techniques, such as think-aloud protocols, were employed to refine the questionnaire and improve its clarity and relevance. Reliability analysis using Cronbach's Alpha was conducted to confirm the internal consistency of the survey items. Additionally, Promax rotation was used in the factor analysis to account for potential interdependencies among variables, and SEM assumptions were carefully considered during data analysis.

Table 3.1 Summary for methodology, timeline, population, sampling adequacy, sampling technique, validation and analysis technique for each stage

	Goals and Timeline	Approaches	Population	Sample and sampling adequacy	Sampling Technique	Validation technique	Measurement and Analysis Technique
1	Gather pilot training and assessment module 1 st Oct 22 to 31 st Dec 22	Scoping review	N.A.	Malaysian pilot training and assessment module & IMO A.960	N.A.	Interview with pilot operator	N.A.
2	Identifying factors for Maritime pilot knowledge, skills and abilities 15 th Jan 23- 30 th Jan 23	FFF model	N.A.	N.A	Interview	Interview questions validated by 5 master mariners	Statistical percentages
3	Develop questionnaire for survey 1 st Feb 23 to 28 th Feb 23	Likert scale questionnaire	N.A.	N.A	Interview	Interview questions validated by 5 master mariners	

	Goals and Timeline	Approaches	Population	Sample and sampling adequacy	Sampling Technique	Validation technique	Measurement and Analysis Technique
4	Pilot study 15 th Mar 23- 30 th Mar 23	Likert scale questionnaire	N.A	10 deck officers from various type of vessel holding COC recognised by IMO	Distribution of Questionnaire forms	Cronbach Alpha	N.A.
5	Data collection 1 st Apr 23- 30 th Jun 23	Final survey Likert scale questionnaire	Malaysian Maritime Pilot	85 participants from 7 Malaysian ports as per Krejcie & Morgan, (1970) table	Distribution of questionnaire forms	N.A	N.A
6	Factor Analysis 1 st Jul 23-30 th Sep 23.	N.A	N.A	N.A	N.A	Cronbach Alpha Frequency analysis KMO Test Bartlett's test	PCA SEM analysis

3.3 Development of Maritime Pilot Knowledge, Skills and Abilities conceptual model and hypotheses.

Table 3.2 Overview of the development of the conceptual model and hypotheses

Process overview	Method	Author
3.3 To gather all possible factors (generic list of factors) that can represent unobserved variables (maritime pilot knowledge, skills and abilities) and minimise the risk of missing any possible factors.	Scoping review.	(Arksey & O'Malley, 2005; The Joanna Briggs Institute, 2015)
3.4 To convert the generic list of factors into factors only related to maritime pilot operations in the scope of maritime science.	FFF model and interview with maritime technical experts.	(Kamis, 2020)
3.5 To identify the components for each factor for the development of the Maritime Pilot KSAs conceptual model and hypotheses.	Developing a survey questionnaire using selected factors.	(Piaw, 2009; Kamis, 2020)

3.4 Selecting factors through scoping review

3.4.1 Method

An informative scoping review approach was selected according to the framework drawn by Arksey & O'Malley (2005). As opposed to systematic reviews that also evaluate the quality of a study, the scoping review framework collects, maps, and summarises the literature based on a specified subject and aims to categorise all current studies on a topic paying little mind to their quality (Arksey & O'Malley, 2005; Kamis, 2020).

The scoping review framework starts with determining the research questions, and then relevant literature was identified. The process continues with selecting literature followed by charting data and finally collating the results of the review.

3.4.2 Determining the scoping review question

In order to explain the attention of the scoping review and ensure the establishment of an effective search approach, the methodology, respondent population, and context were defined (Arksey & O'Malley, 2005; Kamis, 2020). The research question will be able to help to identify precise characteristics of the research question that are essential such as target population, involvements, and result (The Joanna Briggs Institute, 2015; Kamis, 2020). The established research question for this scoping review was,

“What are the factors that can represent maritime pilot knowledge, skills and abilities that can improve pilot competency when conducting pilotage operation?”

3.4.3 Selecting literature

Since the study is focus on Malaysian maritime pilot, the literatures are selected from training and assessment module, ordinances, regulations, guidelines developed by Malaysian pilot boards or Malaysian Government body only. However, IMO Resolution A.960 was also included in the selection of literature as IMO Resolution A.960 is the latest recommendation by the International Maritime Organization that is supposed to be adopted by Malaysia as a member of the IMO . Initially there were total of 12 sets of literatures including IMO resolution A.960 were collected from pilot boards and Government body. However after discussions, only 6 sets of literatures suits the study.

Table 3.3 List of literatures to be reviewed

No.	Title	Author
1	Resolution A.960	IMO
2	Pilotage Rules and Procedures	Pilotage district of Sg Udang Port
3	LPJ Pilot's evaluation report	Lembaga Pelabuhan Johor
4	Pilot Assessment Criteria	Penang Port Commission
5	Pilotage Curriculum	Penang Port Commission
6	Written examination for apprentice pilot	Penang Port Commission

CHAPTER 4

RESULT AND DISCUSSIONS

4.1 Research findings

The result is explained in three stages as follows:

- i. Preliminary result- The objective was to identify the factors and subfactors of maritime knowledge, skills and abilities (KSA) to develop a set of questionnaires as a survey instrument. The process began by gathering and collating maritime training and assessment modules in Malaysia, including the IMO Resolution A960. This is followed by identifying a generic list of factors related to pilotage operations and establishing research criteria for filtering these factors. The selection of maritime KSA factors was conducted by maritime experts using FFF model, with decisions based on majority acceptance or rejection, accompanied by justifications. The accepted factors were further categorized into factors and subfactors derived from their respective sources. A questionnaire was developed and analyzed by technical experts through cognitive interviews. Finally, the questionnaire was submitted to the ethics Committee at UMT for verification.

- ii. Pilot study- The objective of the pilot survey was to assess the reliability of the questionnaire. Deck navigation officers were selected to participate in the pilot survey, as their tasks closely align with those of maritime pilots. Reliability was determined by analyzing the results of the Cronbach's alpha and the KMO-Bartlett test to evaluate the success or failure of the pilot survey. If the pilot survey failed, the questionnaire would be reassessed in collaboration with technical experts until a successful outcome was achieved.
- iii. Full survey- The objective of the full survey was to identify the correlation values between maritime knowledge, skills, and abilities. The process began with the distribution of questionnaires at selected ports in Malaysia. The survey results were then analyzed using SPSS and SPSS Amos to determine the factors and correlation values within maritime knowledge, skills, and abilities.

4.2 Preliminary results

Preliminary results discuss the identification of factors and subfactors representing latent variables, which were identified through the process of scoping review and FFF by interviewing maritime technical experts.

4.2.1 Identifying maritime pilot training and assessment module in Malaysia

The modules taken were from Pilotage District of Sungai Udang, Lembaga Pelabuhan Johor and Penang Port Commission (Table 4.1). The contents of the module include IMO resolution A.960 were reviewed and the contents were then collated.

Table 4.1 The list of training and assessment module reviewed.

No.	Title	Author
1	Resolution A.960	IMO
2	Pilotage Rules and Procedures	Pilotage district of Sg Udang Port
3	LPJ Pilot's evaluation report	Lembaga Pelabuhan Johor
4	Pilot Assessment Criteria	Penang Port Commission
5	Pilotage Curriculum	Penang Port Commission
6	Written examination for apprentice pilot	Penang Port Commission

After reviewing and collating the resolution and modules, the second objective was to identify elements to be incorporated into the assessment module. It started with identifying the best method to access the effectiveness of the elements. According to previous study and literature review, the best method was to use KSA as also stated by Wang, N. et. al., (2005) that it is often the KSA required for performing the tasks, rather than the job tasks themselves, which are tested by licensure and certification exams.

4.3 Maritime Pilot Knowledge

4.3.1 Preliminary Result on Identifying the factors of Knowledge, Skills and abilities

This part of the result discusses all the factors that represents latent variables which are identified through scoping review and FFF model through an interview with maritime technical experts.

4.3.2 Selection of maritime pilot knowledge factors by maritime experts with reference to FFF model

Table 4.3 shows the collating result of factors for pilot maritime knowledge. It is essential to highlight that the factors shown were collected from training and assessment guidelines from Malaysian Pilot Boards and IMO resolution. These factors will be transferred into a generic list of factors as shown in Table 4.1 before they are filtered into maritime pilot knowledge factors. The filtration of the factors was carried out by maritime technical experts as shown on Table 4.2 with reference to the FFF model. All interviewed maritime experts are leaders in the field of maritime pilotage in Malaysia. They hold a Class 1 Deck Master Mariner license issued by the Marine Department of Malaysia and a full pilot license granted by their respective Pilot Boards. In addition, these experts occupy senior positions, such as managers, heads of departments, or owners of pilotage companies or port operators.

Table 4.2 List of technical experts

Expert-1	Capt. Cyril Willie Abah / Port of Labuan
Expert-2	Capt. Jumiati Ghani / Port of Sungai Udang
Expert-3	Capt. Marvel Alberto / Port of Sipitang
Expert-4	Capt. Ooi Swee Siang / Port of Labuan
Expert-5	Capt. Wun Wee Yang / Port of Tanjung Pelepas

Table 4.3 Maritime Pilot Knowledge

No	Factors	Source
1.	Ship handling and Manoeuvring	Pilotage rules & procedures, Sungai Udang Port Pilot's evaluation report, Lembaga Pelabuhan Johor Pilot assessment criteria, Penang Port Commission IMO Resolution A960

No	Factors	Source
2.	Tug boat Operation	Pilotage rules & procedures, Sungai Udang Port Pilot's evaluation report, Lembaga Pelabuhan Johor Pilot assessment criteria, Penang Port Commission IMO Resolution A960
3.	Navigation	Pilotage rules & procedures, Sungai Udang Port Pilot's evaluation report, Lembaga Pelabuhan Johor Pilotage Curriculum, Penang Port Commission IMO Resolution A960
4.	Communication	Pilotage rules & procedures, Sungai Udang Port Pilot's evaluation report, Lembaga Pelabuhan Johor Pilot assessment criteria, Penang Port Commission IMO Resolution A960
5.	Bridge Resource Management	Pilot assessment criteria, Penang Port Commission Pilot's evaluation report, Lembaga Pelabuhan Johor IMO Resolution A960
6.	Personal sea survival	IMO Resolution A960
7.	First Aid	IMO Resolution A960

4.3.3 The factors and sub-factors for maritime pilot knowledge

With reference to table 4.3 all the factors were rearranged in a generic list of factors as can be seen in figure 4.1.

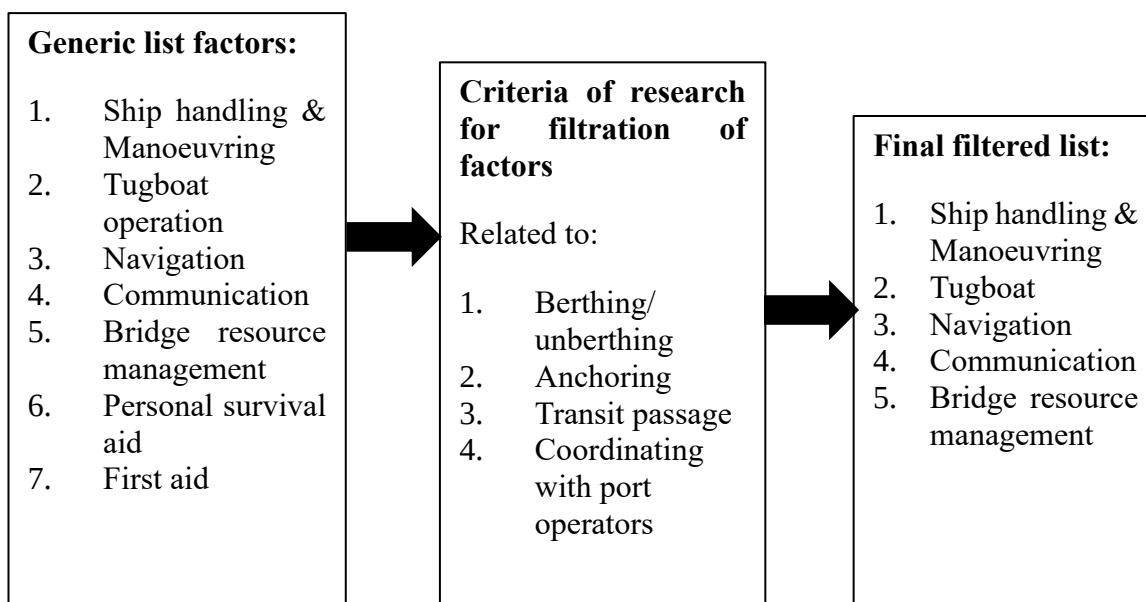


Figure 4.1 Generic list of knowledge factors to final filtered using FFF model

Based on the filtered list in Figure 4.1, all of the factors were filtered using an FFF model by interviewing maritime experts of the field. This interview was aimed at ensuring the acceptability of the factors for measuring maritime pilot knowledge. The reasons for the acceptance and rejection of the factors by the experts are elaborated in Table 4.4 and the accepted factors based on the interview results are illustrated in the cluster bar chart as shown in Figure 4.2 below.

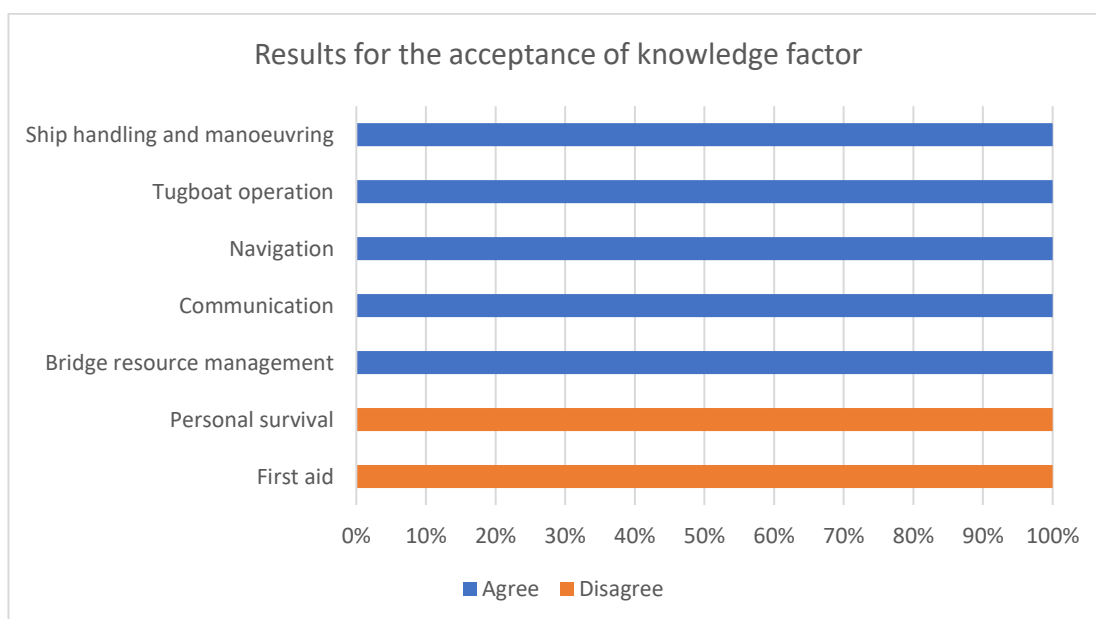


Figure 4.2 Distribution of maritime pilot knowledge factor by maritime experts.

In identifying maritime pilot knowledge toward ship handling and manoeuvring with references to Figure 4.2, 100% of experts had chosen to agree that ship handling and manoeuvring is the essential part of pilotage operation. Expert-1, highlighted that having sufficient such knowledge can help improve pilot skills and abilities in handling and manoeuvre vessel especially during berthing/unberthing, Expert-2, highlighted that these knowledge, skills and abilities can also be applied during anchorage operation and transiting narrow passage.

For Tugboat operation factors, 100% of experts agreed and expert-3 highlighted that, pilots need sufficient and the right knowledge especially the characteristics and history of the tugboat in order to be able to anticipate the capability of tugboat and its tug master thus enabling pilot to be able to coordinate tugboat more efficiently especially during berthing/unberthing and emergency situations. Expert-4 suggested that having familiarization onboard the local port tugs will also help pilot to understand the performance of tug and its tug master.

For Navigation factors, 100% of experts agreed. Expert-5 highlighted that knowledge of navigation is part of pilotage operation that a pilot should possess especially during transiting passage and VTS. Expert-2 added that various knowledge will be applied during navigation which includes knowledge of rules of the road, knowledge of local demographic condition including navigational safety and pollution prevention rules and many more which is essential in supporting the result of pilot skills and abilities thus conducting operation competently.

For Communication factors, 100% experts agreed. Expert-3 highlighted that having the right Communicating knowledge especially SCMP is key in ensuring accurate transfer of information with bridge team or external parties which is the common cause of incident during pilotage operation.

For Bridge Resource Management (BRM) factors, 100% experts agreed. Expert-1 highlighted that knowledge in BRM helps pilot to understand what discussions are required from the Master and the bridge team to ensure sufficient information sharing in order for a pilot to anticipate and plan a safe pilotage operation.

Expert-4 added that understanding standard of the bridge Team is essential for pilot to anticipate expectation of the team. Proper planning of passage together will also help bridge team to have good cooperation during normal passage or emergency.

For Personal Survival factors, although a pilot requires the knowledge of personal survival as it is part of basic safety training course, 100% experts don't agree that knowledge in personal survival is related to the safety or competency during pilotage operation.

For First Aid factors, although a pilot requires the knowledge of personal survival as it is part of basic safety training course, 100% experts don't agree that knowledge in personal survival is related to the safety or competency during pilotage operation.

Only factors with majority votes were selected to represent maritime pilot knowledge factor. The summary of acceptance and rejection is shown below.

