

The role of Alignment for the Impact of Business Intelligence Maturity on Business Process Performance in Croatian and Slovenian Companies

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Abstract - Business intelligence (BI) allows companies to analyze business information in order to support successful decision making. Currently, the research on the level of BI maturity in Croatian and Slovenian companies is limited. In addition, several BI maturity models have been developed, but most of them are not comprehensive. In order to shed some light to this issue, this paper is focused on two goals: (1) to investigate the impact of BI maturity on business process performance and (2) to explore the requirements for the alignment of two concepts, BI and business process management (BPM) within the organization. Paper presents the following: (i) investigation of BI and BI systems in general, (ii) adaption of the BI maturity model (called biMM) for the purpose of this research, (iii) results of the primary research on the sample of Croatian and Slovenian companies which has been conducted as one of the activities of the project financed by the Croatian Science Foundation: IP-2014-09-3729 Process and Business Intelligence for Business Excellence, (iv) level of BI maturity and the role of BI and business process alignment for the impact of BI maturity on business process performance in investigated companies.

I. INTRODUCTION

The vast amount of daily generated data in organization is a result of a growing number of business transactions. It becomes crucial for organizations to transform collected transaction data into valuable information using information technology (IT). According to Dinter [6] and Forrester [38] business intelligence (BI) has the essential role in this part since it encompasses all processes and systems that transform raw data into meaningful and useful information and enable effective, systematic and purposeful analysis of an organization and its competitive environment. BI can be defined as the acquisition of skills and abilities to adapt the organization to different business conditions ([23]; [24]; [16]; [22]). Agile, real-time BI becomes a prerequisite in the environments of constant change in which organizations

operate [39]. In general, the role of BI in improving business process performance has gained a lot of attention because of its ability to provide a detailed insight into business operations and to enhance operational intelligence ([13]; [7]; [8]; [20]).

However, the empirical evidence of how BI impact organizational processes with improving business processes is still lacking. Accordingly, the aim of this paper is to explore if and how the higher BI maturity increases process performance.

This papers presents following sections: a theoretical background about BI and BI maturity model introduction, a discussion about BI and BPM alignment, the detailed empirical research methodology, the results analysis and a discussion on the results and, finally, the conclusions and implications for further research.

II. BI AND ORGANIZATIONAL PERFORMANCE

BI uses different tools and applications for collecting and analyzing business data. Business intelligence systems (BISs) can be defined as software platforms that provide users of the system with relevant information, which enable them to make better decisions. Today, BISs combine methodology, applications, technologies and platforms for storing information such as data warehouses, data marts, analytical tools such as reporting tools, ad hoc analytics (OLAP), in-memory analytics, planning, alerts, forecasts, scorecards, data mining and online analytical mining (OLAM) ([7]). The results of the researches claim that BI became the driver of organizational success and process performance, so business practitioners and academics search for strengths and weaknesses of existing BI structures in order to make these more effective [18]. For this purpose, BI maturity models are applied.

In general, maturity models usually consist of several (4-6) dimensions of maturity and enable organizational assessment and organizational development [21]. Though a large number of BI maturity models exist, the majority of these models still indicate certain shortcoming such as the lack of transparency, comprehensiveness, systematization, appropriate assessment tools and the lack of empirical data ([6]; [26]). Dinter [6] developed a BI maturity model (called biMM) that was structured in 3

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dimensions (functionality, technology and organizational dimension), within each dimension several categories were introduced and the design objects for each category were defined. According to Dinter [6] functionality dimension includes aspects of the use and impact of BI within the organization, as well as other content-related issues. Technology dimension highlights the system and the architecture of the data and the BI tools along with their associated functionality while organizational dimension refers to separate organizational structures, processes, profitability and the strategy of BI in an organization [6]. For the purpose of this research an aggregated BI maturity model based on Dinter's biMM is designed. This model distinguishes ten categories comprising the most important elements of Dinter's biMM.

III. BI AND BPM ALIGNMENT FOR PROCESS PERFORMANCE MEASUREMENT

The emergence of a large number of activities in the process, possible automation and a large number of errors result in the need for business process management (BPM). One of the most widely used definitions of BPM is Harmon's [11]: "BPM is a management discipline focused on improving corporate performance by managing a company's business processes". BPM enables the alignment of business processes and the organization's strategic goals [4] and comprises different phases, from analysis and design, through implementation and automation, to process monitoring and measurement phase [2]. Both of these concepts, BI and BPM, are considered key drivers for process and organizational performance improvement.

