

The Implementation of Business Intelligence and Analytics Integration for Organizational Performance Management: A Case Study in Public Sector

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Abstract—Literature study shows that several works have been conducted on the implementation of BI in performance management, but the analytical aspects were not being considered. Business analytics is an activity of applying analytics to strengthen strategic and operational business activities. While performance management is important to determine organisational success and in public sector, it has become more challenging due to generality of public sector objectives and different level of stakeholders involved. Existing frameworks were built separately and this limits the implementation of Business Intelligence and Analytics as an integrated component, and could not meet the current performance management needs and expectations. The objective of this study is to establish a framework that integrates elements of business intelligence, analytics and performance management for the comprehensive implementation in public sector. This study identifies four main components of this integrated framework: Process, People, Governance and Ability. Each component consists of several key elements and sub-elements. The proposed framework is validated and implemented by real case study conducted in one organisation in Malaysia. The implementation demonstrates the suitability and practicality of this framework to be implemented in real environment.

Keywords—Business intelligence; business analytics; organisational performance management; framework; case study

I. INTRODUCTION

The implementation of business intelligence (or BI) in managing organisation's performance in public sector had drawn people and government attention and interest. The essential of this integration is due to the great impact to the nation and people in general. People are now wiser to evaluate the transparency of public sector administration in managing national resources. Therefore, managing and measuring organisational performance [1] had been critical agenda in public sector transformation process. BI has been identified as an effective technology in strategically managing performance. It enables 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 outcomes of the organisation [2]. It analyses organisational goals and divides them into specific benchmarks to ensure the goals are measurable. Performance management is important to determine organisational success. In public sector, organisational performance management (OPM) become more challenging due to generality of public sector objectives involving different level of people. OPM also consists of multi-level hierarchy that causes complexity in decision making process and dissemination of information to the target group. As we know, public sector includes strict rules and procedures throughout their management processes thus make it more challenging and complicated. BI implementation enables to manage and coordinate information within organisation effectively. However, current BI implementation in managing performance does not effective enough to achieve organisations' competitiveness in business. This is due to large volume of information that beyond the ability of decision makers to conduct analysis for best actions in decision making without proper, integrated and systematics mechanism and tool. In addition, scattered piles of data that led to the provision of information for analysis takes longer time.

BI implementation today should consider and focus on analytic aspects 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. 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 urged

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managers to use analysis, trends and forecasting in their business operations. Base on this, BIA is highly demanded to drive actionable insight for better decision making. Nowadays, BI implementation has shifted to new perspective that require advanced analytic adoption. Both BI and analytic should be implemented parallel to maximise the impact in organizational performance management.

II. BACKGROUND WORKS

The theoretical study of this research focuses on four main areas which are business intelligence, analytics, organizational performance management (OPM) and Business Intelligence and Analytics (BIA) models.

A. Business Intelligence

Business Intelligence (or BI) can be referred to as the technologies, applications and practices that is usually employed to give support to decision making in business. With the use of BI, managers are able to transform and manipulate information from data to valuable knowledge or insight [3]. BI has been earlier introduced as early as in year 1959, where the definition was vague [4] but was strengthen by Howard Dresner in 1989 [5]. Data warehouse introduction in BI is the beginning of transformation in decision support landscape towards data-driven. Data analysis was focused from using previous data and moved to real-time information. Additionally, BI provides enhanced visualisation features that are user friendly, appealing and easy to comprehend, such as scorecard and dashboard to carry out decision making in strategic actions [6] that will improve organisation's performance and operation.

However, the effectiveness of BI implementation depends on how it can be implemented. Kimball Lifecycle methodology to develop BI outlined phases of BI implementation [7] which can be implemented in series of phases: project planning, identify business requirements, design, development, installation and enhancement. This lifecycle has been used as a baseline in many other BI implementation studies and [8] [9] are some of the mentioned studies. In our study, Kimball Lifecycle is used as a baseline of holistic BI implementation as proposed in this research.

BI implementation is a complex process that requires a thorough understanding. Success factors of the implementation play the important role in ensuring the realisation of BI implementation. These factors demonstrate the ability of the organisation to implement and gain value added from its implementation. Critical literature review has revealed and classified the factors into four categories [10] which are the enabler, process, governance and technology. Currently, BI has been applied in various sectors such as medical, education, retails, banking, manufacturing [39] and Enterprise Resource Planning (ERP) [40]. Previous studies has revealed that BI enabled to improve the effectiveness of strategies formulation, operational planning and strengthen relationships with customers [8][11][12]. It improves business processes and collaboration between departments, thus increase organisational performance [13]. BI technology is still growing rapidly with the demand from users to get future forecast information embedded. Therefore, its implementation

needs to be integrated with advanced analytics to be used in an increasingly challenging business environment.

