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The mediating role of data mining on the relationship between business intelligence and project management sustainability

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A B S T R A C T

As a concept, PMS is becoming increasingly important for determining the sustainable success of an organization. PMS refers to how the organizations execute project tasks in a sustainable manner while maintaining the economic, environmental and social equilibrium of their activities. Importantly, the PMS includes actions that are geared toward project goal achievement and sustainable development. At the current time, there is increasing dynamism and availability of information among organizations. Under such conditions, BI emerges as a concept. Business intelligence can be defined as the set of methodologies and tools employed by organizations to capture, analyze and interpret data to gain information. With BI, organizations can achieve increased visibility and improved planning and performance of projects. Despite the importance of BI in helping organizations achieve sustainable success in project results, it cannot be emphasized enough that the sustainability of project results requires even better techniques of information analysis. In this connection, organizations need DM as an advanced form of BI that aims at identifying underlying information from large amounts of data.

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1. Introduction

The concept of project management sustainability (PMS) has gained significance as a key determinant of the sustainable success of organizations. The concept encompasses the ability of organizations to carry out project tasks effectively and sustainably while retaining a balance of economic, ecological and societal impacts. Notably, PMS involves efforts not only towards achieving project goals but also in realizing long-term sustainability (Masad et al.,2025).

In the present age, organizations face increasing levels of dynamism and data availability. Against this backdrop, the concept of business intelligence (BI) comes in handy. BI can be described as techniques and technological tools used to collect, analyze and interpret data into meaningful information. With BI, organizations can promote greater visibility and improve planning as well as performance of projects (Al-Ajlouni et al., 2025).

Notwithstanding the significance of BI, sustainable project results demand more sophisticated means of analyzing available information. To this end, organizations must use data mining (DM), which can be viewed as a development of BI aimed at uncovering hidden information and insights in big datasets (Daabseh et al., 2026). Most companies, especially those operating in developing countries like Jordan, encounter difficulties in incorporating analytics into their project management systems. These difficulties include inadequate technology resources, limited expertise, and inadequate data integration. Hence, the need to appreciate the significance of BI and DM in promoting sustainable projects becomes crucial.

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Past studies indicate that the connections between analysis skills and performance results are often intricate, with mediators involved. Nonetheless, little attention has been paid to how data mining acts as a mediator in the link between business intelligence and project management sustainability. This study seeks to address this knowledge gap in the Jordanian environment (Alnawafleh et al., 2024).

Project Management Sustainability (PMS) is an emerging concept in modern management science, which reflects the movement from the traditional evaluation of project success based on time, cost, and scope to the generation of sustained value. Different from the typical project management methods that concentrate mainly on time, cost, and scope, PMS emphasizes other aspects like environmental sustainability, social effects, and economic viability (Maaitah, 2023). Project Management Sustainability (PMS) can be referred to as the ability of organizations to plan, implement, and control projects with the aim of optimizing resource usage, while at the same time making sure that there is a sustainable organizational benefit from the activities carried out and at the same time a beneficial effect on society. It also involves striking a balance between short-run objectives and long-run sustainability considerations. This includes environmental concerns, ethics and stakeholder satisfaction (Xu et al., 2022).

Academics have pointed out that PMS is a step further away from regular project management in terms of philosophy. An organization practicing PMS adopts a holistic approach that incorporates the principles of sustainability into all phases of project implementation. This ensures resilience, risk reduction, and a positive image for the organization. PMS is linked to strategic alignment because sustainable projects tend to align with the strategic objectives of organizations and enhance their competitiveness. Organizations that adopt sustainable project management practices display greater flexibility and enhanced relationship with stakeholders (almajali et al., 2025).

2.2 Business Intelligence (BI)

Business Intelligence (BI) is thus an ability that plays a central role in turning data into insight. There is a variety of tools, technologies, and procedures involved in business intelligence in order to gather, organize, analyze and communicate data. Business intelligence systems usually involve the use of data warehouses, dashboards, reporting capabilities, and analytical capabilities in order to provide descriptive and diagnostic analytics (mangla et al., 2021).

The main purpose of business intelligence is to facilitate decision-making through better data collection, analysis, and communication. In situations where there is too much data, business intelligence allows organizations to track their operations, analyze trends, and adjust their plans accordingly. Such capabilities are especially vital in the context of project management. The role of business intelligence in performance improvement stems from the provision of higher transparency, reduction of uncertainty and decision making based on evidence. Business intelligence helps to assess project success and allocation of resources effectively as well as to detect possible risks. Business intelligence helps to make strategic decisions by giving information about organizational advantages, disadvantages, opportunities and threats (Aljawarneh, 2024).

