Development and Validation of a BI Success Model

Completed Research Paper

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ABSTRACT

We propose and test a BI Success model, based on DeLone and McLean's IS Success model, that incorporates comprehensive data that is needed for decision-making and computer systems that allow integration and analysis of that data as dimensions of BI success. Our model also includes organizational support structure for BI and the users' involvement in the ongoing development of BI systems as contributing factors. Data collected from over 300 organizations across the world confirmed 7 of 9 hypothesized relationships. Notably, user involvement and the organizational support factors are seen to be associated with the BI capability factors which, in turn, are positively associated with users' perception of net benefits and their satisfaction with BI practices. This is one of the first studies that evaluates the success of BI at organizational level and considers user involvement, characterized by on-going configuration / customization / improvement cycle, as a contributing factor in the classic IS Success model.

Keywords

Business intelligence, BI capabilities, IS success, analytics.

INTRODUCTION

In recent years, many firms have gained competitive advantage by developing advanced data-analysis capabilities (Davenport, 2006; Accenture, 2013). Today, it is not just the large, multi-national organizations, but also smaller, medium-sized organizations that are harnessing their vast data resources. Moreover, the transition to extended use of data for business analysis and decision support is not happening just in developed countries, but also in developing countries (Villate, 2012; Gartner, 2013).

Business Intelligence (BI) is a broad category of applications, technologies, and processes for gathering, storing, accessing, and analyzing data to help business users make better decisions (Watson, 2009). BI represents the most comprehensive view of decision support systems (DSS) thus far[1]. BI practice has spread in firms across many industries and deepened in entrenched sectors as evidenced by numerous vendor white papers and, even, bestsellers (Davenport et al., 2010; May, 2009; Ayres, 2007). For the IS academic community, BI has evolved into a mainstream content area for research and teaching as evidenced by the MIS Quarterly special issue on Business Intelligence and the incorporation of BI into IS 2010 curriculum guidelines (Topi et al., 2010).

The increasing prevalence of BI can be attributed to the convergence of four advancements. First is the advancement in specialized technologies for automatically collecting large amounts of data, including those newly termed as "big data" and their organization in enterprise data warehouses. The second is the availability of computing power to do the data crunching needed for analyzing/mining that data. The third is a clearer understanding of statistical and mathematical modeling techniques needed for discovering, understanding, and exploiting the information contained in the data. And, the fourth is the cumulative experience and the technical knowledge of practitioners, vendors, and the academia, resulting in shortening of implementation cycles of BI projects. Consequently, BI is experiencing a broader business coverage and a better return on investment (March and Hevner, 2005).

BI encompasses critical organizational resources including data repositories along with the specialized information systems that utilize them. Yet, how to fully exploit these resources is a challenge faced by most organizations. This is because BI

[1] Emphasizing the growing importance of analysis capabilities to the information systems that organizations are now building, Gartner changed the name of their Magic Quadrant from "Business Intelligence Platforms" to "Business Intelligence and Analytics Platforms" in 2013. Others have used the term "Business Analytics" to describe the overall concept. In this paper, we use the term BI to encompass all such variations.

systems are fairly complex systems, both technically and organizationally. Technically, numerous decisions go into the design and implementation of these systems (Shankaranarayanan and Even, 2004). Organizationally, extensive managerial acumen is needed at every step of the way – from choosing the areas of decision-making to support to rolling out (Wixom and Watson, 2001). Further, complicating the realization of benefits is the fact that the impact of BI initiatives on performance can be far and wide and is difficult to be solely attributed to the BI initiatives within an organization.

Due to the relative newness of BI technology on the maturity scale (Russell et al., 2010) and dearth of experience in appropriating potential benefits of BI initiatives, there is a lack of adequate theoretical modeling and empirical examination of factors leading to BI success. Moreover, BI systems are sufficiently different from traditional information systems; they are intrinsically data-intensive and their user and usage characteristics are different. Therefore, in this paper, we develop and empirically test a theoretical model of BI success. Our model is derived from the IS success models of DeLone and McLean (D&M) (1992, 2003) and Seddon (1994, 1997). Few researchers have used the IS Success model for evaluating success of BI systems. Popovic, et al., (2012) used a modified IS Success model to include BI systems maturity and analytical decision-making culture to measure the success in terms of usage. Wixom and Watson (2001) modified the IS Success model to investigate the factors affecting data warehousing success. Other researchers have modified it to evaluate success of specific systems such as knowledge management (e.g., Jennex and Olfman, 2002; Kulkarni et al., 2007; Wu and Wang, 2006) and e-commerce (e.g., Molla and Licker, 2001; DeLone and McLean, 2004; Zhu and Kraemer, 2005).

