A Framework of Business Intelligence Systems Effect on Decision-Making Quality in Higher Education Institutions

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Abstract:

The rapid change in the universities environment has increased the need for business intelligence systems (BIS) to leverage the data generated by the educational process. BI tools facilitate decision-making by processing information and converting it into meaningful knowledge. However, the effect of these systems on the decision-making quality, especially in the education sector, has not been verified. This study aims to develop a theoretical model to explore factors of BI that affect decision-making quality in higher education institutions in Yemen. Five independent variables were proposed: data quality, BI scope, BI users, BI management, and BI capabilities. BI capabilities were included as a new variable Based on stakeholder interviews. Data were collected using a survey of 128 decision-makers in some Yemeni universities and analyzed using regression analysis. The results showed that BISs have a significant positive effect on the decision-making quality in higher education institutions at (R^2=.513), supporting all hypotheses. Also, the results indicated that using BIS in educational institutions in Yemen is still in its early stages. Moreover, BI management had the highest positive effect, followed by BI scope, data quality, BI users, and BI capabilities, which confirms a positive relationship between BI aspects and decision-making quality in higher education.

Keywords: Business intelligence systems, decision-making quality, higher education institutions.

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إطار عمل لتأثير أنظمة ذكاء الأعمال على جودة إتخاذ القرار في مؤسسات التعليم العالي

الملخص:

أدى التغيير السريع في بيئة الجامعات إلى زيادة الحاجة لأنظمة ذكاء الأعمال (BIS) للاستفادة من البيانات الناتجة عن العملية التعليمية. تساعد أدوات ذكاء الأعمال في تحسين اتخاذ القرارات من خلال جمع المعلومات وتحويلها إلى معرفة للاستفادة منها. ومع ذلك، لم يتم التحقق بعد من تأثير هذه الأنظمة على جودة اتخاذ القرارات في قطاع التعليم، لا سيما في قطاع التعليم. تهدف هذه الدراسة إلى تطوير نموذج نظري لفحص عوامل ذكاء الأعمال التي تؤثر على جودة اتخاذ القرارات في مؤسسات التعليم العالي في اليمن. تم اقتراح خمسه متغيرات مستقلة: جودة البيانات، نطاق ذكاء الأعمال، مستخدمو ذكاء الأعمال، إدارة ذكاء الأعمال، وقدرات ذكاء الأعمال. تم إدراج قدرات ذكاء الأعمال كمتغير جديد بناءً على مقابلات مع المعنيين. تم جمع البيانات باستخدام استبيان شمل 128 من متخذي القرارات في بعض الجامعات اليمنية وتحليلها باستخدام تحليل الانحدار. أظهرت النتائج أن أنظمة ذكاء الأعمال لها تأثير إيجابي كبير على جودة اتخاذ القرارات في مؤسسات التعليم العالي بنسبة ($R^2 = 0.513$)، مما يدعم جميع الفرضيات. كما أظهرت النتائج أن استخدام أنظمة ذكاء الأعمال في المؤسسات التعليمية في اليمن لا يزال في مراحله الأولى. علاوة على ذلك، كان لإدارة ذكاء الأعمال أكبر تأثير إيجابي، يليها جودة البيانات، ومستخدمي ذكاء الأعمال، وقدرات ذكاء الأعمال، مما يؤكد العلاقة الإيجابية بين جوانب ذكاء الأعمال وجودة اتخاذ القرارات في مؤسسات التعليم العالي.

الكلمات المفتاحية: أنظمة ذكاء الأعمال، جودة اتخاذ القرار، مؤسسات التعليم العالي.

1. Introduction

Technological development is considered a critical reason for the continuous change in the business environment and the access to large amounts of stored data [1]. Many successful organizations use this data to gain a new understanding of their operations and services and achieve a competitive advantage. Business intelligence is one of the most critical techniques to analyze and visualize information and knowledge derived from data to support decision-making and improve organizational performance [2]. According to [3] Business intelligence (BI) is an umbrella term coined in 1989 by Garner Group and its researcher Howard Wisner to describe a set of concepts and approaches in business that help improve decision-making across the use of events and event-based systems. BI is an analytical, technology-enabled quality for gathering and transforming fragmented data from enterprises and marketplaces into information or knowledge about an organization's goals, opportunities, and positions [4]. Business intelligence systems support decision-making in various fields such as tourism, health, sales, and others. It can also be effectively applied to higher education institutions to manage academic data, finance, and human resources and obtain insights about students' information and the progress of educational quality. Many studies show the importance of business intelligence in facilitating decision-making, developing performance, and achieving a competitive advantage for organizations [5-7]. Although many previous studies focused on using business intelligence and its impact on decision-making in many institutions, actual coverage in educational institutions remains limited, especially in developing countries. Therefore, this research aims to investigate the extent of the use of these systems in higher education institutions in Yemen and examine their effect on their decision-making quality by identifying the most important factors of business intelligence that influence decision-making quality.