Table 4.4 Summary of acceptance and rejection of Knowledge Factors

No	Generic list	Status	Reason
1	Ship handling and manoeuvring	Accepted	Knowledge of Ship handling and manoeuvring improves pilots' skill ability of pilot to handle and manoeuvre vessel during operation
2	Tugboat operation	Accepted	Knowledge of Tugboat handling, capability and limitation helps pilot to anticipate the ability of tugboat and challenges that may be faced during berthing/unberthing operation.

No	Generic list	Status	Reason
3	Navigation	Accepted	A pilot should be conversant on Rules of the road, well verse of the local demographic condition including navigational safety and pollution prevention rules.
4	Communication	Accepted	Knowledge on Shipboard Maritime communication phrase (SMCP) with bridge team and external parties are important during pilotage operation to ensure efficient communication as it can reduce miscommunication.
5	Bridge resource management	Accepted	Understanding standard of the bridge Team is essential for pilot to anticipate expectation of the team. Proper planning of passage together will also help bridge team to have good cooperation during normal passage or emergency.
6	Personal survival	Rejected	Although personal survival is part of knowledge required onboard, it should be part of Basic Safety Training course and not part of pilot training and assessment module.
7	First aid	Rejected	Although first aid is part of knowledge required onboard, it should be part of Basic Safety Training course and not part of pilot training and assessment module.

Once factors for knowledge were chosen, sub-factors for knowledge were structured. The factors and sub-factors were used to develop the Likert's scale type questionnaires. The sub-factors of each factor are as follows:

Table 4.5 Summary of Knowledge Factors and sub-factors.

Sub-factor	Factor 1: Ship handling and Manoeuvring	Source
1.1:	Principle of ship handling: Effect of vessel displacement, draft, trim, list and UKC on turning circle and stopping distance.	Pilotage rules & procedures, Sungai Udang Port Pilot's evaluation report, Lembaga Pelabuhan Johor
1.2 :	Principle of ship handling: Effect of wind and current.	Pilotage rules & procedures, Sungai Udang Port IMO Resolution A960 Pilot's evaluation report, Lembaga Pelabuhan Johor
1.3 :	Principle of ship handling: Effect of squat and similar effect when passing shallow water.	Pilotage rules & procedures, Sungai Udang Port
1.4 :	Principle of ship handling: Knowledge of ship handling and manoeuvring during anchorage operation.	IMO Resolution A960 Pilot's evaluation report, Lembaga Pelabuhan Johor Pilot assessment criteria, Penang Port Commission
1.5 :	Principle of ship handling: Knowledge of ship handling and manoeuvring during berthing operation.	IMO Resolution A960 Pilot's evaluation report, Lembaga Pelabuhan Johor Pilot assessment criteria, Penang Port Commission

Sub-factor	Factor 1: Ship handling and Manoeuvring	Source
1.6 :	Principle of ship handling: Knowledge of ship handling and manoeuvring during unberthing operation.	IMO Resolution A960 Pilot's evaluation report, Lembaga Pelabuhan Johor Pilot assessment criteria, Penang Port Commission
1.7 :	Principle of ship handling: Knowledge of ship handling and manoeuvring with or without tugs.	Pilotage rules & procedures, Sungai Udang Port IMO Resolution A960
1.8 :	Principle of ship handling: Knowledge of ship handling and manoeuvring during various type of emergency situation.	Pilotage rules & procedures, Sungai Udang Port IMO Resolution A960

Sub-factor	Factor 2 : Tug boat operation	Source
2.1 :	Principle of tugboat: Knowledge of different types of tugboat characteristics & manoeuvrability.	Pilot's evaluation report, Lembaga Pelabuhan Johor IMO Resolution A960
2.2 :	Port tugboats: Knowledge of Tugboats available at port (characteristics, manoeuvrability and limitations).	Pilot's evaluation report, Lembaga Pelabuhan Johor IMO Resolution A960

Sub-factor	Factor 3 : Navigation	Source
3.1 :	Local Knowledge: Knowledge on limits of local pilotage area	Pilotage rules & procedures, Sungai Udang Port
3.2 :	Local Knowledge: Knowledge on Rules of the road including local navigational safety and pollution prevention rules.	IMO Resolution A960
3.3	Local Knowledge: Knowledge on local marine aids to navigation.	Pilotage curriculum, Penang Port Commission
3.4	Local Knowledge: Knowledge on designated pilot anchorages.	Pilot's evaluation report, Lembaga Pelabuhan Johor
3.5	Local Knowledge: Knowledge on local weather, tides and currents.	
3.6	Local Knowledge: Knowledge on local Vessel traffic services (VTS).	
3.7	Local Knowledge: Knowledge on approaching local channel and waterway.	
3.8	Local Knowledge: Knowledge on local rules, regulations, guidelines and procedures related to pilotage operation.	

Sub-factor	Factor 4 : Bridge resource management	Source
4.1 :	Bridge teamwork: Knowledge on pre-arrival/departure	Pilot's evaluation report, Lembaga Pelabuhan Johor
	exchange with master on passage plan, decision making, situational awareness, contingency plan and emergency procedures.	Pilot assessment criteria, Penang Port Commission
		Pilotage rules & procedures, Sungai Udang Port
		IMO Resolution A960

Sub-factor	Factor 4 : Bridge resource management	Source
4.2 :	Bridge teamwork: knowledge on content and use of pilot card and master pilot exchange.	IMO Pilotage rules & procedures, Sungai Udang Port Resolution A960
4.3	Bridge teamwork: Understanding standard of the bridge team.	Pilot assessment criteria, Penang Port Commission
4.4	Knowledge on vessel bridge equipment and navigational aids.	IMO Resolution A960

Sub-factor	Factor 5 : Communication	Source
5.1 :	Onboard communication: Knowledge on Shipboard Maritime communication phrase (SMCP).	IMO Resolution A960
5.2 :	Onboard communication: Knowledge on use of VHF radio and GMDSS equipment.	IMO Resolution A960 Pilot's evaluation report, Lembaga Pelabuhan Johor Pilotage rules & procedures, Sungai Udang Port
5.3	Onboard communication: Knowledge on radio navigation warning.	IMO Resolution A960
5.4	Onboard communication: Knowledge on communication procedures with vessel traffic services, port authority & port operators.	Pilot's evaluation report, Lembaga Pelabuhan Johor Pilot assessment criteria, Penang Port Commission

4.4 Maritime Pilot Skills

4.4.1 Identifying Maritime Pilot skill factors

The study continued with the filtration of factors for Maritime Pilot Skills. Table 4.6 shows the collating result of factors for pilot maritime skills. It is essential to highlight that the factors shown we collected from training and assessment guidelines from CPA and IMO resolution A.960. These factors will be transferred into a generic list of factors as shown in Figure 4.6 before they are filtered into maritime pilot skill factors. The filtration of the factors was carried out by maritime technical experts with reference to the FFF model.

Table 4.6 Maritime Pilot Skills Factors and Sources

No	Factors	Source
1.	Ship handling and Manoeuvring	Pilot assessment criteria, Penang Port Commission Pilot's evaluation report, Lembaga Pelabuhan Johor IMO Resolution A960 Pilotage rules & procedures, Sungai Udang Port
2.	Tugboat coordination	Pilot assessment criteria, Penang Port Commission Pilot's evaluation report, Lembaga Pelabuhan Johor IMO Resolution A960 Pilotage rules & procedures, Sungai Udang Port

No	Factors	Source
3.	Navigation	Pilot assessment criteria, Penang Port Commission Pilot's evaluation report, Lembaga Pelabuhan Johor IMO Resolution A960 Pilotage rules & procedures, Sungai Udang Port
4.	Communication	Pilot assessment criteria, Penang Port Commission Pilot's evaluation report, Lembaga Pelabuhan Johor IMO Resolution A960 Pilotage rules & procedures, Sungai Udang Port
5.	Bridge resource management	Pilot assessment criteria, Penang Port Commission Pilot's evaluation report, Lembaga Pelabuhan Johor IMO Resolution A960
6.	Passage plan	Pilot assessment criteria, Penang Port Commission Pilot's evaluation report, Lembaga Pelabuhan Johor IMO Resolution A960
7.	Emergency conduct	Pilot assessment criteria, Penang Port Commission Pilotage rules & procedures, Sungai Udang Port
8.	Personal & professional conduct	Pilot assessment criteria, Penang Port Commission

4.4.2 Selection of Maritime Pilot Skills factors by maritime experts with reference to FFF model

Selection of Skills factors were carried out using means of an interview with maritime experts. With reference to Table 4.6, all the factors were rearranged in a generic list of factors as shown in Figure 4.3.

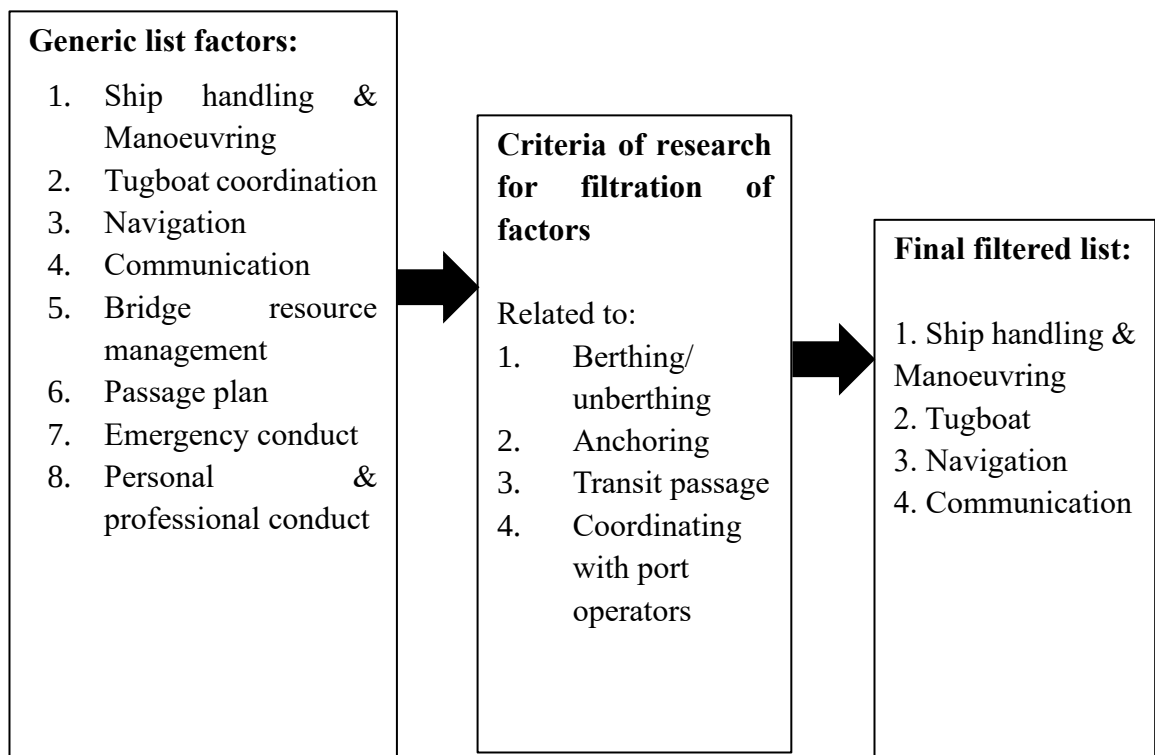


Figure 4.3 Generic list of Skills factors to final filtered using FFF model

Based on the filtered list in Figure 4.3, all of the factors were filtered using an FFF model by interviewing maritime experts of the field. This interview was aimed at ensuring the acceptability of the factors for measuring maritime pilot skills. The reasons for the acceptance and rejection of the factors by the experts are elaborated in Table 4.7 and the accepted factors based on the interview results are illustrated in the cluster bar chart as shown in Figure 4.4 below,

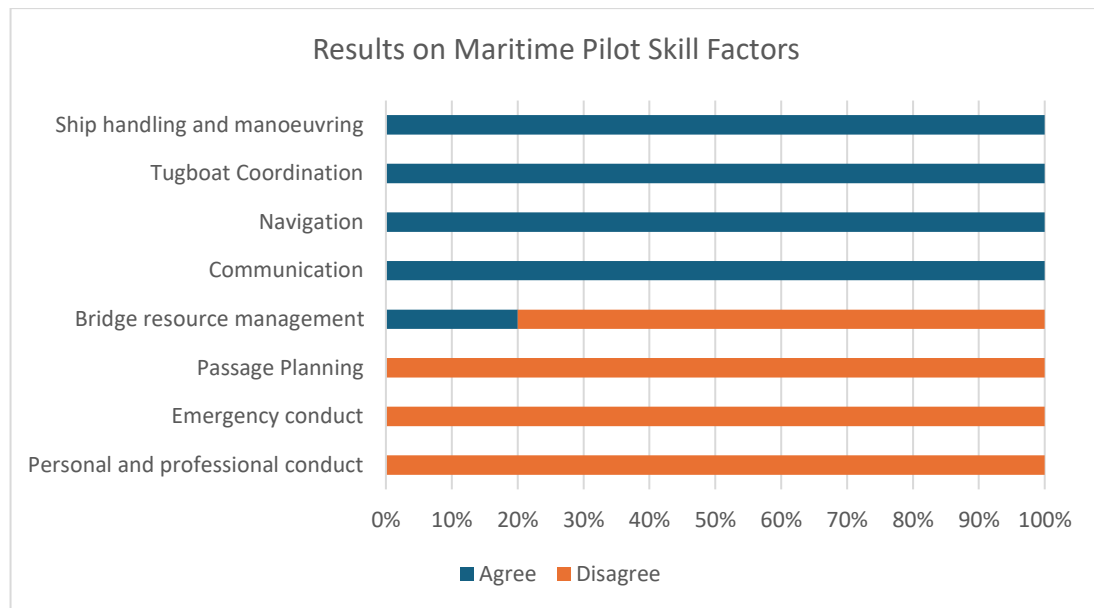


Figure 4.4 Distribution of maritime pilot skills factor by maritime experts.

In identifying maritime pilot skills toward ship handling and manoeuvring with references to Figure 4.3, 100% of experts had chosen to agree that ship handling and manoeuvring is the essential part of pilotage operation. Expert-1, highlighted that these skills are applied in Handling and manoeuvre vessel especially during berthing/unberthing, Expert-2, highlighted that these skills can also be applied during anchorage operation and transiting narrow passage.

For Tugboat operation factors, 100% of experts agreed and expert-3 highlighted that, pilots need to be able to control tugboats during berthing/unberthing operation as every operation will be different from previous operation depending on the characteristics of vessel, tug and meteorological condition. Expert-4 added that good control of tugboat is critical especially during emergency situation.

For Navigation factors, 100% of experts agreed. Expert-5 highlighted that pilot should possess Skill and ability to operate bridge navigation equipment to track and control vessel movements.

For Communication factors, 100% experts agreed. Expert-3 highlighted that foundation of effective communication starts from proper use and tuning of radio and

speaking loud and clear. Expert-1 added that pilot should know how to apply different communication approach with bridge team and third party.

For Bridge Resource Management (BRM) factors, 20% experts agree that BRM is part of Pilotage skills while 80% experts disagree. Expert -4 suggests that a maritime pilot should have the ability to optimize resources obtained from the bridge team including human, equipment, technology and information in decision making to produce efficient pilotage operation and contingency plan. BRM does not require much skills and therefore may not be suitable to be categorized as skills factor. Expert-5 supports the statement by adding that minimum skill is required in processing bridge resources in order to make decision during normal and emergency situation.

For Passage Plan factors, 100% experts rejected that passage plan is part of pilotage skills. Expert-1 explains that passage plan is an action taken during initial stage prior pilotage operation whereby no skills are required. Expert-2 added that passage plan require ability in decision making rather than skills.

For emergency conduct, 100% experts rejected. Expert-3 commented that emergency conduct does not fit as skill. It is more to the conduct ability of pilot to make decisions and taking action during emergency.

For Personal and professional conduct, 100% experts rejected. Expert-5 commented that although personal and professional conduct are part of the attributes of a pilot. It does not fit in to be considered a skill. Only factors with majority votes were selected to represent maritime pilot knowledge factor. The summary of acceptance and rejection is shown below.

Based on the filtered list in Figure 4.3, all of the factors were filtered using an FFF model by interviewing maritime experts of the field. This interview was aimed at ensuring the acceptability of the factors for measuring maritime pilot skills. The reasons for the acceptance and rejection of the factors by the experts are elaborated in Table 4.7. Only factors with majority votes were selected to represent maritime pilot skills factor.

Table 4.7 Factors and reasons

No	Generic list	Status	Reason
1	Ship handling and manoeuvring	Accepted	Pilot should have skills in handling and manoeuvring vessel especially during berthing/unberthing operation.
2	Tugboat operation	Accepted	Pilot should have the skills to control the tugboat handling during berthing/unberthing operation and emergency.
3	Navigation	Accepted	Pilot should be able to operate navigation equipment to track and control vessel movement.
4	Communication	Accepted	Pilot require good communication especially when coordinating with bridge team and port operators.
5	Bridge resource management	Rejected	Bridge Resource Management does not fit as skill. It is more to the conduct ability of pilot to use the knowledge available to prepare a safe pilotage operation plan and understanding the capability of its team.
6	Passage Plan	Rejected	Passage plan does not fit as skills. It is a series of planning and decision making during early stage or pilot operation.
7	Emergency conduct	Rejected	Emergency conduct does not fit as skill. It is more to the conduct ability of pilot to make decisions and taking action during emergency.
8	Personal & professional conduct	Rejected	Although personal and professional conduct are part of the attributes of a pilot. It does not fit in to be considered a skill.

Once factors for knowledge were chosen, sub-factors for knowledge were structured. The factors and sub-factors were used to develop the Likert's scale type questionnaires. The sub-factors of each factor are as follows:

Table 4.8 Summary of Skills Factors and sub-factors.