Although the original IS Success model (DeLone and McLean, 1992) was developed for a single information system with individual user as the unit of analysis, the updated model (DeLone and McLean, 2003) was modified to include IS success at all levels of analysis such as workgroups, organizations, etc. and included the variable net benefits to account for benefits at multiple levels of analysis. We designed a cross-sectional study of BI success across multiple organizations. Instead of evaluating the success of a single BI system in a focal organization, we take a broader view of the BI success dimensions. Our study focuses on the organizational level when measuring and evaluating the various success constructs and their relationships. We test our model with data collected from over 300 organizations from four countries, United States of America, Peru, Vietnam, and India.

In the next section, we develop a theoretical model for BI Success. We then briefly describe the survey instrument development and data collection activities, followed by analysis and presentation of results. The final section discusses our findings. The paper concludes with the limitations and implications of our study and future directions.

THEORETICAL DEVELOPMENT – BI SUCCESS MODEL

We use the IS Success model as guidance to justify some of the key factors in our model and use prior research in related areas for proposing our broader theoretical model. The first departure is that we have looked at BI systems in general and not on a single system.

BI implementations within an organization comprise many information systems that work together in an integrated fashion to provide the user with the needed decision support. This may be in the form of dashboards and scorecards with interactive user-controlled reports that allow the decision-maker to explore alternatives (Chung, 2009). Or, they may be in the form of sophisticated analytical engines that allow optimization, prediction and explanation, and other forms of discovery. More recently, BI is also used in operational settings to make more timely decisions, by acting in response to business events with the help of pre-analyzed business rules built from analysis of historical data (Polites, 2006; Watson et al., 2006). Hence, when we refer to BI systems, we mean a compendium of information systems that provide the user the “intelligence” for making “informed” managerial decisions. Conceptually, this meaning of BI systems is similar to the one adopted by Popovic, et al. (2012).

Our study makes the argument that, in addition to building technology artifacts, firms must pay careful attention to championing and goal setting for BI as well as instilling a culture of respect for evidence-based decision-making for the ultimate success of these efforts. Such organizational factors may influence BI systems success. Thus, as a consequence of studying BI success in multiple organizations, we argue that unlike in a single-organization setting, variability in organizational factors can influence the variability in BI success dimensions.

We also introduce another new variable, user involvement, with a contemporary interpretation. The traditional user-involvement variable is limited to the requirement gathering and development stages of a system (Franz and Robey, 1986; Adelman, 1982; Baroudi et al., 1986). Our user involvement variable considers users’ involvement in the ongoing evolution of BI systems via shorter feedback cycles. We argue that this unconventional interpretation of the user involvement construct, redefined in the context of modern-day, interactive, ever-evolving information systems, needs to be included in the BI success model.

We use the theoretical foundation of the IS Success model and prior research from organizational behavior and other areas to build our BI Success model. See Figure 1. The constructs in the model are attributes in general of the class *organizations*. Thus, Data Capability is the perceived organizational capability in respect of its data resources as experienced by a managerial user of BI systems. In our research model, the organizational attributes are perceived via an individual belonging to the class of managerial users of BI systems. We don't impose any boundary condition on the class of organizations regarding their size, industry sector, etc., except that which is indirectly imposed by the convenience of the sample. We describe the constructs and their hypothesized relationships below.

