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Research Article

Predictors and Outcome of Business Intelligence System Implementation: A Perspective of Manufacturers in Malaysia

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Abstract: As information technology advances from time to time, Business Intelligence (BI) is becoming a powerful tool in decision making process in enterprise environment. A good decision support instrument should assist decision makers in planning and arranging good strategy to achieve company goals in today's dynamic business environment. This purpose of this study is to identify the predictors and outcome of BI system implementation for manufacturers in a developing country, Malaysia. Data was collected via questionnaire from manufacturing companies in Malaysia and Partial Least Square (PLS) of Structured Equation Modeling (SEM) was used to analyze the data collected based on the hypotheses derived from the research framework. Interestingly, technology compatibility, top management support, BI related cost and vendor accessibility are crucial predictors affecting the BI system adoption for Malaysian manufacturers. In addition, the implementation of BI has significant impact on firm performance.

Keywords: Business intelligence, environment, Malaysia, organization, performance, technology

INTRODUCTION

Information systems used in an organization are a reflection of the organization hierarchy. Usually, transaction processing systems are at the bottom of the hierarchy, followed by management information systems, decision support systems and lastly executive information systems sit on the top of the pyramid (Haag *et al*., 2010). However, from all the information systems deployed, data is the common item needed by every system regardless of its type. Data would be captured and stored endlessly as long as the system is still functioning well and the business is still going on. Organizations nowadays collect data with finer degree which is causing much larger volume of records stored (Chaudhuri and Narasayya, 2011). No matter how big or small an information system is, after some time, it will certainly gather a lot of data and the data size will forever keep increasing on top of that (Khan *et al*., 2009).

Now, the question coming up next is what are we going to do with the large data sets captured by the information systems? Instead of leaving the data unutilized, we have to make use of them to increase competency and sustainability. Chen *et al*. (2012) found that organizations from all sectors can gain decisive and advantage knowledge from the large data collected via Business Intelligence (BI) and analytics. Both academic and practitioners have been paying more attention towards subjects of BI particularly in big data analysis since last several years (Chen *et al*., 2012; Isik *et al*., 2013).

Due to the growing need to analyze large amounts of data, some organizations' conventional Decision Support System (DSS) have become ineffective in supporting service for fast, useful and quality information. It is hence crucial to seek for solutions to combine, access, store and analyze the tremendous amount of data and information with the aim to supply queries, complex reports and competitive information to firms' decision makers. According to Golfarelli *et al*. (2004), one of the potential ways for providing such an analytical tool is to adopt BI technology where BI has the capability to transform data into information and then into knowledge (Golfarelli *et al*., 2004).

From the few past researches as mentioned above, it is without doubt that more and more business world players are relying on BI to gain insightful knowledge in order to outperform competitors. As organization sustainability has become one of the major and long term agendas for most of the corporation, BI could be leveraged as one of the secret weapons to attain such goal (Petrini and Pozzebon, 2009). Although compared to organizations in developed countries the deployment rate of BI is low, some large Malaysian companies from different sectors have begun to deploy BI to increase firm's competitiveness (Ong *et al*., 2011).

Nonetheless, adopting technology to get better organization performance is never a smooth and simple process albeit the profound repayment may come along with the technology per se. In Malaysia context, many

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studies have found that there are failures and difficulties in implementing new innovations among enterprises regardless of industry background. For instance, Shahawai and Idrus (2010) identified that one of the international top vendors for ERP system failed to establish to bridge the gap between the requirements and characteristics of SME due to incompatibility of different organizational needs (Shahawai and Idrus, 2010). Also, the adoption of electronic business application by Malaysian companies is relatively slower compared to other countries due to cautions and skeptical on benefits in the new technology (Ang and Husain, 2012).

Likewise, implementing BI system is not an easy process entailing solely the procurement of software and hardware; instead, it is a complicated task demanding proper integration of infrastructure and resources over certain time of period (Yeoh and Koronios, 2009). BI system implementation failures may direct to financial instability and loss of competitive advantage (Grandhi and Chugh, 2013).

LITERATURE REVIEW

TOE framework: The TOE model identifies three aspects of an organization's context namely technology, organization and environment that influence the process by which it adopts and implements a technological innovation. Technology context should include both equipment/infrastructure as well as processes/strategy that concern a firm's information technology operation. While the organizational context refers to the characteristics and resources of the firm, including the firm's size, degree of centralization, degree of formalization, managerial structure, human resources, amount of slack resources and linkages among employees. The environmental context includes the size and structure of the industry, the firm's competitors, the macroeconomic context and the regulatory environment (Tornatzky and Fleischer, 1990). Because there is limited technology adoption model at firm level, over the years TOE has been widely applied in many empirical researches pertaining to assimilation and adoption of different types of new technology (Oliveira and Martins, 2011).

Resources based view: Wernerfelt (1984) proposed that resources of organization are as important as the products and services. Wernerfelt (1984) further exemplified some forms of resources such as technological and financial which when they are utilized correctly, it can help firm to increase performance. In other words, firm resources will influence company performance whereby a firm with more resources has better chance to achieve more competitive advantages (Wernerfelt, 1984). The view of resource-based was further supported by a study which suggested heterogeneity, imperfect mobility, ex ante limits to competition and ex post limits to competition are four cornerstones to firm's competitive advantage (Peteraf, 1993). Furthermore in a more recent paper, some researchers in fact advocated that technology resources should be presumed as digital business strategy where it could offer direction for the next generation of insights (Bharadwaj *et al*., 2013). That school of thought is consistent with one of the investigations proposed in this study where BI system may assist to impact company performance.

