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AN ANALYSIS OF QUALITY ASSURANCE FOR BUSINESS INTELLIGENCE PROCESS IN EDUCATION SECTOR

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Abstract

Quality Assurance for Business Intelligence is aimed at ensuring that BI systems supply proper, reliable, and useful information. This comprises data accuracy checking, standardisation of reporting, user education, data security and privacy alongside data quality enhancement. QA leads to accurate conclusions and the optimisation of organisational performance with the help of BI while upgrading data quality and system efficiency. It is an undisputed fact that quality education plays a crucial role in deciding the growth and progress of modern civilisation. Modern schools and colleges are attempting to develop the active improvement of their programs and to maintain quality control for business information. Exploring the current state of educational quality management is the topic of this article in view of the BI systems' integration and QA in the education sector. In regards to this, it assesses how the conventional QA technique can complemented by using BI tools to enhance data readability, reporting, and decision-making. Thus, the paper, being an analysis of the contribution of BI in enhancing local QA strategies, describes how BI can support operative insights, forecasts, and resource management. It aims to offer a comprehensive framework for combining QA with BI to address the challenges faced by educational institutions, ultimately leading to more effective quality management and continuous improvement in educational outcomes.

Index Terms—Quality Assurance, Business Intelligence, Education, KIPs, Data-Driven Decision Making.

I. INTRODUCTION

The quality of meaning has experienced a great transformation over time; while people at one time used broad concepts, later on, there is a presence of useful concepts and procedures. This assumes that quality can be described by many factors such as value, adherence to specifications, utility, and satisfaction of or going beyond the customers' expectations. This study and practice suggest that quality is one of the essential indicators that define the future prosperity of an organisation. Quality entails the organisation's repute and quality management system in tandem with the product or service [1].

Quality assurance can be defined as a process that is aimed at guaranteeing that products or services are of a particular level or standard and are not faulty. In software development, QA includes activities that aim at meeting the intended quality standards and performance. It comprises different testing types, such as manual testing, where the tester performs test cases, and automated testing, where scripts help in performing test cases efficiently and in large numbers. Quality assurance in BI means that tools used in BI are accurate, reliable and efficient in their job. This includes confirming data integration, checking the quality of the transferred data and the accuracy of reports and dashboards[2][3].

The amalgamation of QA and BI reveals significant value by fortifying the reporting and decision-making activities. The BI tools help organisations to get end to end reports on testing metrics such as efficiency, number of defects, and quality of the software from the QA data. It allows for decision-making based on the issues provided by the BI to be implemented in the changes to be made in the QA processes. Predictive analysis can also be used to prevent quality issues in advance; on the other hand, the performance measures under BI can offer pictorial and tangible solutions to improve the current quality management systems. The combination of QA with BI helps to identify correct strategies for reaching the maximum potential of software quality and using knowledge to support their further enhancement[4].

A.Research motivation and contribution

The rationale for this study is to explore and evaluate the implementation of QA procedures into BI systems in an educational context. This paper is informed by the need to improve effectiveness of Quality Assurance (QA) in educational institutions through the incorporation of Business Intelligence (BI) systems. As educational institutions face increasing demands for accountability, efficiency, and continuous improvement, traditional QA methods may fall short in providing actionable insights and driving informed decisions. By exploring the integration of BI tools with QA processes, this research aims to address these challenges, offering a more robust framework for maintaining and improving educational quality. Here are key research contributions based on the provided research:

- **Quality Evolution:** Quality has become defined processes that surfaced in the context of business, affecting not only products but identities.
- **QA and BI Integration:** Combining QA with BI enhances reporting and decision-making, leveraging data insights to improve QA processes.
- **Education QA:** QA in education ensures alignment with stakeholder expectations and efficient resource use, focusing on different quality aspects like academic and managerial.
- **KPIs in Education:** KPIs measure and improve educational performance, covering administrative efficiency, student support, instructional quality, and student outcomes.
- **BI Architecture:** BI systems in education use data sources, ETL processes, and dashboards to analyse performance and support decision-making.
- **Resource Optimisation:** Highlights the role of BI in optimising resource allocation, including faculty, funding, and facilities, to improve efficiency and effectiveness in education.
- **Predictive Analytics:** Shows how predictive analytics within BI can help identify potential quality issues before they escalate, allowing for proactive management.

II. OVERVIEW OF QUALITY ASSURANCE (QA) AND BUSINESS INTELLIGENCE (BI)

Quality Assurance (QA) ensures products meet standards through testing, defect management, and process improvements. Business Intelligence (BI) analyses and presents business data to support decision-making using tools for reporting, visualisation, and analytics. Integrating QA with BI enhances quality reporting and decision-making by leveraging data insights to improve software quality and predict potential issues[5].