2. Literature Review

Numerous studies have investigated the connection between Business Intelligence and the quality of decision-making. This paper reviews several previous studies that analyzed the influence of Business Intelligence on enhancing decision quality within organizations: Recently,[8] studied the impact of business intelligence systems on the quality of strategic decision-making in senior management. The study focused on data quality, data

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visualization, and business intelligence management as independent variables for the study. It also explored the intermediate effect of the scope of business intelligence between the independent and dependent variables. A survey was conducted to collect data from employees who use business intelligence systems and participate in strategic decision-making. The results showed that all variables had significant and positive correlations with decision quality. The study also emphasized the importance of BI scope as an intermediary variable, demonstrating the impact on the relationship between business intelligence and decision quality.

Also, Berhane, et al. [9] examined the impact of business intelligence on decision-making processes and the fundament for decisions in public organizations. The study focused on three fundamentals of business intelligence-based decision-making: data quality, data analysis, and the human factor. The study is based on the literature in the field of business intelligence and interviews with three Swedish agencies. The results confirmed that business intelligence systems influence decision-making and interconnected processes.

In the same context, Urumsah and Ramad hansyah [10] investigated the impact of the business intelligence implementation on the quality of decision-making at the Indonesian fertilizer company. Discussed this impact by verifying the influential aspects of business intelligence: BI management, BI scope, data quality, content quality, and information quality. The study sample included 130 people from this company. The results showed that BI management is the main factor affecting the quality of decision-making, as well as data quality and information quality can affect the quality of decision-making both independently or together. In addition, the BI scope and content quality have no impact on the quality of decision-making in this company.

Furthermore, Segooa and Kalema [11] designed a framework for big data analysis at South African public universities to improve decision-making. The study used a quantitative approach and identified factors that could affect decision-making in universities: technological issues, environment, organization, structure, Individuals, data quality, and BDA. The results shed light on the challenges that hinder the university from benefiting from the BDA in making the right decision.

Moreover, Wieder and Ossimitz [4] investigated the direct or indirect impact of the aspects of business intelligence on the management decision-making quality, which is the quality of BI management, data quality, information quality, and BI scope. In a survey conducted for senior IT managers in Australian companies. The results confirmed the positive impact of the aspects of BI in general and showed the direct and indirect effect of the quality of BI management on the quality of the decision-making, and the mediating effects of data quality, information quality, and the scope of BI. Table 2 shows a summary of the related works to this research.

Furthermore, Candra and Nainggolan [12] aimed to identify relevant structures that contribute to the success of the organization's business intelligence and analytics system. Data were collected from a questionnaire of 208 decision-makers who use the B I&A system in various business sectors in Indonesia. The study focused on system quality, information quality, service quality, and senior management support as relevant factors contributing to the success of the organization's business intelligence and analytics system. The results confirmed that model building significantly improves the quality of decision-making in a system environment. Also, it found that the quality of service was the highest indicator of system usage, and the quality of information was the highest indicator of user satisfaction.

In addition to, Majali, et al. [13] sought to examine business intelligence factors that subscribe to the quality of decisions at Jordanian telecommunications companies. The study focused on system quality, information quality, and service quality as business intelligence factors in the study. Data were collected from the questionnaires of 103 senior and middle management staff in various business departments who use business intelligence tools in decision-making. The results showed the impact of these factors on decision quality. In addition, it illustrated that system quality is the most influential factor in improving decisions, and information quality and service quality are notable factors in predicting the quality of decisions.

Moreover, Monfared and Akbari [3] explored whether there was a relationship between the quality of decision-making and the business intelligence capabilities of Mellat Bank, and the researcher studied this relationship through several variables: data quality, association with other systems, user access, flexibility, and risk management support. The sample size for this study is 123 people, including managers and experts in the general

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management of Bank Mellat. The results confirmed a positive relationship between decision quality and Mellat bank's business intelligence capabilities at 95% of the confidence level.

Moreover, Visinescu, et al. [7] examined the quality of decisions made using business intelligence support. The study focused on factors associated with business intelligence: the level of use of business intelligence, the complexity of problem space, and the quality of information. Data were collected from 61 business intelligence users in several United States organizations and industries by using the web-based survey. The results indicated that both the level of BI use, the quality of BI information, and the complexity of the problem space affect the quality of perceived decisions in organizations.