Sub-factor	Factor 1 : Ship handling and Manoeuvring	Practical Examples	Source
1.1 :	Practical of ship handling & manoeuvring: Handle and manoeuvre vessel safely and efficiently during pilotage operation in rivers, estuaries and restricted waters in various weather and current condition.	Pilots develop the ability to handle vessels in restricted waters, rivers, and estuaries. Training includes practical simulations and on-the-job scenarios where pilots practice navigating varying weather and current conditions. For example, a pilot maneuvering a tanker through a narrow estuary during high tide ensures that practical competence in such situations is honed.	Pilot assessment criteria, Penang Port Commission IMO Resolution A960 Pilotage rules & procedures, Sungai Udang Port
1.2 :	Practical of ship handling & manoeuvring: Handle and manoeuvre vessel safely and efficiently during anchorage operation in various weather and current condition.	Practical exposure to anchoring techniques in different conditions is critical. This includes understanding anchor deployment mechanics and coordinating with bridge teams to ensure stability.	Pilot assessment criteria, Penang Port Commission IMO Resolution A960 Pilotage rules & procedures, Sungai Udang Port
1.3 :	Practical of ship handling & manoeuvring: Handle and manoeuvre vessel safely and efficiently during berthing and unberthing operation in various weather and current condition.	Simulations focusing on dockside operations, including precise speed control and spatial awareness, enable pilots to safely berth or	Pilot assessment criteria, Penang Port Commission IMO Resolution A960

		unberth vessels even in adverse weather.	Pilotage rules & procedures, Sungai Udang Port
1.4 :	Practical of ship handling & manoeuvring: Handle and manoeuvre vessel safely with or without tugs in various weather and current condition.	Training modules integrate tug coordination with vessel handling in both reliant and non-reliant scenarios.	Pilot assessment criteria, Penang Port Commission IMO Resolution A960 Pilotage rules & procedures, Sungai Udang Port

Sub-factor	Factor 2 : Tugboat coordination	Practical Examples	Source
1.1 :	Coordinating tugboat movement during pilotage operation in various weather and current condition.	Pilots are trained to direct tugboats for effective vessel assistance. For instance, coordinating two or more tugs during a berthing operation in adverse weather and current condition is emphasized during practical drills.	IMO Resolution A960 Pilot's evaluation report, Lembaga Pelabuhan Johor Pilot assessment criteria, Penang Port Commission

1.2 :	Coordinating various type and models of tugboats available at port.	Familiarity with different tug models and their operational capacities is fostered through port-specific training sessions.	IMO Resolution A960 Pilot's evaluation report, Lembaga Pelabuhan Johor Pilot assessment criteria, Penang Port Commission
1.3 :	Coordinating tugboat operation whilst vessel not under command in various weather and current condition.	Exercises on tugboat management when vessels are not under command (e.g., steering failure) prepare pilots for emergencies.	IMO Resolution A960

Sub-factor	Factor 3 : Navigation	Practical Examples	Source
1.1 :	Process of navigating vessel: Demonstrating the use of bridge navigational equipment	Pilots are trained in radar, ECDIS, and AIS operations to enhance situational awareness. Practical examples include identifying nearby traffic during fog.	IMO Resolution A960
1.2 :	Process of navigating vessel: Monitoring and tracking vessel position	Regular practice in tracking vessel positions using charts and electronic	Pilot assessment criteria, Penang Port Commission

		systems ensures precision in pilotage areas.	
1.3 :	Process of navigating vessel: Navigating in pilotage area such as TSS, shallow water and various weather and current condition.	Exercises in Traffic Separation Schemes (TSS) and shallow waters enable pilots to anticipate and mitigate risks in constrained environments.	Pilot assessment criteria, Penang Port Commission IMO Resolution A960 Pilotage rules & procedures, Sungai Udang Port

Sub-factor	Factor 4: Communication	Practical Examples	Source
1.1 :	Use of marine radio communication for contacting local authority and other vessels	Hands-on training in marine VHF radio usage ensures clear communication with port authorities and other vessels. An example includes directing tugs during berthing operations via radio.	Pilotage rules & procedures, Sungai Udang Port IMO Resolution A960 Pilot's evaluation report, Lembaga Pelabuhan Johor

1.2 :	Use of marine radio communication for contacting port staffs	Training modules cover standard procedures for exchanging critical information with dock teams.	Pilotage rules & procedures, Sungai Udang Port IMO Resolution A960 Pilot's evaluation report, Lembaga Pelabuhan Johor
1.3 :	Communication with bridge team		Pilotage rules & procedures, Sungai Udang Port Pilot assessment criteria, Penang Port Commission IMO Resolution A960 Pilot's evaluation report, Lembaga Pelabuhan Johor

4.4.3 Skill development process

The development of maritime pilotage skills relies on a combination of hands-on onboard training and advanced simulations, aligned with the maritime training and assessment framework or integrated into a structured module. This dual approach ensures that pilots gain practical experience in real-world scenarios while also refining their abilities in a controlled, risk-free environment. Ultimately, this enhances overall competency and operational safety.

Onboard pilotage training provides pilots with direct exposure to real-time maritime operations. Trainees have the opportunity to apply theoretical knowledge under the guidance of experienced pilots, allowing them to develop crucial skills such as ship handling and manoeuvring, tugboat coordination, navigation, and effective communication. For example, pilots practice berthing and unberthing operations under varying weather conditions, navigate vessels through Traffic Separation Schemes (TSS) and shallow waters, and coordinate with tugboat operators during challenging situations. Through incremental exposure, trainees start by observing and gradually progress to taking on active responsibilities, fostering confidence and competence. Additionally, onboard training introduces pilots to unplanned events, such as equipment failure or adverse weather, preparing them to make informed decisions during emergencies.

Complementing onboard training, simulation centres provide a structured and controlled environment where pilots can practice high-stakes scenarios. Using high-fidelity bridge simulators equipped with navigational tools like radar, ECDIS, and AIS, pilots simulate realistic port-specific challenges and adverse conditions. For instance, they refine ship-handling techniques during scenarios involving dense fog, strong currents, or high winds and practice emergency responses, such as engine failure or tugboat malfunction. These centres also emphasize communication skills, allowing trainees to practice radio communication protocols with port authorities and bridge teams. Following each simulation, detailed feedback and debriefing sessions help pilots identify areas for improvement and refine their skills.

The integration of onboard and simulation-based training ensures a comprehensive skill development process. Onboard training provides essential real-world experience, while simulation centres offer the opportunity to prepare for complex and critical situations in a controlled setting. Together, these methods equip maritime pilots with the knowledge, expertise, and confidence needed to handle the complexities of pilotage operations effectively and safely.

4.5 Maritime Pilot Abilities

4.5.1 Identifying the Maritime pilot abilities factors

The study continued with the filtration of factors for Maritime Pilot Abilities. Table 4.9 shows the collating result of factors for pilot maritime abilities. It is essential to highlight that the factors shown we collected from training and assessment guidelines from CPA and IMO resolution A.960. These factors will be transferred into a generic list of factors as shown in Figure 4.5 before they are filtered into maritime pilot skill factors. The filtration of the factors was carried out by maritime technical experts with reference to the FFF model.

Table 4.9 Maritime Pilot Abilities and sources

No	Factors	Source
1.	Ship handling and Manoeuvring	Pilotage rules & procedures, Sungai Udang Port Pilot's evaluation report, Lembaga Pelabuhan Johor Pilot assessment criteria, Penang Port Commission IMO Resolution A960
2.	Passage plan	Pilot assessment criteria, Penang Port Commission Pilot's evaluation report, Lembaga Pelabuhan Johor IMO Resolution A960
3.	Pilot Transfer	Pilot assessment criteria, Penang Port Commission

No	Factors	Source
4.	Communication	Pilotage rules & procedures, Sungai Udang Port Pilot's evaluation report, Lembaga Pelabuhan Johor Pilot assessment criteria, Penang Port Commission IMO Resolution A960
5.	Bridge Resource Management	Pilot assessment criteria, Penang Port Commission Pilot's evaluation report, Lembaga Pelabuhan Johor IMO Resolution A960
6.	Emergency conduct	Pilot assessment criteria, Penang Port Commission
7.	Personal & professional conduct	Pilot assessment criteria, Penang Port Commission

4.5.2 Selection of maritime pilot abilities factors by maritime experts with reference to FFF model

Selection of Abilities factors were carried out using means of an interview with maritime experts. With reference to Table 4.9 all the factors were rearranged in a generic list of factors as can be seen in Figure 4.5.

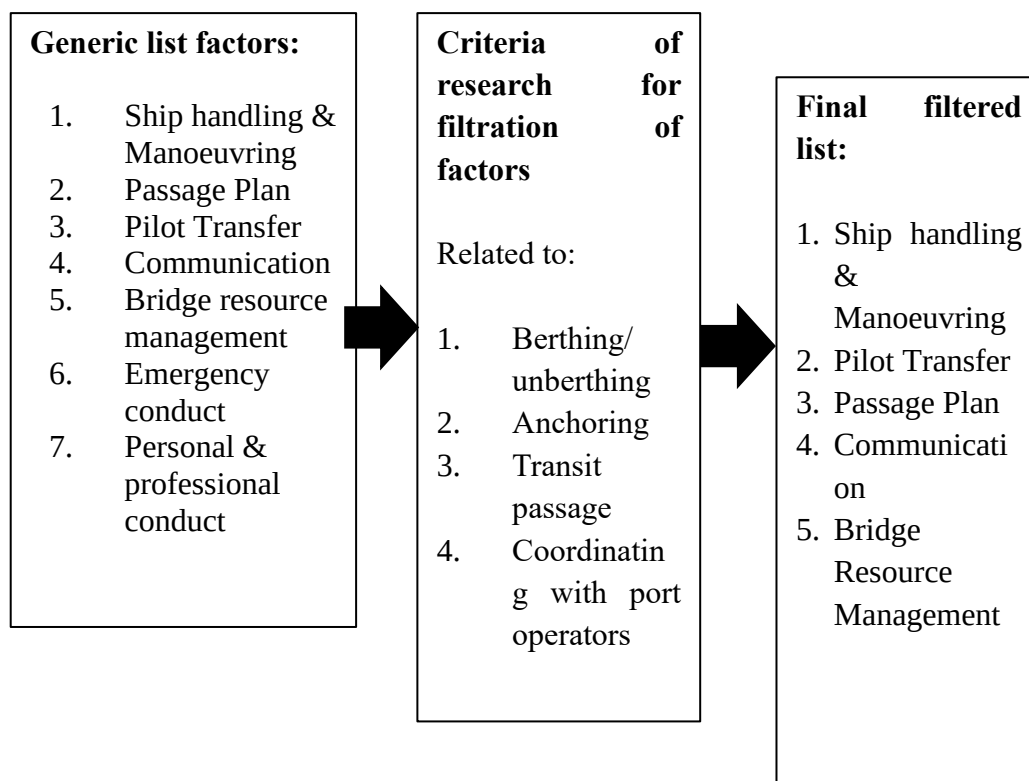


Figure 4.5 Generic list of Abilities factors to final filtered using FFF model

Based on the filtered list in Figure 4.5, all of the factors were filtered using an FFF model by interviewing maritime experts of the field. This interview was aimed at ensuring the acceptability of the factors for measuring maritime pilot abilities. The reasons for the acceptance and rejection of the factors by the experts are elaborated in Table 4.10 and the accepted factors based on the interview results are illustrated in the cluster bar chart as shown in Figure 4.6 below.

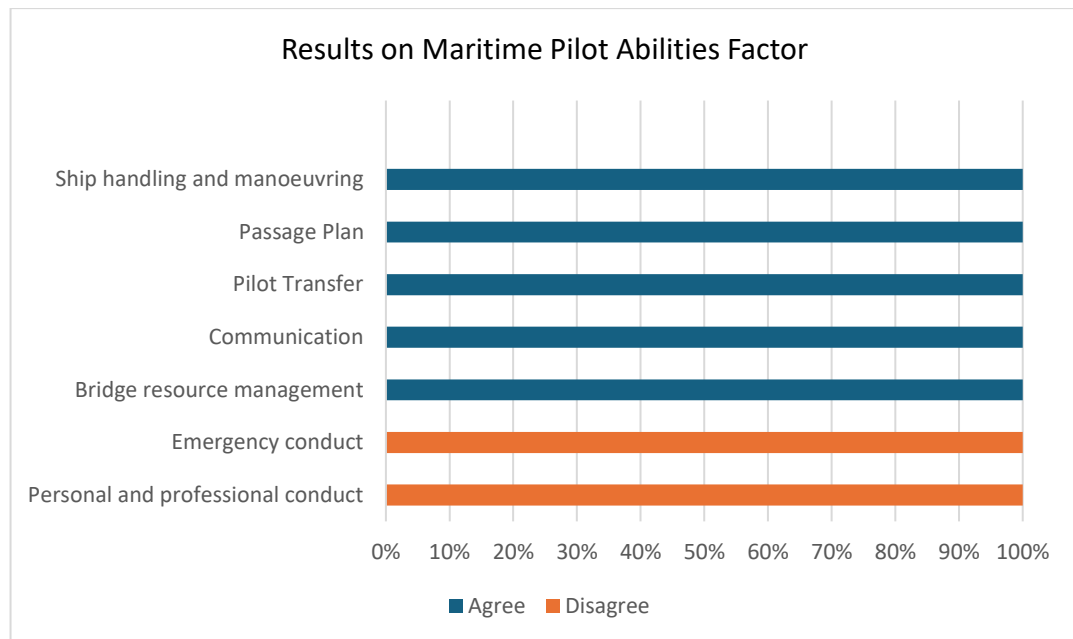


Figure 4.6 Distribution of maritime pilot abilities factor by maritime experts

In identifying maritime pilot abilities towards ship handling and manoeuvring with reference to Figure 4.6 above, 100% of experts has chosen to agree that ship handling and manoeuvring is an essential part of pilotage operations. Expert-2 highlighted that pilot should have the ability to combine the application knowledge and skills when handling and manoeuvre vessel especially during berthing/unberthing operation.

For Passage Plan factors, 100% of experts agreed. Expert-1 highlighted that producing a passage plan requires the ability of pilot to gather knowledge and experience acquired by pilot and master and develop an efficient and safe passage plan for berthing/unberthing operation. Expert-4 added that pilot should also be able to produce contingency plan in case of emergency especially when approaching/leaving berth where various unexpected events can occur such as engine breakdown, tug breakdown, gusting wind and rain.

For Pilot Transfer factors, 100% experts agreed. Expert-5 highlighted that pilot requires the ability to embark and disembark pilot ladder safely. The decision resulted to the safe embarkation includes judgement of weather conditions, vessel speed and location to obtain the optimum rendezvous position. Expert-1 added that the physical ability of the pilot to embark/disembark is also required. Expert-2 added that some

pilot ladder fatality occurred due to pilot unable to make the right judgement especially at the point of transferring from pilot boat to ladder or vice versa.

For Communication factors, 100% experts agreed. Expert-3 highlighted that communication between pilot and other party either directly or through MF/HF/VHF/UHF must be effectively conducted. Therefore, pilot must have the ability to speak clearly and articulately. Expert-4 added that pilot should also be able to communicate effectively through nonverbal device such as Digital Selective Calling (DSC) or SMS.

For Bridge Resource management factors, 100% experts agreed. Expert-1 highlighted that pilot should have the ability to use all resources available such as gathering information from Master and bridge team including checklist such as pilot card, ship particular and master/pilot exchange information to conduct a safe and efficient pilotage operation. Expert-2 suggested that should also be aware of the language and culture barrier on the bridge.

For Emergency conduct factors, 100% experts disagree. Expert-2, highlighted that emergency conduct is not the main factor of pilotage operation. Emergency matters should be specific to the type of pilotage operation. Therefore, should be included in the operation and not as a factor.

For Personal and professional conduct factors, 100% experts disagree. Expert-5, highlighted that although personal and professional conduct are part of the attributes of a pilot. It is not an ability factor for ensuring safe pilotage operation.

Only factors with majority votes were selected to represent maritime pilot abilities factor. The summary of acceptance and rejection is shown below.

Table 4.10 Maritime Pilot Abilities factor

No	Generic list	Status	Reason
1	Ship handling and manoeuvring	Accepted	Pilot should be able to apply knowledge and skills to handle and manoeuvre vessel safely and efficiently.
2	Passage Plan	Accepted	The ability for Pilot to produce a safe passage plan is necessary
3	Pilot Transfer	Accepted	Pilot should be able to complete a safe pilot transfer
4	Communication	Accepted	Pilot should be able to ensure successful communication between bridge team and external parties
5	Bridge resource management	Accepted	Pilot should be able to effectively use all resources including equipment and bridge team for safe and efficient pilotage operation
6	Emergency conduct	Rejected	Emergency matters should be specific to the type of pilotage operation. Therefore, should be included in the operation and not as a factor.
7	Personal & professional conduct	Rejected	Although personal and professional conduct are part of the attributes of a pilot. It does not require as an ability during pilotage operation.

Once factors for abilities were chosen, sub-factors for knowledge were structured. The factors and sub-factors were used to develop the Likert's scale type chart questionnaires. The sub-factors of each factor are as follows:

Table 4.11 Summary of Abilities Factors and sub-factors.