B. Business Analytics

Business analytics (BA) is an activity of applying analytics to strengthen strategic and operational business activities. It is defined as "delivering the right decision support to the right people at the right time" [14]. As revealed by [15], BA comprises of several activities: the process of data collection, data analysis and data transformation. BA implementation represents a combination of a few data analysis procedure for gathering unstated information directed to practical insight. In which each procedure shall combine various analytical methods and techniques for effective BA implementation strategy. The problem to be solved will determine the appropriate analytical method to be used. Hence, BA effectiveness depends on the accuracy of the identification of problems.

Business analytics comprises of six levels of processes that begin with understanding the needs to perform analytics in organization. Down to the task of establishing data to be analysed through the usage of data mining methods to provide solution for identified problem. In identification of data, three levels are involved, these are: (i) data preparation, (ii) data quality, and (iii) format transformation. The process continues with the development of model that consists of designing sequence of data analysis techniques. Thereafter, the developed model needs to be evaluated using selected testing method. And the final process is to apply obtained information in decision-making.

In summary, there are 11 activities that have been identified [10]: Identify problem/opportunity, understand data, collect data, transform data, analyse data, develop model, evaluate model, use, translate output, measure impact and maintenance. Other business analytics implementation process such as measuring impact of model usage and model maintenance got less attention from most researchers. However, in terms of business analytics implementation, it is believed that it is able to ensure sustainability. The success of implementation in business analytics also depends on the skill and knowledge of data analyst and ability of appropriate software used [3].

C. Organisational Performance Management

Managing performance is a critical task in organisation to ensure every sources are organised to improve overall performance of an organisation. One the main activities in managing performance is analysing business process and its related metrics for ensuring the optimisation of general organisation achievement [16]. This research was conducted to enquire into the implementation of BI for Organisational Performance Management (OPM). It focuses on strategizing organisational goals by taking into accounts metrics and processes that impact the organisational performance.

OPM is conducted in organisation to interpret objectives into actions. This includes determining strategic plan, monitoring its implementation, and distributing performance achievement [16] [17]. Concurrently, the performance's implementation shall increase to maximum impact by

continuously assess and enhance the operational processes [18]. This will also support proactive environment within organization to produce strategy [14] that is aligned with organisational objectives. Previous study found [15] that OPM implementation is more challenging in public sector rather than in private sector due to different target in objective between tangible and intangible objectives. Therefore, public sector's performance management requires business intelligence and analytics technologies to support decision making process and organisation's objectives alignment.

D. Current Works of Business Intelligence, Analytics and Organisational Performance Management Integration

Previously, several studies have been carried out on BI, BA and OPM implementation. The Gartner Business Analytics Framework (GBAF) [19] has developed an integrated framework of these three fields. Nevertheless, this framework has limitation in term of implementation from public sector performance management perspective and the overall integration.

In addition, several studies also considered identifying BI, BA and OPM elements and enterprise resource planning [20]. Other studies proposed the implementation framework of BI by focusing on the application of data mining techniques [21][22] [23]. While, others studies [24][25][26] proposed the framework of integration BI and business analytics only. Thus, we can conclude that the existing frameworks are not comprehensive in the perspective of BIA implementation that integrates in managing organisational performance.

Rayner and Schlegel revealed characteristics needed for the implementation of BI, BA and OPM [27] and shall be integrated and comprehensive throughout the organisation, particularly in IT section, management and financial [28]. The organisation should have a complete, effective and efficient life cycle process [27][29] for optimum performance. With proper and systematic life cycle process, any changes in the strategies will follow by appropriate actions from parties involving IT, management and data analysis. Hence, it creates the new innovative environment using intelligence and implied information [30].

In matured BI implementation, organisation should be ready with the integrated technology architecture [27][29] which includes software and hardware to support BI activity and analytics. The secure and flexible architecture [31] is required for easy customisation according to the dynamic needs of the organisation and also to ensure the quality and reliability of information obtained for supporting the analytic implementation and decision making. Furthermore, matured analytic implementation applies prescriptive analysis that requires real time data.

