

Requirements Engineering Model for the Integration of Performance Management System with Business Intelligence and Analytic

Nur Hani Zulkifli Abai, Jamaiah H. Yahaya, Aziz Deraman

Abstract— The importance of applying Business Intelligence and Analytic (BIA) to support Performance Management System has been a recent interest in research with many organizations increasing their investment in BIA to enhance their technological ability and support in decision making. However the implementation of this technological enhancement requires precise planning to ensure return of investment. Theoretical research is conducted to identify a suitable framework for the requirements engineering phase for PMS and BIA integration. The framework combines three main requirements engineering approaches for Business Intelligence and merges performance management and analytic perspectives.

Keywords— business intelligence, business analytics, performance management, requirement engineering

I. Introduction

The implementation of Performance Management System (PMS) has become a recent trend in many organizations. High levels of competition among organizations had exposed a need for systematic performance management implementation. PMS refers to a process in determining objectives, visions and missions, structuring tactical strategies and planning operational action to enhance organizational performance or services systematically [1]–[3]. However, silo implementation of PMS and Business Intelligence and Analytic (BIA) has given rise to inefficiency within performance management. Ineffective strategy implementation, delayed data analysis preparation and inaccurate information have pushed forward misalignment in PMS implementation. Obviously, PMS requires technology that could generate actionable insights for decision making [4], [5].

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Therefore an urgent need for the integration of PMS and BIA has become apparent. Due to the high complexity in implementation, the whole process of integration requires systematic planning and both PMS and BIA perspectives should be given due consideration. Theoretical research has been conducted to propose a suitable requirements engineering framework for the integration. This paper presents a theoretical study in the perspectives of PMS and BIA. It also elaborates the Business Intelligence (BI) requirements engineering approach in Section II while Section III explains the conceptual framework. Requirements engineering framework for the integration of PMS and BIA is explained in detail in Section IV. Section V discusses the conclusions of this research.

II. Theoretical Background

A. PMS Framework

Performance and competitive level improvements in an organization require accurate information at the right time for specific stakeholders [6]. Previous studies to determine best practices of performance management have proven the importance of ensuring that organizational goals are attainable. Several definitions have been put forward by previous researchers [1], [3], [7], [8]. Performance Management System (PMS) can be defined as a process of collecting, organizing, storing, analyzing and presenting executable strategies by stakeholders for the purpose of framing, interpreting, monitoring and controlling performance output. PMS also assists decision makers in identifying and determining further actions for improving strategies to optimize the organization's success.

Otley(1999) proposes a PMS framework for analyzing operation related with Management Control System [9]. This framework emphasizes five significant issues related to organizational objectives, strategy, and planning for structuring achievement, target, rewards and feedback. It also focuses on managing organizational performance in a holistic manner and has been designed in question form. The questions include (1) main objectives in organizational success; (2) objective performance evaluation techniques; (3) strategy and action plan preparation; (4) performance level setting; and (5) rewards and feedback required for performance improvements.

This framework is improved upon by Ferreira and Otley (2009) with adaptations of other comprehensive approaches in PMS especially research conducted outside the Management

Control System boundary [3]. The framework is divided into two categories: the first category details internal activities in managing performance in eight subjective questions and deals with issues related with (1) vision and mission; (2) critical success factor; (3) strategy; (4) action plan; (5) Key Performance Indicator (KPI); (6) target; (7) performance evaluation, and (8) reward. The second category relates to environmental factors such as (1) feedback and information flow; (2) PMS use, (3) PMS change, and (4) coherence and strength in PMS elements.

Adler (2011) meanwhile combines framework from well-known researchers in the performance management field and proposes several changes from other PMS frameworks [10]. According to Adler, strategy implementation towards achieving goals can be divided into internal and external factors: internal factor consists of life cycle stage, organization ownership, leadership style and organization style while natural environment, national culture, global economy and industry fall under the external factor category. Both factors influence the execution of strategy formulation, strategy analysis, strategy implementation and strategy evaluation.