3. Research Model and Hypotheses

The study model consists of five independent variables and one dependent variable. The independent variables are data quality, BI scope, BI user, BI management, and BI capabilities. The independent variable is decision-making quality. These variables were selected based on previous studies and interviews with stakeholders. The decision-making process is one of the most significant tasks of management, so it requires examining data and exerting effort to achieve a successful decision. Decision quality is defined as the indication of effectiveness and efficiency in the decision-making process. Data is usually referred to as facts that are collected, stored, and processed to make sense and add contextual information to the recipient's knowledge. Data quality indicates the quality of the representation of relevant facts[4]. Data is the main component of business intelligence systems, especially in educational institutions that own a large amount of data about students, teachers, educational programs, and others.

H1: There is a positive relationship between the quality of data and the decision-making quality in higher education institutions.

BI scope defined as the difference in the extent to which business intelligence functions are used within organizations, where the software solutions available to support business intelligence vary in terms of purpose, role, functional scope, and level of development [4, 10].

H2: There is a positive relationship between the BI scope and the decision-making process in higher education institutions.

As defined Santoso (2017) BI user is the person who interacts with the system through the user interface.BI users are defined as the users of business intelligence systems at different organizational levels, especially decision makers.

H3: There is a positive relationship between BI users and decision-making quality in higher education institutions.

Business intelligence management capabilities are defined as a reflection of the resources and learning processes required to integrate business intelligence software with organizational strategy into business intelligence solutions and to ensure the achievement of the objectives associated with Business Intelligence Processes[4, 10]. Proper management is the basis for the success of business intelligence systems in higher education institutions to allocate resources and enable the full utilization of these systems in the decision-making process.

H4: There is a positive relationship between BI management and the decision-making quality in higher education institutions.

A new variable was included in the study model through an interview with stakeholders. This variable seeks to reveal several capabilities of business intelligence from stakeholders' perspectives as follows:

Accessibility: is the degree to which information can be accessed when needed, meaning BI tools are easy to use, understand, and navigate for authorized individuals with different abilities, preferences, and devices [14].

Analytical capabilities: The system's effectiveness in analyzing the information obtained in different forms, such as reports, performance metrics, alerts, and dashboards [15].

System integration: The ability of systems to integrate at the data, application, business process, or user level and to make efficient connections between multiple business applications [14].

Real-time information: The ability of a BI system to provide real-time information, providing decision-makers with as up-to-date data as possible [16].

Timeliness: The rate of the system's response time and the degree to which information is up-to-date or accurately reflects the current situation and is received on time[17].

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Forecasting: The system's ability to perform predictive analysis to forecast what might happen based on historical and current data, which reflects the likelihood of the future. These analyses are performed based on patterns and trends revealed by descriptive analytics [18].

H5: There is a positive relationship between the BI capabilities and the decision-making quality in higher education institutions.

Based on the proposed hypotheses, the following model was formed. Figure 1 illustrates the proposed research model.

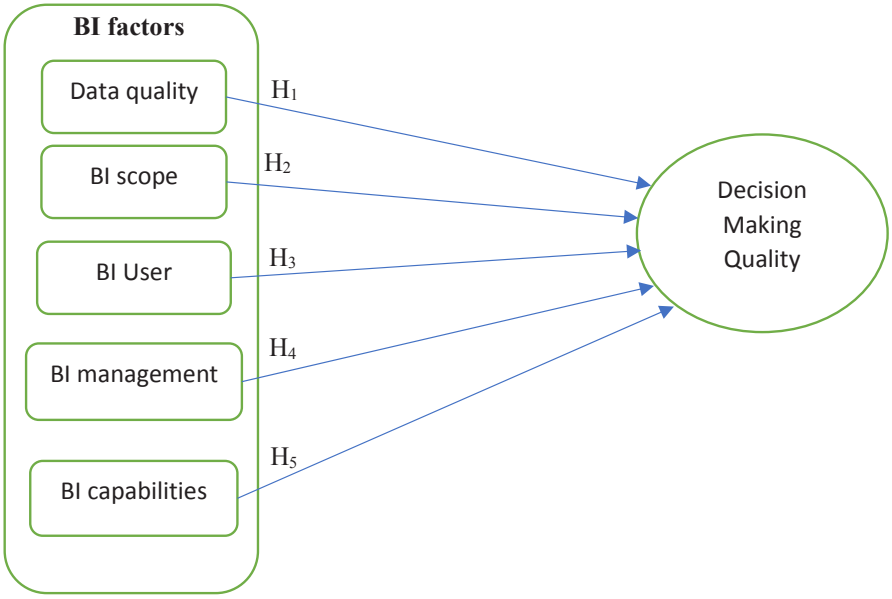

Figure1: Research Model

4. Methodology

There are two main methods of research: quantitative and qualitative research. A quantitative approach is defined as a structured method of combining deductive logic with accurate empirical observations of the behavior and uses data in the form of numbers. A qualitative approach is defined as the non-numerical examination and interpretation of observing to discover underlying meanings and patterns of relationships and uses data in the form of words created from broad responses to questions in interviews or observations [19, 20].

