BUSINESS INTELLIGENCE MATURITY MODEL (BIMM): A MODEL FOR MALAYSIAN PUBLIC UNIVERSITIES

BY

MUHAMMAD HARITH BIN ZAHRULLAILI

A thesis submitted in fulfillment of the requirement for the degree of Doctor of Philosophy of Information Technology

Kulliyyah of Information and Communication Technology
International Islamic University Malaysia

AUGUST 2022

ABSTRACT

The continuous technological advancement increased the amount of business data needed to be stored. Organizations have comprehended the benefits of these data and use business intelligence to gain helpful insights and support decision-making through data analysis. However, only six models were found in the current literature relating to business intelligence maturity models. In addition, most of these models did not provide an assessment tool for their users to measure the maturity level and are not explicitly designed for Malaysian public universities. A new business intelligence maturity model is developed in this study and tested using a mixed-methodology to remedy gaps presented by past models. This study explored business intelligence maturity factors with a quantitative survey involving 296 information technology employees in Malaysian public universities. It identified its relationship with business intelligence maturity level from qualitative in-depth interviews with another 12 information technology employees. The quantitative survey responses were analyzed using the multiple regression analysis. The results show that organization, people, technology, data, process, and outsourcing are the essential predictors of business intelligence maturity. Then, the in-depth interviews revealed that all six factors could be further expanded to sixteen key attributes. Finally, results from quantitative and qualitative were synthesized to produce meta-inferences and develop the final model. The model testing phase shows that Malaysian public universities can use this model to self-assess their business intelligence maturity. A model that contains a self-assessment tool is beneficial to its users in determining their capabilities and helps them adopt successful business intelligence. This study contributes to existing stages of growth theory by developing a new model with a non-linear maturity path using the mixed-methodology.

ملخص البحث

أدى التقدم التكنولوجي إلى زيادة كمية بيانات الأعمال التي تحتاج إلى تخزينها. لقد فهمت المؤسسات فوائد هذه البيانات واستخدمت ذكاء الأعمال للحصول على رؤى مفيدة ودعم اتخاذ القرارات من خلال تحليل البيانات. ومع ذلك، تم العثور على ستة نماذج فقط في الأدبيات الحالية المتعلقة بنماذج نضج ذكاء الأعمال. وبالإضافة إلى ذلك، فإن معظم هذه النماذج لم توفر أداة تقييم لمستخدميها لقياس مستوى نضجهم ولم تكن مصممة صراحة للجامعات العامة الماليزية. تم تطوير نموذج نضج جديد لذكاء الأعمال في هذه الدراسة واختباره باستخدام منهجية مختلطة لمعالجة الفجوات التي قدمتها النماذج السابقة. استكشفت هذه الدراسة عوامل نضج ذكاء الأعمال من خلال مسح كمي شمل 296 موظفا في مجال تكنولوجيا المعلومات في الجامعات الحكومية الماليزية وحددت علاقته بمستوى نضج ذكاء الأعمال من خلال مقابلات نوعية متعمقة مع 12 موظفا آخر في مجال تكنولوجيا المعلومات. تم تحليل ردود المسح الكمي باستخدام تحليل الانحدار المتعدد. وتظهر النتائج أن المؤسسات والأشخاص والتكنولوجيا والبيانات والعمليات والاستعانة بمصادر خارجية هي المؤشرات الأساسية لنضج ذكاء الأعمال. بعد ذلك، كشفت المقابلات المتعمقة أنه يمكن توسيع جميع العوامل الستة إلى ستة عشر سمة رئيسية. وأخيرا، تم تجميع نتائج التحليل الكمي والنوعي لإنتاج استنتاجات وصفية وتطوير النموذج النهائي، والذي تظهر مرحلة اختبار النموذج أن الجامعات الحكومية الماليزية يمكنها استخدام هذا النموذج لتقييم نضجها في ذكاء الأعمال ذاتيا. النموذج الذي يحتوي على أداة تقييم ذاتي مفيد لمستخدميه في تحديد قدراتهم ويساعدهم على تبني ذكاء الأعمال الناجح. تساهم هذه الدراسة في المراحل الحالية لنظرية النمو من خلال تطوير نموذج جديد مع مسار نضج غير خطي باستخدام منهجية مختلطة.

