Understanding Business Intelligence and Analytics System Success from Various Business Sectors in Indonesia

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Abstract—Many studies have shown the impact of the Business Intelligence and Analytics (BI&A) system on decision-making. Many organizations have invested heavily in BI technology and the growth of analytical skills and made the BI&A system a strategic priority over the last eight years by citing it as the largest IT investment. The research aims to determine the relevant constructs contributing to the organization's BI&A system success. Survey research is applied to collect quantitative data for the research questions. The questionnaire is developed in English, which is translated into bahasa Indonesia later. The research obtains 208 decision-makers who use and utilize the BI&A system in various business sectors in Indonesia to achieve this goal. Then, PLS-SEM is used for measurement validation and hypothesis testing. About 8 out of 11 hypothesized relationships between 7 success factors are significantly supported. The findings demonstrate that the model constructs significantly improve decision-making quality in the BI&A system environment. Service quality is found to be the highest predictor of system use. Meanwhile, information quality is the highest predictor of user satisfaction. The research presents practical implications for organizations to adopt the essential factors of BI&A system finding to realize organizational success. Moreover, organizations that have already implemented the BI&A system can use the research as a theoretical basis to measure the ability of the BI&A system to improve decision-making quality.

Index Terms—Business Intelligence, Analytics System, Business Sectors

I. INTRODUCTION

THE amount of data and information generated daily increases continuously. It forces organizations to rely on external knowledge and information to enhance their innovation and performance [1]. Organizations store these data and extract valuable information and knowledge to help business leaders to understand individual demands and make informed decisions [2]. In both literature and business, the field of Business Intelligence and Analytics (BI&A) system has become important over the past two decades. BI&A system can be understood as a set of tools, technologies, applications, and processes for gathering, storing, accessing, and analyzing data to generate useful business information and help users to make better decisions [3–5].

Many organizations have invested heavily in BI technology and the growth of analytical skills. Hence, it has made the BI&A system a strategic priority over the last eight years, citing it as the largest IT investment. According to the latest forecast by Gartner Inc., the overall BI&A system spending grew by 10.4% to $24.8 billion in 2019 [6]. For the past two decades, research in the adoption, utilization, and success of BI systems has increased significantly [7]. In addition, many organizations have also recognized the ability of the BI&A system to produce insights and knowledge from both external and internal sources [8]. The advantages of data-driven decision-making improve efficiency and business value [9–11]. Organizations that adopt data-driven decision-making practices have higher performance [11–14]. BI&A system provides input to strategic and tactical decisions for senior

managerial levels, and it helps lower managerial levels to do their day-to-day work [15]. Meanwhile, outputs of the BI&A system forecast future trends based on historical results on a strategic level and become a basis for decision-making to optimize actions for overall company performance on a tactical level and just-in-time analysis of departmental performance on an operational level [16].

Despite the growing investment in the BI&A system, not all investments are successful. Previous research has shown that many organizations fail to reap the benefit after implementing BI&A system [5, 17–20]. Many studies have shown the impact of the BI&A system on decision making. For example, the study on the impact of the BI system on performance finds that there is an insignificant relationship between BI use and decision quality and between decision quality and performance. It investigates the direct and indirect effects of BI management quality on managerial decision-making quality and confirms that BI management quality has positive direct and indirect effects on data quality, information quality, and scope of BI solution [21]. However, it is still unclear how the system and the resulting information will support decision-making in BI systems literature.

The research attempts to answer the recommendation for future research conducted by previous researchers. Their review of the research is regarding the last two decades on the adoption, utilization, and success of the BI system. It evaluates the success of the BI system on its impact on organizational decision-making using the top management support and Information System (IS) success model grounded with decision theories [7]. Information is critical for managerial decision-making, and the BI&A system is typically designed to support it. So, it will be relevant to evaluate decision-making performance largely missing in BI&A system research.

Moreover, to the best of the researchers' knowledge, little or no research has examined the importance of top management support in contributing to decision-making, especially in Indonesia. Previous research focuses on the technical context, such as data warehouse development and Online Analytical Processing (OLAP), and design and implementation of the system in the organizations to demonstrate difficulties encountered [22–24]. However, the BI&A system is usually intended to decrease ambiguity in the decision-making process and assist decision-making in the organizations effectively. Hence, it is pertinent to measure the benefit of the BI&A system on decision-making quality and justify the investment in the BI&A system.

The research identifies constructs to measure the decision quality as decision-makers use the BI&A system in organizations to understand how the processes and the resulting data support the decision-making of the BI&A system. The researchers believe that it is crucial for system use and user satisfaction which ultimately contributes to the success of the BI&A system in organizations. Moreover, top management support is most widely cited as a success factor of IS implementation. Therefore, the researchers add it as an additional variable.

Moreover, the research seeks to answer: (1) What are the relevant variables that contribute to the success of an organization's BI&A system? (2) Does top management support contribute to the success of the BI&A system? (3) Does the BI&A system improve the quality of managerial decision-making, and if so, how? Based on the research questions, the specific objectives are to measure and validate the relevant variables that contribute to the success of an organization's BI&A system using IS success model augmented with additional constructs like top management support. Then, the research also aims to understand the relationship between top management support and BI&A system success and identify constructs to understand whether the BI&A system improves decision-making quality. The research develops hypotheses concerning how these constructs impact the success of the BI&A system to achieve these objectives.