Business process performance is measured by the business data on the costs and time required to perform the activities so as by the costs and resource capacities involved in the activities, keeping in mind that the focus should be on the quality of products or services [3]. For this purpose, business process management systems (BPMSs), whose functionalities support the documentation, automation and tracking of business processes, real-time monitoring and collecting historical data on the business processes performance and optimization of processes, are used [19]. In terms of internal processes, an organization is directed towards measuring product quality and production costs, while the focus of external processes is aimed at measuring customers' satisfaction. According to empirical data by Huang [12] collaboration of process performance measurement together with the reduction of costs and increased speed of the internal processes, as well as an improved quality of the external processes, result in the improvement of the organizational performance.

Kueng [17] defines process performance measurement systems (PPMSs) as information systems that integrate relevant information of the performance of one or more business processes, compare historical and desired future values with achieved business process value and report the results to participants of the process. Also, data on business processes can be collected from ISs systems, which are focused on the collection and storage of financial and time-oriented data [17]. Similarly, Hammer

[9] emphasizes the need for "match between organization's information and management systems and the process's needs, and the quality of the metrics that the company uses to measure process performance". Since the BISs also serve to collect data relevant to the assessment of process performance this study discusses the effects of connecting BISs and BPMSs.

The results of the researches from business practice show that the full potential of BISs and BPMs integration and information exchange is still not recognized [3]. According to the authors the major obstacles are systemized as follows: "(1) the main goal of BPM initiatives is to improve business processes, while BI initiatives are usually focused on achieving marketing, customers and sales objectives; and (2) although management starts both initiatives, the results evidence lack of the strong commitment towards coordinated usage of BISs and BPMs as tools for supporting performance management" [3].

Hammer et al. [10] specify seven obstacles of performance measurement success in organizations. Some of these imply the need for BPM and BI alignment. According to Hammer et al. [10] "Provincialism" refers to the existence of conflicting goals among departments that result in defining process metrics and KPIs within the functional boundaries. Besides, "Pettiness" or "the policy to measure only a small component of what matters" must be discussed [10]. "Inanity" is concerned with the organization's approach "to implement metrics without giving any thought to the consequences of these metrics on the performance on organizational level" [10]. Such situations could be avoided by setting up and measuring the organizational KPIs on the end-to-end process level and by implementation of performance management systems in line with cross functional processes ([15]; [1]). This approach could help organizations to increase the relevance and usefulness of their performance measurement systems. The authors suggest to coordinate BPM and BI initiatives in a company and to provide very intensive communication between BPM and BI experts and managers ([27]; [3]). According to Nenadal [34] the main goal of process performance system is to identify if processes meet strategic goals and this goal is achieved through "the monitoring of agreed performance indicators". For this reason, it is very important to establish the role of the process owner and to ensure that process owners monitor business process execution and KPIs achievement through BISs and BPMs [25]. It's very important to achieve a common understanding of business process terminology on the level of entire organization ([43]; [9]). Customer focus, collaboration, teamwork, and a willingness to reach process KPIs must be shared and accepted by employees across the organization.

Some authors emphasize the need to apply BI techniques in BPM, so the new term "business process intelligence" is introduced in literature [41]. According to van der Aalst [42] the combination of BPM and data mining, called "process mining" is applied in business practice with the aim to extract and discover knowledge from process events (logs) data. Schifer, Jeng and Chowdhary [40] present a solution for merging business data with typical workflow data by adding process metrics

(such as throughput time, utilization and cost of resources, process volume and frequency) to existing data warehouse technologies. Bucher and Gericke [43] specify several reasons for the integration of BI and BPM platforms, such as: “(1) a lot of operational processes require “data analytics” in real-time or near-real time; (2) operational processes provide the context for data analysis and decision making, hence BI techniques can be used to merge and consolidate raw data about process execution into KPIs; (3) once operational decisions have been made based on KPIs, useful knowledge about KPIs, corresponding decisions and related consequences can be added into a dedicated data store, so developing the rules for future decision making.”

Since the ultimate goal of both, BI and BPM, is to increase process performance, this paper aims to investigate if the need for alignment of these concepts is recognized within the organizations and to evaluate its impact to process performance.