APPROVAL PAGE

The thesis of Muhammad Harith bin Zahrullaili has been approved by the following:

_____
Mohamad Fauzan
Supervisor

_____
Mohd Izzuddin
Co-supervisor

_____
Asadullah Shah
Internal Examiner

_____
Shahrul Azman Mohd Noah
External Examiner

_____
Ma'an Fahmi Rashid Al-Khatib
Chairman

DECLARATION

I hereby declare that this thesis is the result of my own investigations, except where otherwise stated. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at IIUM or other institutions.

Muhammad Harith bin Zahrullaili

Signature…… Date……

INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA

DECLARATION OF COPYRIGHT AND AFFIRMATION OF FAIR USE OF UNPUBLISHED RESEARCH

BUSINESS INTELLIGENCE MATURITY MODEL (BIMM): A MODEL FOR MALAYSIAN PUBLIC UNIVERSITIES

I declare that the copyright holder of this thesis are jointly owned by the student and IIUM.

No part of this unpublished research may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise without prior written permission of the copyright holder except as provided below

1. Any material contained in or derived from this unpublished research may only be used by others in their writing with due acknowledgement.

2. IIUM or its library will have the right to make and transmit copies (print or electronic) for institutional and academic purpose.

3. The IIUM library will have the right to make, store in a retrieval system and supply copies of this unpublished research if requested by other universities and research libraries.

By signing this form, I acknowledged that I have read and understand the IIUM Intellectual Property Right and Commercialization policy.

Affirmed by Muhammad Harith bin Zahrullaili

…… ……..

Signature Date

INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA

DECLARATION OF COPYRIGHT AND AFFIRMATION OF FAIR USE OF UNPUBLISHED RESEARCH

BUSINESS INTELLIGENCE MATURITY MODEL (BIMM): A MODEL FOR MALAYSIAN PUBLIC UNIVERSITIES

I declare that the copyright holder of this thesis is International Islamic University Malaysia.

No part of this unpublished research may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise without prior written permission of the copyright holder except as provided below

1. Any material contained in or derived from this unpublished research may only be used by others in their writing with due acknowledgement.

2. IIUM or its library will have the right to make and transmit copies (print or electronic) for institutional and academic purpose.

3. The IIUM library will have the right to make, store in a retrieval system and supply copies of this unpublished research if requested by other universities and research libraries.

By signing this form, I acknowledged that I have read and understand the IIUM Intellectual Property Right and Commercialization policy.

Affirmed by Muhammad Harith bin Zahrullaili

…… ……..

Signature Date

INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA

DECLARATION OF COPYRIGHT AND AFFIRMATION OF FAIR USE OF UNPUBLISHED RESEARCH

BUSINESS INTELLIGENCE MATURITY MODEL (BIMM): A MODEL FOR MALAYSIAN PUBLIC UNIVERSITIES

I declare that the copyright holder of this thesis is Muhammad Harith bin Zahrullaili.

Affirmed by Muhammad Harith bin Zahrullaili

…… ……..

Signature Date

ACKNOWLEDGEMENTS

All praises to Allah, the Almighty, for all I have accomplished in this journey is made possible with His graciousness and mercy. The tremendous work of finishing my thesis has been made easier as He provided me with the blessing, chance, strength, and endurance to complete this study.

First and foremost, I am most indebted to my supervisor, Prof. Dr Mohamad Fauzan, for his guidance and assistance from the beginning to the end of my study. I was able to grasp my study topic better and finish this thesis with his advice, which I will always be grateful for. I would also like to express my gratitude to Asst. Dr Mohd. Izzuddin, my second supervisor, for his terrific help and support.

Secondly, I would like to thank Universiti Utara Malaysia and the Malaysian Ministry of Higher Education for their financial support of my studies.

My sincere appreciation also goes to my parents, Sr. Dr Zahrullaili bin Yahya and Rusnani binti Safie, for their continuous prayer and encouragement. They never gave me up and always motivated me to keep moving forward in this journey.