Modern researchers focus on the idea that business intelligence is an organizational resource which increases capabilities of organizations and is more than a technological one. Following resource-based theory business intelligence can be perceived as a rare and valuable resource that gives a competitive advantage. Organizations that manage to implement business intelligence systems effectively gain a possibility of utilizing data for innovation and organizational development (aljawarneh, 2024). Nevertheless, the effectiveness of business intelligence also depends on implementation of advanced analysis tools. Although business intelligence allows obtaining descriptive information, it does not provide predictive analysis and decision making. Thus, there is a need for data mining tools as the supplement to business intelligence (Awamleh et al., 2025).

2.3 Data Mining (DM)

Data mining is an essential part of advanced analytics that emphasizes the discovery of hidden patterns, relations, and knowledge from huge data sets. The process uses sophisticated statistical analysis, machine learning algorithms, and computational procedures to study data and gain insight into predictive knowledge. DM helps organizations shift from descriptive analysis to predictive and prescriptive decision-making (Mazzaro, 2024).

The significance of data mining can be seen in its capability to reveal information that cannot easily be observed using traditional analysis techniques. By detecting patterns and trends, DM provides organizations with the ability to forecast future developments and optimize their activities to minimize risks. This characteristic is especially useful for project management, which frequently entails making decisions amid complexity and uncertainty (Al-Maaitah et al., 2025). Data mining improves organizational efficiency and performance through better decisions, higher efficiency and greater innovation. It contributes to functions such as risk analysis, resource optimization and performance prediction. For example, when applied in the field of project management, DM can help to predict project delays, potential cost overrun and more accurate scheduling.

Conceptually, data mining relates to knowledge management and organizational learning. The former converts data into valuable and useful knowledge which then can be used for better decision-making and improved organizational performance. Therefore, data mining becomes an essential function of organizations in order to make effective use of their data assets.

Lastly, data mining is a means of linking data to decisions. Though BI systems collect and analyze structured data, it is data mining which analyzes that output and creates insights from them. That is why integration of BI and DM should be considered essential (Qatawneh, 2022).

2.4 The Relationship between BI, DM and PMS

It will be easier to explore the connection between business intelligence, data mining and project management sustainability if one analyzes them from the point of view of data-based decision-making. Business intelligence offers the framework for the process, whereas data mining improves the ability of data analysis by creating predictive models. All these aspects help to increase project efficiency and realize sustainable goals. BI helps to ensure PMS through its positive influence on information quality, transparency and strategic decision making (Liu& Chen, 2024) Companies implementing the use of BI solutions find it easier to control project implementation, measure its results and optimize resource allocation. As a result, project management improves in terms of results and sustainability.

It should be mentioned, though, that there are other ways in which the application of BI affects PMS apart from direct one. In particular, the mediating effect provided by data mining helps to turn collected data into valuable insights, which can be achieved due to DM's ability to predict future outcomes. Thus, DM helps improve the efficiency of the BI application and thus its influence on sustainability. In particular, the mediating effect of DM is significant when project management becomes more complicated due to the need for sophisticated analytical tools and more elaborate decision-making strategies. Thanks to the combination of both techniques, companies can create a complete strategy for managing projects(Al-Hyassat & Ghasemi, 2025).

Thus, in general, the interaction between BI and DM presents an effective approach to ensuring the sustainability of project management.

3. Hypotheses Development

3.1 Business Intelligence and Project Management Sustainability

Researches conducted on the effect of Business Intelligence (BI) on performance outcomes have demonstrated that the implementation of BI in any organization has a positive impact on organizational performance. This is because, unlike the traditional approaches to decision making, BI allows organizations to use their knowledge to improve planning, monitoring, and execution of activities.

The use of business intelligence systems increases the quality of information used in decision making. The application of BI eliminates uncertainties and ensures that all decisions made within an organization are aligned strategically. PMS necessitates the need to balance efficiency and long-term gains. Therefore, the adoption of BI systems will enhance PMS. The research shows that BI is associated with greater effectiveness, more efficiency and improved quality of decisions. This, in turn, leads to higher sustainability of projects, as organizations are able to foresee problems, improve operations and maintain sustainable performance. Another important point is that BI ensures transparency and accountability, which are two important components of sustainable project management. According to the theory, the resource-based view implies that BI is considered as a firm's strategic capability that affects organizational performance. Thus, the companies with high-level BI capabilities are more likely to develop sustainable competitive advantage (Han et al., 2024).