III. METHOD

An empirical study was conducted in Malaysia to understand issues and problems in current implementation of business intelligence and analytic for performance management (or BIAPM) specifically in Malaysian public sector. In this survey, 18 individuals were interviewed as the informants with various positions in their organisations. They were divided into three different categories of backgrounds

which were business intelligence (BI), business analytics (BA) and organisation performance management (OPM). The results reveal 20 important elements for BIAPM implementation and they are classified into four main components: Process, Governance, People and Ability. The elements are then broken down into 64 sub elements. The 20 elements are: Top Management, Performance Manager, BI implementer, Data Scientist, Domain Expert, Skill, Work Culture, Technology, Strategic Planning, Requirement Analysis, Decision Maker, Performance Evaluation, BI implementation, Software, Finance, Data and Change Management, Documentation, Analytics and Visualisation [10]. Furthermore, in order to obtain the detail implementation of each element in BIAPM, the relationship analysis between sub elements was also been conducted.

The result of this study has disclosed the essential factors and sub factors for the BIA and performance management implementation. The integration factors between business intelligence, analytics and performance management in public sector organisations was conducted and the relationships and relative association of each sub factors were performed and identified based on the significance of the sub factors in related field. The analysis concluded that there were four main factors integrated between these three fields, which are skill, documentation, visualisation and work culture as discussed in our previous paper [10]. The findings verify that in order to integrate BIAPM implementation, every parties involved should have appropriate skills to drive each fields, supported with skilled staff with positive working culture. Furthermore, every staff involved in this implementation should capable to work in a team and highly motivated to ensure that projects and tasks run efficiently. In relation, each team should prepare sufficient documentation to support the project. Another important element in the integrated BIAPM implementation is visualisation of data. This is due to the importance of portraying data to be understood by every party even though they come from different backgrounds.

Fig. 1 illustrates the integration between these factors and the fields. It also illustrates that each factor is interrelated with each other's within these three main fields as defined in this research.

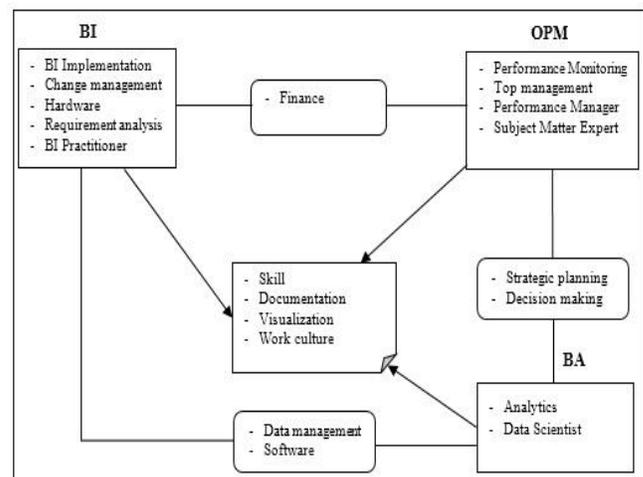


Fig. 1. BA, BI and OPM Integration.

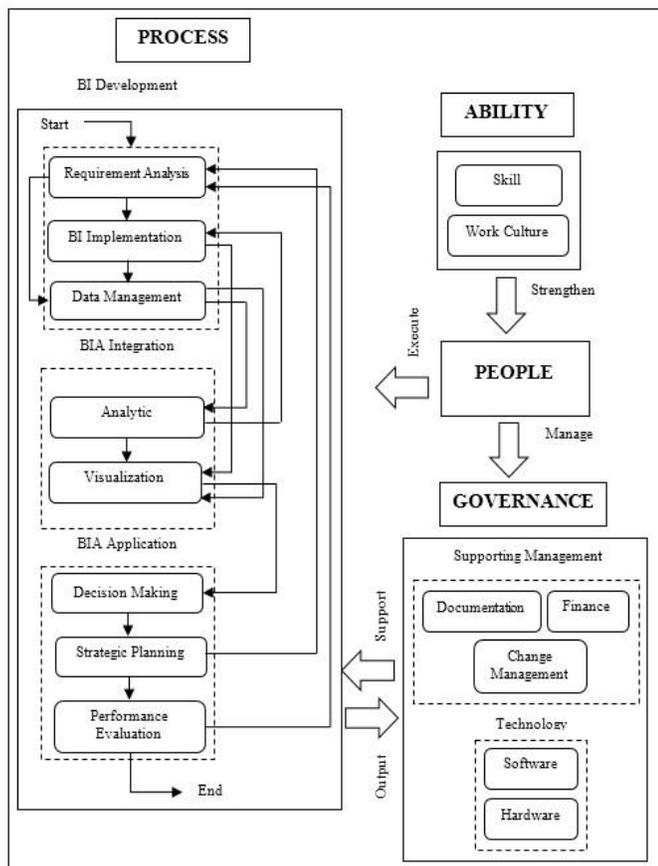


Fig. 2. BIAPM Framework.