Last but not least, I would like to give my special and deepest gratitude to my lovely wife, Nurul Idayu binti Ismail, and my children, Ayu Zulaikha, Harith Zakwan, Harith Zaim, and Harith Zikri, for their undivided love. They never doubt me, not even once, and provide me with the strength and perseverance to go on despite facing many obstacles. Without their precious support and prayer, it would not be possible for me to finish this study.

Once again, we give thanks to Allah for His unending generosity, one of which is allowing us to finish this thesis successfully. Alhamdulillah.

TABLE OF CONTENTS

LIST OF TABLE

LIST OF FIGURES

LIST OF ABBREVIATIONS

BI	Business Intelligence
CMM	Capability Maturity Model
CMMI	Capability Maturity Model Integration
DMP	Data Management Platform
ETL	Extract Transform Load
HEI	Higher Education Insitution
IT	Information Technology
MoE	Ministry of Education
MoHE	Ministry of Higher Education
OLAP	Online analytical Processing
SIEM	Security Information and Event Management

CHAPTER ONE

INTRODUCTION

1.1 CHAPTER INTRODUCTION

This chapter introduces the research. This study aims to create a business intelligence maturity model for Malaysian public universities. The thesis's core theme is summarised in this chapter and then expanded upon in future chapters. First, this chapter provides a quick overview of business intelligence and its significance to organisations. After that, the research context, research questions and objectives, and thesis outline are presented in the subsequent sections. This chapter introduces the research. This study aims to create a business intelligence maturity model for Malaysian public universities. The thesis's core theme is summarised in this chapter and then expanded upon in future chapters. First, this chapter provides a quick overview of business intelligence and its significance to organisations. After that, the research context, research questions and objectives, and thesis outline are presented in the subsequent sections.

1.2 RESEARCH BACKGROUND

Today's world is painted with convolution and a dynamic change in the global business environment. The continuous technological advancement changes the way organizations do their operation nowadays. The use of information technology (IT) systems, such as enterprise resource planning, customer relationship management, and other related technologies, increase the amount of data needed to be stored. As the cost of gathering data has reduced extensively, organizations have become more assertive in acquiring more data

to edge over their competitors (Chaudhuri, Dayal, & Narasayya, 2011; Negash & Gray, 2008a). Over the past couple of decades, there has been a steady progression toward this data revolution.

Organizations have comprehended the benefits that reside in the data. Therefore, they seek an appropriate approach to ways to use this invaluable asset. As a result, business intelligence has become a powerful tool (Agarwal & Dhar, 2014) in producing helpful insights and supporting decision-making through the analysis of oceanic data (Ramakrishnan, Jones, & Sidorova, 2012). Wixom & Watson (2010) define business intelligence, or BI, as a concept which generally represents the technologies, applications, and processes for gathering, storing, accessing, and analyzing data to help users make a better decision. In short, it is a decision-support system that allows firms to enhance their operations and raise their competitiveness by making better decisions using useful data and information.

Even though it is unusual to find a thriving organization that has not yet implemented BI (Chaudhuri et al., 2011), there are still cases where organizations failed in their BI adoption. Scholars have explored the challenges and success factors of BI thoroughly. However, only a few step-by-step models are available to guide organizations in their BI adoption. In response, this thesis evaluates the related available models and develops a new and comprehensive model specifically for Malaysian public universities. This scope was chosen since current studies concentrate on BI's applicability in the business sector rather than the public sector.

1.3 PROBLEM STATEMENT

Due to the broad range of BI issues and challenges (Chaudhuri et al., 2011; Clavier, Lotriet, & Loggerenberg, 2012; Marjanovic, 2007; Yeoh & Koronios, 2010), scholars have conducted many studies to help organizations in their BI application. For example, frameworks have been developed (Baars, 2008; Cates, Gill, & Zeituny, 2005; Chung, Chen, & Nunamaker Jr., 2003, 2005; Chung & Tseng, 2012; Hu & Cercone, 2004; Kemper, Baars, & Lasi, 2013; US 11/927,786, 2007) and, technical solutions have provided (Nguyen, Schiefer, & Tjoa, 2005; Polyvyanyy, Ouyang, Barros, & Van Der Aalst, 2017; Rivest et al., 2005; Zeng, Xu, Shi, Wang, & Wu, 2006) to guide a particular company in implementing BI. However, for two reasons, these remedies are not feasible for a specific context of usage, in this case, Malaysian public universities.