Contingency theory: Essentially according to the contingency theory, there should be no one best way to manage and lead an organization or make business decisions. In fact, the best way of doing it would be adjustments from time to time that go well with the condition and environment (Fiedler, 1965). The different situations such as structure, people, technology, strategy and culture that are experienced in management of organization and decision making process are named as 'contingency variables'. The focus of contingency theory is to build the most suitable business approaches to react to those contingency variables (Liang and Lu, 2013). Contingency theory anticipates firm performance is the result of 'fitness' between such variables and management process (Wiengarten *et al*., 2013). In that case, if all the factors mentioned above can be addressed prudently along the way of business process or making decision, then an organization should perform well (Sirmon and Hitt, 2009).

Balanced Scorecard (BSC): The Balanced Scorecard (BSC) is a dominant yet balanced technique for evaluating firm performance suggested by Kaplan and Norton (1992). According to Kaplan and Norton (1992), at the end of the day, whether an organization is considered performing good or bad, it can be assessed by answering four major questions: how do customers see us? What must we excel at? Can we continue to improve and create value? And how do we help shareholders? Thus, that makes BSC a comprehensive and balanced method to evaluate company performance where it does not only emphasize on financial performance (Kaplan and Norton, 1992). As time advances, beside overall firm performance, BSC is also commonly applied to evaluate the business benefits of a new technology deployment (Papalexandris *et al*., 2004). In a study to examine the RFID implementation and its impact on supply chain performance in logistic industry in China, Lin and Ho (2009) have adopted the performance measurements consist of financial and non-financial indices based on BSC (Lin and Ho, 2009). On the other hand, it looks feasible also to utilize balanced performance measurement in the terms of BI as it facilitates a multidimensional overview of an enterprise (Olszak and Ziemba, 2007).

Theoretical framework: The main purpose of this research is to identify the determinants affecting the Business Intelligence (BI) adoption among

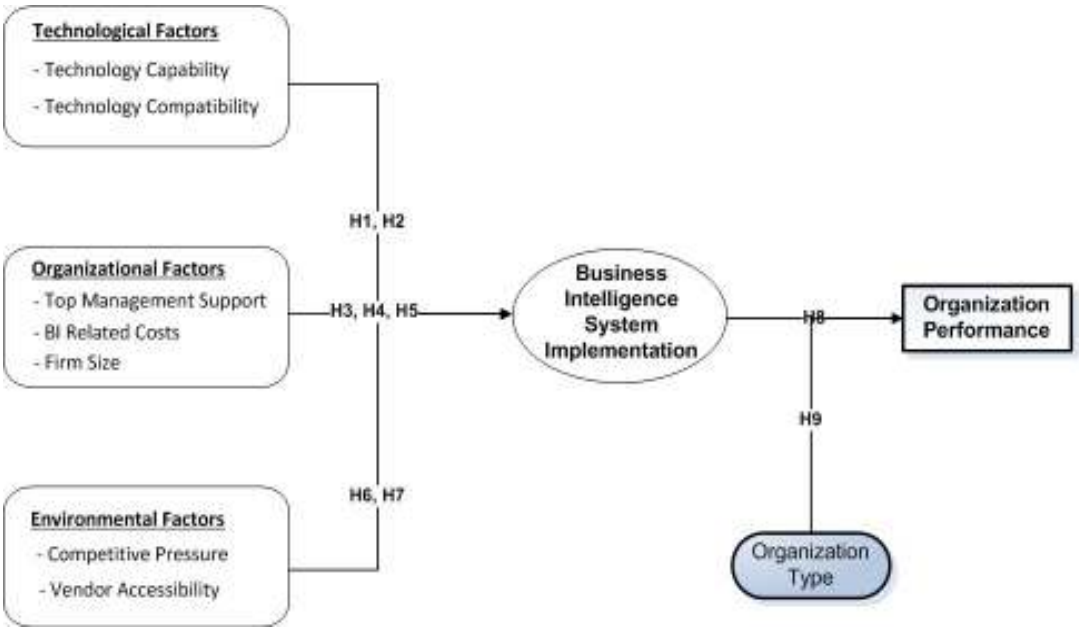

Fig. 1: Research framework

manufacturers in Malaysia. The conceptual model proposed is based on the Technology-Organization-Environment (TOE) framework where it includes the independent variables of technology capability, technology compatibility, top management support, BI related cost and competitive pressure. With the independent variables, this study attempts to examine influence of such factors towards the adoption of BI. At the same time, it would investigate the moderating affect brought by organization type in the framework. Past studies on the factors affecting BI adoption, technology capability, BI related cost and competitive pressure have created inconsistent evidence and limited researches have been done especially in the scope of Penang manufacturers. Therefore, this research attempts to identify the determining influence of these factors on BI adoption. Figure 1 depicts the Research Framework.

BI system implementation: BI is about storing, retrieving, transforming and analyzing the raw data, into dynamic and handy information in order to improve business decision (Azvine *et al*., 2006). Such explanation in previous statement is constant with BI's original definition by its inventor-Luhn. BI system can be described as any IT systems that can capture, access, convert and analyze the raw data and provide suggestion to make decision as output. A conventional BI system should consist of the below modules (Negash, 2004; Azvine *et al*., 2006; Olszak and Ziemba, 2007).

Extraction-transformation-load, ETL (data extraction tools): To transform data from transaction/information systems to data warehouse (Azvine *et al*., 2006).

Data warehouse, DW: To store for aggregated and analyzed data (Golfarelli *et al*., 2004).

On-line analytical processing, OLAP (analytic tools): To access, analyze and model business problems and share information that is stored in data warehouses (Olszak and Ziemba, 2007).

Data mining, DM (analytic and predictive tools): To discover various patterns, generalizations, regularities and rules in data resources (Negash, 2004).

Reporting and inquiring: To generate reports/queries as according to requirement (Azvine *et al*., 2006).

Integrated presentation: To provide information in graphical user interface and multimedia in a comfortable and intuitive form such as dashboard and cockpit (Baars and Kemper, 2008).