Based on this finding, the BIAPM integration framework was developed as shown in Fig. 2. The integrated BIAPM implementation framework consists of four main components: Process, Governance, People and Ability and their relationships between components and elements. The detailed description of BIAPM integrated components and BIAPM framework can also be referred in our previous publications [10][32].

IV. THE CASE STUDY

In order to successfully integrate the business intelligence and analytic with organisation performance management, the flow of the main components and their relationships must be linked and followed systematically. The implementation and application are conducted to verify and validate the proposed framework. It is conducted in a real case study implementation. This method is considered suitable for verification and validation of framework [33] through internal investigation on specific phenomenon and real context data. The case study implementation and application are carried out in three steps as suggested by [33][34]. The activities include case selection, application of the framework, and validation of framework suitability.

A. Case Selection

The organisation selection is based on purposive sampling [35] and the criteria used for selection are: 1) practicing business intelligence technology in organisation performance;

and 2) applies to only organisation in public sector. Several public sector organisations that fulfil these criteria were invited to join this study but only two agreed to participate in depth and comprehensively.

The case study was carried out with two public organisations in Malaysia, Case A and Case B. Case A is a statutory body agency which is also a public university in Malaysia. It has 17 faculties and supported by 28 departments, centres and institutes. In 2009, this public sector organisation has experienced in business intelligence technology, launched a project associated with it and still operating with the staff involved from information technology section, statistic, researchers and management.

B. Application of the Framework

Application of the framework is conducted in three main phases as shown in Table I.

C. Framework Validation

For validation of the framework for suitability, the results and outcomes from the implementation and validation were presented to the stakeholders of the organisation. Recommendation for improvements were being proposed to assist the organisation in implementing integration of business intelligence and analytics for performance management.

V. BIAPM IMPLEMENTATION

The implementation and application of the framework in Case A was carried out based on the steps and activities defined in Table I.

A. Phase 1: Pre Assessment Phase

This phase aims to plan in detail the assessment process of the BIAPM implementation of organisation in Case A. A discussion was carried out to achieve the following aims:

- a) Develop commitment with organisation management
- b) Select assessment team which comprises of head of IT operational, external assessor and representative, internal assessor and representative.
- c) Plan assessment activities to be carried out, resources needed and assessment time duration.
- d) Prepare for assessment material.

TABLE I. BIAPM FRAMEWORK IMPLEMENTATION AND APPLICATION

Phase	Activity
Phase 1 : Pre Assessment	1) Form the task force team
	2) Appoint the assessment team and participants
	3) Plan for the assessment
	4) Preparation for assessment
Phase 2: Current Implementation Assessment	5) Identify and preparation for assessment participants
	6) Interview participants
	7) Document review
	8) Observation
	9) Record information
Phase 3: BIAPM Implementation & Analysis	10) Assessment analysis
	11) Assessment result presentation
	12) Review result and discussion
	13) Report preparation

B. Phase 2: Current Implementation Assessment

- a) Identify and ensure commitment from participants.
- b) Obtain current implementation status and information.
- c) Identify documents status.
- d) Observe working environment.
- e) Gather assessment form.

C. Phase 3: Implementation and Analysis

- a) Assess BIAPM implementation level.
- b) Prepare assessment report.
- c) Present findings to stakeholder.

Phase 3 starts with analysis of data to identify the BIAPM implementation level. There are four score ratings that are for sub elements, element, component and overall implementation. The computational method is adapted and configured from [36] [37]. The scores are computed using formulas as shown in (1), (2), (3) and (4).