II. LITERATURE REVIEW

A. Business Intelligence and Analytics (BI&A)

According to recent studies and business practices, the BI&A system helps organizations to create value and achieve a competitive advantage [25, 26]. It is an organization's core ability to leverage expertise to accelerate product creativity and process re-engineering and improve decision-making. Creativity, absorption, and expansion are examples of its manifestation [27]. Optimizing business processes will help organizations to cut expenses massively [28] and ultimately improve profitability [29]. Previous research on information management has confirmed a strong relationship between business processes efficiency and organizational performance [30]. In the research, the scope of the BI&A system uses data collected by other systems to generate actionable knowledge. The knowledge is disseminated to other organizational systems or human decision-makers. This conceptualization is consistent with the implementation of the most common BI&A system in organizations today, in which forecasts, reports, or has the visualizations as the output of the system.

B. *DeLone and McLean Information System (IS) Success Model*

Assessing the success of IS continues to be a focus of research in the field. It is one of the most developed sources of research in the discipline [29, 31]. Although various theories inform progress in this field, the IS success model is one of the most frequently cited theories in the IS literature [5, 7]. IS success model recognizes that technology is embedded within business processes from a socio-technical lens [32]. Furthermore, the structure of the model explicitly places the users in the center. It means that users in the system will ultimately determine whether the benefits or disadvantages are realized. Existing studies have examined the impact of BI&A system on organizations following the updated IS success model developed by DeLone and McLean [5, 20, 33–35], Knowledge Management System (KMS) [36], Enterprise Resources Planning (ERP) [37, 38], healthcare information system [39–42], e-learning system [43], mobile banking services [44, 45], mobile library service [46], and accounting information system [47].

DeLone and McLean IS success model includes six constructs: system quality, information quality, service quality, system use, user satisfaction, and net benefits [48]. First, system quality is defined as the desired characteristics of IS and is often measured using dimensions of accessibility, response time, integration, reliability, and flexibility [19, 49]. Second, information quality is the quality of the information produced by the IS. It is an essential construct because users decide based on the information provided by the IS. It is often measured using dimensions of understandability, reliability, completeness, accuracy, timeliness, and usability [48]. Third, Service quality means the competence, attitude, and ability of IS technical support, including internal staff and developers, to develop products and services on time. The dimensions of assurance, empathy, and responsiveness evaluate the influence of service quality on system use and user satisfaction [49]. System quality, information quality, and service quality have considerable influence on use and user satisfaction. Fourth, system use is the manner and the extent to which users utilize the IS capabilities. It is a behavior that can be determined to some extent by management. Fifth, user satisfaction can be defined as how users perceive the overall system. It is an attitude that the user can only control. Sixth, the net benefit can be understood as the impact of using the IS on the performance quality of individuals and organizations [48].

III. HYPOTHESIS

A. *System Quality*

System quality is defined as desirable characteristics of the system [48]. BI&A system quality characteristics emerge as one of the most important technology BI&A system success factors in the literature [7, 41, 47, 50]. System quality and its position in research models are conceptualized differently in BI&A system success research. Then, accessibility, response time, integration, reliability, and flexibility are some of the dimensions that research considers when evaluating the quality of the BI&A system. Those dimensions align with the IS success model [19, 47]. In the research context, the researchers adopt this view as other researchers consider system quality a multi-dimensional construct, concentrating on the direct correlation between system quality dimensions like accessibility, attractiveness, ease of use, versatility, and outcomes of interaction and use [50].

Furthermore, previous studies often concentrate on the characteristics of BI&A system that can be interpreted as dimensions or antecedents to system quality, such as the scope of the system, flexibility, interactions with other systems, or compatibility with the required functions [48]. In addition, other characteristics of system quality, such as maturity, problem space fit, stability, technology base, and technology gap, have been described as antecedents of a successful BI&A system [50]. System quality can also be evaluated based on users' perceptions of usage and satisfaction. Therefore, the hypotheses are formulated as follows.

- H1a: System quality will influence the BI&A system use.
- H1b: System quality will influence user satisfaction of the BI&A system.

B. *Information Quality*

Information quality refers to information as an output produced by the IS. It is an essential construct because the users decide based on the information provided by the IS. The information quality construct has been conceptualized as multi-dimensional in the BI&A system and the broader IS domain, even though definitions of the constructs vary widely [51]. It also argued that the degree to which the output of an IS expresses value is inherently correlated with information quality [48]. Understandability, reliability, completeness, accuracy, timeliness, and usability are indicators used to evaluate the quality of the information provided by the BI&A system. For the research purpose, the researchers apply this concept.

The high importance of information quality on system use and user satisfaction has been examined in IS-related research models. Other studies have used data quality rather than information quality as an antecedent of the use of the BI&A system and yielding net benefits [9, 10, 52]. It also emphasizes the distinction between data and information quality [19]. In the BI&A system use, the problem of information quality is relevant to users. Overall, the literature shows that data and information quality are two different constructs. However, both are essential predictors of the success of the BI&A system [5, 9, 52, 53]. High information quality contributes to improving the quality decision-making of managers by using the BI&A system, gaining knowledge, and making better decisions. The high-quality information and interface usability of the BI&A system also influence user satisfaction. Therefore, the hypotheses are formulated as follows.

- H2a: Information quality will influence the BI&A system use.
- H2b: Information quality will influence user satisfaction with the BI&A system.

