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THE INTEGRATED FRAMEWORK OF BUSINESS INTELLIGENCE, BIG DATA ANALYTICS AND ORGANIZATIONAL PERFORMANCE MANAGEMENT IN PUBLIC SECTOR: Technical Report

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1. EXECUTIVE SUMMARY

The implementation of Business Intelligence (BI) and Big Data Analytic (BDA) in managing organizational performance especially in public sector is important and critical. Weakness in managing the implementation strategy and the performance can result a massive impact to people and nation. This research aims to develop an integrated framework of Business Intelligence and Big Data Analytics (BI-BDA) for performance management system (PMS) implementation. The research is conducted in four main phases which include 1) the design of conceptual framework; 2) empirical investigation on business intelligence, big data analytics and performance management practices in public sector; 3) development of integrated framework of BI-BDA for PMS implementation, and 4) framework validation. As a result of this research we manage to develop the new integrated framework of BI and BDA (BI-BDA) for PMS implementation which was validated through case studies that involve public organisations. The framework is valuable to: 1) the practitioners who are handling the process of business intelligence and analytics, can use the framework as their guidelines and standards, and 2) the decision-makers and stakeholders can apply the framework as a mechanism to ensure the organizational performance management to be more effective, dynamic and analytic. In addition to the above findings, this research has produced 8 indexed journal papers, 5 international conferences proceedings and 2 others publications. In term of digital talents development, this research has produced 1 PhD graduates and 3 GRAs at master and PhD levels.

2. ABSTRACT

The implementation of Business Intelligence (BI) and Big Data Analytic (BDA) in managing organizational performance especially in public sector is important and critical. Weakness in managing the implementation strategy and the performance can result a massive impact to people and nation. Therefore, integration of BI and BDA are necessity to assist decision makers to increase efficiency in public services. However, preliminary study had identified limited implementation of BI and business analytics with Performance Management System (PMS) that led to inefficient performance in management practice. At the same time, large amount of data from various resources have led to the emergent of big data analytics (BDA). Therefore, this

research is proposed with the aim to develop an integrated framework of Business Intelligence and Big Data Analytics (BI-BDA) for PMS implementation. To achieve this goal, elements and sub elements of integrated BI-BDA and PMS implementation have been identified which focuses on big data analytics, and the third objective was to validate the BI-BDA framework. The research was conducted in four main phases: Phase 1) the design of conceptual framework; 2) empirical investigation on business intelligence, big data analytics and performance management practices in public sector; 3) development of integrated framework of BI-BDA for PMS implementation, and 4) framework validation. Main outcome from this research is the new integrated framework of BI and BDA (BI-BDA) for PMS implementation which was validated through case studies that involve two public organisations in Malaysia. It is a new findings and knowledge in Information Technology. The proposed framework is valuable to:1) the practitioners who are handling the process of business intelligence and analytics, can use the framework as their guidelines and standards, and 2) the decision-makers and stakeholders can apply the framework as a mechanism to ensure the organizational performance management to be more effective, dynamic and analytic.

3. INTRODUCTION

Business Intelligence (BI) implementation in managing organisations in public sector performance had drawn attention of academicians, researchers and government officers. This is due to the impact of public sector's performance management to nation and people. People are now wiser to evaluate the transparency of public sector administration in managing national resources. Therefore, managing and measuring organizational performance had been critical agenda in public sector transformation process [1]. BI has been identified as an effective technology in strategically managing performance. BI enables the users to gather, integrate, access and analyse data to assist efficient decision making in the organisations.