Organization performance: Richard *et al*. (2008) mentioned the method of Balance Scorecard (BSC) which measures financial performance, customer outcomes, innovation and internal processes provides a broader view for organizational effectiveness. That articulation is consistent with few research papers published across different industries. Hubbard (2006) proposed a conceptual framework called Sustainable Balanced Scorecard (SBSC) which is originated from BSC framework, to measure sustainable firm performance. Few years later, a survey based on the BSC model was conducted on senior personnel from the logistic industry found that, financial measures and customer satisfaction are 2 main performance indicators

for firm performance (Chia *et al*., 2009). Chen *et al*. (2010) have adopted the BSC framework to measure firm performance of navigational business in a research. Considering its application is a process similar to other business activity, hence it is possible to also discuss BI related process with methods of business performance measurement (Chen *et al*., 2010). In terms of business performance measurement, the most universally adopted balanced performance measurement model is the BSC (Lönnqvist and Pirttimäki, 2006). In that case, BSC model is a suitable model to be used to argue about organization performance particularly in this study.

Technology capability: When an organization would like to use a new technology, it is vital for the organization to judge if it has sufficient capability to acquire that new innovation. This is because, the soundness of the entire IT infrastructure is the backbone to facilitate the complete value chain enabled by the newly adopted system (Abdullabhai and Acosta, 2012). Some past studies have further supported that with better capability in terms of IT infrastructures and human capital, decision to deploy new technology by organization is significantly influenced. According to Pudjianto *et al*. (2011), both IT expertise and IT infrastructure have significant positive relationship with e-government assimilation in Indonesia (Pudjianto *et al*., 2011). Besides, organizations' abilities of human resources, software, hardware and connectivity are empirically proven related to their decisions to obtain and utilize new innovation in a study about e-commerce usage in tourism sector in Malaysia (Mohamed *et al*., 2008). As such, a hypothesis is put forward to reflect the relationship between technology capability and BI system adoption.

Hypothesis 1: Technology capability is positively related to business intelligence system adoption.

Technology compatibility: The adoption of new IT system may bring apparent change to organization work practices and business process, therefore compatibility is an important issue to be addressed before a technology is acquired to avoid resistance to change (Premkumar, 2003). Firm must make sure the purpose of adopting new system must not contradict with the cultures, beliefs and values of company. Compatibility was found to have a very significant impact on the adoption decision. The compatibility of a particular adoption with a business's work style environment will portray a favorable impression in decision-makers' minds and hence it will have a higher chance of survival in the organization because they will face less employee resistance when implemented (Ungan, 2004). The factor of compatibility was proven having apparent positive relationship with Internet based technology adoption in an empirical research done among Malaysia companies (Tan *et al*., 2008). Further, the technical compatibility was evidenced to positively affect on IT adoption in a study about RFID adoption for companies in Korea (Park and Rim, 2011). Therefore, a hypothesis is recommended to test the relationship between technology compatibility and BI system implementation.

Hypothesis 2: Technology compatibility is positively related to business intelligence system adoption.

Top management support: The support of top management has been tested in many technology adoption studies before. Top management support has been proven considerably determining the decision to invest and utilize a new innovation especially research based on TOE model. An ERP implementation study concluded that the top management decision is the extremely important factors for the ERP system implementation success in Malaysia (Jafari *et al*., 2006). Thiesse *et al*. (2011) advocated top management support positively influences the adoption of RFID (Thiesse *et al*., 2011). So, a hypothesis is planned to examine the relationship between top management support and BI system deployment.

Hypothesis 3: Top management support is positively related to business intelligence system adoption.

Business intelligence related cost: Perceived financial cost is always a barricade to innovation. That has been proven true in a study on Third Generation (3G) mobile services that perceived cost negatively influences the attitude and intension of use towards 3G value added services (Kuo and Yen, 2009). Costs to implement technology still remain the number-one barrier for technology adoption (Goldzweig *et al*., 2009). Cost has a negative effect on consumers' intention to use of m-commerce (Wei *et al*., 2009). Thus, a hypothesis is proposed to investigate the relationship between BI related cost and BI system adoption.

Hypothesis 4: Business Intelligence (BI) cost is negatively related to business intelligence system adoption.

Firm size: The size of a firm is found as a major factor determining the implementation of ERP (Pan and Jang, 2008). There is positive relationship between organization size and e-marketplace adoption in New Zealand (Qirim, 2005). Hence, firm size seems to have influenced the technology adoption regardless of geographical location. A hypothesis is planned to evaluate the relationship firm size and BI system utilization.

Hypothesis 5: Firm size is positively related to business intelligence system adoption.

Competitive pressure: Failure to implement a new IT system risking a loss of new customers who judge that one technology is less sophisticated compared to others (Khalifa and Davison, 2006). Meanwhile, environment factor in the senses of customer pressure and competitive edge has positive relationship with adoption rate (Wen *et al*., 2009). Thiesse *et al*. (2011) concluded that suppliers and customers within the supply chain are the driving forces of information technology adoption because the new technology can serve as a means for closer integration of organizations along the line of supply chain. Therefore, a hypothesis is suggested to test the relationship between competitive pressure and BI system utilization.

Hypothesis 6: Competitive pressure is positively related to business intelligence system adoption.

Vendor accessibility: Schniederjans and Yadav (2012) have proposed that there is significant relationship between trust factor which was attributed to vendor and consultant process mode with the successful of ERP implementation. If vendor is not accessible easily, it could influence the decision of acquiring new technology (Schniederjans and Yadav, 2012). Researchers have proven that trust is a factor affecting the intention of usage (Benamati *et al*., 2010). So, a hypothesis is proposed to examine the relationship between vendor accessibility and BI system implementation.