First, most of the advice and technical solutions were created for general targeted users. However, according to Lim (2012), various users gain differently from BI. As a result, unique solutions for specially targeted users are required. For instance, both government and private sectors use BI for different purposes (Malomo & Sena, 2016; Spano & Bellò, 2015). Unlike the private sector, the government uses BI to provide better services to citizens, whereas the private sector uses it to maximize its profit. Hence, generalized solutions may not be practical for some users as their BI uses are distinct and necessitate a tailored solution. (Larsen, 2013).

Secondly, most available solutions for adapting BI are only prescriptive measurements for organizations. It prescribes what to do next to improve BI usage without describing its maturity, capabilities, and current BI applications (Raber, Winter, & Wortmann, 2012). As a result, organizations may easily get lost in BI implementation when they fail to define the true meaning and purpose of BI applications based on their organization's situation (Olszak, 2016). Therefore, prescribing remedies without first determining the maturity level of BI is like handing a map to someone lost in the middle of

a vast desert without providing them with a compass to pinpoint their current location beforehand.

According to a survey conducted by INFORMS, which involved 230 organizations, government agencies, and academics, 65% of respondents believed that the idea of "maturity" in business analytics is critical since it can identify the level of their business analytics competence (Smith, 2014). Unfortunately, 82% of the 230 respondents admitted that they do not have metrics to assess their business analytics maturity. As a result, this study contends that a framework and instrument that can describe or evaluate an organization's BI maturity are critical to assist them in their BI application.

Therefore, this thesis aims to develop a BI maturity model for Malaysian public universities to solve the aforementioned research problem. A maturity model is a framework or tool used to describe organizations' maturity stages relating to a particular process or technology application (Maier, Moultrie, & Clarkson, 2012; Poeppelbuss, Niehaves, Simons, & Becker, 2011).

1.4 RESEARCH GAP

The Stages of Growth Hypothesis, proposed by Nolan (1973), serves as the theoretical underpinning for the maturity model. Nolan hypothesized in the 1970s that IT in businesses would evolve in stages. He first suggested four stages (Stage I – Initiation, Stage II – Contagion, Stage III – Control, and Stage IV – Integration). Later, Nolan (1979) expanded his theory with two new stages (Stage V – Data Administration; and Stage VI – Maturity).

Crosby (1979) developed Nolan's idea with his Quality Management Maturity Grid. Crosby kept the concept of growing in stages in his grid. However, he used his version of maturity phases to infer that, during the quality development process, companies would go through five stages of maturity: Stage 1 – Uncertainty; Stage 2 – Awakening; Stage 3 – Enlightenment; Stage 4 – Wisdom; and Stage 5 – Certainty. Compared to Nolan's theory, Crosby added six domains (management understanding and attitude; quality organization status; problem handling; the cost of quality as % of sales; quality improvement actions; and summary of company quality posture) that differentiate each of the five maturity stages.

Humphrey (1989) developed the Capability Maturity Model (CMM) using Crosby's grid a decade later. This model used the same principle of stages growth as Nolan's hypothesis and Crosby's grid, with elements determining the growth. However, because CMM's framework is more practical than the two original models, CMM emerges as the more popular model in terms of usability. So far along, CMM was enhanced to Capability Maturity Model (CMMI) to cater to a more complex business environment (Manzoni & Price, 2003).

Since the advent of CMM and CMMI, multiple maturity models based on CMM and CMMI have been established for various research contexts (Poeppelbuss et al., 2011). Among many of the models developed using the concept of maturity, this study identifies six related BI maturity models (Brooks, El-Gayar, & Sarnikar, 2015; Chuah, 2010; Dinter, 2012; Gastaldi et al., 2018; Raber et al., 2012; Tan, Sim, & Yeoh, 2011). However, even though there are six maturity models for BI, this study discovers two significant gaps that need to be solved.

First, except for Dinter (2012) and (Gastaldi et al., 2018), all models did not include a tool for their users to determine their maturity level. De Bruin, Freeze, Kaulkarni, & Rosemann (2005) mention that two significant elements make a maturity model: maturity levels and factors. However, Pöppelbuß & Röglinger (2011) emphasize that a maturity