However, even with the implementation of performance management in the organization, maintaining good performance can still be challenging. Research has found that management problems and lack of initiative are not significant factors of inefficient strategy execution; instead, environment has a precedent role for strategy success. Therefore, overall discernment of performance management is essential to ensure the survival of the organization in a competitive environment.

B. Business Intelligence and Analytic

The importance of Business Intelligence (BI) towards business management is undeniable. BI is a group of decision making technology formulated to assist professional workers such as executives, managers and business analysts in making better and faster decisions [11]. Previous research has shown the capability of BI in transforming data into information that could lead to better decision making [12]. BI consists of several important components to support its operation.

Since BI is a data processing technology, it should extract valuable data from operational data sources with various platforms. These data can be extracted through the Extract, Transfer and Load (ETL) process that will transform, cleanse, and load it into the data warehouse and subsequently integrate into subject oriented tables and chronological series. By this stage, data is ready to be analyzed. BI also supports by analyzing and providing data mining engine for faster information retrieval.

The recent highlight of the importance of analytic within BI has raised confusion whether it is part of BI, an extension of BI or a new dimension of BI implementation altogether. Many researchers believe analytic to be part of BI [11], [13]; however currently the role of analytic within BI is considered more important than ever. The interest of both academicians and practitioners in utilizing the power of analytic within BI for decision making has increased [4].

Several factors influence the BIA phenomena: a main factor is the increase of complex and competitive organization environments. More organizations are becoming aware of the intense competitiveness in maintaining and strengthening their positions whereby fast and accurate decision making is critical to ensure a continued level of success. Therefore the necessity of analysis to identify required action and forecast impacts of action has increased significantly [5], [14].

Other factors such as reports and data that entail comprehensive analysis before deciding on the next course of action should be taken into account. More complex models and statistical analysis are required to identify actionable insights throughout management process from planning, operating, and evaluation hence the importance of BIA.

C. Requirements Engineering

BIA is a complex technology with high implementation costs and resources for development and maintenance. Requirements engineering for BIA could be classified into three main approaches: Goal-Oriented Approach, User-Oriented Approach and Data-Oriented Approach [15], [16]. Data-Oriented Approach, also known as Supply-Oriented Approach, starts with identifying available data within the operational data source and analyzing it for data mapping. It is necessary to resolve issues related to data redundancy and code structuring to ensure a valid and logical schema data with users choosing suitable data to be used in data analysis.

TABLE I. TABLE 1 : SUMMARY OF RESEARCH IN REQUIREMENTS ENGINEERING MIXED APPROACH FOR BI

Researchers	Data Driven Approach	User Driven Approach	Goal Driven Approach
Winter & Strauch (2004) [17]	✓	✓	
Giorgini et al. (2005) [18]	✓		✓
Mazon et al. (2005) [19]		✓	✓
Gam & Salinesi (2006) [20]	✓	✓	✓
Guo et al. (2006) [21]	✓	✓	✓
Kaldeich & Oliveira (2006) [22]	✓	✓	✓
Jukic & Nicholas (2010) [23]	✓	✓	
Sarkar (2012)[24]	✓	✓	

User-Oriented Approach enforces user participation with collecting requirements from their perspectives. In this approach, end users make known their requirements and these are then mapped to available operational data source. However inability to fulfill user requirements due to lack of data will draw negative impact towards end users.

The third approach is Goal-Oriented which deals with the top management in the organization. Corporate strategy and objectives form the main guideline in identifying requirements of BIA implementation. It starts with interviewing top management to identify objectives and targets. The question on measuring performance is elicited based on each objective. This helps in detailing the required important data before a logical data schema can be designed.

However, some researchers have proposed a mixed driven approach in managing requirements for BIA development. The summary of past researches in mixed approach requirements engineering in BIA is as shown in Table 1.

iii. Conceptual Framework

In order to design a suitable new requirements engineering framework for BIA that could fulfill performance management needs, three main approaches as discussed in Section II are analyzed. These three approaches however contain weaknesses [15], [16], [25] as shown in Table 2; therefore all three should be combined to achieve a better balance in the proposed requirements engineering framework.