Taking all the above-discussed points into account, one can conclude that the application of business intelligence positively impacts the sustainability of project management. Thus, the following hypothesis is formulated:

H_1: *There is a positive association between business intelligence and project management sustainability.*

Apart from the effects of BI on sustainability, another benefit of this type of technology is its contribution towards fostering other advanced analysis tools like data mining (DM). In this regard, BI technology forms the backbone of data mining by offering the basic platform for data collection, integration, and processing (hasan et al., 2026). Firms that adopt BI technology are more likely to develop DM capabilities owing to their capability to gather, integrate, and process quality data. It should be noted that DM requires good organization of data in terms of structure and content. This, in turn, is facilitated by the adoption of BI technology. Besides this, BI promotes organizational learning and knowledge creation, both of which are crucial in the success of DM endeavors. According to these arguments, it is anticipated that BI will positively affect the firm's ability to conduct DM operations. In this respect, the following hypothesis is advanced:

H_2: *There is a positive association between business intelligence and data mining.*

3.2 The Mediating Role of Data Mining

Data mining (DM) is very important in making raw data insightful. It goes further to offer predictions and prescriptive analytics, thus offering decision making tools that are not offered by Business Intelligence. In the field of project management, DM allows firms to recognize risks, make predictions and even optimize processes for sustainability in projects.

Data mining has the capability of enhancing sustainability in project management through its effectiveness in decision making process facilitated by data mining. The use of data mining in analyzing data and recognizing hidden patterns helps in project planning, allocating resources and even managing risks, among other things, for sustainability. Previous research has indicated the significant contribution of high level of organizational analytical capability to improved organizational performance. As a major contributor to analytical capability of an organization, DM makes a major contribution to organizational improvement by enabling predictive analysis, which is crucial for sustainability (Alkhawaldeh et al., 2024).

Furthermore, the effect of DM goes far beyond the improvement of performance of individuals or teams working in organizations. As the effectiveness of decision-making process improves due to data mining, so does the overall organizational performance. This gives rise to the assumption that data mining greatly contributes to sustainability of project management (Al-Wafa, 2025). Thus, the following hypothesis can be stated based on the above considerations:

H_3: *There is a positive association between data mining and project management sustainability.*

Moreover, the influence of business intelligence is anticipated to be mediated by data mining in relation to the relationship with project management sustainability. Whereas BI creates the framework and resources for analyzing the data, DM will make the analytical process easier through gaining deeper insights and predicting future trends (Yang & Zheng, 2020).

The mediation function of data mining implies that the effect of business intelligence on sustainability is achieved not only directly but also indirectly through improved analysis processes. BI facilitates the organization's data gathering efforts and processes; at the same time, DM helps analyze this data and use the obtained insights in order to ensure project success. Such a complementary function demonstrates the importance of using both methods together in organizational activities. The crucial part in the success of many projects requires advanced analytical skills in making effective decisions. Being an intermediary between BI and sustainable project management, data mining makes the overall contribution of BI even greater. Thus, the mediation influence of DM is proposed in the context of the discussed relationship, as shown in Fig. 1. Accordingly, the following hypothesis is presented:

H_4: *Data mining mediates the association between business intelligence and project management sustainability.*

4. Methodology

4.1 Study sampling

The current research used a descriptive survey method for analysis and study of the relationship between business intelligence, data mining, and sustainability of project management. The population of the study was the employees in various government agencies within Jordan, especially those who were involved in the process of project management and decision-making through data use. The participants of the study came from a diverse group of individuals, ranging from managerial and administrative personnel such as executive directors, general managers, heads of departments, and administration managers. Other individuals in the group included professional, technical and operation staff members, as well as assistants and secretaries involved in project management work. Due to the huge number of public sector employees in Jordan, which amounts to an estimated figure of around 220,000 employees it became practically impossible for researchers to use the probability sampling technique. In order to overcome these problems, a convenience sampling method has been used by researchers in this study. It helped them collect data from those who are directly working in the organizations' processes regarding business intelligence, data mining, and project management.

Respondents in this research were selected based on their adequate knowledge and experience in dealing with data, information system utilization, and participation in project management.