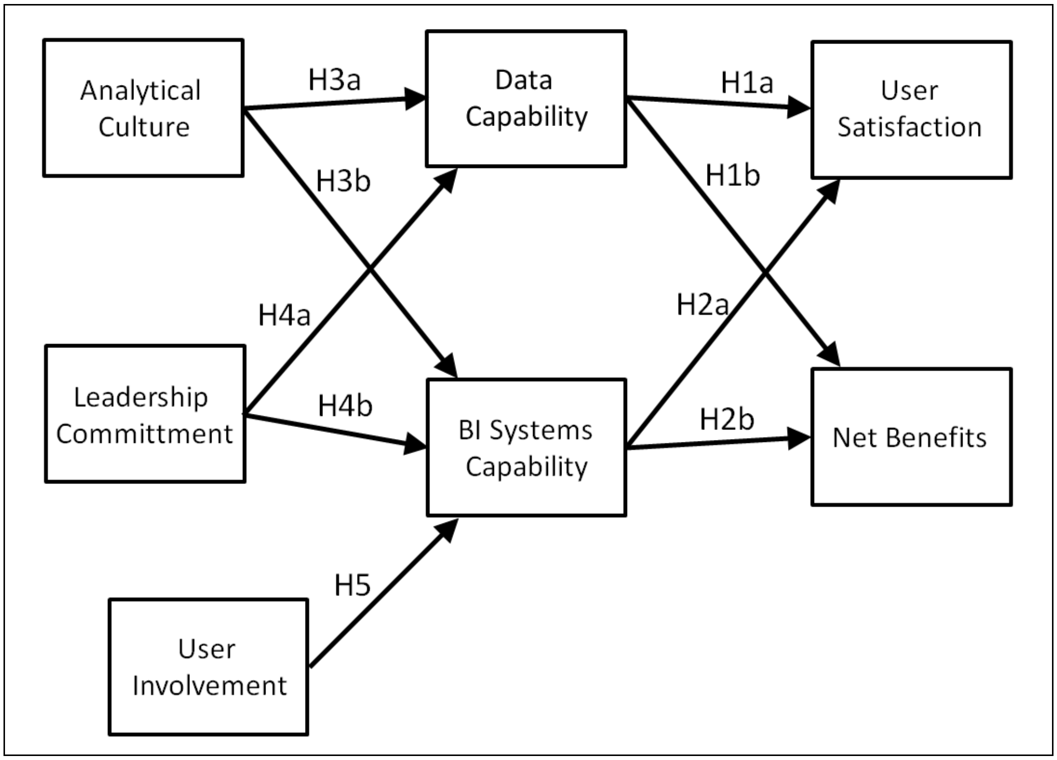

Figure 1. Research Model

BI Capability

The D&M IS Success model, uses *Information Quality* and *System Quality* as dimensions of IS success. The reason for including *both* of these is that a high-quality system can produce useless information if the purpose for which and form in which the information is needed is misunderstood. Similarly, a poorly designed, unfriendly, system may produce accurate and informative reports, but getting them may be a challenge. Together these two constructs can be deemed to describe the concept of "System Capability".

Similar to the two constructs in the IS Success model, we define the concept of BI Capability as having two components: *Data Capability*, i.e., the quality of data available for supporting decision-making and *BI Systems Capability*, i.e., the computer systems that allow access, integration, analysis, and presentation of that data.

Data Capability refers to the availability of basic data needed to support decision-making as perceived by the user. Some of the most important characteristics of data are its comprehensiveness and reliability (Giovinazzo 2009). Access to accurate, dependable, and consistent data that is available at the appropriate level of detail is a precursor to evidence-based decision-making (Isik et al., 2010). Organizations of all sizes are negatively impacted by imperfect, inconsistent, and inaccurate data (Damianakis, 2008). It is estimated that more than 50% of BI projects have failed because of data quality issues which alone cost US businesses over $600 billion dollars a year (Graham, 2008).

BI Systems Capability is defined via the usability and functionality of the systems. A BI system is any computer system that allows access, integration, analysis, and presentation of data needed for managerial decision-making tasks, generally via a database/data warehouse. As mentioned earlier, an organization may have many information systems that work together to provide a managerial user with comprehensive decision support. *Usability* is the technology's ability to provide the needed decision support to the user of the system. Historically, this was understood as the "ease of use" with which the user can interface with the system (Houdeshel and Watson 1987). In more contemporary systems, in addition to the technology, the complexity of the decision problem, the cognitive processes of the user, and the task/tool fit are key in the user's assessment of usability (Keil et al., 1995). *Functionality* includes the ability of the system to provide the user the means to explore the problem space, generate alternatives, and choose a course of action, including the systems' adaptability to the problem space (Franz et al., 1981; Gibson et al., 1984).