Hypothesis 7: Vendor accessibility is positively related to business intelligence system adoption.

Business intelligence system and firm performance: BI was found to be contributed to organization performance in intangible form particularly from internal process and learning growth perspectives (Pirttimäki *et al*., 2006). BI system has helped Thailand Higher Education Department to gather and manage effectively the resources of higher learning institutions in the country (Kleesuwan *et al*., 2010). Established organizations have attained considerably superior business payback from BI (Raber *et al*., 2013). Based on those results, a hypothesis is suggested to examine relationship between BI system adoption and organization performance.

Hypothesis 8: Business intelligence system adoption is positively related to firm performance.

Organization type moderates the relationship between business intelligence system adoption and firm performance: Organization type is one of the key factors that affect the technology adoption decision as well as the adoption impacts on company performance. Past empirical studies based on different geographical locations have evidenced that different management structures and environments would have different impacts on company performance be it financially and non-financially (Sánchez-Ballesta and García-Meca, 2007; Jackling and Johl, 2009). In terms of organization performance as a result of technology acquisition, some researchers have proven that new innovation does improve company performance to certain level (Shrader and Siegel, 2007; Park and Rim, 2011). Nonetheless, such findings contradict with the outcome of a empirical paper conducted in Taiwan (Tsai and Wang, 2008). In fact according to Tsai and Wang (2008), the benefits of new innovation adoption on company performance improves with the firm's research and development effort instead of just plainly from technology adoption per se. A hypothesis is proposed to investigate if organization type moderates the relationship business intelligence system adoption and firm performance.

Hypothesis 9: Organization type moderates the relationship between business intelligence system adoption and business firm performance.

METHODOLOGY

The manufacturing sector in Malaysia has been contributing the biggest share in the total GDP of Penang for past 10 years, which is almost 50% of the total GDP in average (Ooi and Che Yusof, 2013). In actual fact, manufacturing sector is very important in the context of Penang economy as well as it is contributing significantly to the total manufacturing investment in the national level (MIDA, 2012). Therefore, the population frame of this study was the manufacturing companies operating within the state of Penang. These manufacturers were picked based on certain criteria which consist of electrical and electronics including telecommunication, machinery and engineering products, metal products, food beverage, plastic products, paper and printing, furniture and fixtures and others. As these industries have accounted certain fractions of manufacturer overall industry which located in Penang. Primary data and questionnaire method are the two major data sources used in this study. By the way, purposive sampling method is adopted in the survey to determine the sample of survey and make certain this investigation is scientific enough as well as objective. Purposive sampling is a type of non probability sampling in which decisions concerning the organization to be included in the sample based on certain criteria which most likely to contribute appropriate data in term of relevance and depth (Azam *et al*., 2013). The questionnaire items

were adopted and adapted from Negash (2004), Olszak and Ziemba (2007), Li *et al*. (2008), Hawking and Sellitto (2010), Pudjianto *et al*. (2011), Park and Rim (2011), Thiesse *et al*. (2011), Zailani *et al*. (2009) and Schniederjans and Yadav (2012).

All questions were measured using 5-point Likert scale to signify level of agreement (1-Strongly Disagree, 5-Strongly Agree). The collected data would be analyzed using Structural Equation Modeling (SEM) and PLS (Partial Least Square) based on SmartPLS software in order to investigate the relationship among the variables. In detail, the responded data would be tested from the perspectives of reliability, validity (evaluation of measurement model) and hypothesis testing (evaluation of structural model).

RESULTS

A total of 1000 questionnaires were sent out via email to manufacturing firms in Penang state. In total, there were 116 responses successfully collected which was equivalent to 11.6% of response rate. Most of the respondents were senior and mid level managers where the total contribution from these 2 groups were 56% from 116 respondents. It is found that age group between 36 to 40 years old was the majority among the respondents which comprised 35.3% from the total. At the same time, there were only 7 respondents whose age was between 21 to 26 years old. On the other hand, there were 75 out of 116 companies implemented BI from 3 to 10 years. As for the choice of BI vendor,

Table 1: Summary of respondent's profile

Variables	Description	Frequency	(%)
Gender	Female	69	59.5
	Male	47	49.5
Age (years)	26-30	7	6.0
	31-35	20	17.2
	36-40	41	35.3
	41-45	32	27.6
	Above 45	16	13.9
Highest level of education	Certificate/diploma	7	6.0
	Bachelor degree	46	39.7
	Master degree	51	44.0
	PhD/doctorate	11	9.5
	Others	1	0.8
Current job position	Owner/board chairman/president	6	5.2
	CEO/COO/CFO	10	8.6
	Director/MD/ED	15	12.9
	Senior manager	37	31.9
	Mid level manager	28	24.1
	Junior manager	20	17.2
Years of service	Less than 5	22	19.0
	5-10	36	31.0
	11-15	31	26.7
	16-20	19	16.4
	Above 20	8	6.9
Organization type	MNC	45	38.8
	Local companies	71	61.2
Type of industry	Electric and electronics inc. telecommunication products	26	22.4
	Machinery and engineering	22	19.0
	Metal products	10	8.6
	Food and beverage	11	9.5
	Plastic products	11	9.5
	Paper and printing products	12	10.3
	Furniture and fixtures	10	8.6
	Other	14	12.1
Annual sales turnover (ringgit Malaysia)	Less than 250 K	0	0.0
	250 K-1 M	11	9.5
	1-5 M	39	33.6
	5-10 M	32	27.6
	Over 10 M	34	29.3
Years implemented BI (years)	Less than 3	15	12.9
	3-5	33	28.4
	5-10	42	36.3
	Over 10	26	22.4
BI vendor	SAP	40	34.5
	Microsoft	40	34.5
	Oracle	31	26.7
	Jasper soft	2	1.6
	Hyperion	1	0.9
	Bizzscore	1	0.9
	Other	1	0.9

the top three most popular BI vendors were SAP, Microsoft and Oracle based on the data collected. Table 1 shows a summary of the respondents' profile.