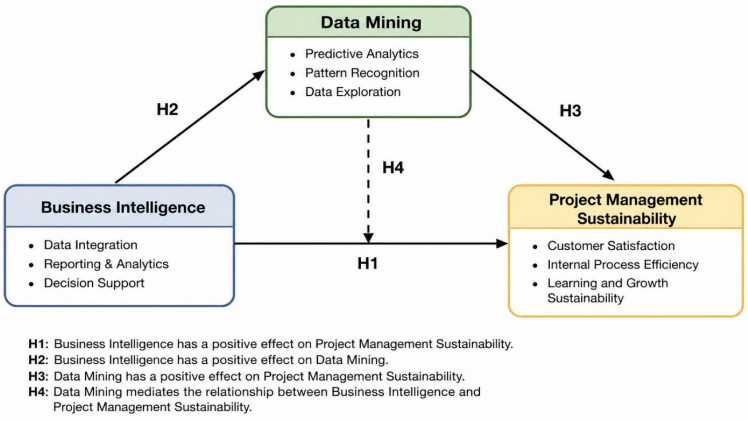

Fig. 1. The proposed method

Source: Authors' own created

Actually, because of some limitations resulting from using probability sampling methods, including random sampling among public sector employees, it was not possible for the research team to use this method in the current study. These limitations include lack of access to complete lists of all employees, as well as geographical spread, costs related to collecting data from various sectors, and limited access to certain categories of employees involved in project management and data activities.

For these reasons, the convenience sampling method was used. This method is very useful, practical, economical, and effective since it involves selection of respondents based on their availability. This method is highly recommended when conducting research involving organizational settings where access to respondents is limited . The data were gathered through an

electronically-based questionnaire developed for the purposes of gathering insights relating to the concepts under study, business intelligence and data mining sustainability as well as project management. The questionnaire link was disseminated among employees who work in public sector organizations. In addition, the researchers made field visits to governmental institutions and worked with human resource managers to help disseminate the questionnaire among employees involved in projects as well as data-mining activities.

Further, the researchers relied on their professional network consisting of colleagues, acquaintances and other professional contacts in order to disseminate the survey link among public-sector organization employees.

Eventually, the researchers received 361 completed questionnaires out of which only 350 questionnaires were found fit for analysis through the process of data screening. Finally, in order to assess the presence of common method bias (CMV) problem in the study, Harman's single factor test was performed by analyzing how much percentage of variance was explained by one single factor. The results revealed that one single factor accounted for 29.71% of total variance which is much lower than the 50% cut-off value recommended by (Malawani et al., 2025).

4.2 Measurement

All dependent and independent variables were measured on a five-point Likert scale ranging from strongly disagree to strongly agree. However, it is important to understand that this study involves higher-order constructs as the independent and dependent variables in order to account for their multidimensionality (chen & wang, 2022). The concept of business intelligence was treated as a higher-order construct comprising three primary dimensions, namely, data integration, reporting and analytics, and decision support. The first dimension involves an organization's ability to effectively integrate its data, while the second one relates to data processing and utilization in decision-making processes. Business intelligence was measured with the help of nine items based on previous research conducted in the field of business intelligence. In the same manner, the sustainability of project management (PMS) was developed based on customer satisfaction, internal process efficiency and sustainability in learning and growth. These aspects are in line with the balanced scorecard (BSC) approach, which measures both financial and non-financial performance for sustainable assessment. The variables associated with PMS were taken from previous research studies where BSC is applied to measure organizational and project sustainability.

On the other hand, data mining (DM) was used as one of the mediating constructs of the study to show the firm's analytics capability. This construct covers elements such as predictive analytics, pattern recognition and knowledge extraction. Six questions about data mining were used to measure this construct. The questions are based on empirical studies related to data analytics and information systems. As part of the efforts to validate the questionnaire, a pilot test was conducted among a selected number of respondents. An open question was provided at the end of the survey form to give suggestions on how to improve the wording and content of the questionnaire. Some revisions were made based on the respondents' feedback.

4.3 Sampling Profile

The demographic details of the respondents used in this study are shown in Table 1 below. It can be observed that the proportion of males among the respondents is relatively high at 66% compared to females, who make up 34% of the sample. As far as the educational status of the respondents goes, most of them possess a bachelor's degree, making up 62% of the total sample size, which makes for a relatively educated sample size.

When it comes to the age structure of the respondents, most of them belong to the age group of 40 to less than 50 years, making for 31% of the total sample size. Concerning their work experience, 31% of the respondents have between 10 to less than 20 years of work experience.