This study employed a mixed method between quantitative and qualitative approaches to provide a more in-depth and complete understanding of the research problem. And it gives more attention to a quantitative approach to testing variables and relationships. The survey research strategy is selected in this study, where the interviews were used to explore another variable of the study from the stockholders' perspective and use the self-questionnaire as a tool for data collection. The population of the current study represents higher education institutions in Yemen. The study focused on universities using business intelligence systems only. Thus, a population frame for the study was defined to include five universities: The University of Science and Technology, AR-Rashid Smart University, The Queen Arwa University, Al-Nasser University, and Al-Razi University. The total population in these universities has reached about 222 employees in senior and middle management according to human resources statistics in those universities. The sample consisted of 144 cases.

These universities were selected for several reasons. First, these universities are among the leading universities in Yemen according to the Yemeni Universities Ranking for 2022/2023 and the Webometrics Ranking. Second, an electronic survey was conducted using Google Forms and distributed to the universities to find out which universities use business intelligence systems, and through it, these universities were using business intelligence and were chosen accordingly. Thus, they are considered representative of the universities, which will allow to generalize of the study results.

The data collection for this study was using a questionnaire method. The questionnaire was constructed and introduced to a group of experts in the field for judgment and verification of its validity and effectiveness. After modifying the questionnaire based on the comments given by the experts, it was introduced to language specialists to translate it into Arabic; whereas the research sample's primary language is Arabic. The questionnaire was distributed on paper through field visits to universities and delivering the questionnaire to the respondents in person. The distribution and receiving of the questionnaire continued for six weeks and took place in several stages. The first phase spanned two weeks, in which the questionnaire was distributed to the University of Science and Technology staff, where 65 questionnaires were distributed and 58 questionnaires were received. The second phase lasted for two weeks, in which the questionnaire was distributed to Queen Arwa and Al-Razi Universities, where 61 questionnaires were distributed,

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and 55 questionnaires were received, during more than one visit to these universities, to increase the response rate. As for the third stage, which lasted for two weeks, the questionnaire was distributed to Al-Rashid and Al-Nasser Universities, where 50 questionnaires were distributed at these Universities and 42 questionnaires were received. After removing the invalid and missing questionnaires, 123 responses, which form 85%, were obtained for data analysis.

5. Data Analysis and Results

Several analytical methods were used in this study, including the analysis of demographic information, reliability analysis, correlation analysis, descriptive statistics, and regression analysis using SPSS. The following subsections explain each of these methods:

5.1 Demographic analysis

Gender

The distribution of gender among the participants is presented in the table 1. Out of the total sample size, 27 (22.0%) are female, while 96 (78.0%) are male.

Table 1: Distribution of Participants' Gender

Gender	N	%
Female	27	22.0%
Male	96	78.0%

Age

The age distribution of the participants is displayed in the table 2. Among the participants, (17.1%) were over the age of 51, (8.1%) were between the ages of 20-30, (35.0%) were between the ages of 31-40, and (39.8%) were between the ages of 41-50.

Table 2: Distribution of participants' Age

Age	N	%
> 51	21	17.1%
20-30	10	8.1%
31-40	43	35.0%
41-50	49	39.8%

Education

The educational background of the participants is presented in table 3. Out of the total participants, 22 (17.9%) held a bachelor's degree, 38 (30.9%) held a Master's degree, and the majority of participants, 63 (51.2%), held a PhD.

Table 3: Distribution of participants' Education

Education	N	%
Bachelor	22	17.9%
Master	38	30.9%
PhD	63	51.2%

Experience

The distribution of participants' experience is provided in table 4. Among the participants, 14 (11.4%) had less than or equal to 5 years of experience, while the majority, 47 (38.2%), had more than 15 years of experience. Additionally, 34 (27.6%) reported having 11-15 years of experience, and 28 individuals (22.8%) had 6-10 years of experience.