Sub-factor	Factor 1: Ship handling and Manoeuvring	Source
1.1 :	Pilotage operation: Complete ship berthing/unberthing safely	Pilotage rules & procedures, Sungai Udang Port Pilot's evaluation report, Lembaga Pelabuhan Johor Pilot assessment criteria, Penang Port Commission IMO Resolution A960
1.2 :	Pilotage operation: Complete safe transit navigation	Pilotage rules & procedures, Sungai Udang Port Pilot's evaluation report, Lembaga Pelabuhan Johor Pilot assessment criteria, Penang Port Commission IMO Resolution A960
1.3 :	Pilotage operation: Control vessel during emergency situation	Pilotage rules & procedures, Sungai Udang Port Pilot's evaluation report, Lembaga Pelabuhan Johor Pilot assessment criteria, Penang Port Commission IMO Resolution A960
1.4 :	Pilotage operation: Complete pilotage operation with or without tugs.	Pilot assessment criteria, Penang Port Commission IMO Resolution A960 Pilotage rules & procedures, Sungai Udang Port

Sub-factor	Factor 2 : Passage Plan	Source
1.1 :	Passage plan: Producing a safe berthing/unberthing plan	Pilot assessment criteria, Penang Port Commission Pilot's evaluation report, Lembaga Pelabuhan Johor IMO Resolution A960
1.2 :	Passage plan: Producing a contingency plan	Pilot assessment criteria, Penang Port Commission Pilot's evaluation report, Lembaga Pelabuhan Johor IMO Resolution A960
1.3 :	Passage plan: Producing a plan for transiting passage	Pilot assessment criteria, Penang Port Commission Pilot's evaluation report, Lembaga Pelabuhan Johor IMO Resolution A960
1.4 :	Passage plan: local navigation warnings	Pilot assessment criteria, Penang Port Commission Pilot's evaluation report, Lembaga Pelabuhan Johor IMO Resolution A960
Sub-factor	Factor 3: Pilot Transfer	Source
1.1 :	Identifying safe pilot boarding arrangement plan	Pilot assessment criteria, Penang Port Commission
1.2 :	Identifying safe rendezvous/boarding point	Pilot assessment criteria, Penang Port Commission
1.3 :	Complete safe embarkation/disembarkation	Pilot assessment criteria, Penang Port Commission

Sub-factor	Factor 4: Communication	Source
1.1 :	Standard Maritime Communication Phrase (SMCP)	Pilotage rules & procedures, Sungai Udang Port Pilot's evaluation report, Lembaga Pelabuhan Johor Pilot assessment criteria, Penang Port Commission IMO Resolution A960
1.2 :	Communicate effectively using MF/HF/VHF	Pilotage rules & procedures, Sungai Udang Port Pilot's evaluation report, Lembaga Pelabuhan Johor Pilot assessment criteria, Penang Port Commission IMO Resolution A960
1.3 :	Communication with bridge team & other parties	Pilotage rules & procedures, Sungai Udang Port Pilot's evaluation report, Lembaga Pelabuhan Johor Pilot assessment criteria, Penang Port Commission IMO Resolution A960

Sub-factor	Factor 5: Bridge resource management	Source
1.1 :	Master/pilot exchange information	Pilot assessment criteria, Penang Port Commission Pilot's evaluation report, Lembaga Pelabuhan Johor IMO Resolution A960
1.2 :	Identifying standard of Master and bridge team	Pilot assessment criteria, Penang Port Commission

Sub-factor	Factor 5: Bridge resource management	Source
1.3 :	Emergency response	Pilot's evaluation report, Lembaga Pelabuhan Johor
		IMO Resolution A960
		Pilot assessment criteria, Penang Port Commission
		Pilot's evaluation report, Lembaga Pelabuhan Johor
		IMO Resolution A960

4.5.3 Practical applications

The practical application of maritime pilotage training is intricately connected to real-world operations, focusing on developing abilities that align with critical factors and subfactors. These abilities are cultivated through hands-on training and simulated scenarios to ensure pilots are well-equipped to handle diverse challenges during pilotage operations.

In ship handling and manoeuvring, the emphasis lies on the practical completion of complex tasks such as berthing, unberthing, and transiting safely through challenging waters. Trainees gain the ability to control vessels under normal conditions and in emergencies, such as engine failure or strong tidal currents. Additionally, the capability to complete operations with or without tug assistance enhances flexibility and resourcefulness, preparing pilots for a range of operational demands.

Passage planning is a vital component that combines theoretical understanding with operational execution. Pilots develop the ability to produce detailed and practical berthing, unberthing, and transit plans, ensuring safety and efficiency. This also includes creating contingency plans to address unexpected developments and

integrating local navigation warnings into operational strategies. Through this, pilots learn to anticipate and mitigate risks proactively.

Pilot transfer focuses on the crucial aspect of embarking and disembarking pilots safely. Trainees are trained to identify optimal boarding arrangements and rendezvous points while mastering embarkation and disembarkation procedures. This skill is essential for ensuring both the pilot's safety and the continuity of operations.

Communication plays a central role in pilotage. Pilots are trained in using the Standard Maritime Communication Phrases (SMCP) effectively and employing MF/HF/VHF communication systems to liaise with bridge teams, port authorities, and other stakeholders. This ensures seamless coordination and mitigates misunderstandings that could compromise safety.

Bridge resource management emphasizes collaboration between the pilot, the master, and the bridge team. The ability to conduct comprehensive master/pilot information exchanges, evaluate the competency of the bridge team, and coordinate emergency responses strengthens the overall operational framework.

By connecting these abilities to real-world operations, the training ensures pilots can adapt to dynamic maritime environments. The integration of practical tasks, such as producing passage plans and managing emergency responses, with collaborative efforts, like bridge resource management and effective communication, underscores the holistic development of maritime pilots prepared to navigate the complexities of their roles.

4.6 Pilot survey

Pilot study sections were analysed into:

- i. Reliability test
- ii. KMO-Bartlett test

The pilot study was conducted on 10 Deck officers holding a minimum license of Deck Watchkeeping Class 3 from various type of vessels and routes. For accessing clarity of instructions or item wording, acceptability of formatting, or ease of administration, a sample of 10 or even fewer may suffice (Hertzog, M. A., 2008). The survey method involved distributing a multiple-choice questionnaire via Google Forms. Responses from the Deck officers were timely and collected within the survey period. The survey was conducted from 15th March 2023- 30th March 2023. There were no significant changes in their daily operations or any incidents during this time that could have influenced the officers' responses. The objective is to assess the reliability of the questionnaire set. To be specific, the initial reliability of the questionnaire set was evaluated by determining the Cronbach's Alpha value ranging from 0 to 1 of the questionnaire sections. The Cronbach's Alpha values, which ranged from 0.60 to 0.70, indicated a low adequacy limit (Hair et al., 2010). The value that is usually approved for the Cronbach's Alpha lower limit is 0.70 (Hair et al., 2010) while value of 0.8 is statistically significant (Hair et. al., 2010). The value recorded in this study was ranged between 0.910 and 0.954, which is higher than the regular value and also significant. Sampling adequacy was evaluated through the KMO-Bartlett test, as seen in Table 4.12. Essentially, the samples of this study are regarded as adequate if the KMO value was amounted higher than 0.60 (Kaiser & Rice, 1974).

Moreover, a sufficient correlation between the variables is indicated when Bartlett's test of sphericity sig. value was lower 0.05 (Hair et al., 2010).

Table 4.12 Reliability test, Cronbach's Alpha (α), and KMO-Bartlett test before PCA.

Variables		Cronbach's Alpha α	N of items	Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy	Bartlett's Test of Sphericity		
					χ^2	Df	Sig.
Maritime Knowledge	Pilot	0.954	22	0.785	1281.280	231	<.001
Maritime Pilot Skills		0.910	13	0.767	687.944	78	<.001
Maritime Abilities	Pilot	0.926	17	0.775	856.619	136	<.001

4.7 Full survey

Another separated survey was carried out in several ports in Malaysia for full survey. Full survey sections were analysed into:

- i. Demographic analysis
- ii. Factor analysis
- iii. Structural equation modelling

4.7.1 Full survey empirical results

a. Participant demographics

All 85 surveys obtained were deemed valid, yielding a response rate of 82%. Participants was chosen are only those having license and operating as a harbour pilot in selected Malaysian ports. Therefore, the variables concerned will be more specific to the study. Number of maritime pilots from respective ports involve in the study is shown in Figure 4.7.

In particular the highest percentage of participants which is 37.7% have the experience of being a harbour pilot for between 5-10 years (Figure 4.8). While those with experience for 10-15 years comes in second highest with the percentage of 22.4%. Those with experience between 15-20 years, 20-25 years and 25 years or more has an accumulation percentage of 28.2%. Finally, 11.8% of harbour pilot are with experience of less than 5years.

70.6% of participants are carrying the highest pilotage license issued by JLM which is A or UR license. While 7.1% are carrying the highest pilotage license issued by JPDS which is Unlimited GRT license. Remaining 22.3% of the participants are carrying license C 3.5%, B 3.5%, A2 5.9%, A1 3.5%, Below 40,000 GRT 3.5% and finally below 20,000 GRT 2.4%. (Figure 4.9).

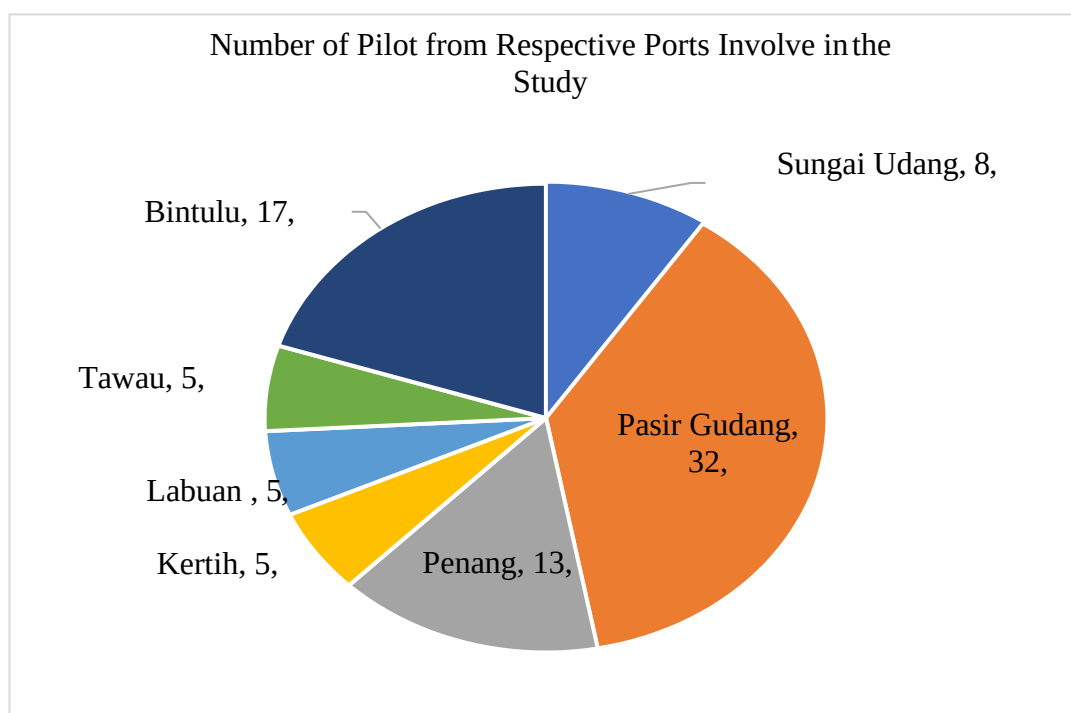


Figure 4.7 Number of respondents from respective ports

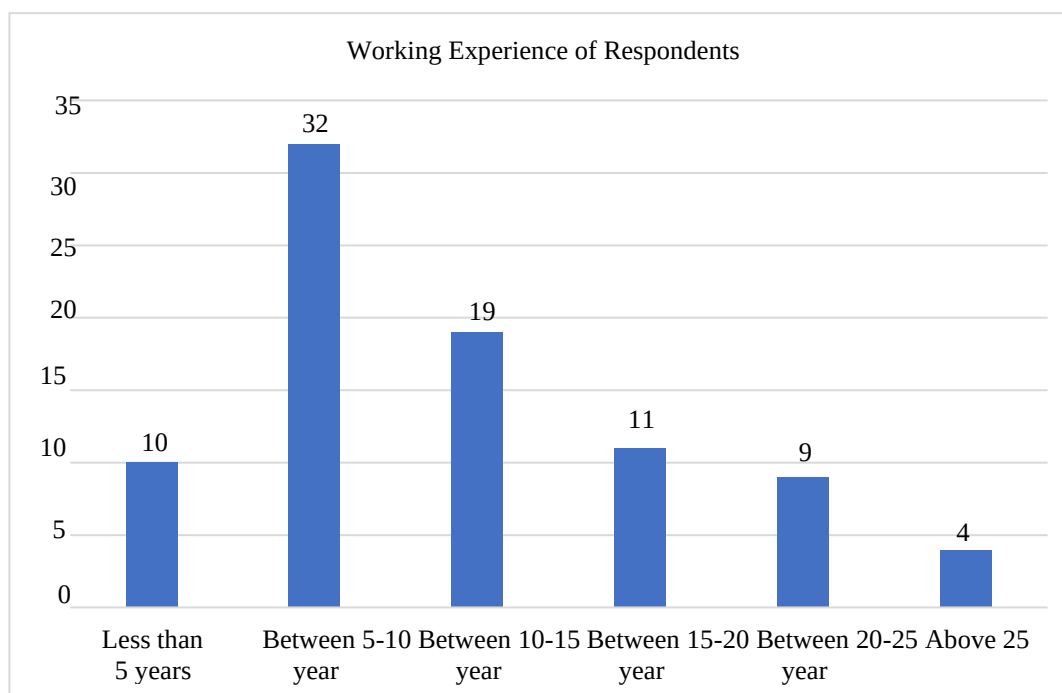


Figure 4.8 Working experience of respondents

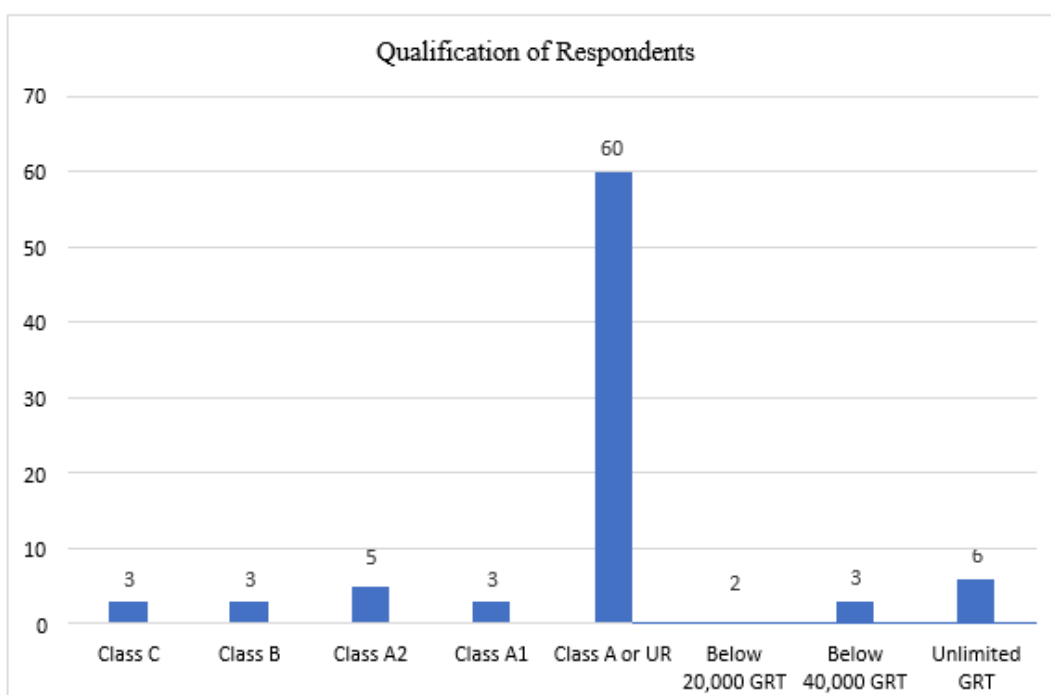


Figure 4.9 Qualification of the respondents

4.7.2 Bias Discussion and Response Pattern Analysis

The study achieved an 82% response rate, with all 85 surveys considered valid. Participants were specifically selected from licensed harbor pilots operating at designated Malaysian ports, ensuring that the variables measured were highly relevant to the study's objectives. However, this focused sampling introduces potential biases that must be considered.

One notable bias stems from the selection criteria. By including only harbor pilots with licenses and experience at selected ports, the sample excludes perspectives from less experienced or unlicensed maritime professionals who might contribute alternative insights. This could lead to an overrepresentation of seasoned pilots' perspectives, potentially skewing the results towards a narrower operational focus.

Another bias may arise from geographical and regulatory constraints. The study focused exclusively on Malaysian ports, which might limit the generalizability of findings to other regions with different maritime operational practices or regulatory environments.

The experience distribution among participants highlights an overrepresentation of mid-career pilots, with 37.7% having 5–10 years of experience, followed by 22.4% with 10–15 years. Those with less than 5 years of experience accounted for only 11.8%, while those with over 15 years comprised 28.2%. This distribution indicates a potential bias toward mid-career insights, which might underrepresent the challenges faced by novices or veterans.

The licensing data further reveals another pattern. A significant majority (70.6%) of participants hold the highest pilotage license issued by JLM (A or UR license), followed by 7.1% with the highest license from JPDS (Unlimited GRT). Lower-tier licenses collectively accounted for 22.3% of the sample. This skew towards highly licensed pilots suggests that the findings may disproportionately reflect the practices and opinions of those at the top of the licensing hierarchy, potentially overlooking the perspectives of pilots with limited operational scopes.

These biases should be acknowledged when interpreting the results. The dominance of experienced and highly licensed participants enhances the study's focus on advanced operational knowledge but may limit its applicability to less experienced or differently licensed pilots. Future studies could address these limitations by including a more diverse participant pool, incorporating perspectives across experience levels, licensing tiers, and geographic locations to provide a more holistic understanding of the factors influencing pilotage operations.

4.8 Factor analysis

The purpose of factor analysis is to determine the factors and subfactors of KSA on pilotage training. The responses were using a six-point Likert's Scale where 1 = strongly disagree, 2 = disagree, 3 = slightly disagree, 4 = slightly agree, and 5 = agree, 6 = strongly disagree (Joshi et al., 2015).