Measurement model: The measurement model represents the relationship between latent variables and measurable variables in questionnaire. Factor loadings, Composite Reliability (CR), convergent validity and discriminant validity were assessed in order to test the measurement model of the present research (Suki *et al*., 2011). Factor loadings refer to the individual item reliability measure. All reliability measures from this research (Table 2) were higher than the recommended level of 0.5, hence that indicated all the questions were meant for a particular variable. From the Table 2, it is observed that the lowest value of CR came from Vendor Accessibility which was 0.844. At the same time, the Average Variance Extracted (AVE) of Vendor Accessibility (0.520) and Firm Performance (0.574) were quite low. However, all values have exceeded the recommended threshold values where CR value must bigger than 0.7 and AVE value must greater 0.5 (Gefen *et al*., 2000). Thus in conclusion, the measurement model of this study possessed sufficient convergent validity. Table 2 shows the Convergent Validity of Constructs (Fig. 2).

Table 2: Convergent validity of constructs

Construct	Item	Loading	AVE	CR
BI related cost	BICost01	0.814	0.715	0.909
	BICost02	0.889		
	BICost03	0.864		
	BICost04	0.813		
BI system implementation	BISys01	0.812	0.659	0.931
	BISys02	0.807		
	BISys03	0.820		
	BISys04	0.834		
	BISys05	0.799		
	BISys06	0.827		
	BISys07	0.781		
Competitive pressure	ComPres01	0.821	0.764	0.951
	ComPres02	0.840		
	ComPres03	0.887		
	ComPres04	0.897		
	ComPres05	0.903		
	ComPres06	0.893		
Firm performance	FirmPerf01	0.730	0.574	0.931
	FirmPerf02	0.710		
	FirmPerf03	0.790		
	FirmPerf04	0.800		
	FirmPerf05	0.706		
	FirmPerf06	0.804		
	FirmPerf07	0.724		
	FirmPerf08	0.782		
	FirmPerf09	0.790		
	FirmPerf10	0.731		
Firm size	FirmSize01	0.924	0.902	0.973
	FirmSize02	0.966		
	FirmSize03	0.965		
	FirmSize04	0.942		
Technology capability	TechCap01	0.856	0.720	0.928
	TechCap02	0.833		
	TechCap03	0.850		
	TechCap04	0.877		
	TechCap05	0.827		
Technology compatibility	TechCom01	0.849	0.709	0.907
	TechCom02	0.851		
	TechCom03	0.837		
	TechCom04	0.832		
Top management support	TopMan01	0.820	0.713	0.925
	TopMan02	0.891		
	TopMan03	0.874		
	TopMan04	0.839		
	TopMan05	0.796		
Vendor accessibility	VenAces01	0.775	0.520	0.844
	VenAces02	0.693		
	VenAces03	0.747		
	VenAces04	0.684		
	VenAces05	0.704		