TABLE II. TABLE 2 : STRENGTHS AND WEAKNESSES OF BI REQUIREMENTS ENGINEERING APPROACHES

Approach	Strength	Weakness
Data Driven Approach	1.Assurance of data availability from data source. 2.ETL design aligned with data source 3. Low implementation cost	1.Requires a longer period in requirement analysis phase 2.Multidimensional schema might not fit user requirement. 3.Technical data schema that consists a lot of data might confuse end user.
User Driven Approach	1.Increases user acceptance towards system	1.Failure in fulfilling user requirement will convey negative impact towards user commitment. 2.Tactical user perspective might be biased to their business area 3.Requires a longer period in matching and understanding organizational goals.
Goal Driven Approach	1.Maximizes ability in fulfilling organizational requirement	1.Requires high involvement from top management throughout requirement analysis phase. 2.Difficult to design ETL

The Goal-Oriented approach is important since PMS itself is implemented as a means of managing organizational goals [26], [27]. In PMS perspectives, the key element in ensuring a structured performance management implementation is to determine the objectives, visions and missions of the organization. From the objectives, strategies are then formulated using various strategy formulation theories and executed by implementing action plans. It is therefore essential in any managing performance endeavor to adapt Goal Oriented as the main approach in the framework.

The Requirements Engineering approach that is vital to fulfil the strategy evaluation and analysis perspective is the

User Oriented Approach. In monitoring performance, end users require various analysis and reports that can visually show organizational performance levels. It is important for end users to continuously monitor performance level towards the goal so that the organization could enhance strategies [16]. In this approach, the requirements of each department and section in monitoring their goals are considered. The requirements focus on user needs in analyzing data to test strategy as well as monitoring their performance.

Finally, the data-oriented approach is required to assist in mapping goals and user requirements into available data within the data source [25]. These requirements from top management and end users are combined into a single data schema. At the same time, available data from various data sources are analyzed and mapped into a single metadata. Both data schema and metadata are then mapped for data modeling. Figure 1 shows the conceptual framework that integrates both PMS and BIA perspectives.

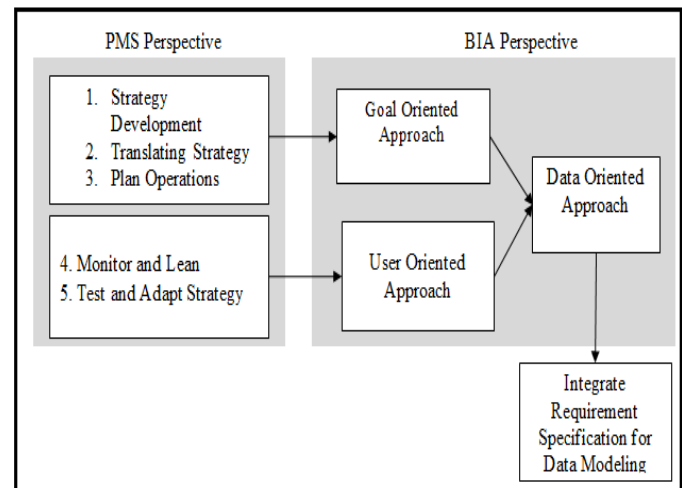


Figure 1: Conceptual Framework combining PMS and BIA perspectives

iv. Requirements Engineering Model for PMS and BIA

The proposed Requirements Engineering model shown in Figure 2 is focused on the integration of PMS and BIA, while considering the former's perspective of visibility throughout whole process and the unique requirement of PMS implementation using BIA as analytical tools. One of the important aspects is requirement expansion, an aspect missing in previous BI requirements engineering frameworks. Since PMS is a full circle process[2], [3], the requirement for BIA will expand and change in time and lead to different requirements in data analysis. Requirement expansion is therefore an important element in requirements engineering for this integration.