Performance management is a process to facilitate in managing resource and measuring outcome in the organisation [2]. It analyses organisational goals and divides it into specific benchmarks to ensure the goals are measurable. Performance management is important to determine organisational success. In public sector, organisational performance management become more challenging due to generality of public sector objectives involving different level of people. It also consists of multi-level hierarchy that cause complexity in decision making process

and dissemination of information. Public sector involves tight rules and procedures in financial and decision making process [3]. Therefore, managing public sector performance is more challenging and complicated. BI implementation enables to manage and coordinate information within organisation effectively [4]. However, current BI implementation in managing performance does not help enough for the organisation to stay competitive. This is because the large volume of information is beyond the ability of decision makers to conduct analysis for best actions in decision making [5]. In addition, scattered piles of data that led to the provision of information for analysis takes longer time [5], [6].

Therefore, BI implementation should emphasise analytic aspects in order to meet current performance management needs. Analytic generally means skills in applying data analysis, especially in thinking or reasoning process. In the context of this study, analytic refers to the process of develop an understanding of action through defining problem and use of statistical models on existing data [7]. The integration of business intelligence and analytics (BIA) improves the sustainability of organisation in their business environment and stays competitive. The increasing in complexity and competitive in current business environment had urge managers to use analysis, trends and forecasting [8] in their business operations. Base on this situation, BIA is highly demanded to drive actionable insight for better decision making. Nowadays, BI implementation had shift to new perspective that require advance analytic adaptation. Both BI and analytic should be implement parallel to maximise the impact in organizational performance management.

4. RESEARCH METHODOLOGY

i. Phase 1: Conceptual Framework Design

The first phase of this research was to investigate further and formulate Business Intelligence & Analytics (BIA) and the Performance Management (PMS) conceptual framework. The references consisted of latest journals, books, and proceedings. The aim of this phase was to identify key elements existed in BIA and PMS implementation. It was also to investigate issues and problem arose related to its implementation. Outcome of this phase was the conceptual framework of BIA and PMS implementation.

ii. Phase 2: Empirical Investigation on Business Intelligence, Data Analytics and Performance Management

The second phase was to design the semi-structured interview questions and conducted interviews with identified experts in these areas. The interviewees were the practitioners in Business Intelligence and Analytics or Performance Management. They were chosen based on their experiences and their positions in these related works. The purpose of this study was to identify processes, human resources and other key elements which were essential in BIA and PMS implementation. The interviews were conducted face to face and the interview sessions were recorded in audio file. The interview audio had undergone the transcription process and was analysed using qualitative analysis software (ATLAS.TI). The outcome of this phase has revealed the key elements in Business Intelligence (BI)and Big Data Analytics (BDA) for PMS implementation.

iii. Phase 3: Development of Integrated Framework of BI-BDA for PMS

The next phase was to develop an integrated framework for BI-BDA for PMS implementation based on empirical study findings as well as theoretical study. The Relationships between key elements were investigated and modelled to support the framework development. The outcome of this phase was the Integrated Framework of Business Intelligence and Big Data Analytics (BI-BDA) for PMS implementation.

iv. Phase 4: Framework Validation and Refinement

The last phase of this research were the verification and validation of the proposed integrated BI-BDA framework. The verification was carried out through expert review approach and the validation was adopted the case study approach. Two experts in BIA and PMS implementation were identified and invited to review the integrated BI-BDA framework. The BI-BDA framework was applied in real practice which involved collaborating with two government agencies for evaluation. All the review and validation reports were analysed and used to refine the framework.

5. LITERATURE REVIEW

The literature study covers two main areas which are the business intelligence and business analytics in performance management.

i. Business Intelligence

The concept of data collection and integration to simplify report generation was introduced since 1970-ies known as Management Information System (MIS). The foundation had been upgraded to Executive Information System (EIS) in early 1980-es. In 1990-es, the term BI was used extensively. It had improved EIS by introducing data warehouse to extract, coordinate and store data from various database platforms. Data warehouse was introduced by Bill Inmon to overcome problems regarding integration, integrity and credibility of data used in generating reports [9]. One of the goals of data warehouse is to store data from various sources into a uniform structure from the early stage of data collection.