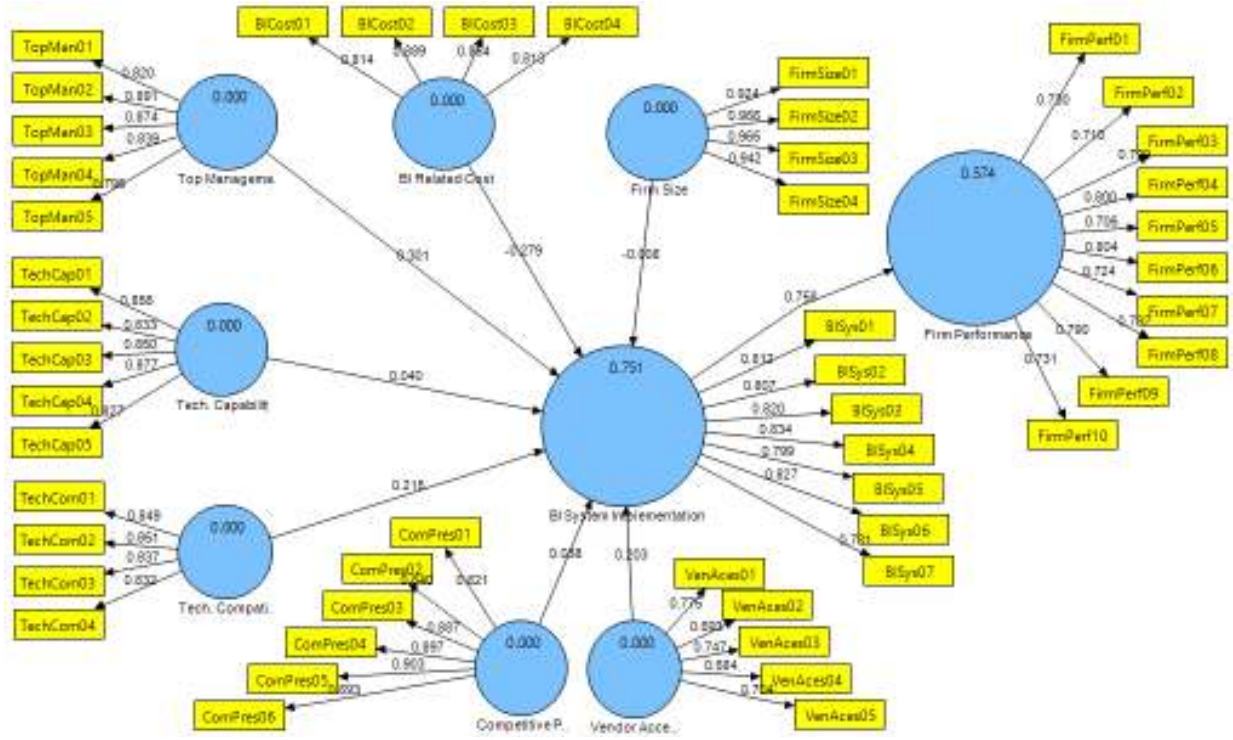

Fig. 2: Measurement model

Table 3: Discriminant validity of constructs

	BI related cost	BI system implement	Competitive pressure	Firm performance	Firm size	Technology capability	Technology comp.	Top management support	Vendor access
BI related cost	**0.846**								
BI system implementation	-0.674	**0.812**							
Competitive pressure	-0.528	0.644	**0.874**						
Firm performance	-0.570	0.758	0.714	**0.758**					
Firm size	-0.008	0.164	0.021	0.028	**0.950**				
Technical capability	-0.457	0.692	0.702	0.664	0.213	**0.849**			
Technical compatibility	-0.543	0.764	0.683	0.637	0.288	0.809	**0.842**		
Top management support	-0.524	0.763	0.615	0.643	0.246	0.786	0.819	**0.844**	
Vendor accessibility	-0.403	0.579	0.483	0.481	0.119	0.436	0.466	0.426	**0.721**

Diagonal values in bold represent the square root of the AVE

In order to test the discriminant validity, the value square root of AVE would be compared to the squared correlations between each constructs. In Table 3, the correlation matrix for the construct was listed. The diagonal elements in the "correlation construct" (in bold) were the value for square root of AVE. Off-diagonal elements were the correlation among constructs. From the results (Table 4), it showed that AVE square root values were greater than any squared correlation between constructs. As such, the assessment of discriminant validity for this study can be concluded as all constructs possessed adequate validities.

Structural model: The variance explained R2 for variable BI System Implementation was 0.751 which represented 75.1% of the variance in BI System Implementation could be explained by the associated independent variables. Meantime, the variance explained R2 Firm Performance was 0.574 which indicated 57.4% of the variance in Firm Performance can be explained by the BI System Implementation. Independent variables such as Technology Capability (H1: $\beta = 0.042$, $p>0.05$), Firm Size (H5: $\beta = -0.001$, $p>0.05$) and Competitive Pressure (H6: $\beta = 0.039$, $p>0.05$) were not significantly related to BI System

Table 4: Summary of hypotheses testing

Hypothesis	Path	Standard β	S.E.	t-value	Supported
H1	Technology capability -> BI system implementation	0.042	0.085	0.475	No
H2	Technology compatibility -> BI system implementation	0.213	0.090	2.375*	Yes
H3	Top management support -> BI system implementation	0.299	0.097	3.117**	Yes
H4	BI related cost -> BI system implementation	-0.278	0.067	4.145**	Yes
H5	Firm size -> BI system implementation	-0.001	0.046	0.165	No
H6	Competitive pressure -> BI system implementation	0.039	0.067	0.570	No
H7	Vendor accessibility -> BI system implementation	0.203	0.069	2.949**	Yes
H8	BI system implementation -> Firm performance	0.756	0.054	13.715**	Yes
H9	BI system implementation * Org. type -> firm performance	-0.083	0.100	1.036	No

t-values*: >1.96 ($p<0.05$); t-values**: >2.58 ($p<0.01$); S.E.: Standard error

Implementation. However, independent variables such as Technology Compatibility (H2: $\beta = 0.213$, $p<0.05$), Top Management Support (H3: $\beta = 0.299$, $p<0.01$) and Vendor Accessibility (H4: $\beta = 0.203$, $p<0.01$) were all positively and significantly associated to BI System Implementation while BI Related Cost (H4: $\beta = -0.278$, $p<0.01$) was negatively and significantly related to BI System Implementation. Meanwhile, BI System Implementation was significantly associated to Firm Performance (H8: $\beta = 0.756$, $p<0.01$). Lastly, the moderating effect of Organizational Type with BI System Implementation and Firm Performance was (H9: $\beta = -0.083$ $p>0.05$). As shown in Table 4, H2, H3, H4, H7 and H8 were supported while H1, H5, H6 and H9 were not supported.

DISCUSSION

Hypothesis 1 has suggested that technology capability is positively affecting the BI implementation. Nonetheless from the result of tested hypothesis, it showed that technology capability (H1: $\beta = 0.042$, $p>0.05$) has not influenced the implementation of BI system adoption. Albeit the result is seemed contradicting with the TOE framework, some past researchers have found that technology capability in terms of infrastructure is not the determinant for technology adoption. In year 1995, an empirical study on information system adoption in small business has posited that firms adopted information system did not because of the existing infrastructure (Thong, 1999). On the other hand, such outcome is consistent with another research result carried out by Pan and Jang (2008) where technological infrastructure was proven insignificantly affect the decision for ERP adoption among Taiwan's communication companies. When organizations have attained high implementation of IT structure, technology capability eventually a no-factor determining IT adoption (Pan and Jang, 2008). Likewise, that seems to be reason justifying why such insignificant result was found for technology capability in the current study. It is learnt that 87.1% of the total surveyed firms have implemented BI system for at least 3 years. That is why when it comes to technological capability, it is no longer perceived as the major factor deciding the BI system adoption.

Hypothesis 2 has proposed that there is positive relationship between technology compatibility and BI implementation. The result of this hypothesis showed it has a β-value of 0.213 with $p<0.05$. Thus, H2 is accepted as there is a significant positive relationship between technology compatibility and BI system adoption. This is no surprise as the tested hypothesis from this independent variable is persistent with the findings from past researches. That outcome is supported in another paper on adoption of internet based IT which the author concluded that technical compatibility is an important factor for technology innovation based on the data collected (Tan *et al*., 2008). On the other hand, Ungan (2004) has proven that compatibility is one of the major factors determining the adoption of manufacturing best practice. The findings from Ungan (2004) are crucially related to the present study. As the targeted population of this research is the manufacturing companies in Penang state, therefore the findings from Ungan (2004) helps to explain why technological compatibility is perceived as one of the factors influencing the decision of BI implementation. As mentioned before, most of the times implementation of new system may cause changes to work practices and business process, therefore compatibility is a vital element to be discussed to avoid resistance to change.