Formula (1) is used to compute scores for sub elements.

$$S = \frac{1}{6} * \sum_{i=1}^n X_i \tag{1}$$

Where, S= average score for each sub element

n= number of items

X_i= value for sub element

Formula (2) is to compute scores for each elements.

$$E = \frac{1}{n} * \sum_{i=1}^n S_i \tag{2}$$

Where

E= average score for each element

N= number of items

S_i= average score value for sub elements

In the third step, formula (3) is used to compute scores for each components in the proposed framework.

$$K = \frac{1}{n} * \sum_{i=1}^n E_i \tag{3}$$

Where

K= average score for each component

n= number of items

E_i= average score value for element

In the fourth step, formula (4) is used to compute the overall score for the implementation of BIAPM as proposed in this framework.

$$F = \frac{1}{n} * \sum_{i=1}^n K_i \tag{4}$$

Where

F= average score for BIAPM implementation

n= number of items

K_i= average score for each sub elements and elements

TABLE. II. IMPLEMENTATION LEVEL FOR SUB ELEMENT, ELEMENT AND COMPONENT

Level	Implementation Level	Description
5	Excellent	The implementation is complete and organisation.
4	Good	Organisation has a clear definition on practices and has overall implementation.
3	Moderate	Organisation has become part of management practice but seem not considered as important to be implemented.
2	Need Improvement	Organisation recognise practices but the implementation has not be focused.
1	Not Implement	No information on the implementation practices.

Scores obtained in this exercise which comprises of scores by sub elements, elements and components are then mapped into implementation assessment scale for public organisational performance assessment as shown in Table II.

VI. RESULTS AND DISCUSSION

Organization A is selected as a suitable case study to apply and implement BIAPM framework. It is a public university in Malaysia. The application and case study implementation are described and detailed in three stages of implementation: The application of BIAPM framework, findings and results of the BIAPM application, and recommendation for improvement. The following sections describe these in detail.

A. The Application of BIAPM Framework

The application and implementation exercise were taken placed during the month of June 2015. It was conducted according to the processes explained in previous section. Five person were identified to be the valid participants which included Senior IT Officer, IT Officer, Assistant IT Officers and Social Science Research Officer. The current implementation assessment was carried out through interview, observation and document review.

B. Findings and Results of the BIAPM Application

The collected data was analysed and assessed based on computational method and formulas discussed in previous section. The results of the implementation are mapped into the implementation level as shown in Table IV.

TABLE. III. IMPLEMENTATION LEVEL FOR BI, BA AND OPM INTEGRATION

Level	Implementation Level	Description
1	Not implemented	No information on the implementation practices.
2	Initial	Organisation recognise practices but the implementation has not be focused.
3	Moderate	Organisation has become part of management practice but seem not considered as important to be implemented.
4	Nearly comprehensive	Organisation has a clear definition on practices and has overall implementation.
5	Strategic	Organisation has used and applied BIAPM components for strengthen the implementation strategic for organisation's future growth.

TABLE. IV. IMPLEMENTATION LEVEL FOR EACH ELEMENT AND SUB ELEMENT (CASE A)

Element	Sub Element	Average score	Score	Implementation Level
Process				
Requirement Analysis	• Requirement acquisition	5.00	5	Excellent
	• Data Security	2.50	3	Moderate
	• Software Identification	5.00	5	Excellent
	• Data Resource	5.00	5	Excellent
	• Story Board Requirement	5.00	5	Excellent
BI Implementation	• Design	5.00	5	Excellent
	• Development of BI	5.00	5	Excellent
	• Data Transfer	5.00	5	Excellent
	• Testing	5.00	5	Excellent
Data Management	• Data Source	5.00	5	Excellent
	• Criteria	5.00	5	Excellent
	• Standardisation	5.00	5	Excellent
	• Quality	4.25	4	Good
Decision Making	• Report Analysis	5.00	5	Excellent
	• Make Decision	2.75	3	Moderate
	• Implied Information	1.00	1	Not Implemented
Analytic	• Problem Analysis	1.00	1	Not Implemented
	• Analysis Design	1.00	1	Not Implemented
	• Data gathering	1.00	1	Not Implemented
	• Data Analysis	1.00	1	Not Implemented
	• Model development	1.00	1	Not Implemented
	• Quality Analysis	1.00	1	Not Implemented
Visualisation	• Display	4.75	5	Excellent
	• Story	1.00	1	Not Implemented
	• Self-Service BI	2.50	3	Moderate
Strategic Planning	• Vision & Mission	5.00	5	Excellent
	• Objective	5.00	5	Excellent
	• Success Factor analysis	1.00	1	Not Implemented
	• Strategy	5.00	5	Excellent
	• Action Plan	5.00	5	Excellent
	• KPI	5.00	5	Excellent
	• Target	5.00	5	Excellent
Performance Evaluation	• Measurement	5.00	5	Excellent
	• Control	5.00	5	Excellent
Governance				
Documentation	• Business Definition	1.80	2	Need Improvement
	• User Manual	3.00	3	Moderate
	• Metadata documentation	3.00	3	Moderate
	• Operational Documentation	2.67	3	Moderate
	• Analysis Data Documentation	1.00	1	Not Implemented