5. Data Analysis and Results (Start Section)

5.1 Measurement Model Results

To analyze the gathered data, partial least squares structural equation modeling (PLS-SEM) was utilized in testing the proposed hypotheses. PLS-SEM is very applicable to this study because it permits simultaneous analysis of both the measurement model (for the purposes of measuring reliability and validity) and the structural model (for hypothesis testing).

Moreover, PLS-SEM has proven to be very effective when dealing with complex models that involve higher-order constructs, like business intelligence and sustainability of project management in the current study. This model is equally applicable to predictive studies as well, and it is also suitable for conducting an analysis even with a small number of participants.

Given all these advantages, the choice of PLS-SEM for conducting this study was deemed justified. To examine the measurement model, several parameters were considered, such as factor loadings, composite reliability (CR), average variance extracted (AVE) and discriminant validity.

The factor loading values greater than 0.70 show that constructs are valid. At the same time, CR value exceeding 0.70 proves the reliability of constructs, and AVE greater than 0.50 ensures convergent validity.

Table 1
Respondents' Profile

Category	Sub-Category	Frequency	Percentage (%)
Gender	Male	23	55
	Female	18	22
Educational Level	Secondary School	35	10
	University	22	26
	Master	55	10
Age	15	25	21
	30	30	18
	40	40	20
	50	20	15
Experience	10	20	21
	15-20	10	29
	21-25	59	20
	30-50	57	21
Total	—	350	100

Source: created by authors

PLS-SEM may be useful in some cases of research that cannot apply to other methods of analysis when it comes to complicated modeling and higher-order constructs. For these reasons, the PLS technique was utilized in this research to adequately achieve the goals and evaluate the theoretical assumptions made.

In this context, various indicators were applied for the evaluation of the measurement model that consisted of factor loadings, composite reliability (CR), average variance extracted (AVE), and discriminant validity. The threshold value of factor loading and CR was above 0.60 and AVE was above 0.50 that is considered good convergence. Moreover, the AVE values of all constructs exceed the values of correlations between each other, which was confirmed by the correlation table. Thus, discriminant validity of the model was proved by Fornell-Larcker criterion As one can see in Table 2 and Fig. 2, all values of factor loadings, composite reliability, and AVE are within the appropriate limits, thus the measurement model proved its reliability and validity. In addition, Table 3 shows the discriminant validity of the model, which is at the acceptable level.

5.2 Structural Model Results

The evaluation of the structural model constitutes the second phase of the PLS-SEM approach, which serves as a means for testing the hypotheses (Hair et al., 2019). As shown in Table 4 and Figure 3, the findings suggest that the project management sustainability is positively affected by the business intelligence ($\beta = 0.824$, $p = 0.000$) and data mining ($\beta = 0.558$, $p = 0.000$) factors. This implies that hypotheses H_1 and H_3 are valid. Furthermore, it is evident that data mining is positively affected by business intelligence ($\beta = 0.776$, $p = 0.000$), thereby validating hypothesis H_2.

Table 2
Convergent Validity Results

Variables	Cronbach's Alpha	Composite Reliability (CR)	Average Variance Extracted (AVE)
Customer Satisfaction (CS)	0.808	0.808	0.846
Data Integration (DI) *(formerly GAGH)*	0.920	0.922	0.863
Reporting & Analytics (RA) *(formerly GPB)*	0.970	0.950	0.940
Internal Process Efficiency (IPI)	0.949	0.950	0.915
Data Mining (DM) *(formerly IP)*	0.950	0.930	0.815
Learning and Growth Sustainability (LG)	0.970	0.920	0.930
Decision Support (DS) *(formerly PPP)*	0.908	0.908	0.845