IV. EMPIRICAL RESEARCH METHODOLOGY

Based on the previous theoretical discussion, it is reasonable to expect, that BI and BPM will result in higher process performance improvement when they are implemented as coordinated and aligned initiatives. Thus, we put forward the following hypotheses:

H1: Business intelligence maturity positively influences Process performance.

H2: BPM/BI alignment positively influences Process performance.

H3: Business intelligence maturity positively influences BPM/BI alignment.

H4: The impact of Business intelligence maturity on Process performance is mediated by BI/BPM alignment.

Our questionnaire is presented in appendix, and was developed based on the previous theoretical knowledge, as presented in parts II and III of this paper, in order to assure content validity. We used a structured questionnaire with five-point Likert scales, with anchors ranging from totally disagree (1) to totally agree (5), for all items used in our study. The data were collected through a survey of medium- and large-sized business organizations in Croatia and Slovenia. Questionnaires were addressed to top management in the contacted organizations. The two rounds of call-up were conducted yielding altogether a sample of 65 completed surveys in Croatia and 118 in Slovenia.

V. RESEARCH RESULTS: ANALYSIS AND DISCUSSION

To conduct the data analysis, partial least squares (PLS), a component-based structural equation modeling (SEM) technique, was used. This is a widely used methodology in the IT and IS field as it is suitable for predicting and theory-building because it examines the significance of the relationships between the research constructs and the predictive power of the dependent variables ([28]; [32]). The estimation and data manipulation were performed using SmartPLS [36] and SPSS.

We have examined the reliability and validity measures for our reflective measurement model. In the

model, all Cronbach's alphas by far exceeded the 0.7 threshold [35]. Without exception, the latent variables composite reliabilities were higher than 0.8 and in all cases even higher than 0.9, showing the high internal consistency of indicators measuring each construct and thus confirming construct reliability ([35]; [32]). The Average Variance Extracted (AVE) was generally around 0.7 or higher, thus exceeding the threshold of 0.5, demonstrating the convergent validity of the constructs [29]. The reliability and convergent validity of the measurement model were also confirmed by computing standardized loadings for the indicators and Bootstrap t-statistics for their significance. All standardized loadings of the indicators in the model exceeded the 0.7 threshold and they were found without exception to be significant at the 0.001 significance level, thus confirming the high indicator reliability and convergent validity ([33]; [32]). Based on the discriminant validity tests, that “two conceptually different concepts should exhibit sufficient difference” [32], BI3 and BI9 indicators were excluded due to too high cross loadings with BI/BPM ALIGNMENT indicators. Discarding the mentioned items substantially and sufficiently improved the discriminant difference between the items of the two constructs.

The assessment of the indicator loadings on their corresponding constructs indicated that manifest variable correlations with their theoretically assigned latent variables are an order of magnitude larger than other loadings to other constructs [30]. Therefore, all the item loadings met the criteria. The square roots of AVE for constructs were significantly higher (and also substantially larger than the threshold of 0.5) than the correlations between the constructs, thus confirming that they are sufficiently discriminable ([28]; [29]).

We further estimated the inner path model. We tested the significance of the hypothesized relationships between the constructs by bootstrapping with 1,000 replicates. The structural model was then assessed (see Figure 1) by examining the coefficient of determination (R^2) of the endogenous latent variable, the estimates for the path coefficients of relationships in the structural model and their significance levels (via bootstrapping) [28].

The path and indicator loadings are shown in Figure 1. The influence of BI MAT and BI/BPM ALIGN explain 20.3 % of the variance in PP. Further the influence of BI MAT on BI/BPM ALIGN explains 48.3% of the variance in BI/BPM ALIGN. Since the exogenous variables explain a moderate to high proportion of the variance of the endogenous variable, we may conclude that the model holds sufficient explanatory power and is capable of explaining the constructed endogenous latent variable [32]. The direct impact of BI MAT on PP is not statistically significant ($\hat{\beta} = 0.200$; $p = 1.660$) rejecting H1. The direct impact of BI/BPM ALIGN on PP is statistically significant ($\hat{\beta} = 0.289$; $p = 2.592$) and positive thus our H2 is supported. The positive impact of BI MAT on BI/BPM ALIGN is statistically significant ($\hat{\beta} = 0.694$; $p = 13.189$) and supporting our H3. To test that the impact of BI MAT on PP is mediated by BI/BPM alignment we followed the procedures explained in Kenny [14] and Rucker et al. [37].

