SAFETY ASSESSMENT MODEL OF COASTAL PASSENGER VESSEL IN THE PERSPECTIVE OF LIFE JACKET COMPATIBILITY

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A thesis submitted in the fulfilment of the
requirements for the award of the degree of
Doctor of Philosophy (Mechanical Engineering)

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I declare that this thesis entitled "*Safety Assessment Model of Coastal Passenger vessel in the Perspective of Life Jackets Compatibility*" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in the candidature of any other degree.

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To my beloved family, teachers and supporting group in UTM

ACKNOWLEDGEMENT

I would like to express my sincere gratitude to my supervisors, Prof. Ir. Dr. Ab. Saman bin Abd. Kader and Associate Prof. Dr. Mohd Zamani bin Ahmad for their kind guidance and professional support and sharing of experience during the execution of this research. The research would not be completed and successful without their contributions and perseverance.

Last but least, I would like to thank my beloved parents Dato' Brig. Jen. Ahmad Fuad Harun and Che Ton Abd Rahman, parent in-laws, my wife Nor Azazura, my dear sisters Abidah and Salamah, and other family members that supported me throughout this PhD journey.

I would like to express my appreciation to former Dean of Faculty of Marine Science and Maritime Studies UMT, Dato' Prof. Saharuddin for his approval and encouragement in my PhD study by using the SLAI scholarship from MOHE. I would like also to thank Capt. Mohd Naim, Capt. Noor Apandi, Mohd Hafizi, Izhar, Mat Nasir, and Hafiz of Department of Nautical Studies and Maritime Transportation UMT for their continuous support.

I would like to thanks my friends in UTM that supported me during my study; namely Azuwan, Aminuddin, Azmirul, Aswin, Fauzi, Razak, Dr. Nurzaher, Nurol, Sunarsih, Zulkifli, Asmawi, Nurhanani, Raihan, Narisa, Zamari. Khudzairi and other names not mentioned.

ABSTRACT

This research was conducted due to frequent occurrence of passenger vessel accidents related to the use of life jackets, which believed due to incompatibility between life jackets and passenger vessels. To address this problem, the research sets to develop a safety assessment model of coastal passenger vessel (CPV) in the perspective of life jacket's compatibility, which is known as Life Jacket Compatibility Index (LCI) model. The main purpose of LCI model is to evaluate the life jacket's compatibility with CPV. The LCI model was developed based on a combination of variables from four previous safety models. Compatibility was introduced as a new variable in the present model. The development of the LCI model started by mapping the variables from both life jacket model and passenger vessel safety combined model. Variables were selected based on the research criteria and used to develop the Life Jacket Compatibility Index (LCI) model. The LCI model was transformed into LCI Static and LCI Dynamic algorithms that are based on Fault Tree analysis approach. The LCI Static assesses the life jacket's compatibility with CPV which is under the approved plan and number of passengers, while the LCI Dynamic assesses the same compatibility during CPV is in the operational mode. The LCI model's accuracy was verified by using regression method and the results were further validated by case studies and sensitivity analyses. Results from LCI Static showed that the open-deck CPV *Explorer 320* equipped with inherently buoyant life jackets has better compatibility (2.79) than closed-deck CPV *Duta Pangkor 3* and *Bahagia No. 1* (1.79 and 1.84 respectively). The LCI model was used to improve the safety performance of *Bahagia No. 1*. It was found that LCI Dynamic of the vessel can be improved by 3.4% when the number of passengers was reduced from 57 to 55. In conclusion, the newly developed LCI model is significant to assess and improve the safety of CPV.

ABSTRAK

Kajian ini dijalankan kerana berlakunya kejadian kemalangan kapal penumpang yang kerap berkaitan dengan penggunaan jaket keselamatan, yang dipercayai disebabkan oleh ketidakserasian antara jaket keselamatan dan kapal penumpang. Bagi menangani masalah ini, kajian ini telah membangunkan model penilaian keselamatan kapal penumpang pesisir (CPV) dalam perspektif keserasian dengan jaket keselamatan yang dikenali sebagai model Indeks Keserasian Jaket Keselamatan (LCI). Tujuan utama model LCI dibangunkan adalah untuk menilai keserasian antara jaket keselamatan dengan CPV. Model LCI telah dibangunkan berdasarkan gabungan pembolehubah-pembolehubah dari empat model keselamatan sebelumnya. Keserasian diperkenalkan sebagai pembolehubah baru dalam model ini. Pembangunan model LCI bermula dengan pemetaan pembolehubah dari kedua-dua model jaket keselamatan dan model keselamatan kapal penumpang yang gabungkan. Pembolehubah-pembolehubah dipilih berdasarkan kriteria penyelidikan dan digunakan untuk membangunkan model (LCI). Model LCI berubah menjadi algoritma LCI Statik dan LCI Dinamik dengan menggunakan pendekatan analisa *Fault Tree*. Fungsi LCI Statik adalah menilai keserasian jaket keselamatan dengan CPV berdasarkan pelan kapal dan bilangan penumpang yang diluluskan, manakala fungsi LCI Dinamik adalah menilai keserasian yang sama semasa CPV beroperasi. Ketepatan model LCI telah disahkan dengan menggunakan kaedah regresi dan pengesahan lanjut telah buat melalui kajian kes dan analisis sensitiviti. Keputusan LCI Statik menunjukkan bahawa CPV jenis dek terbuka *Explorer 320* yang dilengkapi dengan jaket keselamatan apung kekal mempunyai keserasian yang lebih baik (2.79) berbanding CPV jenis tertutup dek *Duta Pangkor 3* dan *Bahagia No. 1* (1.79 dan 1.84 masing-masing). Model LCI telah digunakan untuk meningkatkan prestasi keselamatan *Bahagia No. 1*. Adalah didapati bahawa LCI Dinamik kapal tersebut boleh dipertingkatkan sebanyak 3.4% apabila bilangan penumpang dikurangkan daripada 57 kepada 55. Kesimpulannya, model LCI yang baru dibangunkan ini adalah penting untuk menilai dan meningkatkan keselamatan CPV.