Table 4: Distribution of Participants' Experience

Experience	N	%
<=5 years	14	11.4%
6-10 years	28	22.8%
11-15 years	34	27.6%
>15 year	47	38.2%

Position

The distribution of participants' positions is presented in table 5. Among the participants, 30 (24.4%) held the position of Dean or Deputy of Dean. There were 2 (1.6%) who held the position of General Secretary, while 34 (27.6%) were the Head of Academic Departments. The majority of participants, 51 (41.5%), held the position of Manager or Head of Department. Finally, 6 (4.9%) held the position of University President or Deputy President.

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Table 5: Distribution of participants' position

Positions	N	%
Dean/deputy	30	24.4%
General Secretary	2	1.6%
Head of Academic Dept	34	27.6%
Manager / head of Dept	51	41.5%
University president /deputy	6	4.9%

Which BI tools do you use?

Participants were asked about the business intelligence tools they use at the university to determine the extent of use of these systems in higher education institutions. Table 6 show the results.

Table 6: BI tools used in HEI

Which BI tools do you use?	Responses		Percent of Cases
	N	Percent	
Excel	111	23.7%	85.4%
BSC	60	12.8%	46.2%
Query reporting	62	13.2%	47.7%
Digital driving dashboard	14	3.0%	10.8%
ERP	74	15.8%	56.9%
SPSS	66	14.1%	50.8%
PMS	12	2.6%	9.2%
Data store	22	4.7%	16.9%
Data mining	12	2.6%	9.2%
Machine learning	19	4.1%	14.6%
Direct analytical process	5	1.1%	3.8%
Others	12	2.6%	9.2%
Total	**469**	**100.0%**	**360.8%**

a. Dichotomy group tabulated at value 1.

As shown in table 6, the most commonly used tool was Excel, with 111 (23.7%) indicating its usage. BSC (Balanced Scorecard) was used by 60 (12.8%), followed closely by Query reporting with 62 (13.2%). Other frequently used tools included ERP (Enterprise Resource Planning) with 74 (15.8%) and SPSS (Statistical Package for the Social Sciences) with 66 (14.1%). Digital driving

dashboard and Machine learning were used by 14 (3.0%) and 19 (4.1%) respectively. The remaining tools, including PMS (Project Management software), Data store, Data mining, Direct analytical process, and others, were used by a smaller percentage of participants. The total number of responses was 469, indicating that some participants may have selected multiple tools. Please note that the percentages in the table exceed 100% due to participants selecting multiple tools.

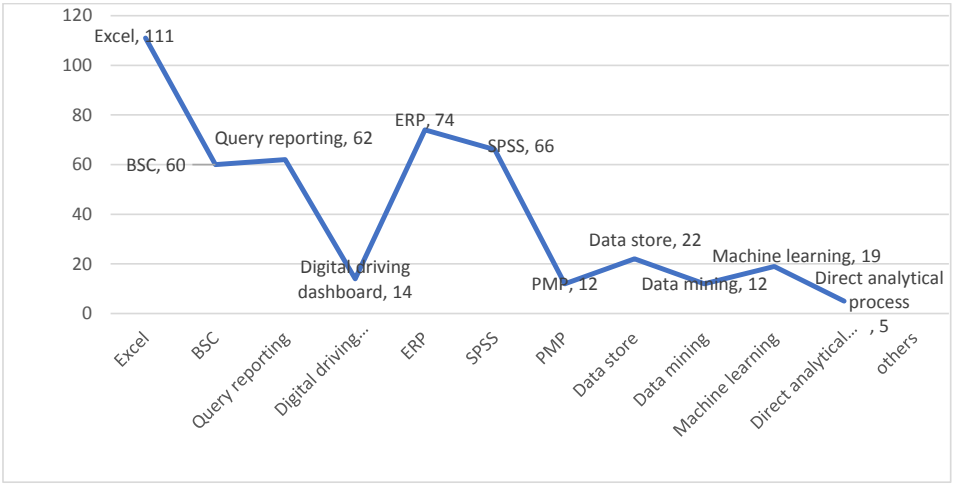

Figure 2: BI tools used in HEI

Based on the previous results and According to Gartner's Maturity Model [21] the level of use of business intelligence systems in universities is still in the beginning stages. Figure 3 show Gartner's Maturity Model levels that are unaware, opportunistic, standards, enterprise, transformative.

5.2 Reliability Analysis

Reliability is an indicator of the stability and consistency with which a concept is measured and helps evaluate the quality of the measure [22]. Table 7 presents the results of Cronbach's alpha analysis, which assesses the internal consistency or reliability of the measurement scales used in the study. The measurement scales examined include Decision-making Quality, Data Quality, BI Management, BI Scope, BI Users, and BI Capabilities. The analysis revealed that all the measurement scales exhibited high levels of internal consistency. These findings indicate that the measurement scales used in the study are reliable and internally consistent measures for assessing the respective constructs.