C. Service Quality

Service quality of IS refers to the credentials of IS support function or system developer [48]. Consequently, service quality can be said to represent the personnel expertise in the BI&A system success model [10, 12]. Having trained, experienced, and professional BI&A system personnel will help organizations to achieve greater system success [31, 49]. Assurance, empathy, and responsiveness are crucial factors influencing service quality and considerably user satisfaction.

The updated IS success model outlines information quality, system quality, and service quality impacting system use and user satisfaction. Then, it also influences individual and organizational performance [48]. Previous research on the impact of training, stakeholder engagement, knowledge transfer, talent attraction, and retention on the success of the BI&A system emphasizes the value of personnel expertise [49, 54]. However, few studies have been found in the literature to differentiate between the expertise of technical support and users of BI&A systems during data collection [49]. It is difficult to distinguish both. Instead, research of personnel expertise often ignores various positions of these users in the organization. The importance of technical support in the literature for the adoption phase, process, and post-implementation of the BI&A system, influences users and organizations' work practices and use behavior of information technology [7, 49]. Hence, the next hypotheses are as follows.

- H3a: Service quality will influence the BI&A system use.
- H3b: Service quality will influence user satisfaction of the BI&A system.

D. Top Management Support

Top management support is one of the widely cited implementation success factors. The research is defined as leadership involvement and commitment, promoting the use of IS and willingness to ensure sufficient allocation of resources [55]. Top management needs to target the use of the system strategically to get the maximum benefit from the BI&A system [10, 49]. Furthermore, the BI&A system usage must be empowered from the top down of the organizations. By managing the change process, obtaining necessary resources, and facilitating collaboration between business units, top management support accelerates the use of the BI&A system [11, 49]. The failure to do so will prevent organization from fully benefiting from the BI&A system [35, 55].

The challenges in terms of BI&A system adoption, usage, and implementation success are users' low-level acceptance of utilizing the BI system [11], lack of motivation [56], fear of losing power over information [11], lack of knowledge [57, 58], system issues [59], inadequate communication between IS support staff, and system users [60]. It becomes necessary for the management to address these challenges so that the system can be integrated into their daily work and fully utilize its benefits. User satisfaction will increase if top management remains committed to its use and strategically utilize the output of the BI&A system. Overall, top management support significantly affects the implementation success of the BI&A system. It also influences system use and user satisfaction directly and indirectly as management allocates sufficient resources, changes the structure to support user adoption, and promotes system use [11]. Therefore, the hypotheses are as follows.

- H4a: Top management support will influence the BI&A system use.
- H4b: Top management support will influence user satisfaction with the BI&A system.

E. System Use and User Satisfaction

The updated version of IS success model defines the construct 'user satisfaction' preceded by 'use' in a process sense but in an informal sense. User satisfaction is achieved by the positive experience with 'use' [48]. It is subsequently predicted that satisfaction is a strong predictor of continuance usage [44]. User satisfaction can be defined as how users perceive the

overall system. It can be measured as transactional or overall satisfaction. It is an attitude that the user can only control.

Many studies have tested the system use [50, 61] and user satisfaction [44, 62, 63] as the dependent variable. Use is a behavior that can be determined to some extent by management. Embeddedness or the extent to which the BI&A system is used and becomes an integral part of the organizational work system plays an important indicator to measure the success of the BI&A system in the post-implementation phase [64]. Frequency of use, the nature of use, the amount of use, the extent of use, or the purpose of use are indicators used to measure system use [31]. Previous research measuring the success of BI in South Africa finds that system quality, information quality, and system use significantly affect user satisfaction [41]. Therefore, the next hypotheses are as follows.

- H5: System use will influence user satisfaction of the BI&A system.

F. Decision-Making Quality

Organizations invest substantially in the BI&A system to support decision-making activity and achieve improved organization performance. Decision-making is viewed as a creative and adaptive process where decision-makers collect, interpret, and explore different ideas through found alternatives [65]. Using the BI&A system helps organizations to move towards more precise, relevant, and high-quality data-driven decision-making. The organization's ability to provide high-quality information and system help decision-makers to make more effective decisions as they can apply the information provided by the BI&A system in real-time decision-making conditions. Moreover, adjust it to operational and other purposes. The benefits of BI&A system use are much more indirect, long-term, and difficult to measure.

There are four constructs of the decision-making process quality: procedural rationality, exhaustivity of information, effort, and openness of spirit [66]. Previous research presents a verified and simplified research model of perceptual indicators of the quality of the decision made with the help of business intelligence [20]. Their findings support the idea that information quality and system use help to improve the perceived quality of the decision. Another previous study uses the speed of decision-making, decision effectiveness, informed decisions, and decision-making accuracy as measures to evaluate decision-making quality [21]. The researchers adopt this concept. It is expected that system use and user satisfaction will improve decision-making quality. Therefore, the hypotheses are formulated as follows.

- H6a: System use will influence the decision-making quality of the BI&A system.
- H6b: User satisfaction will positively influence the decision-making of the BI&A system.

IV. RESEARCH METHOD

The research applies a survey research to collect quantitative data for the research questions. The questionnaire is developed in English, which is then translated into bahasa Indonesia. The questionnaire is divided into two parts. The first part of the questionnaire consists of demographic information, such as gender, age, education, job level, job function, business sector, working experiences using the BI&A system. The second part measures the main research variables. The measurement elements are selected based on previous BI&A system research. The researchers conduct the research in a natural environment with minimal interference by delineating the relevant variables, collecting the relevant data, and analyzing them to develop the findings. A Likert scale of 1 (strongly disagree) to 5 (strongly agree) is used to assess all items. The theoretical history of constructs and measuring metrics used in the research is summarized in Table A1 (see Appendix).