Data warehouse application in managing organisational information has altered the landscape of decision support technology. The architecture, methodology, implementation process and data analysis using data warehouse had coined BI concept that is used nowadays. In 2000-es era, BI software started to emerge and float in the market and draw attentions among industry practitioners. Focus in BI implementation had shifted from analysing historical data into analysing real-time data. In addition, attractive visualisation feature in BI such as dashboard and scorecard able to facilitate strategic decision-makers for strategic planning to improve organisational performance [10].

In recent years, BI had been implemented in various field such as medical [11], [12], education [13], [14], retail [15], banking [16], manufacturing [17] and public sector management [18], [19]. Previous studies revealed that BI had been implemented to increase the effectiveness of strategy, action plan and operational planning; improve customer relation; as well as analyse and enhance business process and operation. This indirectly increases the collaboration between departments and improves performance throughout the organisation [20], [21]. Currently, BI technology is growing rapidly because of the demand from users in obtaining forecast information and trend. Therefore, BI implementation should be integrated with advance analytics so that it can be applied in current challenging business environment and requirements.

ii. Business Analytics

Business Analytics (BA) is a domain that focuses in applied analytics to support business strategic activities [7]. It consists of human and technology involvement in the process of collecting, analysing and transforming data to support decision making [22]–[24]. [25] [25]. C. Holsapple et al. reviewed BA definition and formulate it into six categories according to different perspectives that are analytic movement, application in decision making, data for information transformation process, competitive ability, decision making paradigm and specific activities in business process [25].

Generally, BA is implemented to retrieve insight of data that enable actionable and effective decision making in organisation [26]. The concept of BA implementation lead to the development of forecasting model, scenario simulation, and other quantitative and qualitative analysis methods [24], [27], [28]. It is to enhance the organisational ability in rebuilding routine process and eliminate obsolete and inefficient procedures [27]; improve competitiveness [25]; adopting more efficient behaviours [27],[29]; better decision making process [5],[25] and create strategic decisions that align with organizational objectives [25], [27].

BA implementation aims to provide high impact to organisation especially in customer and marketing analysis (marketing, sale and service), manufacturing (operational and supply chain) and human resource management [27]. BA is also well suited for organisational performance management implementation [27],[30]. However, to maximise the impact of BA implementation, organisational problems should be understood clearly to ensure appropriate selection of suitable analytical approach to be used and applied. Different analytical approach provides different data perspectives; implement to different problems and produce different information insight to guide decisions and actions [31]. Therefore, to implement BA in Organisational Performance Management (OPM), organisation must always aware of the appropriate data to be used. [32] had identified suitable and potential data that increase organisational performance which were performance observation data, progress report, audit report, assessment and consultation, scorecard performance, customer survey and economic value added metrics. Organisation that successfully applied BA has been acknowledged better than their competitor, easy to adapt with uncertain environment and grows effectively [5],[25].

Previous study had revealed that 70% of organisation that applied BI did not reach maturity level due to lack of analytic implementation [33]. Organisations are still unclear with the concept of BA implementation and how to adapt it effectively [25]. Main aspect to increase BA implementation is to strategically integrate it with BI. On the other hand, BI enables to integrate data efficiently and improve data management process that could simplify BA implementation. Data regarding economic factors toward business strategic could be gathered using BI and will drive effective BA practices [27].

However, the challenge to integrate BI and BA implementation is to get consolidated implementation framework. The framework should able to itemise BIA concept and clearly explain its structure and implementation limitations [31]. Formal and structured framework on integrated implementation of BI and BA currently are very limited in current literature. BIA implementation should able to answer the question of the current organisation situation, predict future condition and suggest actions to be taken [31]. Majority of the previous developed frameworks do not contain comprehensive components to be implemented in current requirements. Therefore, further study on framework of integrated BI and BA implementation is essential and needed to manage organisational performance in current demands and expectations [34].