User Satisfaction and Net Benefits

While BI Capability attempts to model the semantic (data) and technical (systems) levels of BI success, for modeling the effectiveness or influence level of BI success, we draw directly from the D&M's IS Success model (2003). This is because at the organizational level, although profitability measures are preferred, they are difficult to be attributed solely the the IS. Hence, asking users of a system to assess the improved profitability due to the system may not be the best approach for measuring success.

Use (System Use) is an appropriate variable when the system under investigation is a voluntary system. Because our boundary condition for BI Systems includes a compendium of information systems (see BI systems definition above), some of which may be mandatory, we refrain from using Use as a success dimension. Unlike a stand-alone DSS of the past, where the use of the system was voluntary, for modern day BI systems the line between voluntary and mandatory usage is blurred. For example, a modern BI system may include an interactive dashboard that not only provides the information needed for managerial decision-making in a graphical form, but also registers the managerial user's choices and decisions. The manager may not have a way of circumventing the use of such a system.

Hence, *User Satisfaction and Net Benefits* are the only appropriate success measures in multiple organization settings. Although the D&M (2003) model prescribed User Satisfaction as a mediating variable between the quality dimensions and the net benefits, others have questioned such a relationship and examined the direct relationship between the quality measures and Net Benefits. For example, prior researchers have found strong support for the relationship of System Quality to Net Benefits while examining various systems such as EDI, data warehouse (Farhoomand and Drury, 1996; Wixom & Watson, 2001). On the other hand, the relationship between Information Quality and Net Benefits at the organizational level has shown mixed results and needs further examination.

As for User Satisfaction, at the organizational level system qualities such as functionality of executive IS and ease of use of a mobile computing information system were found to be related to User Satisfaction (Benard and Satir, 1993; Scheepers et al., 2006). But, these studies are too few and far in between to draw any definite conclusions from. Similarly, Information Quality is shown to have some relationship with User Satisfaction (Coombs et al., 2001; Scheepers et al., 2006) and further studies are needed to examine these relationships in detail. Thus, drawing on arguments above and based on the IS Success model, we formulate the following hypotheses:

Hypothesis 1a: Higher level of Data Capability leads to higher level of User Satisfaction

Hypothesis 1b: Higher level of Data Capability leads to higher level of Net Benefits

Hypothesis 2a: Higher level of BI Systems Capability leads to higher level of User Satisfaction

Hypothesis 2b: Higher level of BI Systems Capability leads to higher level of Net Benefits

Organizational Factors

How organizational factors affect IT implementations has been extensively studied in various contexts such as ERP systems (Ke and Wei 2008) and knowledge management systems (Alavi et al., 2006, Kulkarni et al., 2007), but not as much for BI implementations (Popovic et al., 2012; Ramamurthy et al., 2008). Organizational issues are often at the heart of IT implementation failures and must be considered in benefit assessment (Watson et al., 1999). Two dimensions of organizational factors need to be specifically considered: the culture of evidence-based decision making within an organization and the commitment of the organizational leadership to BI related efforts (Davenport 2006).

Organizational culture includes, among other things, behavior of and attitude toward work, work practices, and co-workers (Hofstede et al., 1990; Bates et al., 1995). It is the values and preferences through which a firm strives to attain its goals (Trice and Beyer, 1993). *Analytic Culture* means having an organization-wide respect for measuring, testing, and evaluating quantitative evidence in making decisions. This kind of culture encourages looking for data and information to support one's work (ideas, proposals, conclusions, opinions, etc.), and having a decision-making process that includes quantitative /

numeric analysis, sometimes with advanced mathematical techniques. We argue that such a culture would stimulate the demand for better data related as well as systems related capabilities from managers.

Cultural values are typically shaped by senior management. Senior management sets rules that can have a major effect on decision-making styles of employees by influencing perceptions of what is acceptable and useful to their firm (Sackman, 1991). *Leadership Commitment* is a subjective measure of commitment to BI initiatives and investments by the top levels of management. It is exhibited via understanding of the role of BI in business decision-making, commitment to BI demonstrated via strategy formulation, goals setting, and having explicit policy and guidelines with respect to BI activities, and attempting to hire and retain personnel with analytical skills. Thus it is logical to project that such a commitment from the leadership to BI related investments would result in higher BI related capabilities.