A. Procedure and Sampling

The survey was conducted in various business sectors in Indonesia from February 1st, 2021, to February 28th, 2021. The questionnaire is available to BI&A system users through the Internet. The samples are collected using non-probability snowball sampling to obtain data of BI&A users. A total of 270 users have completed the survey, but only 208 users meet the criteria: decision-makers and use BI&A for decision-making activity. The relevant target population of the research includes various levels of the organization, starting from supervisors, managers, or higher levels that use the BI&A system for reporting, performing various types of analysis, and supporting decision-making.

The sample is consistent with targeted population characteristics. The respondents' profile is shown in Table I. They are mostly between 29 and 38 years old (37%), followed by 39 and 48 years old (27%). For the education, most of them are bachelors (69%). The result is followed by a master's degree (26%). Moreover, their job level includes managers (82%), supervisors (14%), and directors/commissioners (3%). It means that director at the senior managerial level work in the organization as a team and proves that they use the BI&A system as a source of information. Moreover, the average number of years of work experience in the

TABLE I
THE RESPONDENTS' PROFILE.

Variable	Measurement	Frequency	%
Gender	Male	170	82
	Female	38	18
	Total	208	100
Age	18–28	10	5
	29–38	77	37
	39–48	57	27
	49–58	64	31
	Total	208	100
Education	High School	9	4
	Bachelor's Degree	143	69
	Master's Degree	54	26
	Others	2	1
	Total	208	100
Job Level	Director/C Level	7	3
	Manager	171	82
	Supervisor	30	14
	Total	208	100
Job Function	Operation	109	52
	Sales & Marketing	15	7
	Finance & Accounting	34	16
	Information Technology	6	3
	Human Resources	19	9
	Legal & Compliance	2	1
	Others	23	11
	Total	208	100
Business Sector	Mining	14	7
	Basic Industry and Chemicals	1	0
	Miscellaneous Industry	1	0
	Consumer Goods Industry	7	3
	Property, Real Estate, and Building Construction	62	30
	Infrastructure, Utility, and Transportation	81	39
	Finance	27	13
	Trade, Service, and Investment	15	7
	Total	208	100
Working Experiences	≤2 years	10	5
	3–7 years	46	22
	8–12 years	52	25
	13–17 years	30	14
	≥ 18 years	70	34
	Total	208	100
Working Experiences Using BI&A	≤ 2 years	111	53
	3–7 years	81	39
	8 –12 years	10	5
	≥ 13 years	6	3
	Total	208	100

job and using the BI&A system are above five and two respectively. The sample also contains various job functions and business sectors, which further credence to generalize research findings.

B. Research Model

Figure 1 illustrates the research model developed for the research. The research model tries to explain the constructs that contribute to the success of the BI&A system in the Indonesian context. The research model consists of seven constructs. Each construct, in turn, is measured using multiple dimensions adapted

from current literature and input from BI&A system experts. Next, the researchers test the hypotheses using Partial Least Squares-Structural Equation Modelling (PLS-SEM) on the collected responses from BI&A system users.

V. RESULTS AND DISCUSSION

PLS-SEM is used for measurement validation and hypothesis testing, commonly used in IS research. PLS-SEM is chosen because it can calculate interrelationships between multiple constructs simultaneously and use a bootstrapping method to evaluate the mediation hypothesis [67]. In contrast to the covariance-based method, PLS-SEM is optimal for obtaining information from small to medium samples [68] and having a higher degree of statistical power in small sample sizes [69].

According to the literature, the sample size of the PLS-SEM study must be ten times the maximum number of exogenous constructs containing endogenous construct like structural paths that load on the specified constructs [67]. The researchers adopt this recommendation. As a result, the minimum required sample size is N = 190. Therefore, the research meets the requirements with 208 responses used in the final research. It allows researchers to use PLS-SEM to analyze the structural model and find the significant relationships with path coefficients of the research model. A two-step phase approach is used to validate the analytical model [67]. The validity and reliability of the measurement model are evaluated as the first step. The structural model is evaluated in the second step using four stages of statistical analysis: path coefficient, coefficient of determination (R^2), predictive relevance (Q^2), and Goodness of Fit (GoF).

A. Measurement Model

Table II shows the validity and reliability measures for the model constructs. The factor loading of items is tested on their respective constructs. The factor loadings of assessed items show a good level of validity, above the cut-off value of 0.700 [70]. Meanwhile, Cronbach's alpha and composite reliability test the reliability of the research constructs. The values of composite reliability and Cronbach's alpha range from 0.877 to 0.936 and 0.813 to 0.910, respectively. Thus, construct values fulfill the recommended cut-off value of 0.700, indicating that the items assessed are statistically reliable [71].