6. RESEARCH FINDINGS

In the era of information and technology today has shown a rapid development in the field of data management. Data not only important for report analysis but it should be harvested analytically to obtain insight information. It is an important source in decision making process in order to improve organizational performance consistently. Business Intelligence (BI) is a technology that enables users to manage data from multiple platforms. Despite studies have been conducted on the implementation of BI in performance management, analytical aspects are not getting adequate attention. This causes lack of impact in BI implementation in organisation performance management which involves strategy formulation and performance enhancement. The existing frameworks were built separately and this limits the implementation of Business Intelligence and Analytics (BIA) and could not meet the current performance management needs and expectations. Therefore, this study was aimed to develop a framework that integrates elements of BI, analytics and performance management (BIAPM) to improve the implementation of BIA in

management of organisational performance. This study has identified four main components of this integrated BIAPM framework which are Process, People, Governance and Ability. Each component consists of several key elements and sub-elements. The proposed BIAPM was verified and validated involving experts in these areas and validated through two real case studies.

7. PUBLICATIONS

1. Kertas Seminar/ Persidangan;Kerangka Perlaksanaan Integrasi Kecerdasan dan Analitik Bisnes dalam Pengurusan Prestasi Organisasi bagi Sektor Awam;Nur Hani Zulkifli Abai, Jamaiah Yahaya, Aziz Deraman;Softam Postgraduate Seminar 2015;2015
2. Prosiding/ Pascasidang;An integrated framework of business intelligence and analytic with performance management system: a conceptual framework;Nur Hani Zulkifli Abai, Jamaiah H. Yahaya, Aziz Deraman;Science and Information Conference 2015;2015
3. Prosiding/Pascasidang; Incorporating business intelligence and analytics into performance management for the public sector issues and challenges;Nur Hani Zulkifli Abai, Jamaiah H. Yahaya, Aziz Deraman; International Conference on Electrical Engineering and Informatics (ICEEI) 2015, Bali, Indonesia;2015
4. Prosiding/Pascasidang; Managing Business Performance using business intelligence and analytics; Nur Hani Zulkifli Abai, Jamaiah Yahaya, Aziz Deraman; 2015 International Conference on Electronics Systems and Information Technology (ICESIT-15);2015
5. Jurnal; Business Intelligence and Analytics in Managing Organisational Performance: The Requirement Analysis Model;Nur Hani Zulkifli Abai, Jamaiah Yahaya, Aziz Deraman; Journal of Advances in Information Technology;2016
6. Jurnal; Business Intelligence and Big Data Analytics for Organisational Performance Management in Public Sector: The Conceptual Framework; Jamaiah H. Yahaya, Aziz Deraman, Nor Hani Zulkifli Abai, Zulkefli Mansor, Yusmadi Yah Jusoh; Advanced Science Letters; 2016
7. Jurnal; Current challenges and conceptual model of green and sustainable software engineering;Komeil Raisian, Jamaiah Yahaya, Aziz Deraman; Journal of Theoretical and Applied Information Technology; 2016
8. Prosiding/Pascasidang; The quality dynamic website development: the empirical investigation among practitioners; Azhar Abdulridha Ibrahim, Jamaiah H. Yahaya, Aziz

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9. Jurnal; Software Quality and Productivity Model for Small and Medium Enterprises; Jamaiah H. Yahaya, Asadullah Tareen, Aziz Deraman, Abdul Razak Hamdan; International Journal of Advanced Computer Science and Applications; 2017
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11. Jurnal; Towards the quality factor of software maintenance process: A review; Ku Saimah Ku Ibrahim, Jamaiah H. Yahaya, Zulkefli Mansor and Aziz Deraman; Journal of Telecommunication, Electronic and Computer Engineering; 2017
12. Bahan Seminar/Persidangan; The determinants of business intelligence & analytics in organisational performance process; Nur Hani Zulkifli Abai, Jamaiah Yahaya, Aziz Deraman; The 2017 6th International Conference on Electrical Engineering and Informatic (ICEEI); 2017
13. Jurnal; Information security factors in the implementation of industrial control system into cloud environment; Asma Zubaida M. Ibrahim, Jamaiah H. Yahaya; Advanced Science Letters; 2018
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15. Jurnal; Integrating Business Intelligence and Analytics in Managing Public Sector Performance: An Empirical Study; Nur Hani Zulkifli Abai, Jamaiah Yahaya, Aziz Deraman, Abdul Razak Hamdan, Zulkefli Mansor, Yusmadi Yah Jusoh; International Journal on Advanced Science, Engineering and Information Technology, Vol. 9 (2019) No. 1;2019.