4.8.1 Knowledge

There were 20 questions/items on factor knowledge. The Cronbach's Alpha value to measure reliability was 0.874 (Table 4.13), which is considered statistically significant (Hair et. al., 2010). The range of frequency is from 4.39 to 5.50, which falls into the category of strongly agree as shown in Table 4.14. The standard deviation is ranging from 0.516 to 0.931 (5.5% to 9.2%), which indicates a small variation (Huck et al., 2012). According to Huck et al. (2012), a standard deviation close to zero indicates that the data points tend to be very close to the mean, showing little variability among the responses. This small variation suggests that the respondents had a high level of agreement on the factor knowledge items, reinforcing the reliability of the measured construct.

a. Analysis

The Cronbach's Alpha value of 0.874 demonstrates excellent internal consistency among the items, suggesting that the items are measuring the same underlying construct. A high Cronbach's Alpha (generally above 0.7) is desirable in social science research because it indicates that the scale is reliable (Taber, 2018). The frequency ranges from 4.39 to 5.50 signifies that respondents consistently selected responses towards the 'strongly agree' end of the scale, reflecting a strong agreement with the statements related to factor knowledge. The small standard deviation range (0.516 to 0.931) indicates that the responses were clustered closely around the mean, signifying that there was little variability in how respondents rated the items. This small percentage range (5.5% to 9.2%) emphasizes that the data points are tightly grouped, reinforcing the high reliability of the responses.

Table 4.13 Cronbach's Alpha of Factor Knowledge

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.874	0.878	20

Table 4.14 Descriptive Statistics on Factor Knowledge

Descriptive Statistics			
Item	Mean	Std. Deviation	Analysis N
KH1	5.54	0.714	85
KH2	5.48	0.823	85
KH3	5.43	0.762	85
KH4	4.73	0.789	85
KH5	5.03	0.763	85
KH6	5.38	0.779	85

Descriptive Statistics			
Item	Mean	Std. Deviation	Analysis N
KH7	5.50	0.741	85
KT1	5.25	0.841	85
KT2	5.16	0.807	85
KT3	5.28	0.783	85
KN1	4.94	0.874	85
KN2	4.86	0.518	85
KN3	4.39	0.720	85
KN4	4.90	0.666	85
KN5	4.57	0.685	85
KN6	5.05	0.516	85
KB1	4.43	0.886	85
KB2	4.81	0.855	85
KC1	5.08	0.734	85
KC2	4.80	0.931	85

Result of Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy on knowledge factor was 0.813 (Table 4.15), which is meritorious (Kaiser, 1974). Table 4.15: Pattern Matrix of Factor Knowledge depicted five (5) components extracted using an eigenvalue greater than 1 from the 20 items (questions). Bartlett's test of sphericity was less than 0.05, indicating a substantial correlation between all items. Hence, the data was appropriate for factor analysis. Table 4.16 shows the pattern matrix where 5 components were extracted using Principal Component Analysis and Promax rotation. The extracted components 1, 2, 3, 4, and 5 were named navigation knowledge, ship handling and manoeuvring knowledge, tugboat operation knowledge, bridge resource management knowledge, and communication equipment knowledge, respectively.

Table 4.15 KMO and Bartlett's Test of Factor Knowledge

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.813
Bartlett's Test of Sphericity	Approx. Chi-Square	1631.184
	df	190
	Sig.	<.001

b. Principal Component Analysis (PCA) And Item Reduction

PCA was carried out to identify reproducible components from the set and to reduce items. Two stages were followed for item reduction. In the first stage, PCA and Promax rotations were performed to determine the components of the items, with those having a loading less than 0.6 being ignored. The number of components was determined by a scree plot, with eigenvalues greater than 1 (Hair et al., 2010). In the second stage, the final list of items was chosen based on its relation to the factors identified using the FFF model for the particular item set. A reliability test was performed before and after PCA to ensure the reliability of the items before finalizing the questionnaire for the full survey. The rationale for performing the reliability test twice was to determine which items should be deleted or included in the survey. Loadings used in this design consisted of: (1) Lower limit = 0.40; (2) Moderate level = 0.60; and (3) Well-defined value = 0.80 (Guadagnoli & Velicer, 1988). The following criteria were chosen to select items for the full survey: (1) Items with a value of more than 0.6 (moderate level), and (2) Items related to the factor.

Table 4.16 Pattern Matrix of Factor Knowledge

Item	Component				
	1	2	3	4	5
KH1	0.935				
KH2	0.893				
KH7	0.823				
KH3	0.794				
KH5	0.766				
KH6	0.679				
KH4	0.671				
KN5		0.955			
KN3		0.841			
KN6		0.792			
KN2		0.694			
KN1		0.580			
KN4		0.560			
KT3			0.984		
KT1			0.935		
KT2			0.903		
KC1				0.974	
KC2				0.849	
KB1					0.940
KB2					0.898

Extraction Method: Principal Component Analysis.

Rotation Method: Promax with Kaiser Normalization.^a

a. Rotation converged in 7 iterations.

The component correlation matrix in Table 4.17 illustrates the correlation between the extracted components under Factor knowledge. The range of the

correlation values spans from -0.09 to 0.482. Correlation values above 0.32 indicate that the factors are strongly correlated (Tavakol & Wetzel, 2020). This suggests that when the correlation value exceeds 0.32, there is a significant relationship between the components, implying they tend to vary together. Therefore, components with correlation values greater than 0.32 are considered to have a substantial association, which is important for understanding the underlying structure and relationships in the data.

Table 4.17 Component correlation matrix of Factor Knowledge

Component	1	2	3	4	5
1	1.000	0.152	0.264	0.419	0.251
2	0.152	1.000	0.343	0.274	-0.009
3	0.264	0.343	1.000	0.482	0.160
4	0.419	0.274	0.482	1.000	0.104
5	0.251	-0.009	0.160	0.104	1.000

Extraction Method: Principal Component Analysis.
Rotation Method: Promax with Kaiser Normalization.

c. Practical Interpretations, Factor Relationship Analysis, and Comparative Findings

The findings from the analysis of the Factor Knowledge demonstrate high internal consistency, as reflected by a Cronbach's Alpha of 0.874. This underscores the reliability of the instrument used to measure knowledge-related factors. The small range of standard deviation (0.516–0.931) indicates minimal variability in responses, suggesting a high level of consensus among respondents. The frequency range (4.39–5.50) corresponds to the "strongly agree" category, emphasizing a positive perception of knowledge components among participants.

The Kaiser-Meyer-Olkin (KMO) measure of 0.813 confirms the data's suitability for factor analysis, as it surpasses the threshold of 0.7. Bartlett's test of sphericity, with a significance value less than 0.05, further validates the strong

intercorrelation among items. Five key components were extracted using PCA and Promax rotation:

1. Navigation Knowledge
2. Ship Handling and Manoeuvring Knowledge
3. Tugboat Operation Knowledge
4. Bridge Resource Management Knowledge
5. Communication Equipment Knowledge

The pattern matrix reveals that each item strongly correlates with its respective component, with loadings above 0.6, thereby confirming the robustness of the extracted factors. The correlation matrix shows that components 1 and 4 (navigation and bridge resource management knowledge) have the highest interrelationship, with a correlation value of 0.419.

Comparing the extracted components, navigation knowledge and ship handling and manoeuvring knowledge exhibit the highest mean scores (5.54 and 5.50, respectively). This highlights their critical importance in the overall knowledge framework for pilotage operations. Components related to tugboat operation knowledge and bridge resource management knowledge showed strong reliability but slightly lower mean scores, emphasizing the need for targeted skill enhancement in these areas.

The strong correlation among components suggests that enhancing one knowledge area could positively influence others. For instance, improving bridge resource management knowledge can reinforce skills in navigation and communication equipment use. By integrating these insights into simulation-based training and onboard practical exercises, maritime professionals can achieve a more cohesive and efficient operational framework.

4.8.2 Skills

There were 11 questions on Factor Skill. The Cronbach's Alpha value to measure reliability was 0.928 (Table 4.18), which is significant (Hair et. al., 2010). Table 4.19 shows the frequency score of each question under Factor Skill. The range of frequency is from 4.25 to 5.29 and it falls in category of strongly agree. The standard deviation is ranging from 0.855 to 0.975 which is small (Huck et al., 2012).

Table 4.18 Cronbach's Alpha of Factor Skill

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	Based on N of Items
0.928	0.928	11

Table 4.19 Descriptive statistics of Factor Skill

Descriptive Statistics			
Item	Mean	Std. Deviation	Analysis N
SH1	4.56	0.927	85
SH2	4.29	0.895	85
SH3	4.25	0.925	85
SH4	4.64	0.877	85
ST1	5.29	0.906	85
ST2	4.71	0.975	85
SN1	4.87	0.954	85
SN2	4.57	0.875	85
SN3	4.70	0.855	85
SC1	4.56	0.947	85
SC2	4.77	0.949	85

Result of Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy on knowledge factor was 0.859 (Table 4.20), which is meritorious (Kaiser, 1974). Bartlett's test of sphericity was less than 0.05, which showed a substantial correlation in the data (Hair et. al., 2010).

Table 4.20 KMO and Bartlett's Test of Factor Skill

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.859
Bartlett's Test of Sphericity	933.803	968.456
	55	78
	0.000	<0.001

Table 4.21 shows four (4) components were extracted by using eigenvalue more than 1 from the 11 items (questions). Extracted components 1, 2, 3, and 4 in Table 4.21 were named as ship handling and manoeuvring skill, navigation skill, communication skill, and tug boat coordination skill, respectively.

Table 4.21 Pattern Matrix of Factor Skill

Item	Component			
	1	2	3	4
SH4	0.860			
SH3	0.837			
SH2	0.832			
SH1	0.781			
SN3		0.885		
SN2		0.849		
SN1		0.827		
ST2			0.981	
ST1			0.714	
SC2				0.893
SC1				0.752

Extraction Method: Principal Component Analysis.

Rotation Method: Promax with Kaiser Normalization.^a

a. Rotation converged in 6 iterations.

The component correlation matrix in Table 4.22 shows the correlation between the extracted components under Factor skill. Range of the correlation values were from 0.393 to 0.608. Correlation values above 0.32 depicts the factors are strongly correlated (Tavakol & Wetzel, 2020).

Table 4.22 Component Correlation Matrix of Factor Skill

Component	1	2	3	4
1	1.000	0.546	0.393	0.608
2	0.546	1.000	0.564	0.578
3	0.393	0.564	1.000	0.459
4	0.608	0.578	0.459	1.000

Extraction Method: Principal Component Analysis.
Rotation Method: Promax with Kaiser Normalization.

a. Practical Interpretations and Factor Relationship Analysis of Skills

The skill factor in the study was assessed using 11 items, with a Cronbach's Alpha value of 0.928, indicating excellent internal reliability. The frequency scores ranged from 4.25 to 5.29, placing them within the "strongly agree" category, while the standard deviation ranged from 0.855 to 0.975, suggesting minimal variability among responses. These findings indicate a strong consensus among participants regarding the importance of skill-related aspects in pilotage operations.

The Kaiser-Meyer-Olkin (KMO) measure of 0.859 confirms that the sample size was adequate for factor analysis, while Bartlett's test of sphericity ($p < 0.001$) supports the presence of significant correlations among items. Principal Component Analysis (PCA) identified four distinct skill components:

Ship Handling and Manoeuvring Skill – Encompassing SH1, SH2, SH3, and SH4, this component relates to a pilot's ability to maneuver a vessel safely in various operational scenarios. The high factor loadings (0.781 to 0.860) indicate a strong

correlation between these items, highlighting the critical nature of precise ship handling skills.

Navigation Skill – Comprising SN1, SN2, and SN3, this component measures a pilot's proficiency in navigation, route planning, and ensuring a safe passage. The high loadings (0.827 to 0.885) reinforce the importance of accurate navigation in maintaining vessel safety.

Tug Boat Coordination Skill – Represented by ST1 and ST2, this component focuses on the ability to work effectively with tugboats during berthing and unberthing maneuvers. The factor loadings (0.714 to 0.981) suggest that coordination with tugboats is a distinct yet highly relevant skill within pilotage operations.

Communication Skill – This component (SC1 and SC2) assesses a pilot's ability to communicate effectively with bridge teams, tugboat operators, and other maritime personnel. The high loadings (0.752 to 0.893) indicate that effective communication is a fundamental skill for safe operations.

The component correlation matrix reveals strong interrelationships between the extracted skill factors. Correlation values range from 0.393 to 0.608, all above the 0.32 threshold (Tavakol & Wetzel, 2020), confirming substantial associations between these skill components. Notably:

Ship handling and tug boat coordination skills ($r = 0.608$) exhibit the strongest correlation, suggesting that efficient ship maneuvering is highly dependent on proper tugboat coordination. This aligns with practical maritime operations, where pilots often rely on tugboats to ensure precise berthing and unberthing.

Navigation and communication skills ($r = 0.564$) also show a strong relationship, reflecting the necessity of clear communication for effective navigation, particularly in congested or restricted waters.

Ship handling and navigation skills ($r = 0.546$) are closely linked, indicating that a pilot's ability to maneuver a vessel is inherently tied to their navigational expertise.

Compared to the knowledge factor (Cronbach's Alpha = 0.874), the skill factor demonstrates a slightly higher internal consistency ($\alpha = 0.928$), reinforcing that participants were more consistent in their responses regarding skills. The high inter-component correlations further validate the interdependent nature of pilotage skills, emphasizing that mastery in one area (e.g., ship handling) significantly enhances performance in another (e.g., tug coordination).

These findings suggest that pilot training programs should adopt an integrated approach, where ship handling, navigation, communication, and tugboat coordination are not taught in isolation but rather in combination to reflect real-world pilotage challenges. Simulation-based training in a controlled environment can be particularly useful in developing these interdependent skills.

Overall, the study confirms that skill development in harbor pilots is a multidimensional process where individual competencies are closely interconnected. Future training strategies should focus on enhancing these skills collectively to ensure safer and more efficient maritime operations.

4.8.3 Ability

There were 17 questions on ability factor. The Cronbach's Alpha value to measure reliability was 0.946 (Table 4.23), which is considered significant (Hair et. al., 2010). Table 4.24 shows the descriptive statistics of ability factor. Range of frequency is from 4.10 to 5.29 falls in category of strongly agree. The standard deviation is ranging from 0.754 to 1.053, which is small.

Table 4.23 Cronbach's alpha of Factor Ability

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.946	0.945	17

Table 4.24 Descriptive statistics of ability factor

Descriptive Statistics			
Item	Mean	Std. Deviation	Analysis N
AH1	4.10	0.816	85
AH2	4.32	0.912	85
AH3	4.37	0.754	85
AH4	4.48	0.812	85
AP1	4.00	0.861	85
AP2	5.01	0.995	85
AP3	4.98	1.045	85
AP4	5.07	0.950	85
AM1	5.04	0.962	85
AM2	5.18	0.983	85
AM3	5.19	0.986	85
AC1	5.29	0.820	85
AC2	4.66	0.935	85
AC3	4.83	1.026	85
AT1	5.06	1.053	85
AT2	5.26	0.947	85
AT3	5.19	1.032	85

Result of Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy on knowledge factor was 0.909 (Table 4.25), which is meritorious (Kaiser, 1974). Bartlett's test of sphericity was less than 0.05, which showed a substantial correlation in the data (Hair et. al., 2010).

Table 4.25 KMO and Bartlett's Test of Factor Ability

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.909
Bartlett's Test of Sphericity	1297.054	1643.944
	136	136
	0.000	<0.001

Table 4.26 shows that five (5) components were extracted using an eigenvalue greater than 1 from the 17 items (questions). The extracted components 1, 2, 3, 4, and 5 were named ship handling and manoeuvring abilities, communication abilities, bridge resource management abilities, passage plan abilities, and pilot transfer abilities, respectively.

Table 4.26 Pattern Matrix of Factor Abilities

Item	Component				
	1	2	3	4	5
AP1	0.949				
AP2	0.791				
AP4	0.765				
AP3	0.724				
AH3		0.901			
AH1		0.802			
AH2		0.743			
AH4		0.578			

Item	Component				
	1	2	3	4	5
AM2		0.974			
AM3		0.954			
AM1		0.761			
AT2			0.852		
AT3			0.781		
AT1			0.760		
AL3					0.883
AL2					0.784
AL1					0.769

Extraction Method: Principal Component Analysis.

Rotation Method: Promax with Kaiser Normalization.^a

a. Rotation converged in 6 iterations.

The component correlation matrix in Table 4.27 shows the correlation between the extracted components under Factor abilities. Range of the correlation values were from 0.284 to 0.598. Correlation values above 0.32 depicts the factors are strongly correlated (Tavakol & Wetzel, 2020).

Table 4.27 Component Correlation Matrix of Factor Ability

Component	1	2	3	4	5
1	1.000	0.378	0.576	0.545	0.541
2	0.378	1.000	0.473	0.397	0.284
3	0.576	0.473	1.000	0.535	0.605
4	0.545	0.397	0.535	1.000	0.598

Extraction Method: Principal Component Analysis.

Rotation Method: Promax with Kaiser Normalization.

a. Practical Interpretations and Factor Relationship Analysis of Skills

The ability factor was assessed using 17 items, with a Cronbach's Alpha value of 0.946, indicating excellent internal reliability. The mean frequency scores ranged from 4.10 to 5.29, placing them within the "strongly agree" category, while the standard deviation values ranged from 0.754 to 1.053, indicating minimal variability in responses. These findings suggest that the respondents consistently acknowledged the significance of various ability-related factors in pilotage operations.