The Average Variance Extracted (AVE) values ranged from 0.596 to 0.784, higher than the recommended value of 0.500. To assess the discriminant validity, the researchers calculate the square root of
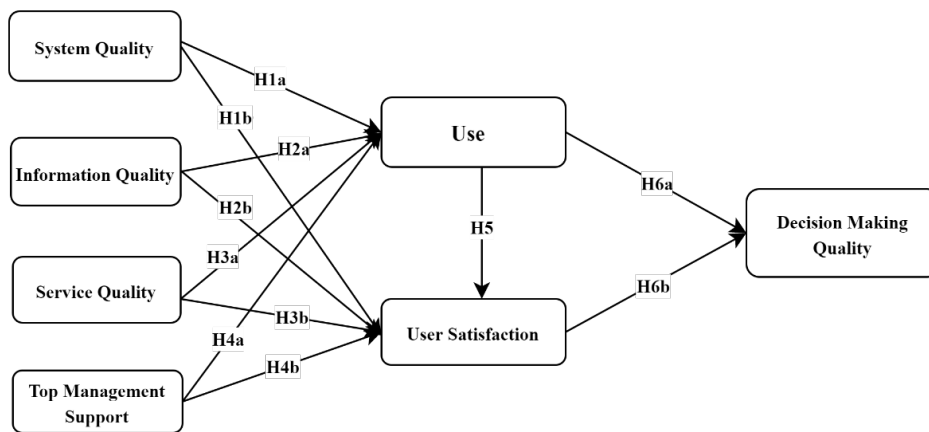
Fig. 1. Research model.

TABLE II
DESCRIPTIVE STATISTICS, ITEM LOADINGS, AND CONSTRUCTS RELIABILITY RESULTS.

Constructs	Items	Mean	SD	Loading	Cronbach's Alpha	Composite Reliability	AVE
Decision-Making Quality	DMQ1	4.067	0.568	0.840	0.910	0.933	0.735
	DMQ2	4.072	0.554	0.874			
	DMQ3	4.005	0.661	0.857			
	DMQ4	3.995	0.616	0.858			
	DMQ5	4.024	0.616	0.858			
Information Quality	INQ1	3.966	0.567	0.811	0.813	0.877	0.641
	INQ2	4.010	0.572	0.781			
	INQ3	3.938	0.629	0.788			
	INQ4	4.024	0.558	0.820			
Service Quality	SRQ1	3.995	0.710	0.800	0.854	0.896	0.632
	SRQ2	3.986	0.690	0.814			
	SRQ3	4.058	0.602	0.745			
	SRQ4	4.120	0.612	0.830			
	SRQ5	4.101	0.608	0.784			
System Quality	SIQ1	3.784	0.698	0.756	0.864	0.898	0.596
	SIQ2	3.928	0.686	0.770			
	SIQ3	3.933	0.669	0.820			
	SIQ4	4.014	0.584	0.721			
	SIQ5	3.870	0.692	0.823			
	SIQ6	3.808	0.694	0.736			
Top Management Support	TMS1	4.236	0.633	0.885	0.908	0.936	0.784
	TMS2	4.072	0.700	0.874			
	TMS3	4.082	0.692	0.874			
	TMS4	4.139	0.592	0.908			
Use	USE1	4.034	0.615	0.874	0.891	0.924	0.753
	USE2	3.971	0.627	0.874			
	USE3	3.933	0.632	0.856			
	USE4	3.995	0.592	0.867			
User Satisfaction	UST1	4.125	0.599	0.846	0.854	0.901	0.695
	UST2	3.880	0.628	0.835			
	UST3	3.904	0.651	0.845			
	UST4	3.942	0.663	0.809			

the AVE of each construct. It evaluates the correlation degree between the constructs, and the result should be greater than the intercorrelations of the corresponding rows and columns [72]. Then, the researchers compare the square root of the AVE of each construct with the correlation of all other constructs in the model. If the correlation between the constructs is higher than the square root AVE, they may not be sufficiently discriminable. As seen in Table III, all constructs are higher than the correlations between the constructs.

Additionally, the researchers assess the items' cross-loadings and correlation constructs [73]. All construct

TABLE III
DISCRIMINANT VALIDITY RESULTS.

Constructs	Decision-Making Quality	Information Quality	Service Quality	System Quality	Top Management Support	System Use	User Satisfaction
Decision-Making Quality	**0.857**						
Information Quality	0.679	**0.800**					
Service Quality	0.689	0.746	**0.795**				
System Quality	0.688	0.768	0.716	**0.772**			
Top Management Support	0.636	0.538	0.577	0.618	**0.885**		
System Use	0.761	0.642	0.702	0.638	0.537	**0.868**	
User Satisfaction	0.773	0.738	0.705	0.730	0.640	0.697	**0.834**

Note: Diagonal values (in bold) are square roots of AVE. Off-diagonal values are the estimates of inter-correlation between the latent constructs.

TABLE IV
STONE–GEISSER TEST AND COEFFICIENT OF DETERMINATION RESULTS.

Constructs	R^2	Q^2
Decision Making Quality	0.693	0.595
Use	0.548	0.574
User Satisfaction	0.690	0.482

Note: Q2 value indicates: 0.02 = small; 0.15 = moderate; and 0.35 = large.

cross-loadings are higher than the corresponding cross-loadings. Consequently, it can be inferred that the discriminant validity of the measurement model is good.

B. Structural Model

Following the validation of the measurement model, bootstrapping technique with a minimum sample size of 5,000 subsamples is used to determine the importance and relevance of path coefficients in the structural model [67]. Then, the explanatory power of the structural model is determined by calculating the coefficient of determination (R^2) for each dependent variable. The portion of the variance of dependent variables is represented by R^2 [69]. The acceptable value of R^2 depends on the research context [69]. The researchers follow the standard form [68]. It recommends the value of 0.75 for significant, 0.50 for moderate, 0.25 for a weak level of predictive accuracy. As shown in Table IV, all R^2 scores are significant. The results explain the variance in the model are 54.8% of BI&A system use, 69% of user satisfaction, and 69.3% of the decision-making quality.