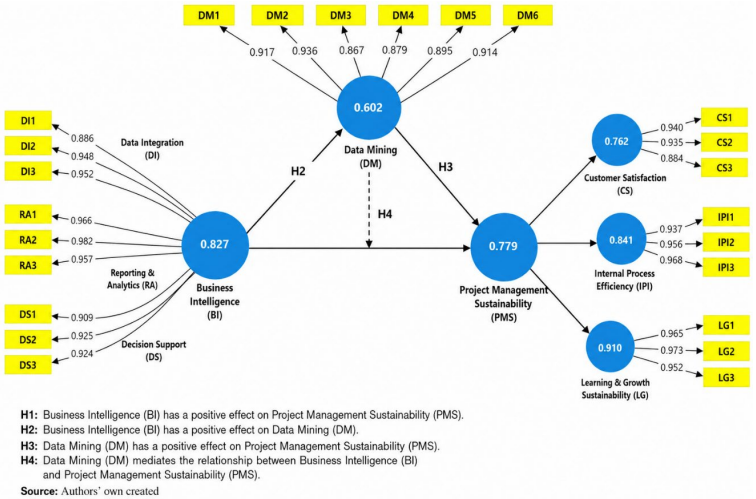

Fig. 2. The summary of the results

Table 3
Discriminant validity results

Variables	CS	DI	RA	IPI	DM	LG	DS
CS (Customer Satisfaction)	0.920						
DI (Data Integration)	0.620	0.929					
RA (Reporting & Analytics)	0.734	0.911	0.968				
IPI (Internal Process Efficiency)	0.708	0.452	0.542	0.954			
DM (Data Mining)	0.981	0.662	0.721	0.746	0.902		
LG (Learning & Growth Sustainability)	0.807	0.519	0.601	0.892	0.838	0.963	
DS (Decision Support)	0.850	0.657	0.740	0.660	0.847	0.712	0.919

Source: Authors owns created

The findings for discriminant validity are shown in Table 3 using the criterion set by Fornell and Larcker. The square root of AVE (diagonal entries) is greater than the correlation between constructs (off-diagonal entries). This implies that all constructs in the model are discriminately valid since they have empirical differences from each other.

Table 4
The summary of the results

#	Paths	Original Sample (β)	t-value	p-value	Decision
H_1	Business Intelligence → Project Management Sustainability	0.824	10.825	0.000	Supported
H_2	Business Intelligence → Data Mining	0.776	9.357	0.000	Supported
H_3	Data Mining → Project Management Sustainability	0.558	8.757	0.000	Supported
H_4	Business Intelligence → Data Mining → Project Management Sustainability	0.787	9.340	0.000	Supported

Source: Authors owns created

According to Table 4, there is a significant mediating effect of data mining in the impact of business intelligence on project management sustainability. In other words, there is evidence to show that business intelligence increases sustainability performance not only directly but also indirectly by developing data mining techniques. Thus, hypothesis (H_4) is verified.

According to the results presented in Table 4 below, business intelligence has a significant and positive impact on project management sustainability, thereby accepting hypothesis H_1. In this regard, businesses with effective business intelligence systems have the potential to produce sustainable project results due to improved planning, monitoring, and control. Through the use of information that is accessible, accurate, and timely, there is enhanced operational efficiency and reduced uncertainty in project settings. Furthermore, the results show that there is a strong positive relationship between business intelligence and data mining, thereby validating hypothesis H_2. The finding emphasizes the importance of business intelligence systems as basic components that enable sophisticated analysis. With business intelligence systems in place, companies can effectively engage in data mining because these systems ensure quality, systematic, and integrated data collection. In this context, business intelligence helps in knowledge generation and enhances the organization's capacity to extract meaningful information from vast and complicated data sets.

Further, the results indicate that data mining has a significantly positive influence on the sustainability of project management. Therefore, hypothesis H_3 is supported by the results obtained. The result emphasizes the importance of data mining in improving project performance through proactive decision-making. Furthermore, regarding the mediating role, the results clearly show that data mining plays a vital mediating role in the relationship between business intelligence and project management sustainability, which means hypothesis H_4 has been supported by this finding. That is to say, not only has the influence between business intelligence and sustainability been demonstrated to be direct, but it has also been proven to be indirect due to the facilitation of analysis brought about by business intelligence.

Despite many benefits and contributions made by this study, there are still some limitations that must be addressed. First, the study could not use any probability sampling method because of the high expense involved in acquiring such a sample, which included the cost for collecting data from various public sector companies, as well as the challenge of getting the list of the names of the employees and their contact details, as well as time consumption. The second limitation of the study is that the scope of this research is limited to the public sector in Jordan only, which limits the possibility of applying its results to any other case. The culture, institutions, and technology in other countries, especially those belonging to the MENA region, might affect the adoption of business intelligence and data mining. Future research needs to repeat this study in other places geographically and organizationally to test and confirm the present findings.

Finally, the research model used in the present study is a quantitative model, which was tested using survey data from the public sector in Jordan. Although this technique can give meaningful results statistically, it does not provide a thorough explanation of the mechanism through which business intelligence and data mining affect the sustainability of projects. Lastly, this study focuses on the role of data mining as a mediator in the link between business intelligence and sustainability in project management. The researcher recommends future research into other possible mediating or moderating variables that would further enhance the comprehension of this association. Organizational culture, readiness for technology, trust, and engagement are some of the factors that might be relevant here.

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