A.Quality Assurance (QA)

The process of making sure that the goods supplied to clients fulfil their contractual obligations and other predetermined standards for performance, design, reliability, and maintainability is known as quality assurance or QA. This term is applied to both the manufacturing and service sectors of the economy. QA is a way of management that encompasses all the planned and systematic activities required to ensure that a product, service, or outcome will meet the required standards for quality and be suitable for its intended purpose. Figure 1 shows the areas of Quality Assurance (QA).

Fig. 1. Quality Assurance (QA) area

A Quality Assurance program is "the total of all the actions taken to meet that specified benchmark."[6]. The goal of any monitoring program or assessment should be to provide data that is sufficient, accurate, and dependable for the intended use. This implies that there has to be a data quality target or a clear understanding of the kind and requirements of the information sought before the project begins. To develop a system that can keep uncertainty to a reasonable level within the parameters set, data quality goals are used. These objectives may be either quantitative or qualitative in nature. End users of the data, who are often the ones paying for the project, work with the relevant technical specialists to establish these goals. In addition to boosting public and funding agency trust, quality assurance for recreational water monitoring programs helps guarantee accurate findings. From hygiene surveys to laboratory procedures, QA covers everything when it comes to data collecting. Data should not be included in any evaluation unless it can be verified; unverified observations are useless and could lead to incorrect classification.

B. Business Intelligence System

The BI technology is covered in this article; it is a powerful instrument for decision making assistance and also has a lot of promise in other areas. To help readers grasp the fundamentals and the use of this technology in business management, we provide and clarify the essential definitions.

1) Business Intelligence Architecture and Life Cycle

BI is a set of tools and techniques used to extract useful information from data in order to aid in decision-making. These tools and techniques include mathematical models.

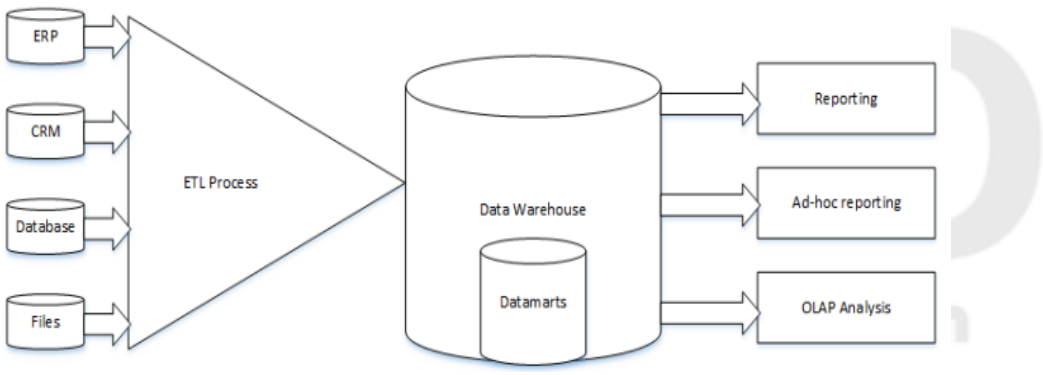

Fig. 2. Typical architecture of the BI system[7]

Three primary components make up the business intelligence system architecture shown in Figure 2: data sources, data warehouses, and data storage.

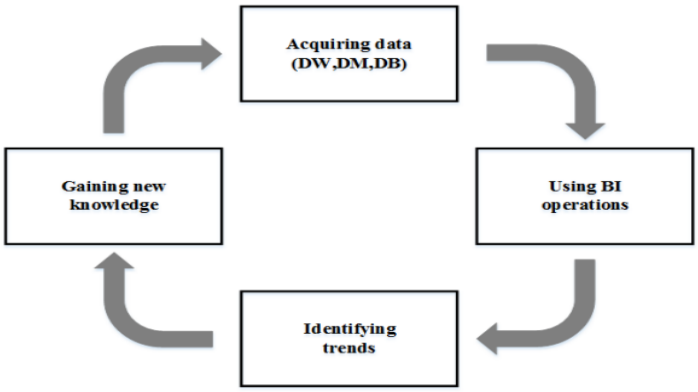

Fig. 3. Life cycle of analysis within the BI[7]

In Figure 3, which mirrors the BI system architecture mentioned above, the analytical life cycle is shown. A ring of four interdependent phases is necessary for the BI system to function properly.

III. FUNDAMENTAL QUALITY ASSURANCE IN EDUCATION SECTOR

Governments invest substantial resources into education systems, and these systems include a wide range of internal and external players. As a result, there is a need to reassure stakeholders that resources are being used effectively. As a result, quality assurance is crucial for showing that stakeholder expectations are met by an organisation's goal and objectives [8][9]. The following Table 1 provides the classification of quality assurance in education institutions.