The researchers also tested the Stone–Geisser (Q^2) as a predictor of the predictive relevance model, which only considers endogenous latent variables [74, 75]. The Q^2 value greater than 0.02 represents small, 0.15 represents moderate, and 0.35 represents large predictive relevance of the PLS path model [69]. All values

in Table IV are greater than 0.35. Thus, the results demonstrate that the model has a large predictive value for endogenous constructs. Finally, GoF is used to provide the geometric mean of AVE and the mean of R^2 of all the endogenous constructs to evaluate the measurement and structure of the proposed model. It is to see whether the overall performance in the model is fully representative of the population [76]. Hence, the researchers calculate GoF using the following formula.

$$GoF = \sqrt{(-R^2 \times -AVE)} \qquad (1)$$

The AVE for each latent variable equals the corresponding communality index. For the model to be valid in PLS, the GoF values must be higher than 0.36 [77]. The researchers found that the GoF score is 0.66. Hence, it implies that the model is valid. The results are shown in Table V. In service quality, the results are $\beta = 0.404$ and p = 0.000. They confirm that service quality has a significant relationship with BI&A system use. Meanwhile, information quality ($\beta = 0.158$, p = 0.116), system quality ($\beta = 0.149$, p = 0.076), and top management support ($\beta = 0.126$, p = 0.092) have no significant relationship with BI&A system use. Therefore, H3a is not rejected, while H1a, H2a, and H4a are rejected.

On the other hand, information quality ($\beta = 0.269$, p = 0.002), system quality ($\beta = 0,183$, p = 0,013) and top management support ($\beta = 0.203$, p = 0.002) suggest significant relationship on user satisfaction. Meanwhile, service quality ($\beta = 0.092$, p = 0.379) reveals that service quality has no significant relationship on user satisfaction. Hence, H1b, H2b and H4b are not rejected, while H3b is rejected. System use ($\beta = 0.234$, p = 0.014) shows significant relationship on user satisfaction. So, H5 is not rejected. Finally, the findings point out that both system use ($\beta = 0.432$, p = 0.000) and user satisfaction ($\beta = 0.472$, p = 0.000) have significant relationship on decision-making

TABLE V
HYPOTHESIS TESTING RESULT.

Hypotheses	Path	Standard β	Sample Mean (M)	Standard Error	T-Values	F^2	P-Values	Hypotheses Result
H1a	SIQ → USE	0.149	0.151	0.084	1.772	0.016	0.076	Rejected
H1b	SIQ → UST	0.183	0.181	0.073	2.494	0.035	0.013	Not Rejected
H2a	INQ → USE	0.158	0.160	0.101	1.573	0.018	0.116	Rejected
H2b	INQ → UST	0.269	0.270	0.086	3.144	0.076	0.002	Not Rejected
H3a	SRQ → USE	0.404	0.397	0.099	4.073	0.136	0.000	Not Rejected
H3b	SRQ → UST	0.092	0.090	0.105	0.879	0.009	0.379	Rejected
H4a	TMS → USE	0.126	0.131	0.075	1.688	0.020	0.092	Rejected
H4b	TMS → UST	0.203	0.203	0.066	3.077	0.076	0.002	Not Rejected
H5	USE → UST	0.234	0.236	0.095	2.467	0.080	0.014	Not Rejected
H6a	USE → DMQ	0.432	0.434	0.078	5.520	0.313	0.000	Not Rejected
H6b	UST → DMQ	0.472	0.471	0.073	6.470	0.373	0.000	Not Rejected

Note: Decision-Making Quality (DMQ), Information Quality (INQ), Service Quality (SRQ), System Quality (SIQ), Top Management Support (TMS), System Use (USE), and User Satisfaction (UST).
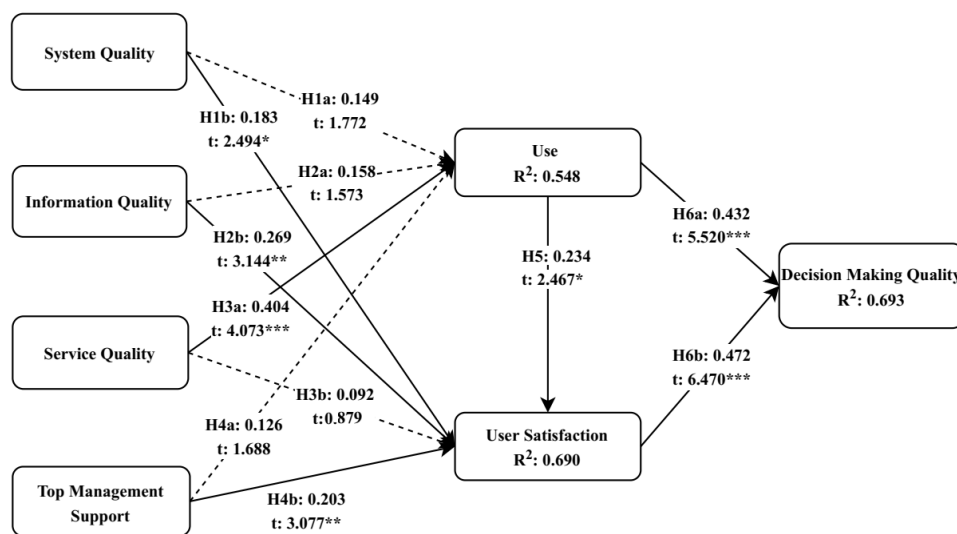

Fig. 2. Research model. It is significant at *p < 0.05, **p < 0.01, and ***p < 0.001. Bold line is significant and dash line is not significant.

quality. Therefore, H6a and H6b are not rejected. Figure 2 depicts the findings of PLS analysis.