Based on the above discussion, we formulate the following hypotheses:

> *Hypothesis 3a: Higher level of Analytical Culture leads to higher level of Data Capability*
>
> *Hypothesis 3b: Higher level of Analytical Culture leads to higher level of BI Systems Capability*
>
> *Hypothesis 4a: Higher level of Leadership Commitment leads to higher level of Data Capability*
>
> *Hypothesis 4b: Higher level of Leadership Commitment leads to higher level of BI Systems Capability*

User Involvement

User Involvement has been mainly studied in the context of development of traditional information systems (Barki and Hartwick, 1994). User involvement in the development process results in net benefits as well as increased satisfaction with the systems (Franz and Robey, 1986; Adelman, 1982; Baroudi et al., 1986).

We adapt the User Involvement Theory (Robey and Farrow, 1982; Ives and Olson, 1984) to the context of modern-day enterprise systems. Complex systems such as ERP and BI systems are licensed from vendors and configured with the help of experts (in-house or outside) to fit the organization's needs. Hence, the concept of user involvement needs to be modified to include "user engagement in the on-going improvement of systems". The more engaged the users are in the exploitation of the capabilities of the system and in the on-going configuration / customization / improvement of the BI system, the more likely are the potential capabilities of the systems as perceived by the users. In this context, an "involved" user base is characterized by having a good knowledge of the system's capabilities, features, and limitations, being committed to the success of the system, participating in the evaluation of the system, and contributing to the ongoing improvement of the system by suggesting/reviewing enhancements. Hence, we formulate the following hypothesis:

> *Hypothesis 5: Higher level of User Involvement leads to higher level of BI Systems Capability*

DATA COLLECTION

A survey instrument was created based on previous available instruments (Davis 1989; Doll and Torkzadeh, 1994; Kulkarni et al., 2007). The questions were changed to appropriately reflect BI systems constructs. A focus group of seven executives was consulted to validate the instrument. This panel provided feedback that led to minor changes for clarification. The first batch of surveys was used to test for reliability of the instrument. Once reliability of the instrument was confirmed, the survey was finalized.

The survey was globally administered to groups of professionals attending corporate executive seminars on BI Strategy. These seminars were conducted in four countries: India, Peru, United States and Vietnam between May and December of 2012. The attendees were mid-level managers in organizations of various sizes. The respondents were familiar with BI systems in their respective companies and as such had chosen to attend the BI seminars. Barring a few exceptions, all respondents belonged to different companies and hence represented separate organizations. Three hundred and eleven surveys were collected out of which two hundred and ninety were fully completed. Ten percent of the surveys were collected in India, fifty seven percent in Peru, nineteen percent in the US, and fourteen percent in Vietnam. The respondents worked in a variety of industries: 25% in the Banking, Insurance, and Finance sector, 14% in the Information Technology sector, 11% in the Service sector, 6% in Manufacturing, 6% in Energy, 6% in the Government, 5% in Telecommunications, 4% in Healthcare, and 3% in Mining and related services. The remaining 20% came from Travel and Tourism, Agriculture and food, and other sectors. The average respondent was about 35 years old with a work experience of 10.8 years. 15.9% of the respondents worked in organizations with less than 100 employees, 21.4% came from organizations having 100 to 499 employees, 15.5% came from those having 500 to 999 and the majority (47.2%) came from organizations with over 1000 employees. Gender distribution was 76% men and 24% women.

DATA ANALYSIS AND RESULTS

The analysis was carried out using the SmartPLS software version 2.9.M3 (Ringle et al., 2005). The research model presented in the previous sections was analyzed using the PLS and Bootstrap algorithms of the software. The software simultaneously examines the structural component (path model) and measurement component (factor model) in the proposed model. Therefore, it provides an assessment of the scales used to measure each variable in terms of reliability and validity, as well as the estimates of the parameters of the structural model.

The results of the reliability test are reported in Table 1. These results show that the measures are robust; they show internal consistency through the composite reliability scores. The seven measures have composite reliabilities that range from 0.89 to 0.97. All seven values exceed the recommended threshold value of 0.70 (Nunnally, 1978). Also, following the recommendation of Fornell and Larcker (1981), the average variance extracted (AVE) for each measure exceeds the 0.50 recommended level.