The Kaiser-Meyer-Olkin (KMO) measure of 0.909 confirms that the sample size was highly adequate for factor analysis, while Bartlett's test of sphericity ($p < 0.001$) supports the presence of significant correlations among items. Principal Component Analysis (PCA) identified five distinct ability components:

1. Ship Handling and Manoeuvring Abilities – This component includes AP1, AP2, AP3, and AP4, with factor loadings ranging from 0.724 to 0.949. The high loadings indicate that a pilot's ability to maneuver a vessel efficiently is a key determinant of operational success.
2. Communication Abilities – Encompassing AH1, AH2, AH3, and AH4, this component focuses on a pilot's proficiency in communicating with the bridge team and other maritime personnel. The high loadings (0.578 to 0.901) reinforce the necessity of clear and effective communication in harbor operations.
3. Bridge Resource Management Abilities – Represented by AM1, AM2, and AM3, this component assesses a pilot's capability to manage bridge resources efficiently. The highest factor loadings (0.761 to 0.974) indicate that bridge resource management is a highly specialized ability requiring extensive experience.
4. Passage Plan Abilities – Comprising AT1, AT2, and AT3, this component pertains to a pilot's ability to plan and execute safe and efficient passage routes. The factor loadings (0.760 to 0.852) highlight the importance of detailed passage planning in maritime navigation.

5. Pilot Transfer Abilities – This component (AL1, AL2, and AL3) assesses a pilot's ability to board and disembark from vessels safely. The high loadings (0.769 to 0.883) indicate that pilot transfers are a critical aspect of operational safety.

The component correlation matrix reveals significant interrelationships among the extracted ability factors. Correlation values range from 0.284 to 0.598, with values above 0.32 indicating strong correlations (Tavakol & Wetzel, 2020). Notably:

- Bridge resource management and ship handling abilities ($r = 0.576$) show a strong relationship, suggesting that effective vessel maneuvering is closely tied to a pilot's ability to manage bridge resources.
- Passage plan and pilot transfer abilities ($r = 0.598$) also exhibit a strong correlation, indicating that pilots who are adept at passage planning are also more proficient in executing safe vessel transfers.
- Ship handling and passage plan abilities ($r = 0.545$) highlight the interdependent nature of these competencies, as effective passage planning enhances a pilot's ability to maneuver vessels safely.

When compared to the skill factor (Cronbach's Alpha = 0.928), the ability factor demonstrates an even higher internal consistency ($\alpha = 0.946$), indicating that respondents were more consistent in evaluating ability-related aspects. Furthermore, the higher KMO measure (0.909 vs. 0.859 for skills) suggests that the ability factor was more suitable for factor analysis, reflecting a clearer structure among ability-related competencies.

The findings indicate that ability development in harbor pilots is a multi-faceted process where individual competencies are interrelated. Training programs should focus on integrated learning, emphasizing the connections between ship handling, bridge resource management, passage planning, and pilot transfer procedures. Simulator-based training can be particularly effective in reinforcing these interdependent abilities.

In summary, the study highlights the need for comprehensive training programs that address all five ability components collectively. By improving these abilities in a structured manner, harbor pilots can enhance operational safety and efficiency, leading to better maritime navigation outcomes.

4.8.4 Practical Significance and Industry Implications

a. Knowledge Factor Analysis and Industry Relevance

The analysis of the Knowledge Factor demonstrated high internal consistency, as reflected by a Cronbach's Alpha of 0.874, indicating a reliable instrument for assessing knowledge-related aspects. The minimal variability in responses, evidenced by a standard deviation range of 0.516–0.931, suggests a strong consensus among respondents, further validated by frequency scores (4.39–5.50) in the "strongly agree" category.

The practical significance of these findings is that maritime professionals recognize the pivotal role of knowledge in enhancing pilotage competencies. The high correlation between Navigation Knowledge and Bridge Resource Management Knowledge ($r = 0.419$) suggests that improving bridge resource management knowledge directly benefits navigational effectiveness. This reinforces the necessity of structured learning modules focusing on integration between these knowledge areas.

For the maritime industry, these findings suggest the need for enhanced training frameworks that prioritize knowledge transfer in real-world operational contexts. Training institutions should develop curricula that integrate practical navigation techniques with bridge resource management principles, ensuring that pilot trainees develop a well-rounded understanding of ship operations. Additionally, companies can leverage simulation-based training to reinforce knowledge acquisition, minimizing operational risks associated with human error.

b. Skills Factor Analysis and Practical Implications

The Skills Factor demonstrated excellent internal reliability (Cronbach's Alpha = 0.928), with frequency scores falling within the "strongly agree" category (4.25–5.29). The high inter-component correlation values (ranging from 0.393 to 0.608) confirm that skill development is interdependent, reinforcing the idea that mastering one skill area can positively impact others. Notably, the strongest correlation between Ship Handling and Tug Boat Coordination Skills ($r = 0.608$) highlights the operational importance of seamless tug coordination in ensuring safe berthing and unberthing maneuvers.

The practical interpretation of these results underscores that maritime pilotage is a multidimensional process requiring cross-functional skills. Pilots must be proficient not only in ship maneuvering but also in communicating effectively with tugboat operators and navigation teams. Given that Navigation and Communication Skills ($r = 0.564$) show a strong relationship, it is critical that training programs incorporate real-time communication exercises, particularly for congested ports or high-risk navigational areas.

For the maritime sector, these findings suggest an urgent need to integrate multi-skill training modules into professional development programs. Simulation-based learning should include team coordination exercises, where pilots and tugboat operators engage in synchronized maneuvers under controlled conditions. Additionally, competency-based assessments should be revised to reflect the interconnected nature of pilotage skills, ensuring that maritime professionals are adequately prepared for complex navigational challenges.

c. Ability Factor Analysis and Industry Applications

The Ability Factor exhibited the highest internal reliability (Cronbach's Alpha = 0.946), with respondents consistently acknowledging the critical nature of various ability-related components in pilotage operations. The high KMO measure of 0.909

further validates the suitability of the dataset for factor analysis, reinforcing that ability-related competencies are well-structured and interrelated.

The practical significance of these findings is evident in the strong correlations observed among ability components. For instance, Bridge Resource Management and Ship Handling Abilities ($r = 0.576$) suggest that effective vessel maneuvering is heavily reliant on strategic resource allocation and decision-making competence. Similarly, the high correlation between Passage Plan and Pilot Transfer Abilities ($r = 0.598$) highlights the need for pilots to be well-versed in safe embarkation and disembarkation procedures, particularly in adverse weather conditions.

From an industry perspective, these results highlight the necessity of holistic training methodologies that encompass all five ability components—ship handling, communication, bridge resource management, passage planning, and pilot transfers. Maritime organizations should incorporate structured mentorship programs, where experienced pilots guide trainees through real-world pilotage challenges. Additionally, simulation-based evaluations should focus on scenario-based training, emphasizing decision-making in high-pressure environments to improve overall maritime safety.

d. Conclusion and Industry Recommendations

The study provides compelling evidence that maritime pilotage competency is not built on isolated skill sets but rather on interdependent knowledge, skills, and abilities. The maritime industry must take a systematic approach to training development, ensuring that learning modules are designed to enhance cross-functional competencies.

Key industry recommendations include:

Integrating Knowledge Components into Training Frameworks – Maritime institutions should develop learning models that seamlessly integrate navigation, ship handling, bridge resource management, and communication knowledge.

Enhancing Multi-Skill Training Approaches – Simulation exercises should incorporate team coordination, navigation, and real-time communication exercises to reflect practical pilotage scenarios.

Fostering Holistic Ability Development – Industry stakeholders should emphasize mentorship programs, scenario-based learning, and competency-based evaluations to ensure pilots are well-equipped for real-world challenges.

Adopting Adaptive Learning Strategies – Continuous professional development programs should be tailored based on emerging maritime trends and technological advancements, ensuring that pilots remain adaptable to evolving industry demands.

By implementing these insights, maritime organizations can enhance pilot training effectiveness, reduce navigational errors, and ultimately improve operational safety in global shipping and port management.

4.9 Confirmatory Factor Analysis (CFA)

CFA is a statistical method that is used to test the fit of a series of observed variables with a predetermined factor structure (Shek & Yu, 2014). It is a form of SEM whereby a researcher tests whether or not a relationship between a series of observed variables and hypothetical latent constructs exists. It is a hypothesis—driven method, and as such, a researcher uses CFA to accept or reject preconceived theories about the structure of their data. This therefore makes CFA a critical methodology in all the fields where the constructs by which data observed effect must be tested for reliability and validity.

CFA is very significant in the context of maritime training and assessment (Li et al., 2020). To ensure the safety of ships, maritime pilots require a high level of competence in various competencies to ensure safe and efficient navigation. These competencies are often instanced as knowledge, skills, and abilities (KSA). Maritime,

like many other regions, poses unique and increased risks and challenges in Malaysia (Othman & Naintin, 2016). Effective training and a suitable assessment framework shall ensure the mitigation of these challenges. A consistent implementation of an effective CFA in the context of this research can be used to point out key strengths and weaknesses of the training programs in effect and suggest improvements in the same. At the same time, CFA may be made use of to validate the KSA constructs, thus giving stakeholders the confidence that the training and assessment frameworks are at the same time comprehensive and reliable.

4.9.1 Theoretical Framework

a. Overview of CFA in Educational Research

Confirmatory Factor Analysis (CFA) is one of the most powerful statistical tools used in almost every education research to ensure the validity of measurement models. It works well for testing hypotheses made on the structure of latent constructs, which are normally theoretical variables that are not visible physically, but their existence can be gauged from other observed variables. Examples of these constructs in an educational setting include cognitive abilities, motivational factors, and a range of competencies.

For this reason, CFA provides a clear a priori specification of the number of factors ordinary researchers would expect to find, as well as the loadings pattern, hence making it a powerful hypothesis testing tool. This is in contrast with Exploratory Factor Analysis (EFA), which is done to discover the underlying factor structure without prior hypotheses. Through CFA, a researcher is able to establish whether the data under study fit the hypothesized model, hence providing evidence for construct validity (Thompson, 2004).

In educational research, CFA can be used to validate a wide range of measurement instruments, from standardized tests to surveys of student attitudes and behaviours. For example, CFA has been used to validate the structure of intelligence

tests so that they actually measure different cognitive domains as hypothesized. CFA has been used to validate scales that measure student engagement, motivation, and self-efficacy so that the utility of such instruments is predicated upon the play of the intended constructs (Darmayanti et al., 2021).

The stages of its operation are model specification or identification, estimation, test of model fit, and modifications. The indices of model-data fit include Chi-square, CFI (Comparative Fit Index), TLI (Tucker-Lewis Index), and RMSEA (Root Mean Square Error of Approximation) (Xia & Yang, 2019). A good model fit indicates that the hypothesized model adequately fits the data, therefore supporting the validity of the constructs that one is measuring. CFA is the bedrock for developing reliable and valid measurement tools, which are pivotal in developing theoretical understanding and informing practice and policy in education.

4.9.2 EFA Summary Results

This brief overview summarizes the EFA results for each construct by flagging the number of factors, variance accounted, and relevant loadings for skills, abilities, knowledge.

a. Knowledge

The EFA for knowledge constructs reached five factors that explained a total variance of 75.80%. The KMO measure was 0.813, which is good for factor analysis, and Bartlett test was significant ($\chi^2 = 1631.184$, $df = 190$, $p < 0.001$). Key factor loading demonstrated high values for theoretical knowledge: KH1= 0.935, KH2 0.893, for navigational knowledge: KN5= 0.955, KN3= 0.841. The strong contributions to factors show the relevance to their respective factors, also validating their constructs' critical role in the knowledge domain of the EFA model for maritime pilot training.

b. Skills

The EFA for skills returned four separate factors that accounted for a total variance of 83.37%. Kaiser-Meyer-Olkin (KMO) showed that the sample was adequate for factor analysis (0.859). Bartlett's test of sphericity was significant ($\chi^2=933.803$, $df= 55$, $p < 0.001$), showing that variables demonstrated correlations at an acceptable level. Relevant loadings had high values for SH4= 0.860, SH3= 0.837 and for situational navigation skills: SN3 = 0.885, SN2 = 0.849, which is a contribution of a rather critical factor.

c. Abilities

The EFA for abilities extracted five factors which accounted for a total of 77.97% of the variance. The KMO possessed a high value of 0.909, and Bartlett's test was significant ($\chi^2= 1643.944$, $df= 136$, $p < 0.001$). Relevant factor loadings showed high values for attention to detail (AT1 = 0.852, AT3= 0.781) and for spatial orientation (AP4= 0.817, AP3= 0.804). The high loading on these items indicates the critical role of this ability in the maritime pilot's activity. Besides, all communalities of items are above 0.6, showing the relevance of factors and the robustness of the model in the EFA approach.

4.9.3 CFA Model Specification

Each of the model indicators links to its respective latent variable. These form a comprehensive confirmatory measurement model that represents the structure of knowledge that is essential for maritime pilots.

This section aims to present and discuss the Confirmatory Factor Analysis of the proposed KSA model. The analysis was through AMOS software, where factor loadings, CR, AVE, and many other goodness-of-fit indices were determined.

a. The CFA Model Visual Representation

In the path diagram below, one can see the relationships that latent variables have with the indicators much better. The standardized path coefficients from Knowledge to Skills (0.25), Skills to Abilities (0.46), and Knowledge to Abilities (0.28) under temperamental model are all positive and significant and relate to the meaning of the hypothesized relationship (Bandalos & Finney, 2018). The individual construct coefficients are Knowledge = 0.27; Skills = 0.53; and Ability = 0.71 (Figure 4.1).

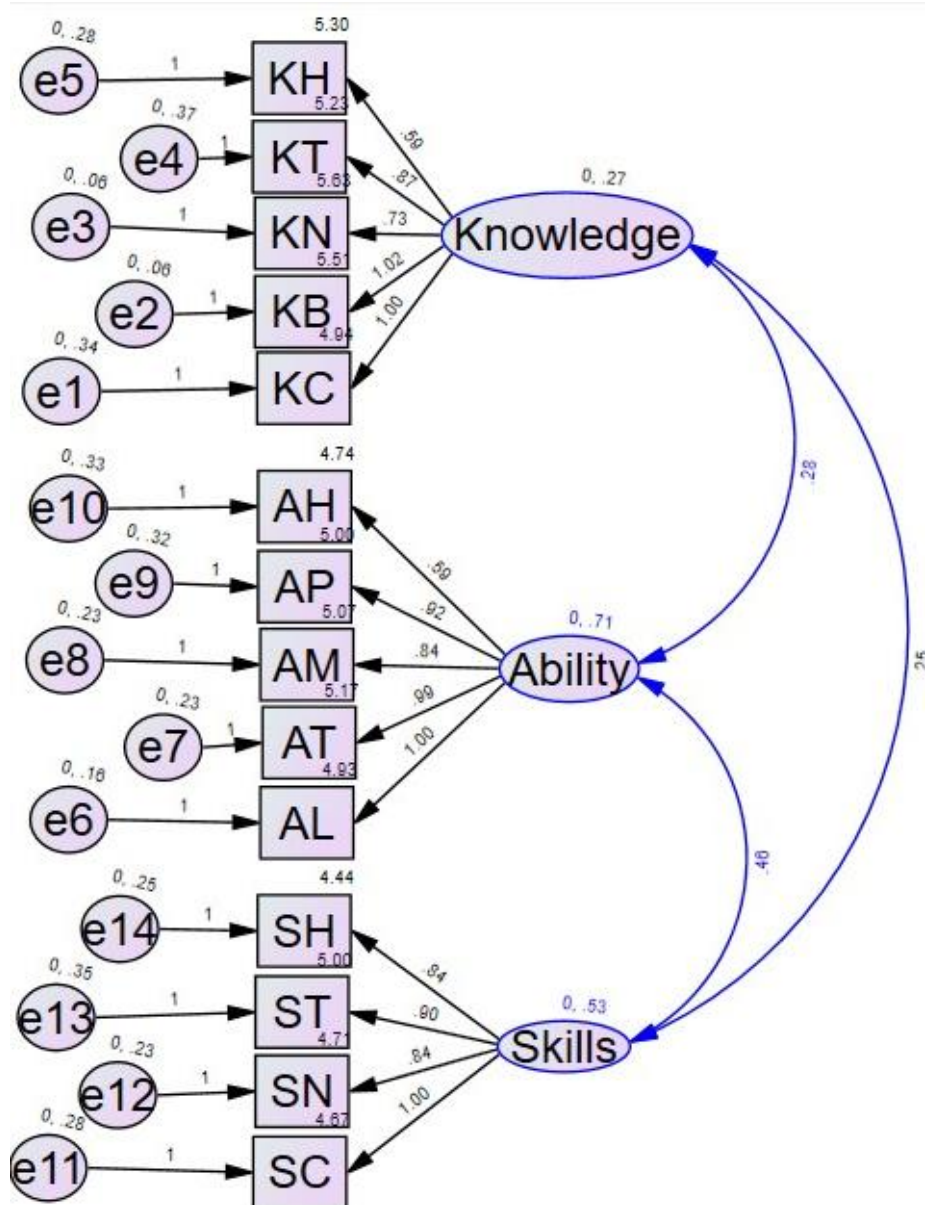


Figure 4.10 Path Diagram of the KSA Model Convergence Validity Test

b. Factor Loadings

Factor loadings indicate the degree or strength of the relationship between the measured indicators and the represented latent variables. High factor loadings indicate strong measures by the indicators of the represented latent minds.

Table 4.28 Factor Loadings for Knowledge, Skills, and Abilities

Knowledge	
Item	Loading
KC - Communication Knowledge	0.667
KB - Bridge Resource Management Knowledge	0.913
KN - Navigation Knowledge	0.842
KT - Tugboat Operation Knowledge	0.595
KH - Ship Handling and Manoeuvring Knowledge	0.508
Skills	
Item	Loading
SC	0.809
SN	0.787
ST	0.746
SH	0.773
Abilities	
Item	Loading
AL	0.902
AT	0.865
AM	0.827
AP	0.808
AH	0.656

All indicator loadings are above 0.6, supporting the interpretation that the indicators are strongly correlated with their respective latent variables (Awang, 2015). In particular, the highest loading for Knowledge is for KB, which loads at 0.913. This indicates that concern with Bridge Resource Management is a particularly strong indicator of Knowledge. The highest loadings for Ability and Skills are obtained for AL, which loads at 0.902, and SC, which loads at 0.809, respectively.

c. Composite Reliability (CR) and Average Variance Extracted (AVE)

Composite Reliability (CR) gives a measure for the internal consistency of the latent constructs, while Average Variance Extracted (AVE) shows the amount of variance captured by the construct in relation to the amount of variance due to measurement error.