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Table 7: Reliability Analysis

Variables	Cronbach's Alpha	N of Items
Decision-making Quality	.855	7
Data Quality	.884	5
BI Management	.871	6
BI Scope	.884	8
BI Users	.837	7
BI Capabilities	.897	11

5.3 Discriminant validity

The correlations between Decision-making Quality and the other variables (Data Quality, BI Management, BI Scope, BI Users, and BI Capabilities) range from 0.431 to 0. 593.Table 8 explain these correlations.

Table 8: Discriminant validity

	Decision-making Quality	Data Quality	BI Management	BI Scope	BI Users	BI Capabilities
Decision-making Quality	0.733					
Data Quality	.515	0.828				
BI Management	.577	.483	0.782			
BI Scope	.558	.410	.505	0.748		
BI Users	.527	.428	.466	.479	0.721	
BI Capabilities	.431	.425	.434	.455	.593	0.702

As shown in table 8, these correlations are moderate to strong, suggesting shared variance between the constructs. However, they are not perfect correlations, indicating that each variable captures distinct aspects of the construct. These results provide evidence of discriminant validity, indicating that the variables represent different dimensions of the overall construct. It suggests that Decision-making Quality, Data Quality, BI Management, BI Scope, BI Users, and BI Capabilities are distinct but related constructs within the context of the study.

5.4 Descriptive statistics

descriptive statistics used to examine all measures in the study represent mean, standard deviation, and relative importance. All items were measured using a five-point Likert scale and labeled from very high to very low:

- **Decision-making quality:** when considering the overall decision-making quality dimension, the mean score was (Mean=4.136) with a standard deviation of SD=0.464. This indicates a generally high extent of agreement among respondents regarding decision-making quality at the university.
- **Data quality:** regarding the overall data quality dimension, the mean score was (Mean = 3.995) with a standard deviation of (SD=0.579). This indicates a positive perception of data quality in the business intelligence systems used at the university among respondents.
- **BI management:** as for the overall dimension of BI management, the mean score was (Mean=3.783) with a standard deviation of SD=0.607. This indicates a generally positive perception of the management of business intelligence systems at the university among respondents.
- **BI scope:** when considering the overall dimension of the scope of BI at the university, the mean score was (Mean=4.200) with a standard deviation of SD=0.514. This indicates a generally positive perception of the scope of BI at the university among respondents.
- **BI users:** when considering the overall dimension of BI users, the mean score was (Mean=3.943) with a standard deviation of SD=0.530. This indicates a generally positive perception of the users' role and abilities in utilizing BI systems at the university among respondents.
- **BI capabilities:** when considering the overall dimension of BI capabilities, the mean score was 3.715 with a standard deviation of 0.546. This suggests a generally positive perception of the capabilities of BI systems at the university among respondents.

5.5 Regression Analysis

Tables 9 and 10 present the results of the regression analysis, which aimed to investigate the impact of various business intelligence dimensions on the dependent variable, Decision-making Quality. The analysis involved examining the coefficients and statistical significance of each predictor. The findings revealed several noteworthy patterns.

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Table 9: Result of the Regression Analysis – Coefficientsa

Model	Unstandardized Coefficients		Standardized Coefficients	t	p
	B	Std. Error	Beta		
Data Quality	.170	.031	.358	5.473	<.001
BI Scope	.211	.035	.403	5.941	<.001
BI Users	.168	.033	.330	5.024	<.001
BI Management	.197	.032	.404	6.156	<.001
BI Capabilities	.071	.032	.148	2.231	.028

a. Dependent Variable: Decision-making Quality

The model summary indicates that the predictors collectively account for a considerable proportion of the variance in the dependent variable, Decision-making Quality. The model's R-squared value of (R^2=.513) indicates that approximately 51.3% of the variance in decision-making quality can be explained by the predictors. The adjusted R-squared value of (adj R^2 =.492) considers the number of predictors and provides a more conservative estimate of the model's explanatory power. The standard error of the estimate is .33090, representing the average distance between the observed and predicted values. These results confirm that the model has adequate explanatory power.

Table 10: Model Summary[a]

Model	R	R^2	Adjusted R^2	Std. Error of the Estimate
1	.716[a]	.513	.492	.33090

a. Predictors: (Constant), Data Quality, BI Management, BI Users, BI Capabilities, BI Scope

As showed in table 11 the ANOVA test shows that the regression model is statistically significant ($p < .001$). The F-statistic of (F=24.677) indicates that the predictors collectively have a significant effect on decision-making quality.