Variable constructs	**Composite Reliability (internal consistency)**	**Average Variance Extracted**
Analytical Culture	0,8998	0,6920
Leadership Commitment	0,9383	0,7922
Data Capability	0,8957	0,6822
BI Systems Capability	0,9277	0,7624
User Involvement	0,9321	0,6961
User Satisfaction	0,9284	0,8122
Net Benefits	0,9669	0,8541

Table 1. Reliability Assessment of the Measurement Model

A test of discriminant validity was also performed and the results are shown on Table 2. The values in the diagonal of Table 2 are the square roots of the corresponding AVEs and they are all greater than the values in the off-diagonal cells for each row and column. This supports the discriminant validity of the scales.

	AnaCult	**LeadCom**	**DataCap**	**BISysCap**	**UserInv**	**UserSat**	**NetBen**
1. Analytical Culture	**0.8319**						
2. Leadership Commitment	0.6726	**0.8901**					
3. Data Capability	0.4869	0.4105	**0.8260**				
4. BI Systems Capability	0.4505	0.4298	0.5495	**0.8732**			
5. User Involvement	0.4554	0.4905	0.2933	0.4403	**0.8343**		
6. User Satisfaction	0.5112	0.4944	0.6554	0.6332	0.4046	**0.9012**	
7. Net Benefits	0.5035	0.3761	0.5798	0.6267	0.3150	0.4944	**0.9242**

Table 2. Discriminant Validity of the Constructs

Table 3 shows the factor loadings and cross loadings as reported by the SmartPLS software. The convergent validity test requires that all items loaded on their corresponding construct should have a factor loading greater than 0.7 (Yoo and Alavi, 2001). The test also requires the loadings of the items to be greater than any other cross loadings on any other construct.

	AnaCult	LeadCom	DataCap	BISysCap	UserInv	NetBen	UserSat
Analytical Culture							
Encouragment to make informed decisions	***0,8655***	0,5660	0,4074	0,4379	0,3777	0,4474	0,4561
Encourgament to look for data/information	***0,8403***	0,5067	0,3614	0,3891	0,3632	0,4283	0,4239
Respect for measuring and evaluating	***0,8268***	0,5874	0,3839	0,3087	0,3764	0,3703	0,3930
Quantitative/numeric analysis	***0,7932***	0,5771	0,4604	0,3526	0,3962	0,4217	0,4218
Leadership Commitment							
BI plays an important role	0,6551	***0,8549***	0,3221	0,3380	0,3843	0,3744	0,4137
Sponsosrs for BI initiatives	0,5946	***0,9227***	0,3796	0,3891	0,4391	0,3512	0,4399
Commitment via policy/guidelines/activities	0,5965	***0,9389***	0,3910	0,3889	0,4727	0,3102	0,4675
Hire and retain people with analytical skills	0,5573	***0,8395***	0,3630	0,4082	0,4429	0,3096	0,4356
Data Capability							
Data is comprehensive	0,3744	0,2994	***0,8191***	0,3934	0,1551	0,4727	0,5206
Data has appropriate level of detail	0,4153	0,3530	***0,8382***	0,5013	0,2529	0,4908	0,5433
Data is reliable	0,4183	0,3571	***0,8436***	0,4652	0,2938	0,4822	0,5701
Data is timely	0,3992	0,3448	***0,8023***	0,4522	0,2620	0,4695	0,5299
BI Systems Capability							
BI systems are easy to use	0,4325	0,4016	0,4889	***0,8318***	0,3916	0,5053	0,5333
BI systems allow exploration	0,3474	0,3446	0,4459	***0,8771***	0,4170	0,5281	0,5295
BI systems are customizable	0,3630	0,3697	0,4713	***0,8811***	0,3625	0,5683	0,5390
BI systems have needed features/functionality	0,4280	0,3846	0,5105	***0,9011***	0,3693	0,5840	0,6054
User Involvement							
Users have good knowledge of the system	0,3403	0,3711	0,2358	0,3900	***0,7874***	0,2326	0,3167
Users use most of the features	0,3040	0,3675	0,2321	0,3252	***0,8107***	0,1693	0,3061
Users are committed	0,4644	0,5043	0,3186	0,4459	***0,8769***	0,3464	0,3968
Users participate in the evaluation	0,3683	0,3524	0,2228	0,3649	***0,8454***	0,2973	0,3181
Users contribute to the ongoing improvement	0,3836	0,4361	0,2373	0,3446	***0,8697***	0,2878	0,3677
Users suggest/review periodic enhancements	0,4022	0,4051	0,1975	0,2998	***0,8120***	0,2115	0,3036
Net Benefits							
BI capability improves performance	0,4763	0,3425	0,5260	0,6089	0,2788	***0,9232***	0,6456
BI capability increases productivity	0,4534	0,3394	0,5575	0,5889	0,2851	***0,9360***	0,6527
BI capability enhances effectiveness	0,4745	0,3327	0,5378	0,5641	0,2916	***0,9434***	0,6638
BI capability makes job easier	0,4614	0,3889	0,5228	0,5505	0,2896	***0,8999***	0,6551
BI capability is useful	0,4611	0,3359	0,5343	0,5816	0,3111	***0,9176***	0,6478
User Satisfaction							
BI capability makes it easy to find information	0,4172	0,3761	0,5483	0,5322	0,2812	0,6507	***0,8684***
BI capability satisfies information needs	0,4721	0,4684	0,5899	0,5484	0,3693	0,6069	***0,9246***
BI capability meets my needs adequately	0,4886	0,4854	0,6289	0,6250	0,4331	0,6527	***0,9097***