Table 4.29 Composite Reliability (CR) and Average Variance Extracted (AVE)
Average Variance Extracted (AVE) and Composite Reliability (CR)

Construct	AVE	CR
Knowledge	0.519902	0.838090
Skills	0.606974	0.860571
Abilities	0.665792	0.907873

It evidently shows that all constructs have good internal consistency since the CR values for all constructs exceed the prescribed threshold value of 0.6 (Hair et al., 2010). The AVE values are also larger than 0.5 (Hair et al., 2010), which means that the constructs account for a common variance of the observed variables.

d. Goodness-of-Fit Indices

The other indicators represent the goodness-of-fit indexes with the proposed model, which matches the observed data. A good number of fit indices have been used to make a comprehensive assumption.

Table 4.30 Goodness-of-Fit Indices

Fit Index	Value	Thresholds	References
Chi-Square (CMIN/DF)	1.812	Acceptable if CMIN/DF ≤ 2 (sometimes up to 3 is considered acceptable)	(Kline, 2023)
Comparative Fit Index (CFI)	0.935	Good fit: CFI ≥ 0.95 Acceptable fit: CFI ≥ 0.90	(Hu & Bentler, 1999)
Root Mean Square Error of Approximation (RMSEA)	0.087	Good fit: RMSEA ≤ 0.06 Acceptable fit: $0.06 < \text{RMSEA} \leq 0.08$	(Browne & Cudeck, 1992)
Tucker-Lewis Index (TLI)	0.920	Good fit: TLI ≥ 0.95 Acceptable fit: TLI ≥ 0.90	(Hu & Bentler, 1999)
Goodness of Fit Index (GFI)	0.868	Good fit: GFI ≥ 0.95 Acceptable fit: GFI ≥ 0.90	(Jöreskog et al., 2001)
Adjusted Goodness of Fit Index (AGFI)	0.876	Good fit: AGFI ≥ 0.90 Acceptable fit: AGFI ≥ 0.85	(Jöreskog et al., 2001)
Parsimony-Adjusted Measures (PCFI)	0.760	There is no universally agreed threshold for PCFI, but values closer to 1 are generally preferred	(Mulaik et al., 1989)
Hoelter's Critical N (HOELTER.05)	77	Good fit: HOELTER.05 ≥ 200	(Hoelter, 1983)
Hoelter's Critical N (HOELTER.01)	85	Good fit: HOELTER.01 ≥ 200	(Hoelter, 1983)

The CMIN/DF was 1.812, and since that number is way below 3, the fit is good according to the index. The CFI is above 0.9; the same goes for the TLI, which means the fit is excellent. Although 0.087 for RMSEA slightly exceeds the ideal 0.06 recommended value, it is within the allowable threshold value. Other indices, such as NFI, GFI, and AGFI, again being slightly lesser than the ideal level of 0.9, are close

enough to suggest a reasonable fit. The parsimonious fit indices (PNFI and PCFI) are both greater than 0.5, suggesting good balance between model complexity and fit.

4.9.4 Interpretation of the Measurement Models

a. Knowledge Measurement Model

The construct Knowledge is defined by five indicators, KC (Communication Knowledge), KB (Bridge Resource Management Knowledge), KN (Navigation Knowledge), KT (Tugboat Operation Knowledge), and KH (Ship Handling and Manoeuvring Knowledge). The factor loadings of these items are high, indicating that these are good measures of the Knowledge construct. The composite reliability is 0.838090 and the average variance extracted is 0.519902, which confirms that the construct is reliable and valid. The goodness-of-fit indices for the model Knowledge provide a good fit; the value of CFI and TLI is over 0.9, while RMSEA gains less than an acceptable range.

b. Skills Measurement Model

Constructed from four indicators, the Skills construct includes SC (Communication Skills), SN (Navigation Skills), ST (Tugboat Coordination Skills), SH (Ship Handling & Manoeuvring Skills). The factor loadings of the items into Skills construct vary from 0.746 to 0.809; hence they are high, with strong relationships between the indicators and latent variable. The CR is 0.860571 with an AVE of 0.606974; therefore, we are left with a reliable and valid measurement model. To conclude, values of goodness-of-fit indices for Skills model illustrate a nice model fit; except for CFI and TLI that are slightly greater than 0.9, RMSEA remains below acceptable range.

c. Abilities Measurement Model

The ability constructs are: AL—Bridge Resource Management Abilities, AT—Communication Abilities, AM—Pilot Transfer Abilities, AP—Passage Planning Abilities, AH—Ship Handling & Manoeuvring Abilities.). Actual factor loadings for the ability's constructs range from a minimum of 0.656 to a maximum of 0.902 indicating strong indicator - latent variable relationship. In this regard, the CR value of 0.907873 and the AVE value of 0.665792 confirm good reliability and validity of the measurement model for the Abilities measurements. The goodness-of-fit indices of the Abilities model reveal a good fit of the model, showing a CFI and a TLI greater than 0.9, and an RMSEA within an acceptable range.

d. Convergence Validity and Goodness of Fit Summary

The results of the CFA support the hypothesized model of the KSAs and confirm that the proposed maritime pilotage knowledge, skills, and abilities are interrelated constructs contributing to the competencies of effective maritime operations. The high factor loadings all indicate strong relationships between the indicators and their respective latent variables. Its CR and AVE values show satisfactory internal consistency and convergent validity of the constructs. In general, indices point out to an acceptable model fit to the data. CFI and TLI both are above 0.9, indicating that the model is a good fit to the data. Although the RMSEA is slightly above the desired threshold, it is still within acceptable limits, suggesting that the model is a reasonable estimate of the true structure of the data. Holistically, CFA results will provide good support developed KSA model where adequate knowledge, skills, and abilities in the field of maritime credential to shore-based support and operation. The implications of such findings are important for training and assessment to ensure that holistic education and training are given to them to acquire both theoretical and practical skills. A validated KSA framework can be used, therefore, to create the base upon which focused strategies for training and assessment can be developed to improve performance in maritime pilotage.

4.9.5 Hypotheses Testing

The role of this section was to evaluate the current hypotheses as hypothesized from the standardized path coefficients from the CFA. The current hypotheses are drawn from the theorized rationale introduced earlier, which is the KSA model that relates to general knowledge and knowledge to formulate the basis of skills and which further enhance abilities.

a. Hypothesis 1 (H1): Maritime pilotage knowledge positively affects maritime pilotage skills

Knowledge to Skills had a standardized coefficient of 0.25 (Bandalos & Finney, 2018). It indicated a positive, moderate relationship between knowledge and skill, and consequently, Hypothesis 1 was confirmed. The found relationship was positive; though of moderate value, it proved a positive increase in knowledge of maritime pilotage and enhanced skills. This is consistent with what is theoretically expected, given that foundational knowledge in vessel dynamics, navigation, and communication protocols equips individuals with the ability to effectively carry out their duties. Knowledge of how to handle a ship directly translates to skills in vessel operations. The large value for the path coefficient shows clearly that knowledge is a key precedent to the acquisition of practice-oriented skills linked with maritime pilotage. This has further confirmed the above said requirements of training packages focusing on developing a knowledge base for maritime pilots that is solid. The emphasis in training modules towards theoretical issues that could be translated into skills developments would be clubbed. Strengthening the knowledge base can better prepare maritime pilots to acquire and develop practical skills to ensure safe and efficient pilotage service delivery.

b. Hypothesis 2 (H2): Maritime pilotage skills positively affect maritime pilotage abilities

The standardized path coefficient from Skills to Abilities is 0.46 (Bandalos & Finney, 2018), showing a strong positive relationship between the two constructs:

support for Hypothesis 2. The paths clearly underline the pivotal meaning of seafaring skills, from this knowledge aiming at wider competencies and general effectiveness in the maritime pilot profession. The mentioned skills in handling ships, coordination with tug boats, navigational skills, and communication directly assist the pilot to perform in complex situations, and in the advent of emergencies. The coefficient for the said path is strong, which seems to indicate that a firmly developed effect whereby developed skills enhance the ability to integrate the many aspects of pilotage toward safe and high operational efficiency. The major component of maritime pilotage training being hands-on training and practical experience, it might be translated to engender a great effect of skills on abilities. The use of simulation-based training, on-the-job training, and real-world practical practice translates the knowledge gained in theory into practical skills and, in effect, builds on their developed abilities. Therefore, training programs should amply provide the pilots with chances of practicing and perfecting the skills in realistic environments in preparation for the challenges of Maritime operations.

c. Hypothesis 3 (H3): Maritime pilotage knowledge positively affects maritime pilotage abilities

The standard path coefficient from Knowledge to Abilities is 0.28 (Bandalos & Finney, 2018). The sign of this coefficient is positive, indicating the support of Hypothesis 3: An increased knowledge base not only contributes to the development of skills but also directly enhances the general abilities of a pilot. A deep knowledge of the maritime principles, which encompass the rules of navigation and the dynamics of ships together with relevant emergency procedures, enables pilots to have the necessary insights for well-informed decisions and to be able to adequately manage complex situations. The positive path coefficient thus tests the prime requirement of knowledge in the development of holistic abilities needed for the effective piloting of ships. That is, the direct influence of knowledge on abilities underpins the astute theoretical knowledge that demands maritime studies programs. Curricula, therefore, should embrace a large portion of the study field so that pilots inure in all the fields related to maritime operations. Such a broad knowledge base allows for the building up of competencies to cope with the different challenges of pilotage, from routine

manoeuvres to responses to emergency situations. An emphasis on a base of knowledge for abilities also implies that continuous education and professional development are essential to sustain and improve pilotage.

Individual Construct Coefficients

In addition to the path coefficients of the relations among the constructs, one should also pay attention to the results related to the individual coefficients for knowledge, skills, and abilities, directly. These positive coefficients indicate the strength of each of those constructs in the total model (Bandalos & Finney, 2018). So, the one for Knowledge having a value of 0.27 (Figure 4.1) indicates that Knowledge is a significant, but rather moderate contributor to the total model. It thus reinforces the thought that through Knowledge is needed, its bearing in the model is weaker than that of Skills. Evidence that such is the case is shown by the high value of the coefficient for Skills, which is 0.53 (Figure 4.1)) being thus a stronger component than in the case of Knowledge. Skills then have a major bearing on Knowledge and Abilities, again suggesting a central role for them. The coefficient for Skills is 0.71 (Figure 4.1)), showing that abilities are of higher importance compared to the rest of the components. This shows that the combination of knowledge and skills into integrated abilities is the true climax of maritime pilotage training and evaluation.

The coefficients of the individual constructs connote mere relationships, as dictated by knowledge, skills, and abilities according to the KSA model. Training programs should be sequenced so that the development of a solid foundation in knowledge is followed by the building of practical skills. There must be a consistent improvement and broadening in the acquired skills through practice and advanced training. The focus on skills as the most important construct indicates that there is a need to produce pilots with the abilities to competently handle all the tasks involved in maritime operation.

Test results on hypothesis thus ascertained the assumptions on the proposed KSA model: the constructs are all interrelated, and together, they represent competencies needed for the job of an effective marine operation. Similarly, the

positive path coefficients from the constructs to each other support the theoretical postulation that knowledge enhances skills, skills foster abilities. The individual construct coefficients further confirm the central role of skills and abilities in the overall model.

CHAPTER 5

CONCLUSION

It is important to highlight that this study is to examine the current maritime pilot training and assessment module developed by Pilot Boards in Malaysia and IMO A.960 on the factors related to maritime pilot knowledge, skills and abilities then by applying KSA method to develop a maritime pilot training and assessment conceptual framework for Malaysian maritime pilots. Which then can be a guideline for Pilot operators to develop their training and assessment module that prepares trainees to safely pilot ships through harbours, ports and other passageway. Therefore, three objectives that need to be achieved to satisfy the aims have been formulated as follows:

- O1. To examine the current training and assessment modules used by Malaysian pilots including recommendation by IMO Resolution A.960 in relation to maritime knowledge, skills and abilities.
- O2. To identify the factors and subfactors pertaining to knowledge, skills, and abilities.
- O3. To determine correlations between the factors for maritime knowledge, skills and abilities

This chapter will discuss the research findings, which explains research objectives, research contribution, and the recommendation for the future research accordingly.

5.1 The research findings

Examining the current training and assessment modules used by Malaysian pilots including recommendation by IMO Resolution A.960 in relation to maritime knowledge, skills and abilities.

The first objective is to examine the current training and assessment modules used by Malaysian pilots including recommendation by IMO Resolution A.960 in relation to maritime knowledge, skills and abilities. The modules taken were from selected Pilot Boards in Malaysia which includes Pilotage District of Sungai Udang, Lembaga Pelabuhan Johor and Penang Port Commission.

The contents of the module including IMO as per resolution A.960 were also reviewed. It was found that training and assessment manual used in this study was developed by the pilot Board committee of state or district. It is also worth noting that these training and assessment manuals have been used to produce qualified maritime pilot of their state or district.

IMO resolution A.960, offers recommendation for training and assessment guidelines was also integrated in the trainings and assessment especially by Pilot Boards which have not developed their training and assessment modules.

Table 5.1 The list of training and assessment module were reviewed.

No.	Title	Author
1	Resolution A.960	IMO
2	Pilotage Rules and Procedures	Pilotage district of Sg Udang Port
3	LPJ Pilot's evaluation report	Lembaga Pelabuhan Johor
4	LPJ Training Matrix	Lembaga Pelabuhan Johor
5	Pilot Assessment Criteria	Penang Port Commission
6	Pilotage Curriculum	Penang Port Commission
7	Written examination for apprentice pilot	Penang Port Commission

5.1.1 Identifying the factors and subfactors pertaining to knowledge, skills, and abilities.

The second objective was to identify the factors and subfactors pertaining to maritime knowledge, skills, and abilities obtained from the modules and IMO A.960. It started with identifying the best method to access the effectiveness of the elements. According to literature review, the best method was to use KSA approaches as the implementation of KSA theory has been studied in a number of areas for decades, such as the aviation (Walters J. M., 2002), education technology (Kang & Ritzhaupt, 2015), accounting (Palmer N. Krsitine, 2004), human resources (Stevens & Campion, 1994), medication, IT, engineering, hospitality management (Cetin, Demirciftci & Bilgihan, 2016), Agriculture workforce (Erickson et. al., (2018).

After a review was carried out to find best suit model for KSA, it was found that Meta-competencies theoretical framework by N. Hairi et. al., (2019) in Figure 1.3 fit perfectly. With this identified meta-competencies theoretical framework, The correlation as proposed in the hypotheses can be measured.

Subsequently, another question was raised on how to determine factors without missing any possible factors in the process. These factors have been determined by gathering factors from the maritime pilot training and assessment modules using the scoping review technique by the PRISMA model as a reliable method to organise and synthesise literature (Liberati et al., 2009; Moher D et al., 2009).

Then the gathered factors were filtered by the FFF model so that it is personalised to measure only maritime pilot operations, and the selection of factors based on the FFF model was carried out by maritime technical experts. After all the factors were selected, a set of questionnaires was developed, and a survey was carried out.

5.1.2 Determining correlations between the factors for maritime knowledge, skills and abilities

The third objective is to determine the correlations between the factors of maritime pilot knowledge, skills and abilities. This final objective will determine whether the proposed hypotheses was confirmed to be true whereby Maritime Pilot Knowledge positively effects Maritime Pilot Skills, Maritime Pilot Skills positively impacts Maritime Pilot Abilities and finally Maritime Pilot Knowledge positively impacts Maritime Pilot Abilities. A quantitative approach using questionnaire was used to provide empirical data. A final set of survey questionnaire was distributed between 85 participants which consists of maritime pilots from Malaysia and the data were analysed using factor analysis and SEM analysis.

The elements otherwise known as factors were determined by:

- 1) Gathering factors from the maritime pilot training and assessment modules from Pilot Boards and IMO resolutions.
- 2) Filtering gathered factors using FFF model so that they were personalised to measure only pilot operation tasks, and selecting factors based on the FFF model by maritime technical experts.
- 3) Performing factor analysis to determine the factors and subfactors of KSAS on maritime pilot training. The analysis starts with Cronbach's Alpha to measure the internal consistency reliability of a set of items in a questionnaire or survey (Mclain & Jarrell, 2007; S. Meyers et al., 2013). The second data analysis was frequency analysis to produce mean score and linguistic value for each question. Frequency analysis is a statistical method used to analyse the distribution of a variable in a dataset. The third data analysis was KMO Test to assess the appropriateness of using factor analysis on the data set. The fourth data analysis was Bartlett' test of sphericity to determine whether a set of variables in a dataset are correlated with each other. The fifth data analysis was Principal Component Analysis with Promax rotation to identify the underlying factors or dimensions that explain the correlations among a set of variables.