Finance	• Source	4.20	4	Good
	• Budget	4.20	4	Good
	• Management	3.80	4	Good
Change Management	• Time management	5.00	5	Excellent
	• Data Scope & Addition	5.00	5	Excellent
	• BI improvement	5.00	5	Excellent
Software	• Database	5.00	5	Excellent
	• ETL	5.00	5	Excellent
	• BI tools	5.00	5	Excellent
	• Analysis Tools	1.25	1	Not Implemented
Hardware	• Server	5.00	5	Excellent
	• Network	5.00	5	Excellent
Practitioner				
Top Management		5.00	5	Excellent
BI Implementers		5.00	5	Excellent
Performance Manager		5.00	5	Excellent
Data Scientist		1.20	1	Not Implemented
Domain Expert		5.00	5	Excellent
Ability				
Skill	Training	3.00	3	Moderate
	Knowledge	3.40	3	Moderate
	Experience	3.20	3	Moderate
Work Culture	Motivation	4.80	5	Excellent
	Collaboration	5.00	5	Excellent
	Adaptability	4.80	5	Excellent
	Positive Attitude	5.00	5	Excellent

TABLE. V. AVERAGE SCORE OBTAINS BY EACH COMPONENTS (CASE A)

Component	Average Score	Score	Implementation Level
Process	3.81	4	Good
Governance	4.08	4	Good
Practitioner	4.24	4	Good
Ability	4.05	4	Good

Furthermore, the average score values for each components are computed using formula (3) and the results are shown in Table V.

C. Recommendation for Improvement

Based on results in Table V shows that Case A attains good level for the four components which are process, governance, people and ability. These components are referred to the components inclusive in our proposed BIAPM framework. The highest score is obtained by component people where it shows that this organisation has almost complete and essential implementers to support the BIAPM implementation. The lowest score is obtained by the process component. This is due to more works need to be done in term of processes for implementing the BIAPM integration in this organisation.

In summary, the overall score achieved by Case A in this exercise is 4.04. This score is computed using formula (4). The result shows that BIAPM implementation in organisation A fall in level 4 and this score value is mapped into Table III to gain the appropriate implementation level. In this case, it

obtains Nearly Comprehensive which shows that this organisation has a clear definition on practices and has the overall implementation plan. At the same time several elements need to be improved and put in place in integrated and strategically way.

VII. CONCLUSIONS

This paper has presented our proposed integrated framework of business intelligence and data analytics for organisational performance management or BIAPM. BIAPM comprises of 4 main components which are process, people, governance and ability. Each components are broken down into several elements and sub elements as discussed in our previous papers. This paper focuses on the implementation of BIAPM framework through real case study conducted in Malaysia. It was implemented collaboratively with a semi-government organisation which in this case was a public university. The implementation and application were carried-out according to the proposed framework and the analysis and results of this exercise are presented in this paper. As discussed in this paper, organisation of the case study obtained overall score as Nearly Comprehensive in term of their BIAPM implementation. Further improvement are suggested to the organisation. The case study implementation has revealed the suitability and practicality of the BIAPM framework.

Comparing with similar and available frameworks from literature, discovers that even though several studies have been done in the similar domain of BI, BA and OPM implementation but only a few frameworks that integrate the three fields as being focused in this research. One of them is Gartner's Business Analytics Framework (GBAF) [19]. This framework is aimed to be the reference for business intelligence, analytics and performance management implementation. However, Gartner's framework requires enhancement particularly in the perspective of managing performance in public sector and comprehensive BIAPM implementation. Besides GBAF, there are few more studies which relate to BIAPM and they can be identified as Pourshahid et al. [38], Cosic et al. [25], Martin et al. [22] and Wu [23]. Martin et al. and Wu considered two fields integrated which are BI and BA without integrating with OPM, while Pourshahid et al and Cosic considered BIA but without comprehensive implementation with OPM.

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