8. CONFERENCES AND WORKSHOPS

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2. International Conference of Computer, Environment, Social Science and Technology; Medan, Sumatera, Indonesia, 23/05/2016-24/05/2016; Ikatan Alumni USM, Sumatera Utara and USM
3. The International Conference on Information Systems and Technology (ICIST 2016); Kota Kinabalu, Sabah, 28/11/2016-30/11/2016; Universiti Malaysia Sabah
4. Kerja Lapangan Penyelidikan FRGS, Integrated Business Intelligence and Big Data Analytics Framework for Organizational Performance Management in Public Sector, UUM Sintok Kedah, 14/4/2016 -15/3/2016.
5. Bengkel Penulisan Berimpak-Geran Penyelidikan FRGS, Integrated Business Intelligence and Big Data Analytics Framework for Organizational Performance Management in Public Sector, Hotel Bangi-Putrajaya, 16/06/2017-16/06/2017.
6. The 2nd International Conference on Data, Internet & Education Technologies 2017 (The DIET 2017); Bali Indonesia 01/04/2017-02/04/2017; Indonesia Telematics Society.
7. The 10th Malaysian Software Engineering Conference (MySEC2017); Kuala Terengganu, 07/08/2017-09/08/2017; Malaysian Software Engineering Interest Group (MySEIG) & School of Informatics and Applied Mathematic
8. The World Congress on Engineering 2018 (WCE 2018); Imperial College, London, UK, 04/07/2018-06/07/2018; The International Association of Engineers (IAENG)
9. Bengkel Kemajuan dan Rumusan Projek Penyelidikan FRGS, Integrated Business Intelligence and Big Data Analytics Framework for Organizational Performance Management in Public Sector, Blok H FTSM UKM., 24/9/2018.
10. Bengkel Penyediaan Laporan Akhir FRGS, Integrated Business Intelligence and Big Data Analytics Framework for Organizational Performance Management in Public Sector, Hotel Dorsett Putrajaya, 3/1/2019.

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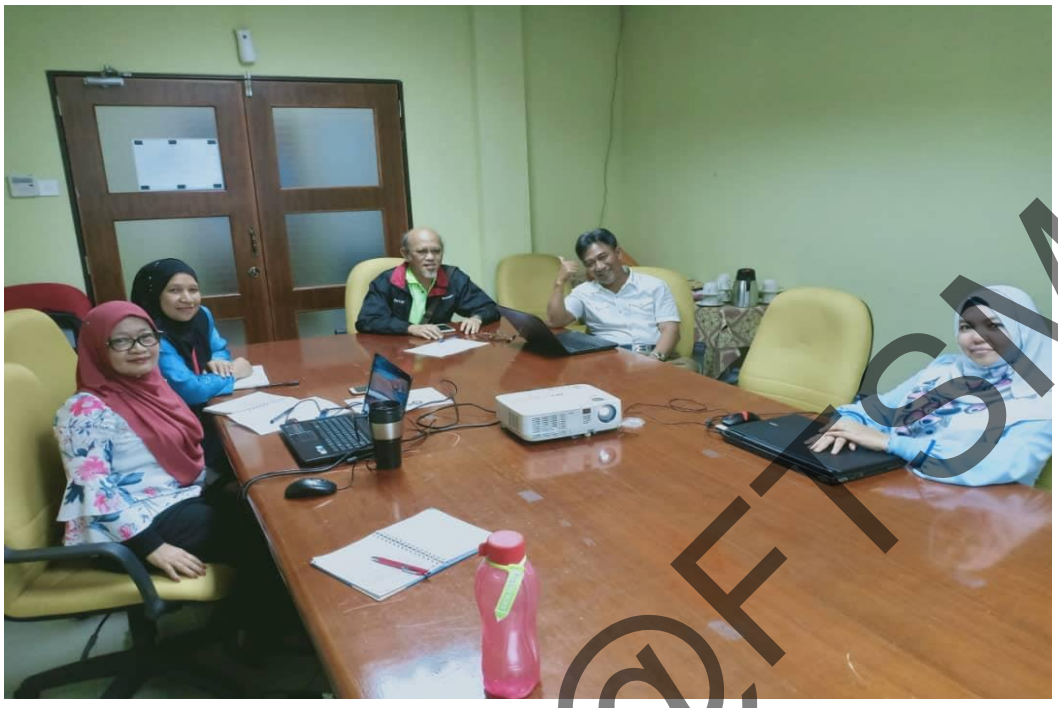
10. RESEARCH PHOTOS