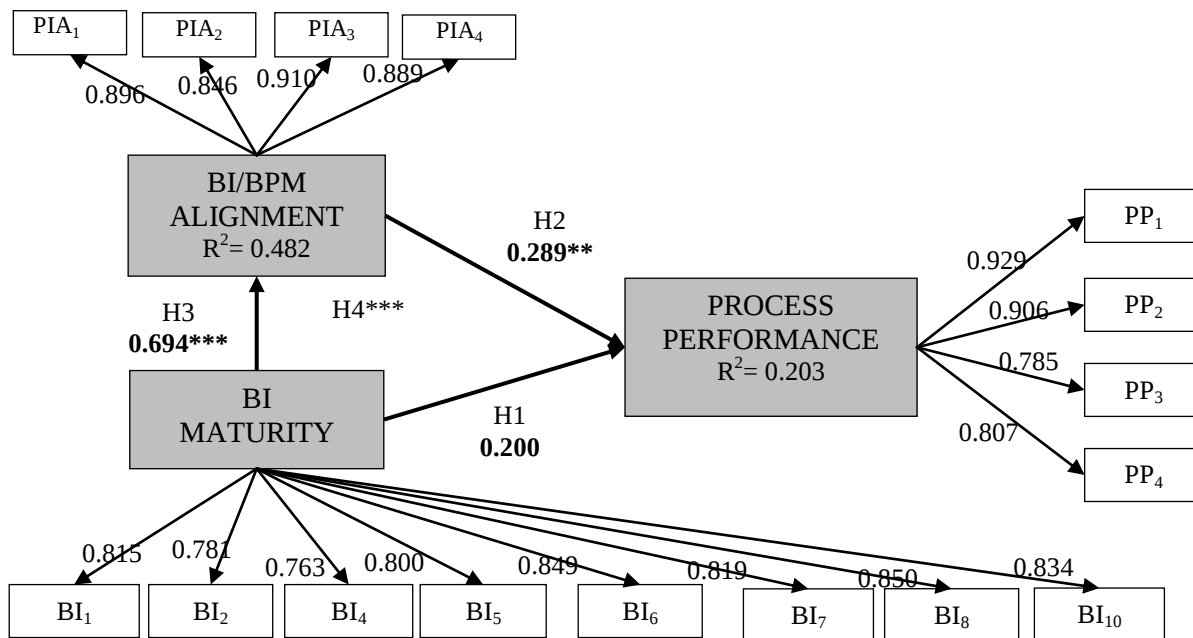


Figure 1: The final structural and measurement model

Notes (Figure legend): The structural model (the inner path model): statistical significance (no stars) - non-significant; * significant at the 0.05 level (two-tailed test); ** significant at the 0.01 level (two-tailed test); *** significant at the 0.001 level (two-tailed test); grey squares – constructs; R^2 – explanatory power of the constructs; $\hat{\beta}$ - written in bold – indicating path loadings.

The (reflective) measurement model: white squares – indicators of the constructs; loadings of the measurement model presented on the (thin) black arrows.

First, the direct effect of BI MAT on use intentions was tested. The direct impact of BI MAT on PP is not statistically significant, thus our hypothesis H1 is rejected. However, the causal variable (BI MAT) is correlated (0.400) with the outcome (PP), thus there is an effect that may be mediated [14]. In the second step, the mediator (BI/BPM ALIGN) needs to be treated as the outcome variable and BI MAT as the causal variable [14]. The path is statistically significant at 0.001% significance level, where BI MAT have direct positive influence on BI/BPM ALIGN. The causal variable is also correlated with the mediator (0.693). The third step involves showing that the mediator affects the outcome variable [14], which was tested with H2 and proven to be statistically significant. Since, the direct impact of BI MAT on PP is not statistically significant, BI/BPM ALIGN completely mediates the impact of performance perceptions on use intentions [37], proving our H4.

VI. CONCLUSION

In this paper we have presented preliminary results of the comprehensive research conducted in Croatian and Slovenian companies. Structural equation model was developed in order to test hypothesis. First, the impact of BI maturity to business process performance (H1) was not confirmed. Second, the positive impact of BPM/BI alignment to the process performance (H2) was confirmed. Third, positive impact of business intelligence maturity to BPM/BI alignment (H3) was confirmed. Fourth, the mediating effect of BI/BPM alignment to the

impact of BI maturity on Process performance (H4) was confirmed, which is an important finding, since the direct impact was not confirmed. The contribution of this model is thus to indicated a path towards the future research on a interrelation of BPM/BI alignment and Process performance. Practical implication of this research stems in the greater need of the synchronized efforts in the implementation and development of BI and BPM.