Table 3. Factor Loadings and Cross Loadings

Figure 2 presents the results of the structural model. Each path is presented with its corresponding path coefficient representing the direct influence of the predictor upon the predicted latent construct. The organizational factors (Analytical Culture and Leadership Commitment) show mixed results. Analytical Culture presents a strong positive influence (β=0.39 $p<0.001$) on Data Capability and also a positive influence (β=0.23 $p<0.01$) on BI Systems Capability. On the other hand, Leadership Commitment exhibits a path that is significant only at the $p<0.1$ level with β=0.15, indicating a mild positive influence on Data Capability. The hypothesized influence on BI Systems Capability is non-significant. User Involvement shows a significant and positive influence (β=0.26 $p<0.001$) on BI Systems Capability. Both BI Capability constructs show a strong positive influence on the effectiveness dimensions of IS success, Net Benefits and User Satisfaction. Data Capability influences User Satisfaction (β=0.44 $p<0.001$) and Net Benefits (β=0.34 $p<0.001$). Similarly, BI Systems Capability influences User Satisfaction (β=0.39 $p<0.001$) and Net Benefits (β=0.44 $p<0.001$).

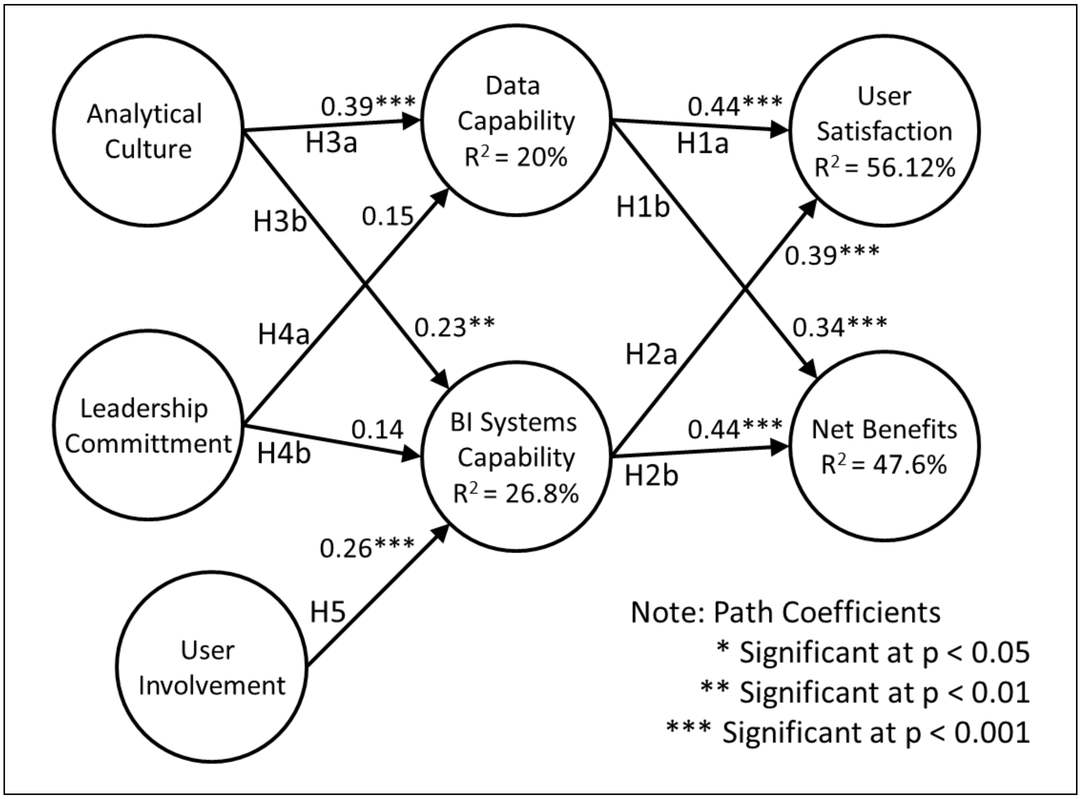

Figure 2. The Structural Model

CONCLUSION

This is one of the first comprehensive studies that evaluates the success of BI at organizational level using the IS Success model as its basis. The study found that both BI Capability factors, Data Capability and BI Systems Capability are significantly and positively associated with the IS success factors. This is in congruence with our arguments and confirms some of the earlier work while establishing these relationships for the first time with significant conviction. Managerial users of BI systems feel that availability of high quality data and functional/useful BI systems are precursors to a more satisfactory and effective performance in decision-making. Organizations who are in the forefront of providing BI support to their managerial workforce are likely to find that employees who have to make operational, tactical, and, perhaps even, strategic decisions are likely to be not only more satisfied with the support available to them for decision-making but that they are also more effective with the decisions they make and the results they obtain.