- 4) Performing SEM which consists of CFA and path model (Piaw, 2009) to test the hypotheses through statistical means to identify the commonality among variables (Hoyle, 2000; Kamis, 2020). In this study, path analysis was used to identify a relation between maritime pilot knowledge, skills and abilities. It also determined to what extent the conceptual model is supported by the sample data (Schumacker & Lomax, 2010; Kamis, 2020).
- 5) With reference to the outcomes of the FFF model, PCA and empirical verification by CFA & SEM, it was indicated from the study shows that factors underlying maritime pilot Knowledge constructs for maritime pilot are “Knowledge of Ship handling and Manoeuvring”, “Knowledge of Tugboat Operation”, “Knowledge of Navigation”, “Knowledge of Bridge Resource Management” and “Knowledge of Communication”.
- 6) In contrast, the maritime pilot skill construct consists of five underlying factors. This study underlines the suggestion that the underlying factors of maritime pilot knowledge can improve maritime pilot skills on “Skills of Ship handling and Manoeuvring”, “Skills of Tugboat Operation”, “Skills of Navigation”, and “Skills of Communication”.
- 7) This study also underlines the suggestion that the underlying factors of maritime knowledge and maritime skills can improve abilities of maritime pilots on “Abilities in Ship handling and Manoeuvring”, “Abilities in Bridge Resource Management”, “Abilities in Communication”, “Abilities in passage plan”, and “Abilities in Pilot Transfer”.
- 8) Additionally, it was discovered from the CFA that maritime knowledge to maritime skill indicated a moderate positive relationship which is a prove that there is a positive improvement of maritime skills from maritime knowledge. For maritime skills to abilities, there was found to be strong positive relationships between the two constructs. While for maritime knowledge to maritime abilities was found to be moderate positive relationship between the two constructs.
- 9) These findings suggest that maritime pilot knowledge and/or skill will improve the abilities of maritime pilot in performing pilotage operation tasks such as berthing/unberthing, anchoring, navigating passage and coordinating

with port operators. For example, Maritime M. (2021) suggests that the Pilot must have the ability to make quick decisions under pressure. This can be achieved if the pilot has sufficient knowledge and/or skills related to the pressure involved. Therefore, the developed maritime pilot training and assessment framework can guide Pilot Boards to produce training/assessment module that has the knowledge and skills to improve abilities of training pilot. Furthermore, it is often the knowledge, skills, and abilities (KSAs) required for performing the tasks, rather than the job tasks themselves, which are tested by licensure and certification exams (Ning Wang et.al., 2005)

- 10) Therefore, based on above result of analysis, it can be concluded that the proposed hypotheses was confirmed to be true whereby Maritime Pilot Knowledge positively effects Maritime Pilot Skills, Maritime Pilot Skills positively impacts Maritime Pilot Abilities and finally Maritime Pilot Knowledge positively impacts Maritime Pilot Abilities.

5.2 Research Contribution

5.2.1 Research application

This study contributed to the field of nautical science. The empirical technique used to train and assess trainee pilots contributes to the performance of the future generation of maritime pilot trainees in Malaysia. This maritime pilot KSAs framework could assist Marine Department of Malaysia, Pilot Boards and port operator in developing their maritime pilot training and assessment module. This in return strengthens the foundation of the KSAs of future trainee pilots in Malaysia thus prepares them better to face challenges ahead such as increasing of bigger ships, busier waterways and advancing navigation technologies.

5.2.2 Global Implications

This research and the developed framework based on the Knowledge, Skills, and Attitudes (KSA) method can be applied beyond the Malaysian maritime pilot domain. The framework can be extended to Competent Pilotage Authorities, particularly for member states of the International Maritime Organization (IMO). Since the general foundation of maritime pilotage competency is similar across ports worldwide, the Competent Pilotage Authority of each state can develop their training and assessment manuals using this maritime pilot training and assessment framework.

By implementing this framework, countries facing similar challenges in maritime pilot competency assessment and training can benefit from a structured and validated approach. The use of the KSA-based framework ensures a standardized method to evaluate and enhance maritime pilot skills, ultimately leading to safer and more efficient port operations worldwide.

5.2.3 United Nation Sustainable Development Growth programme

This study eventual objective is to reduce accidents during pilotage operation thus contributes to the agenda of United Nation Sustainable Development Growth-Goal no.14 life under water. Which is to conserve and sustainably use the oceans, seas and marine resources for sustainable development. Therefore, reducing accidents means protecting the sea from pollution and damages caused by accident.

5.2.4 Verification of current KSA framework

This research also verifies the consistency of the current KSA findings with previous studies, thereby contributes significantly to the understanding of KSA. It was found that maritime knowledge improves the skills of a maritime pilot and maritime skills improve abilities of pilot to complete maritime pilot operation tasks such as safely berthing and unberthing a vessel. Through this finding, the current KSA

framework was verified, and its consistency was present in this existing study. Therefore, a significant contribution was provided in the effort in understanding KSA.

5.3 Recommendations for future research

Like any other profession, maritime pilot training and assessment requires continuous education and practice to ensure that pilots improve their competence and stay updated with the latest regulations, technologies, and best practices. Therefore, several recommendations are being suggested.

5.3.1 Extension of KSA research.

As recommended in IMO A.960 resolution that Governments should encourage the establishment or maintenance of competent pilotage authorities to administer safe and efficient pilotage systems (IMO, 2004). This study can be extended by conducting research outside of Malaysia. By collating more training and assessment manuals, and obtaining maritime pilot respondents outside of Malaysia, the maritime pilot training and assessment framework which is based on KSAs method could be improved. The research can commence from major ports where there are busier waterways and larger vessels. The database obtained from such ports can provide more valuable input to improve future maritime pilot training and assessment frameworks as well as its modules. This in return can prepare future Malaysia maritime pilot trainee to be more competent.

5.3.2 Human error in maritime pilotage

As stated by Demirci, S. E., et. al., (2023) that the enormous growth of the capacity and number of ships during the last decade have led to congested marine traffic in narrow canals, straits, rivers, and ports. It can be expected that accidents or near miss due to human error will increase. Ernstsen and Nazir (2018) stated that

human error happens all the time and is inevitable part of human nature. Within the maritime industry however, human errors generate critical consequences so severe they are worth spending time and resources to prevent from mitigate. Therefore, research on improving pilot training can be extended to understanding the cause of human error in pilotage and developing training that can help reduce human error during pilotage operation.

5.3.3 Assessment of pilot using technology

Performance assessment is fundamental for determining the success of training programmes, and it is critical that the measurements used for the assessment are adequately reliable and valid (Ernstsen and Nazir, 2020). Conventional method of assessing is by senior pilot assessment onboard vessel during pilotage operations. However, recent research indicates a need to strengthen the validity and reliability of performance assessment methods for maritime navigation (Ernstsen & Nazir, 2018a). Therefore, research on improving assessment methods for maritime pilot can be another future research to be conducted. Assessment by simulating pilotage operation in a simulation centre is one of the method that can be considered for future research as the operation can be conducted more frequently, each exercise can be recorded as well as reviewed and more experts can be involved in the assessment process.

5.3.4 Future Research Directions

While this study has successfully established that the KSA approach can be applied in developing a maritime pilot training and assessment framework, there are certain limitations that future research should address. One key limitation is the relatively small sample size of the study, which may impact the generalizability of the findings. Future studies should aim to expand the sample size by including a broader range of maritime pilots from different ports and regions, as well as increasing the diversity of respondents.

Additionally, the reliance on quantitative methods in this research means that certain qualitative insights may not have been fully captured. Future research could incorporate field observations, in-depth interviews, and case studies to gain a deeper understanding of how the KSA framework is implemented in real-world training and assessment scenarios. This mixed-methods approach would allow for a more comprehensive validation of the framework.

Furthermore, longitudinal studies tracking maritime pilots over time would provide valuable insights into the long-term effectiveness of the KSA-based training framework. By monitoring the competency development of maritime pilots throughout their careers, researchers could refine and enhance the framework to better meet industry needs.

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APPENDICES

Appendix 1

Questionnaire

RESEARCH ON THE APPLICATION OF KNOWLEDGE SKILLS AND ABILITIES FOR PILOT TRAINING & ASSESSMENT

Dear Sir/Madam,

University Malaysia Terengganu is undertaking research on the application of **Knowledge Skills and Abilities for Pilot Training & Assessment** for maritime pilots in Malaysia. We would like you be part of the research by responding to these questionnaires. The aim of the survey is to identify the relevance of Knowledge, Skills and abilities required by pilot and the objective of this research is to help improve the pilot training and assessment module for Competent Pilot Authority in Malaysia. Your participation in this survey is voluntarily and it take about 10 minutes to complete. All information gathered will be treated as confidential. Your cooperation is very much appreciated.

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** Indicates required question*

1. Name *

2. Which port are you operating as Harbour Pilot *

Mark only one oval.

- ☐ Bintulu Port
- ☐ Kemaman Port
- ☐ Kertih Port
- ☐ Kota Kinabalu & Sepanggar Port
- ☐ Kuantan Port
- ☐ Kuching Port
- ☐ Labuan Port
- ☐ Lumut Port
- ☐ Miri Port
- ☐ North Port, Port Klang
- ☐ Pasir Gudang Port
- ☐ Penang Port
- ☐ Port Dickson Port
- ☐ Sandakan Port
- ☐ South Port, Port Klang
- ☐ Sungai Udang Port
- ☐ Tanjung Pelepas Port
- ☐ Tawau & Lahad datu Port
- ☐ West Port, Port Klang
- ☐ North Port, Port klang

3. If other than above, Please specify (Location)

4. How long have you been serving as a ^{*} Harbour Pilot?

Mark only one oval.

- ☐ Less than 5 years
- ☐ 5-10 years
- ☐ 10-15 years
- ☐ 15-20 years
- ☐ 20-25 years
- ☐ More than 25 years

5. What is your current pilotage license ^{*}

Mark only one oval.

- ☐ Class C (Issued by JLM)
- ☐ Class B (Issued by JLM)
- ☐ Class A or A2 (Issued by JLM)
- ☐ Class A1 (Issued by JLM)
- ☐ Class A Unlimited or UR (Issued by JLM)
- ☐ Below 20,000 GRT(Issued by JPDS)
- ☐ Below 40,000 GRT (Issued by JPDS)
- ☐ Unlimited GRT (Issued by JPDS)

MARITIME PILOT KNOWLEDGE

FACTOR 1 - SHIP HANDLING AND
MANOEUVRING

6. KH1 - A pilot should be able to describe the effect of vessel displacement, draft, trim, list and under keel clearance on turning circles and stopping distance. *

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

7. KH2 - A pilot should be able to describe the effect of wind and current on ship handling *

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

8. *
KH3 - A pilot should be able to
describe the effect of squat and similar
effects when passing shallow water

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

9. *
KH4 - A pilot should be able to
describe anchorage operation

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

10. * KH5 - A pilot should be able to describe berthing unberthing operation

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

11. KH6 - A pilot should be able to describe various ways of handling vessel with or without tugs

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

12. KH7 - A pilot should be able to identify ship handling methods used for different types of emergency situations *

Mark only one oval.

- ☐ Strongly Not Agree
- ☐ Not Agree
- ☐ Slightly Not Agree
- ☐ Slightly Agree
- ☐ Agree
- ☐ Strongly Agree

Maritime Pilot Knowledge

Factor 2: Tug Boat Operation

13. KT1 - A pilot should be able to identify different types of tug boat. *

Mark only one oval.

- ☐ Strongly Not Agree
- ☐ Not Agree
- ☐ Slightly Not Agree
- ☐ Slightly Agree
- ☐ Agree
- ☐ Strongly Agree

14. *
KT2 - A pilot should be able to describe tug boat characteristics and maneuverability during pilotage operation.

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

15. *
KT3 - A pilot should be able to identify tug boat limitations during pilotage operation.

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

Maritime Pilot Knowledge

Factor 3: Navigation

16. KN1 - A pilot should be able to identify the limits of local pilotage area *

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

17. KN2 - A pilot should be able to explain Rules of the road *

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

18. *
KN3 - A pilot should be able to
describe the local marine aids to
navigation (i.e local buoys system)

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

19. *
KN4 - A pilot should be able to
identify the approach channel and
waterway

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

20. *
KN5 - A pilot should be able to
describe the characteristic of local
VTS

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

21. *
KN6 - A pilot should be able to
explain the local rules, regulations,
guidelines and procedures related to
pilotage operation

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

Maritime Pilot Knowledge

Factor 4: Bridge Resource Management

22. KB1 - A pilot should be able to explain the content in Master/Pilot exchange form. *

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

23. KB2 - A should be able to explain the content in the pilot card *

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

24. *
KB3 - A pilot should be able to
identify the standard of bridge team
on piloted vessel

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

Maritime Pilot Knowledge

Factor 5: Communication Equipment

25. *
KC1 - A pilot should be able to
explain the concept of IMO Standard
Maritime communication
Phrase(SMCP)

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

26. *
KC2 - A pilot should be able to explain the function and operation of marine VHF radio

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

27. *
KC3 - A pilot should be able to explain the communication procedures for external parties (port control, port team etc)

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

Maritime Pilot Skill

Factor 1: Ship handling and manoeuvring

28. ★
SH1 - A pilot should be able to
demonstrate safe pilotage operation

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

29. ★
SH2 - A pilot should be able to
demonstrate safe anchoring
operation

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

30. SH3 - A pilot should be able to demonstrate safe berthing and unberthing operation

*

Mark only one oval.

- ☐ Strongly Not Agree
- ☐ Not Agree
- ☐ Slightly Not Agree
- ☐ Slightly Agree
- ☐ Agree
- ☐ Strongly Agree

31. SH4 - A pilot should be able to demonstrate ship handling with or without tug boat

*

Mark only one oval.

- ☐ Strongly Not Agree
- ☐ Not Agree
- ☐ Slightly Not Agree
- ☐ Slightly Agree
- ☐ Agree
- ☐ Strongly Agree

Maritime Pilot Skill

Factor 2: Tug Boat Coordination

32. *
ST1 - A pilot should be able to
organize tug boat movement during
pilotage operation

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

33. *
ST2 - A pilot should be able to
organize various type of tugboats
operating in the port

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

34. *
ST3 - A pilot should be able to
organize tugboat movement when
towing vessel not under command
(N.U.C)

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

Maritime Pilot Skill

Factor 3: Navigation

35. *
SN1 - A pilot should be able to
demonstrate the use of onboard
navigational equipment

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

36. *
SN2 - A pilot should be able to
produce the vessel's position and
monitor its progress

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

37. *
SN3 - A pilot should be able to
demonstrate the process of
navigating vessel under pilotage

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

Maritime Pilot Skill

Factor 4: Communication

38. *
SC1 - A pilot should be able to demonstrate the use of marine radio to contact local authority and other vessels

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

39. *
SC2 - A pilot should be able to demonstrate the use of marine radio to contact with port members

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

40. *
SC3 - A pilot should be able to demonstrate effective communication with bridge team

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

Maritime Pilot Abilities

Factor 1: Ship Handling and Manoeuvring

41. *
AH1 - By recognizing limitation of vessel; weather and current conditions; and organize of tugboats, a pilot can complete ship berthing/unberthing operation safely.

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

42. *
AH2 - By recognizing limitation of waterway and control of ship handling and manoeuvring; a pilot can complete a safe transit navigation

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

43. *
AH3 - By recognizing limitation of vessel; weather and current conditions; and control of vessel handling and manoeuvring, a pilot can control vessel during emergency situation

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

44. *
AH4 - By recognizing limitation of vessel; weather and current conditions; and control of vessel handling and manoeuvring, a pilot can control vessel with or without tugs

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

Maritime Pilot Abilities

Factor 2: Passage Plan

45. *
AP1 - By recognizing limitation of vessel; weather and current conditions; and control of vessel handling and manoeuvrability, a pilot can produce a safe berthing/unberthing plan

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

46. *
AP2 - By recognizing limitation of vessel; weather and current conditions; and control of vessel handling and manoeuvrability, a pilot can produce a contingency plan

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

47. *
AP3 - By recognizing limitations of channel; weather and current conditions; and demonstrate the use of navigation aid, a pilot can produce a safe passage plan

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

48. *
AP4 - Being able to locate position of navigation warning broadcast and documenting it on ECDIS/Chart, a pilot can be precise in making Navigation decision

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

47. *
AP3 - By recognizing limitations of channel; weather and current conditions; and demonstrate the use of navigation aid, a pilot can produce a safe passage plan

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

48. *
AP4 - Being able to locate position of navigation warning broadcast and documenting it on ECDIS/Chart, a pilot can be precise in making Navigation decision

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

Factor 3: Bridge Resource management

49. *
AM1 By identifying standard of master and crew; and demonstrate communication with bridge team, a pilot can produce an effective bridge teamwork

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

50. *

AM2 By relate the right information from master pilot exchange/pilot card; and be precise in giving instruction with bridge team, a pilot can to complete a safe pilot operation.

Mark only one oval.

- ☐ Strongly Not Agree
- ☐ Not Agree
- ☐ Slightly Not Agree
- ☐ Slightly Agree
- ☐ Agree
- ☐ Strongly Agree

51. *

AM3 By recognizing bridge and navigation operational procedures; and demonstrate an effective communication with bridge team, a pilot can be precise in navigating vessel

Mark only one oval.

- ☐ Strongly Not Agree
- ☐ Not Agree
- ☐ Slightly Not Agree
- ☐ Slightly Agree
- ☐ Agree
- ☐ Strongly Agree

Maritime Pilot Abilities

Factor 4: Communication

52. *
AC1 By recognizing (SMCP)
Standard Maritime communication
phrase and demonstrate the use of
marine radio, a pilot can organize
effective communication with external
parties

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

53. *
AC2 By identifying MF/HF/VHF operating procedures and demonstrate the use, a pilot can show more efficient communication

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

54. *
AC3 Being able to describe own vessel navigation warning and documenting it on ECDIS/Chart, a pilot can demonstrate awareness to concerned parties.

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

Maritime Pilot Abilities

Factor 5: Pilot Transfer

55. *
AT1 - By identifying the boarding arrangement plan; weather conditions and be precise in embarking pilot access point, a pilot can complete an embarkation/disembarkation safely.

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

56. *
AT2 - By identifying the rendezvous/boarding point; and be precise in informing master the best position, a pilot can produce a time efficient of pilot transfer operation (embarkation/disembarkation)

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree

57. *
AT3 - By identifying problem with vessel embarkation arrangement and be precise in informing master the issue, a pilot can organize a safer embarkation/disembarkation safely

Mark only one oval.

- ☐ Strongly Not Agree
☐ Not Agree
☐ Slightly Not Agree
☐ Slightly Agree
☐ Agree
☐ Strongly Agree
-