Hypothesis 3 has recommended that top management support is positively related BI implementation. Based on the result of tested hypothesis, it proved that top management support (H3: $\beta = 0.299$, $p<0.01$) has influenced the implementation of BI system adoption. Therefore, H3 is accepted based on the responded data. The factor of top management support has been proven significantly influencing the decision to invest and utilize a new innovation especially from researches based on TOE model. For example, an ERP implementation study concluded that the top management decision is the extremely important factor for the system implementation success in Malaysia (Jafari *et al*., 2006). Such result is further backed by a later research on RFID implementation throughout few countries. Thiesse *et al*. (2011) posited that top management support has positive relationship with the adoption of RFID. The findings from pass studies as well the current research are fairly consistent

because top management support is the source and force for organization resources. Therefore, support and commitment from top management are always imperative to the success of technology implementation (Teo *et al*., 2009).

Hypothesis 4 has suggested that there is negative relationship between BI related cost and BI implementation. The tested hypothesis showed it has a β-value of 0.213 with $p<0.05$. Thus, H4 is accepted as there is a significant negative relationship between BI related cost and BI system implementation. As perceived financial cost is always a barricade to innovation, therefore the finding from the present research is consistent with that notion which has been suggested by past studies. For instance, it has been confirmed true in a study on Third Generation (3G) mobile services that perceived cost negatively influences the attitude and intension of use towards 3G value added services (Kuo and Yen, 2009). Not just that, it is summarized from a meta analysis that costs to implement technology still remain the number-one barrier for technology adoption (Goldzweig *et al*., 2009). In fact, that is further supported with an empirical study carried out to investigate drivers for m-commerce adoption in Malaysia (Wei *et al*., 2009). Sometime, the investment for information system implementation could be huge, especially the price for technology adoption such as BI is never going to be cheap in any senses. In normal instance, the less expensive the technology, the more likely it will be acquired (Sharma *et al*., 2007). As such, the result from this tested hypothesis is supported with the findings and literatures from previous researches.

Hypothesis 5 has recommended that firm size is positively influencing the BI adoption. However based on the result of the tested hypothesis, it indicated firm size (H5: $\beta = -0.001$, $p>0.05$) has not affected the implementation of BI system adoption. Thus based on the collected data, H5 is rejected. Such outcome contradicts with the findings from other researchers that organization size does significantly influence the decision of system adoption (Qirim, 2005; Pan and Jang, 2008). Although from past studies it is found that large organization would adopt more new technology compared to smaller firms, the insignificant outcome from this hypothesis is not without precedence as a research on e-commerce adoption in tourism sector in Malaysia showed that firm size does not affect the decision of technology implementation (Mohamed *et al*., 2008). Such result was further confirmed by another paper of RFID adoption (Thiesse *et al*., 2011). According to Thiesse *et al*. (2011), over the years, established standards in technology platform have reduced the risks of technology adoption which lowers the barrier of new technology deployments and hence it makes adoption more attractive even to smaller firms. That thought is consistent with the latest trend in software development industry. Scalability is one of most highlighted features by the software makers nowadays. In layman terms, a good software system must not only work well for large corporation. In fact, good software must be affordable and useable by small and medium firms as well.

Hypothesis 6 proposed that there is positive relationship between competitive pressure and BI implementation. The tested hypothesis showed it has a β-value of 0.039 with $p>0.05$. Thus, H6 is rejected as there is no significant positive relationship between competitive pressure and BI system implementation. At first glance, the outcome from the hypothesis seems to go against the theory TOE framework as most of the past researches have proven the other way round. For examples, Khalifa and Davison (2006) concluded that customer and competitor pressures are the drivers for adopting the electronic trading system. That thought is consistent with some other researches about technology implementation where external pressure are positively related to new technology engagement (Wen *et al*., 2009; Park and Rim, 2011; Thiesse *et al*., 2011). Nevertheless, Zailani *et al*. (2009) has evidenced with an empirical research on e-business deployment that external and customer pressures do not significantly influence the technology adoption (Zailani *et al*., 2009). By the way, Pan and Jang (2008) have also found that competitive pressure has little influence to affect the decision on adoption of ERP based on a study conducted with Taiwan communication industry. One of the possible reasons found to explain such phenomenon is that competition is more significant during the initiation stages of adoption but less important for the assimilation stages of adoption (Zhu *et al*., 2006). As in the context of the present study, it is believed that the internal organizational factors such as the support of top management and the cost of BI (as discussed above) are more important rather than the external factor of competitive pressure in terms of BI system implementation.

Hypothesis 7 recommended that there is positive relationship between vendor accessibility and BI implementation. Based on the result of tested hypothesis, it showed that vendor accessibility (H7: $\beta = 0.203$, $p<0.01$) has influenced the implementation of BI system adoption. Hence, H7 is accepted based on the data gathered. The output of such tested hypothesis is persistent with findings from other studies. For instance, a paper researching IT adoption concluded there is significant relationship between trust factor which was attributed to vendor and consultant process mode with the successful of ERP implementation (Schniederjans and Yadav, 2012). In a related study integrating trust with Technology Acceptance Model (TAM), the researchers have proven that trust is a factor affecting the intention of usage, thus it leads to adoption (Benamati *et al*., 2010). By the way, a meta analysis

about IT adoption for small and medium firms posited that the help of expertise, consultants, vendors and their quality is one of the most important aspects of the technology adoption process within companies (Ghobakhloo *et al*., 2012). In other words, if vendor is not accessible easily, it could influence the decision of acquiring new technology.