Table 11: ANOVA[a] Test

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	13.510	5	2.702	24.677	<.001[b]
	Residual	12.811	117	.109		
	Total	26.321	122			

a. Dependent Variable: Decision-making Quality

b. Predictors: (Constant), Data Quality, BI Management, BI Users, BI Capabilities, BI Scope

5.6 Hypotheses Testing

H1: There is a positive relationship between the quality of data and the decision-making quality in higher education institutions.

First of all, Data Quality emerged as a significant predictor of Decision-making Quality ($\beta = 0.358$, $t = 5.473$, $p < .001$) as shown in table 9. High-quality data, characterized by accuracy, completeness, and reliability, is essential for generating reliable insights and informed decision-making. Thus, this hypothesis is supported.

H2: There is a positive relationship between the BI scope and the decision-making quality in higher education institutions.

Second, BI Scope emerged as a powerful predictor, demonstrating a strong positive effect ($\beta = 0.403$, $t = 5.941$, $p < .001$) as shown in table 9. This indicates that organizations with a broader scope of business intelligence implementation tend to exhibit higher decision-making quality. A wider scope allows for a more comprehensive and holistic understanding of the business environment, enabling informed and effective decision-making. Thus, this hypothesis is supported.

H3: There is a positive relationship between BI users and decision-making quality in higher education institutions.

In addition, the results indicated that BI Users played a crucial role in decision-making quality ($\beta = 0.330$, $t = 5.024$, $p < .001$) as shown in table 9. This finding suggests that organizations should prioritize user engagement and ensure that individuals across the organization are equipped with the necessary skills and resources to effectively utilize business intelligence tools. Thus, this hypothesis is supported.

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H4: There is a positive relationship between BI management and the decision-making quality in higher education institutions.

Moreover, the study identified a significant positive relationship between BI Management and Decision-making Quality ($\beta = 0.404$, $t = 6.156$, $p < .001$) as shown in table 9. Effective management of business intelligence initiatives, including strategic planning, resource allocation, and organizational support, can significantly contribute to better decision-making outcomes. Thus, this hypothesis is supported.

H5: There is a positive relationship between the BI system capabilities and the decision-making quality in higher education institutions.

Finally, the study found that BI Capabilities had a statistically significant positive relationship with Decision-making Quality ($\beta = 0.148$, $t = 2.231$, $p = .028$) as shown in table 9. This suggests that organizations with more advanced and sophisticated business intelligence capabilities tend to make higher-quality decisions. Thus, this hypothesis is supported.

To sum up, these findings collectively highlight the importance of various business intelligence factors in driving effective decision-making processes. Therefore, it could be said that all the hypotheses are supported. Table 12 summarized the hypothesis testing results.

Table 12: Summary of the Hypotheses Testing Result

Hypothesis	Statement	Result	Statues
H1	There is a positive relationship between the quality of data and the decision-making quality in higher education institutions.	$\beta = 0.358$, $t = 5.473$, $p < .001$	Supported
H2	There is a positive relationship between the BI scope and the decision-making quality in higher education institutions.	$\beta = 0.403$, $t = 5.941$, $p < .001$	Supported
H3	There is a positive relationship between BI users and decision-making quality in higher education institutions.	$\beta = 0.330$, $t = 5.024$, $p < .001$	Supported
H4	There is a positive relationship between BI management and the decision-making quality in higher education institutions.	$\beta = 0.404$, $t = 6.156$, $p < .001$	Supported
H5	There is a positive relationship between the BI system capabilities and the decision-making quality in higher education institutions.	$\beta = 0.148$, $t = 2.231$, $p = .028$	Supported

6. Discussion

Data quality was presented as an essential factor that has a direct effect on the quality of decision-making in various. Previous studies have confirmed that the quality of data has a significant positive impact on the quality of decision-making [4, 7-9]. The results of the current study are consistent with those of previous studies where it was found that the quality of data provided by BIS has positively affected the quality of decision-making in higher education institutions. The BI scope has been found to have a positive effect on the quality of decision-making directly or indirectly in many previous studies [4, 7, 8, 10] . The results of this study are consistent with previous studies that considered the BI scope to have positive effects on the quality of decision-making in higher education institutions. Also, this study found that users of BI have a significant positive impact on the quality of decision-making in higher education institutions. This result is consistent with the findings of a previous study that emphasized the influence of the human factor on the quality of decision-making [9]. BI management is a critical factor affecting the quality of decision-making [23, 24]. Many previous studies have confirmed a significant positive impact of business intelligence management on the quality of decision-making [4, 8, 10]. The findings of this study are consistent with the results of previous studies. As mentioned above, BI management is essential in facilitating the successful integration of business intelligence with the company's strategy and allocating the required resources to ensure the achievement of the desired goals and contributes significantly to improved decision-making outcomes. Finally, BI capabilities were included in this study as a new factor after stakeholder interviews. It is hypothesized to have a significant positive impact on the quality of decision-making in higher education institutions.