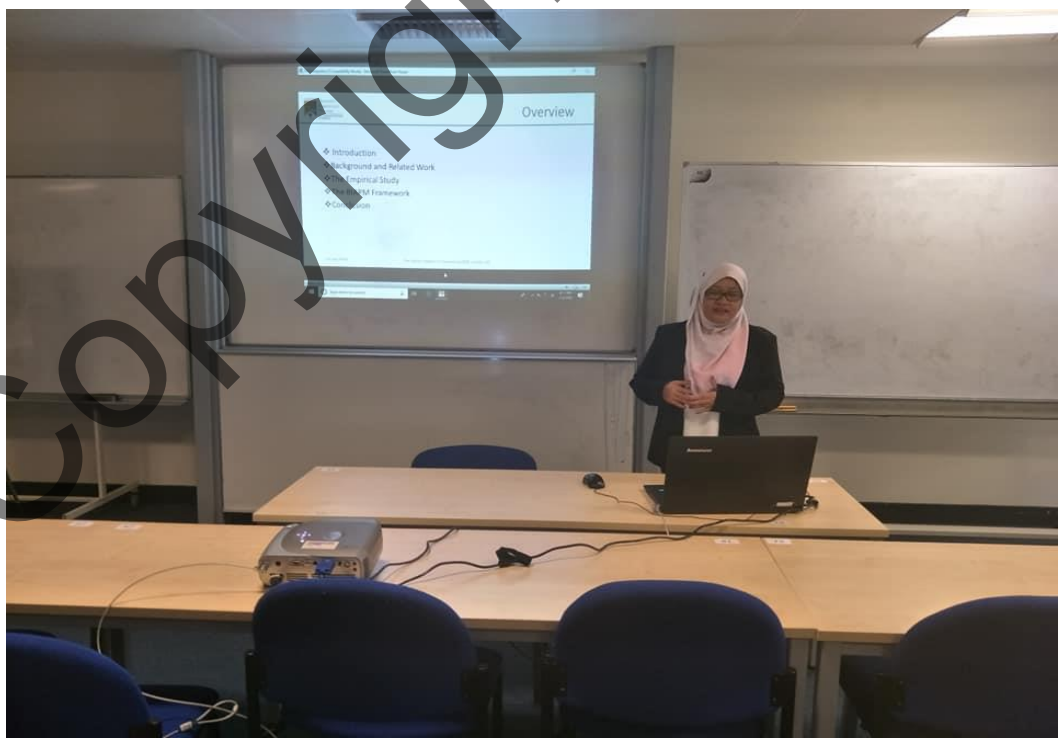
FRGS Final Report Workshop, Hotel Dorsett Putrajaya, 3/1/2019