The strong relationship between Analytical Culture and both the BI Capability constructs means that having such an environment is a must for organizations building such capabilities. A culture of fact-based decision making is not only a good practice but it should also be constantly emphasized and communicated by senior executives. Making changes in culture, processes, and behavior and skills of employees takes time; so, starting early and taking deliberate steps to inculcate it would be key. The Leadership Commitment did not seem to make a significant contribution to either of the BI Capability variables. This result was counter to our expectations. It may be that Leadership Commitment (investments in BI projects, highly skilled BI workforce, and formal guidelines and policies) do not directly improve BI Capabilities, at least as perceived by the users. This relationship needs further investigation.

Finally, user involvement in the ongoing improvement of the BI systems does seem to be strongly associated with better BI Systems Capabilities. This is a novel contribution to the research on BI Success. Managerial users are generally likely to use the interactive capabilities of such systems. Involving them in the shorter usage-testing-feedback loops to enhance and customize the systems' capabilities can work towards much more effective decision-support which, in turn, can lead to more satisfied users and more effective decisions.

One of the limitations of this study is that the sample of respondents is a convenience sample. The survey was administered to an audience participating in a multi-day corporate seminar on BI strategy. Although the level of seniority of the respondents in order to answer the questions regarding the organizations they represented was appropriate, there may be a difference between this sample and our population characteristics. Also, the sample represents managers who self-enrolled or whose employer sponsored their enrolment in the seminar. It is possible that this selection bias may introduce discrepancies because the participants' value proposition of BI, based on their experiences and expectations with BI, may be different from that of our population.

Future research will follow a couple of new directions. We would like to extend our work by exploiting the country-level data that we have collected. We can examine the BI success dimensions of organizations across different countries which, according to Hofstede's indices of national culture, differ significantly. Additional data from currently represented countries and from other countries is being collected. Another direction is in developing a deeper understanding of the user involvement construct starting from the user involvement theory (Ives and Olson, 1984) and its interaction with the organizational factors, but by modifying the user involvement construct in the context of modern-day enterprise systems where on-going system evolution is the rule.

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