Fortunately, the results of the current study confirmed that business intelligence capabilities had a significant positive impact on the quality of decision-making in higher education institutions, which is consistent with what stakeholders suggested.

7. Recommendations

The findings in this study indicated that business intelligence factors represented in data quality, BI scope, BI users, BI management, and BI capabilities significantly affect the quality of decision-making in higher

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education institutions. Therefore, this study suggests a set of recommendations to decision-makers in higher education institutions as the following:

- Decision-makers in higher education institutions must support a building data warehouse that is the main component of business intelligence.
- The management of higher education institutions should facilitate the management of business intelligence by providing the resources required to support the implementation of systems in a timely and budgeted manner.
- This study recommends that the university administration shed more light on training employees in various departments on using business intelligence systems by conducting training courses and making leading business intelligence training platforms available to employees.
- This study found that the expansion in the use of business intelligence systems improves the quality of decisions taken. Therefore, higher education institutions must consider the diversification of using business intelligence techniques and tools in various university jobs and use advanced business intelligence tools such as data mining and Dashboard.
- The study advises higher education institutions to add a new policy to impose data-driven decisions using BI systems to the university policy.
- This study recommends that universities further improve the capabilities of business intelligence systems by keeping up with the latest BI tools and systems to expand the benefits of these systems.

8. Action Plan

In light of the above recommendations, this study presents an action plan to improve the use of business intelligence systems in higher education institutions:

- Assess the status of the business intelligence environment by conducting a comprehensive assessment of the institution's needs regarding business intelligence systems. This includes analyzing current operations, identifying strengths and weaknesses, and understanding the specific needs of each department (registration, financial affairs, and academic affairs). Also, examine the current technical infrastructure.
- Develop a clear strategy to identify the main objectives that will be achieved through using business intelligence systems, link these objectives to the overall institutional strategy, and identify the key performance indicators (KPI) that will be used to measure the achievement of the desired goals.
- Develop a robust data infrastructure by unifying different data sources in a central data warehouse and ensuring data quality through cleaning, verification, and security processes.

- Select appropriate business intelligence tools that meet the institution's needs in terms of features and cost, implement the selected tools, and integrate them with existing systems.
- Train and qualify staff by organizing workshops and training courses for employees to familiarize them with how they use these systems effectively and build specialized teams in data management and analysis.
- Expand the use of BIS across different departments, and improve and update dashboards regularly to meet changing business needs.
- Use the BI system to collect and analyze data and develop useful reports such as student records and financial reports.
- Monitor the organization's performance during the use of these systems to get user feedback and improve the system accordingly.
- Measure the results of using business intelligence systems and evaluate their impact by comparing results with specified indicators, then identify successes, challenges, and document lessons learned.

By following these steps, higher education institutions in Yemen can improve the use of these systems efficiently, which provides valuable insights, supports data-based decision-making, and leads to improved performance and development of the educational process.

9. Conclusion

The rapid change in the university market environment increased the need for business intelligence systems to help capitalize on the enormous amount of data generated by the educational process. Business intelligence provided a powerful tool that facilitated decision-making by allowing information to be processed and translated into knowledge that can be easily and quickly utilized.

This study aimed to investigate the impact of business intelligence systems on the quality of decision-making in higher education institutions. It also sought to determine the extent of the use of business intelligence systems in higher education institutions in Yemen. In addition, it aimed to identify the most significant business intelligence factors affecting the quality of decision-making in higher education institutions, develop an action plan to improve the use of business intelligence systems in higher education institutions and produce a set of recommendations to help decision-makers benefit from these systems to improve the quality of decisions made in universities.

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To achieve these objectives, this study proposed a model based on previous literature that included five independent variables: data quality, BI scope, BI users, BI management, and BI capabilities (a new variable in this study), as well as one dependent variable: the quality of decision-making. The study model was tested using regression analysis, correlation, and other statistical analyses. The results showed that business intelligence systems had a significant positive impact on the quality of decision-making in higher education institutions. The results also indicated that BI management had the highest positive effect, followed by BI scope, data quality, BI users, and BI capabilities, respectively. Additionally, it showed that the correlation between dependent and independent variables was powerful and positive.

This study presented a set of scientific contributions, including recommendations for decision-makers to benefit from these systems in developing the educational process and improving performance.

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