The research contributes to both research and practice and offers implications for IS literature by validating the updated DeLone and McLean IS success model combined with top management support. The factors refine it to be more suitable to the success of the BI&A system in the context of various business sectors in Indonesia. The findings show no significant relationship between system quality and BI&A system use. It is consistent with the result of previous studies [61, 78]. However, the result is contradicted with previous studies that system quality has the most influence on system use, which will encourage the continued use of the implemented BI&A system [37, 41].

Moreover, system quality has a significant relationship with user satisfaction. This result contradicts the result of previous studies that the capacity and reactivity of the BI&A system to execute users' requests and perform complex tasks have no substantial relationship with user satisfaction of the BI&A system since it is considered a mandatory system [79–81]. The respondents' average score of the respondents may explain these findings. Respondents agree that the quality of the implemented BI&A system is easy to use and access, runs as necessary and combines data from the entire organization effectively. However, 27% of respondents experience issues with the stability of BI&A system performance. Stability is related to system performance, accessibility, and usability. When there is disturbance from the internal, the system can restore to its original state. Most of the respondents are satisfied with the quality of the implemented BI&A system, but that is not the main reason they use the BI&A system. Furthermore, the results show no significant relationship between information quality

and BI&A system use. This result is in contrast with previous studies which obtained information quality influence system use significantly [34, 41, 61, 63, 82].

Meanwhile, information quality has a significant relationship with user satisfaction. It is in line with the result of previous studies [41, 63, 63, 78, 81, 82]. The possible explanation for these findings is that the BI&A system used in the research is mandatory for users, so there is no other alternative to obtain information within the organizations. The average score of respondents agrees that the information provided by the BI&A system is complete, understandable, and relevant. The information meets their needs. They are satisfied with the system, but it does not encourage them to use the BI&A system.

Moreover, the findings show a significant relationship between service quality and the BI&A system use. This finding is consistent with the result of previous studies [37, 41, 63, 83]. This finding can be explained that there is available technical support. It provides support to resolve problems encountered by users. However, the research finds no significant relationship between service quality and user satisfaction. Previous studies agree that quality dimensions significantly influence user satisfaction [41, 44, 62]. Around 58% of users are dissatisfied with the service provided by technical support. This dissatisfaction is caused by the attitude of technical support who shows no sincerity when helping users to solve problems encountered and lacks understanding of users' needs, availability, and the speed of service when needed by users. Another reason for the dissatisfaction may be related to the lack of technical training for users and technical support. Both need to be empowered and improved to utilize and take advantage of BI&A system tools fully. Therefore, regularly scheduled training is highly recommended for users to increase their computer skills.

Surprisingly, the results show no significant relationship between top management support and BI&A system use. It is inconsistent with the result of previous studies that top management support is important because it can create positive experiences and attitudes among users towards the system [35], impacting the continued use of the BI&A system and its subsequent success [35, 38]. It means that management support contributes to the utilization and continuous use of the BI&A system. The possible explanation for the finding is the exclusivity of the research background, which is a supervisor and above in mandatory use context. With realizing their positions, they will use the BI&A system for their decision-making and are expected to encourage their below line to use the BI&A system.

Moreover, the findings confirm the support given by top management. It has a significant relationship to user satisfaction. Most respondents agree that top management support is in the implementation process. Top management also understands the importance of the BI&A system, encourages users all over the company, allocates sufficient resources, and makes its implementation strategically important. Although the use of the system is mandatory, this support provides satisfaction for BI&A system users. Therefore, management needs to provide continuous support to augment the level of satisfaction of the BI&A system users.

The findings suggest a significant relationship between system USE and user satisfaction. It is consistent with the result of previous studies [37, 61, 63, 78, 82, 83]. Users use the BI&A system to perform analysis for better decision-making, pinpoint the causes of certain problems, acquire crucial information, and explore more alternatives related to decisions. When users can find reliable and accurate information that they need quickly and easily anywhere and anytime for their activities, it can lead to contentment and satisfaction of the BI&A system.

The results also reveal that the BI&A system use and user satisfaction have a significant relationship with the improvement of decision-making quality with the highest path coefficient 0.432 and 0.472, respectively. The finding is consistent with the results of the prior study [36]. Therefore, it can be concluded that user satisfaction and system use have mediating effects on the relationship between system quality, information quality, service quality, and top management support on the decision-making quality.

Measuring the updated IS success model constructs combined with top management support allow the researchers to pinpoint the factors that influence the success of an organization's BI&A system, which can be interpreted as improving users' decision-making through the use and utilization of the system. The research also offers a theoretical basis for assessing the ability of the BI&A system to improve decision-making quality. The BI&A system success model developed and tested in the research will shed light on organizations, which want to adopt the BI&A system or have implemented the BI&A system. They can find important factors to realize the organizational success and the validated constructs to measure the success of the system. In addition, organizations need to address users-centric issues by providing support to overcome problems, promoting continuous use, and training users to fully leverage the system and acquire success in their investment in the BI&A system.