Another important aspect that has to be considered is the requirement of identifying algorithm and formula for KPI and target setting. Indeed the process of setting KPI and targets are essential elements for performance measurement [28] and has become an important requirement in identifying its algorithm

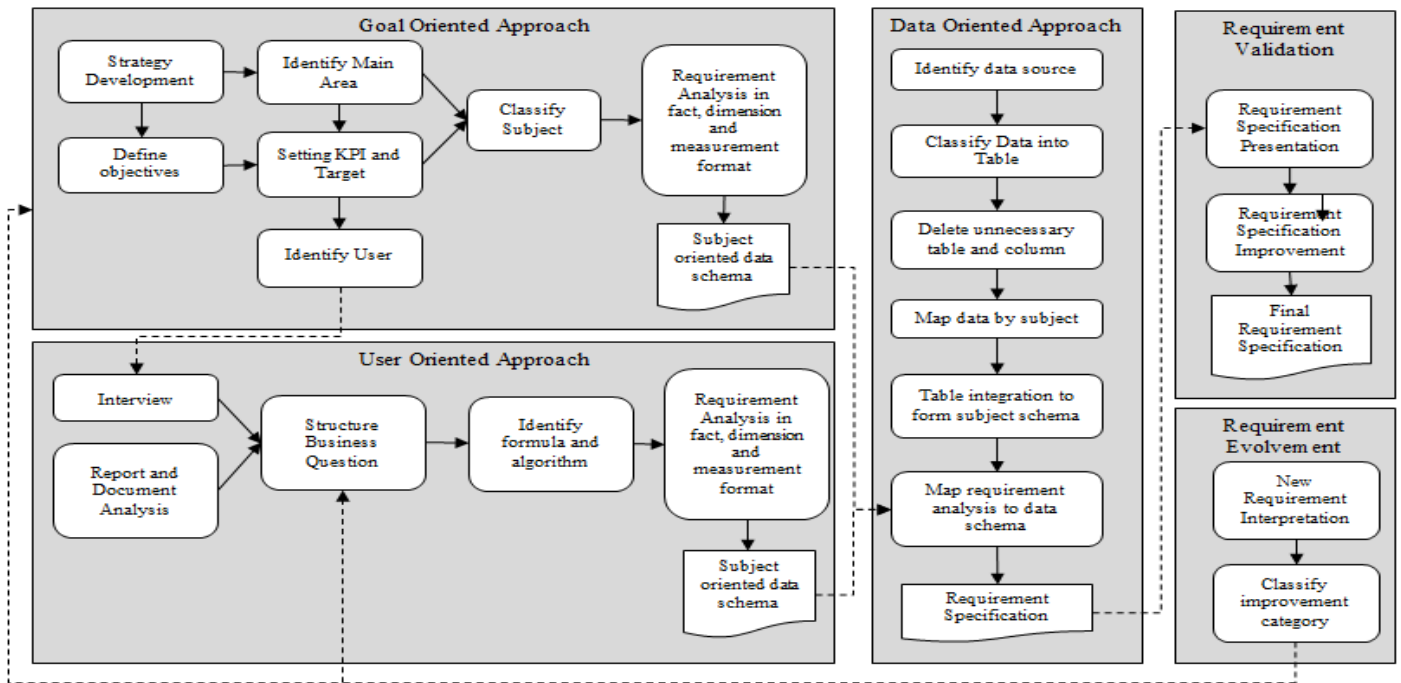


Figure 2 : Requirements Engineering Model for the Integration of Business Intelligence and Analytic with Performance Management System

and formula and ensure smooth development or improvement of the BIA itself. The final criteria that is considered in this framework is developing a complete concept of requirements engineering in terms of requirement elicitation, requirement analysis, requirement specification and requirement evaluation [29], [30].

v. Conclusions

This paper has presented the issues of requirements engineering related to Business Intelligence and Analytics (BIA). Currently, the implementation of BIA in performance management is executed separately which has resulted in inefficiency in managing performance. Obviously, the requirement of BIA and PMS should be analysed from both perspectives. Theoretical research has been done to determine the important elements that should be considered in the requirements engineering phase for the integration of PMS and BIA. Empirical study needs to be undertaken in future to ensure the suitability of models of implementation in industry

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