Research Progress and Findings Workshop, FRGS, Blok H FTSM UKM, 24/9/2018

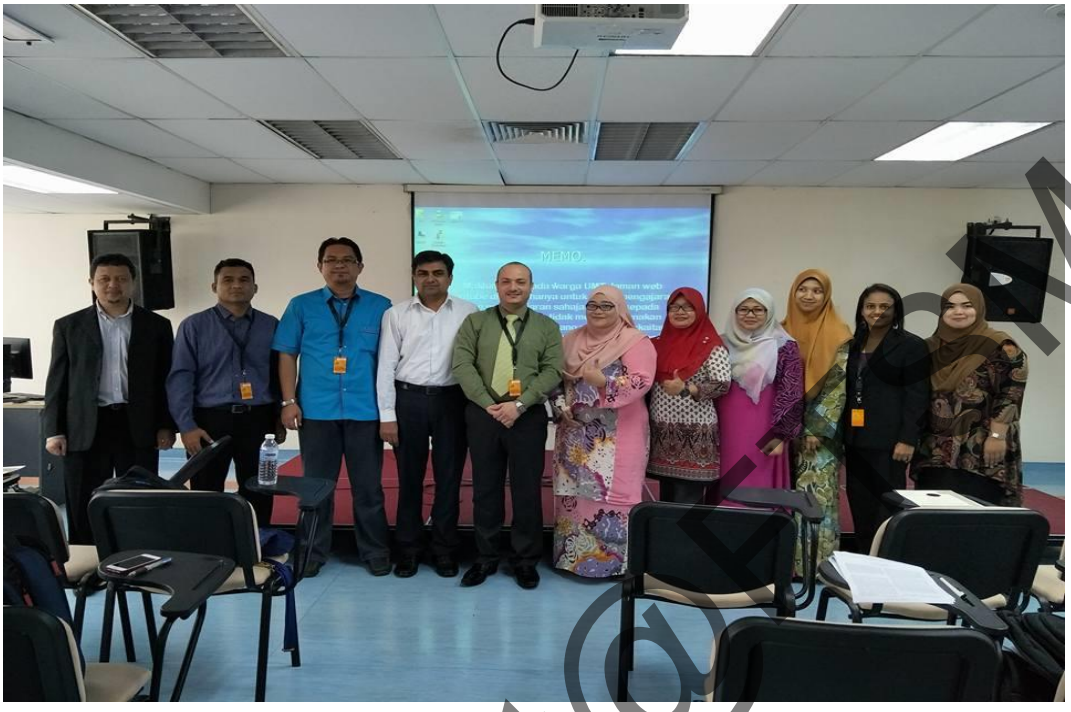


Research @ FTSM. Fakulti Teknologi dan Sains Maklumat UKM, 20/9/2018

The World Congress on Engineering 2018 (WCE 2018); Imperial College, London, UK; The International Association of Engineers (IAENG), 04/07/2018-06/07/2018.



The 10th Malaysian Software Engineering Conference (MySEC2017). Kuala Terengganu, 07/08/2017-09/08/2017



The 2nd International Conference on Data, Internet & Education Technologies 2017 (The DIET 2017); Bali Indonesia 01/04/2017-02/04/2017

International Conference of Computer, Environment, Social Science and Technology & Research Network, Medan, Sumatera, Indonesia; Universitas Sumatera Utara & Universiti Sains Malaysia, 23/05/2016-24/05/2016.

The International Conference on Information Systems and Technology (ICIST 2016); Kota Kinabalu, Sabah, Universiti Malaysia Sabah 28/11/2016-30/11/2016

FRGS Field Work at UUM Sintok Kedah, 14/4/2016 -15/3/2016

The International Conference on Electrical Engineering and Informatics 2017 (ICEEI2017), Langkawi, Malaysia, 2017.

FRGS Impact Writing Workshop, Hotel Bangi-Putrajaya, 16/06/2017 and other related activities

THE END