Hypothesis 8 has proposed that there is positive relationship between BI system implementation and firm performance. Based on the result of tested hypothesis, it showed that BI system adoption (H8: $\beta = 0.756$, $p<0.01$) has influenced the firm performance. Therefore based on the data gathered, H8 is accepted. The finding of such tested hypothesis is consistent with past studies researching on impacts of BI system implementation. In a case study to evaluate Business Intelligence (BI) output based on Balanced Scorecard (BSC), Pirttimäki *et al*. (2006) concluded that BI did contributed to organization performance in intangible form particularly from internal process and learning growth perspectives (Pirttimäki *et al*., 2006). Also, in a more recent empirical study, it is found that established organizations have attained considerably superior business payback from BI (Raber *et al*., 2013). Based on the collected data, no doubt BI system has improved the firm performance both in the perspectives of financial and non-financial. The part that BI system has contributed most is its ability to help decision makers to make good decisions, especially in the real business world where changes can take place in every now and then. As what contingency theory has anticipated, firm performance is the result of 'fitness' between contingency variables and management process (Liang and Lu, 2013; Wiengarten *et al*., 2013). So with the assistance of BI system in making decision according to environmental changes, firm is able be more adaptive, agile and flexible. On the flip side, the significant result from this hypothesis has further supported the Based View (RBV) which suggests that organization performance is affected by its competitive advantages which determined by the utilization resources and capabilities. In this case, organizations responded has utilized the internal resources of technical to improve firm performance. In fact, resources from technological perspective were proven one of the prevailing sources helping to increase firm performance (Wernerfelt, 1984).

Hypothesis 9 has suggested that organization type moderates the relationship between business intelligence system adoption and firm performance. The tested hypothesis showed it has a β-value of -0.083 with $p>0.05$. Thus, H9 is rejected as organization type does not moderate the relationship between BI system implementation and firm performance. Such finding contradicts with past researches where researchers have found that different management structures and environments would have different impacts on company performance be it financially and non-financially (Sánchez-Ballesta and García-Meca, 2007; Jackling and Johl, 2009). Tsai and Wang (2008) have proven that company performance as the result of technology adoption was not solely moderated by the organization culture and structure based on the outcome of their empirical paper conducted in Taiwan. Instead of management structure and culture, the extent how firm can gain competitive advantage after adopting new technology, actually depends on how extensive the firm spends the effort on research and development on the technology per se.

Implications: Generally, the current study has aided to develop groundwork for the study of BI system implementation and its impact from firm performance perspective. More or less, the developed basis has generated some knowledge and arguments to organization stakeholders such as employer/decision makers, BI system users and BI vendors to understand the factors that affecting BI adoption and its perceived business values. From the findings of this research, it has found that factors such as technology compatibility, top management support, BI cost and vendor accessibility have significant relationship with BI system implementation. From employer's point of view, the significant effect of technology compatibility indicates that change management for adopting a new technology is a crucial issue to be handled prior to acquisition of any technologies. Thus probably it is a good idea to conduct a compatibility assessment before adopting a new technology. That way, the problem of resistant to change can be monitored and reduced to the least effect. Only when issues and problems can be minimized, the BI system implementation could only produce the maximum benefits as perceived. Otherwise, if more time would have to be spent on dealing with issues, then it may defeat the purpose of deploying new innovation.

In terms of BI related cost, that should provide some indications to BI vendors who wish to get more sales on BI business. The findings from this study indicate that the investment cost is negatively related to implementation of BI system. That means BI cost is apparently a great barricade to those potential adopters. If that is the case, proposal would be suggested from this study to those BI vendors, they have to find out ways and means to mitigate the barrier of financial cost. For instance, one way of doing it is to adopt the scalability strategy as elaborated in earlier section. BI vendors should only propose solution that is actually needed by clients. When a BI system package is in a smaller scale, relatively the cost of implementation would be reduced. Besides, the BI vendors can also recommend longer time of deployment period or implementation with multiple phases. When the whole implementation schedule is in multiple phases, the

investment cost can be spread up into longer periods, thus the cost can be perceived as lower compared to one time cost.

BI vendors should pay attention to the service quality as the current study has shown that vendor accessibility is a vital factor significantly determining the BI adoption among manufacturing firms in Penang. Overall, despite the responded organizations are satisfied with the knowledge and quality provided by the BI vendors thus far, there is one item that most of the responders could not agree on. It found that majority of the mangers disagreed that BI vendors or consultants are honest to reveal everything about the BI system including its disadvantages and limitations. Obviously, this is an ethical issue that the BI vendors must look at it seriously. A long lasting and sustainable business relationship is always built on the foundation of human virtue such as trust, honesty and mutual respect. That means, there is no 'fast food' or 'touch and go' kind of business relationship. As such, BI vendors should think a way to stress on this point or at least to reduce the perception from clients that they are not honest when dealing with limitation.

CONCLUSION

Thus far, the present research has concluded that these three factors: technology compatibility, top management support and vendor accessibility have significant positive relationship with BI system implementation while BI investment cost is negatively related to BI adoption. Furthermore, this study has also evidenced that the BI system implementation has significant relationship with the firm performance. Albeit BI system is a powerful tool that able to help to increase firm performance and much have been talked about of its business values, there is only limited studies that try to link the driving factors for adoption and its impact supported with empirical data. As such, this study intents to bridge the gap by revealing the antecedent and outcome of implementation of BI system. While the investment on BI might be still high, there are ways and means that both clients and BI vendors can compromise and collaborate to bring down the cost. This is particularly important when everyone is aware of the benefits and values that BI system can bring to an organization. With the competitive advantage gained from BI system, firms should be more confident to face new challenge in an ever changing business world.

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