VI. CONCLUSION

The research empirically develops, and measures IS success model to determine the relevant constructs that contribute to the success of the organization's BI&A system. The findings show that service quality is the highest predictor of system use and the lowest predictor of user satisfaction of the BI&A system, with a path coefficient of 0.404 and 0.092, respectively. From these results, the need to build and empower sufficient skills and competencies of technical support staff is identified to assist users. Because quality affects user satisfaction, the organization needs to evaluate technical support performance compared to users' expectations comprehensively. Empathy is one of the important aspects of service quality to feel that users' issues should be prioritized and pay personal attention to users' specific needs. Thus, technical support staff must consider empathy while providing services. Moreover, information quality is the highest predictor of user satisfaction with a path coefficient of 0.269, followed by system use with a path coefficient of 0.234. The results confirm that information provided by the BI&A system is complete, understandable, and relevant. It has met users' needs which in turn affect user satisfaction. Then, top management support is also found as one of the predictors of user satisfaction with a path coefficient of 0.203. It is behind information quality and system use. Therefore, continuous support, such as instilling incentives and promoting strong teamwork, advice, and guidance, is needed to increase user satisfaction. The findings answer the research questions and confirm that all the model constructs significantly improve the decision-making quality in the organizations. The result will benefit the company and technical support to understand what users need and what action to take.

The researchers admit that the study has some limitations that should be considered for future study. To begin with, the business sectors as the respondents are diverse. Therefore, it will be interesting to narrow the sample to a specific business sector and analyze its BI&A system success. Additionally, it will be interesting to analyze decision-making quality in a non-mandatory context using the same model with the specific business sector since the system used in the research is mandatory for users.

The researchers want to apply decision theories to understand how the process is, and the generated information can be helpful in decision-making. However, the findings obtained in the research do not sufficiently clarify these attempts. Instead, the researchers focus on how the implemented system improves decision-making activity. Therefore, these limitations give opportunities for future research. The first focus can be an in-depth analysis of how the system and information produced can benefit decision-making. Previous research confirms that the BI&A system improves decision-making, but it remains unclear how the BI&A system improves decision-making activity. Thus, future research can also apply decision-making process quality dimensions [84], combined with decision theory to evaluate users' decision-making performance.

Then, future research can evaluate competencies of technical support and users, such as skills, knowledge, and other individual characteristics. Research on competencies is necessary as technical support competency is found to be the driving force for system use and user satisfaction which can lead to continuous use or abandonment of the BI&A system. The dissatisfaction can lead to abandonment or termination of the implemented system. Competencies required for technical support and users are different as they have different importance but are related to each other. Therefore, future BI&A system research should differentiate what competencies are required for both parties. Future research can also apply individual-level theories, such as the motivation theory and social cognitive theory to establish individual behaviour in the BI&A system research.

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APPENDIX

The Appendix can be seen in the next page.

TABLE A1
INSTRUMENT CONSTRUCTS IN THE SURVEY.

Constructs	Label	Items	Sources
System Quality	SIQ1	I find that the BI&A system is easy to use.	[39, 41, 47, 48, 61, 78, 85]
	SIQ2	The BI&A system is always up and running as necessary.	
	SIQ3	BI&A system provides appropriate functions for retrieving documents and information	
	SIQ4	BI&A system can effectively combine data from different departments across the entire organization.	
	SIQ5	BI&A system can allow me to find the information I am looking for easily.	
	SIQ6	BI&A system has a stable system performance.	
Information Quality	INQ1	The information provided by the BI&A system is complete.	[39, 41, 47, 48]
	INQ2	The information provided by the BI&A system is understandable.	
	INQ3	The information provided by the BI&A system is relevant.	
	INQ4	The information provided by the BI&A system meets and fits our needs.	
Service Quality	SRQ1	The technical support staff for the BI&A system is available when we need it.	[47, 48]
	SRQ2	The technical support staff for the BI&A system assists with fast service.	
	SRQ3	The technical support staff for the BI&A system is empowered to resolve users' problems.	
	SRQ4	The technical support staff for the BI&A system understands users' specific needs.	
	SRQ5	When a user has a problem, the technical support staff for the BI&A system shows his/her sincerity.	
Top Management Support	TMS1	Top management understands the importance of the BI&A system.	[11, 55, 86]
	TMS2	Top management allocates sufficient resources for the BI&A system deployment.	
	TMS3	Top management publicly put the BI&A system deployment as strategically important.	
	TMS4	Top management strives for support from all over the company.	
System Use	USE1	I use BI&A when I need to conduct analysis for better decision-making.	[61, 62]
	USE2	I use BI&A when I try to pinpoint the causes of certain problems related to my decisions.	
	USE3	I use BI&A when I attempt to explore more alternatives in decision-making.	
	USE4	I use BI&A when I need to acquire crucial information and knowledge related to decisions.	
User Satisfaction	UST1	I think the system is very helpful.	[41, 87]
	UST2	I am satisfied with the functions provided by the BI&A system.	
	UST3	I am content with the performance of the BI&A system.	
	UST4	If a colleague asks, I will recommend the BI&A system.	
Decision-Making Quality		By using the BI&A system, I can:	[86]
	DMQ1	- Improve the quality of decisions.	
	DMQ2	- Gather better information for decisions.	
	DMQ3	- Make decisions faster.	
	DMQ4	- Analyze more alternatives in decision-making.	
	DMQ5	- Quickly decide the best course of action	