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APPENNDIX I BUSINESS INTELLIGENCE MATURITY

BI	BUSINESS INTELLIGENCE MATURITY					
Please, indicate how you would rate BI maturity in your organization along the following dimensions (X = don't know, can't judge).						
Statement A			Statement B			
BI-1	What is the scope of business intelligence systems use in your organization?					
BI is used in isolated manner by individuals.	1	2	3	4	5 X	BI is used in all (wherever needed) organizational units, hierarchical levels, and application areas.
BI-2	What is the level data architecture maturity in your organization?					
Business data management is not addressed in organization. There is non-existing or heterogeneous semantics.	1	2	3	4	5 X	Internal (both structured and unstructured) and external data are fully integrated, and requirements (e.g. data quality) are met.
BI-3	What is the impact of business intelligence in your organization?					
Impact of BI is not considered as relevant.	1	2	3	4	5 X	Decision-making is based on BI and BI is perceived as having a critical impact on organizational performance.
BI-4	What is the level of technical architecture maturity of BI in your organization?					
There is no dedicated BI storage used.	1	2	3	4	5 X	Enterprise-wide data warehouse is used.
BI-5	What is the level of data management maturity in your organization?					
Data integration is manual.	1	2	3	4	5 X	Data integration is automated, dedicated tools for data management and integration are used.
BI-6	What kind of BI tools is used your organization?					
We don't use any specific BI tool, manual analysis is performed.	1	2	3	4	5 X	A broad range of BI tools and techniques is used, such as reporting tools, ad hoc analytics (OLAP), in-memory analytics, planning, alerts, forecasts, scorecards, mobile BI, data mining, predictive analytics, and other advanced techniques of analysis and visualization.
BI-7	What is the the organizational structure related to business intelligence in your organization?					
There are no specifically defined roles and organizational units for BI.	1	2	3	4	5 X	BI (business data analytics or similar) competence center with a comprehensive spectrum of tasks and competences exists.
BI-8	What is the level of maturity of BI processes (e.g. requirements engineering and service management) in your organization?					
BI is used in isolated manner by individuals.	1	2	3	4	5 X	BI is used in all (wherever needed) organizational units, hierarchical levels, and application areas.
BI-9	What is the level of the profitability assessment of business intelligence in your organization?					
There is no profitability assessment of BI.	1	2	3	4	5 X	Cross-project and benefit oriented profitability assessment of BI takes place.
BI-10	What is the level of BI strategy in your organization?					
No BI strategy exists in our organization.	1	2	3	4	5 X	There exists a dedicated BI strategy that clearly reflects business/IT alignment.

APPENNDIX II BPM/BI ALIGNMENT

PIA	BPM/BI ALIGNMENT		
Please, indicate to what extent you agree / disagree with the following statements.		1 = completely disagree; 5 = completely agree; X = don't know, can't judge	
PIA-1	BPM initiative is coordinated with BI initiative in a company. Very intensive communication between BPM and BI experts and mangers exists.		1 2 3 4 5 X
PIA -2	BPM and BI terminology is aligned. BI and BPM use common terms, a glossary of BPM&BI terms exists.		1 2 3 4 5 X
PIA -3	BI system enables performance measurement and management of cross-functional processes.		1 2 3 4 5 X
PIA -4	BI system is regularly used by process owners and other process actors for monitoring business process execution.		1 2 3 4 5 X

APPENNDIX III PROCESS PERFORMANCE

PP	PROCESS PERFORMANCE		
Please, indicate to what extent you agree / disagree with the following statements.		1 = completely disagree; 5 = completely agree; X = don't know, can't judge	
PP-1	The efficiency of our processes is high above the average of the industry.		1 2 3 4 5 X
PP-2	The quality of our processes is high above the average of the industry.		1 2 3 4 5 X
PP-3	The flexibility of our processes is high above the average of the industry.		1 2 3 4 5 X
PP-4	The quality of our products/services is high above the average of the industry.		1 2 3 4 5 X