TABLE I. CLASSIFICATION OF QUALITY ASSURANCE IN EDUCATION INSTITUTIONS[10]

Type	Area of focus
Academic QA	• Focused on subject knowledge and curriculum. • Different quality values across education.
Managerial q QA	• Focused on institutional policies, systems and procedures • Invariant quality values across education.
Pedagogical QA	• Focused on people's skills and competencies • Invariant quality values across education.
Employment/ output Focused QA	• Focused on output, graduate attributes and learning outcomes • Variant as well as invariant quality values across education.

Responsibility, community happiness, cost-effectiveness, and efficiency are the primary concerns of governments that fund educational institutions. As a result, students are primarily worried about finances and employment prospects, while institutions are keen on ensuring and improving the quality of academic programs, student management, and personnel. The diverse variety of stakeholder demands and viewpoints puts pressure on education systems to show their compliance with these criteria. Education systems have also come to see that they may differentiate themselves from other institutions and ensure their long-term existence by providing high-quality services and a high level of customer satisfaction[11][12].

A.Key Performance Indicators for Education Quality Assurance

Education systems employ KPIs to compare performance in certain domains. To ascertain the degree of satisfaction or goal compliance, the actual performance is assessed and contrasted with the KPI. The accomplishment level might indicate whether or not the education system is in line with the organisation's purpose and strategic goals since KPIs are closely linked to the latter. Furthermore, [13] highlighted that high-quality information and datasets are necessary for making smart judgements while making decisions. Both research and education may benefit from the use of metrics and KPIs. It may include student assessments, time-series data on accomplishment and attrition, and a computerised review of reports and submissions. These data sets' findings may be combined on an individual, school, discipline, faculty, institution, or systemic level. Schindler et al. 2015[14] looked at the research on education quality indicators and came up with a four-part classification system.

1) Administrative Indicators

Administrative indicators measure the efficiency and effectiveness of institutional management and operations. These can include metrics related to budget management, resource allocation, faculty and staff recruitment, and infrastructure maintenance. Effective administration ensures that the educational institution runs smoothly and resources are utilised optimally.

2) Student Support Indicators

Student support indicators assess the availability and quality of support services provided to students. This includes academic advising, counselling services, career services, financial aid, and extracurricular activities. Strong student support systems contribute to student satisfaction, retention, and overall well-being.

3) Instructional Indicators, and:

Instructional indicators evaluate the quality of teaching and learning processes. These metrics can encompass faculty qualifications, teaching methodologies, curriculum design, and the use of educational technology. Effective instruction enhances student engagement, learning outcomes, and overall educational experience.

4) Student Performance Indicators:

Student performance indicators focus on measuring student achievement and progress. This includes graduation rates, exam scores, job placement rates, and further education enrollment. High student performance indicates that the institution is successfully imparting knowledge and skills, preparing students for future careers or advanced studies.

B. Challenges of Quality Assurance in Education

The majority of faculty members are not excited about the accreditation process or its associated data-collecting duties, which include preparing documents and forms, aggregating data, analysing data, gathering evidence, and developing remedial measures, according to research. A large portion of the quality assurance methods in the education system are based on the protocols that are followed throughout the stages of curriculum creation, instruction, assessment, and planning [15]. Key challenges of the QA in education sector are as follows:

- **Resistance to Change:** Faculty members and staff may resist QA processes due to the perception that they add to their workload without providing immediate benefits. Resistance can stem from a lack of understanding of the QA process's importance or its perceived interference with academic freedom and creativity.
- **Data Collection and Management:** QA processes require extensive data collection, analysis, and reporting. Managing large volumes of data from various sources can be challenging. The collection of valid, reliable, and consistent data is challenging because of the various systems used and manual data entry problems [16].
- **Resource Constraints:** Establishing and sustaining the QA systems may not be cheap; it may involve much time, capital and expertise. Due to the fact that most of the institutions present have a finite financial and human capital adequate funding of QA activities may be difficult.
- **Maintaining Continuous Improvement:** QA is a dynamic process that needs to be regularly checked assessed and altered if necessary. Many times, maintaining the pace and interest in QA initiatives can be challenging as activities may not yield instant results.
- **Standardisation vs. Customization:** Creating processes that are ISO compatible while at the same time addressing the needs of various departments, programs and courses is not such an easy task. The quality assurance practices that institutions adopt have to standardise some practices while at the same time utilizing unique features in others.
- **Communication and Collaboration:** QA must be a team effort that involves the identification of several specialized departments and interest groups. This usually makes it difficult to share information and the best practices across institutions since departments act as independent silos.
- **Technological Integration:** The use of such tools as AI, ML, and BI in QA processes can help in making the processes more efficient and less error-prone. Nevertheless, the implementation of these technologies presents difficulties that revolve around the necessity of technical skills, IT infrastructure, and probable employees' resistance towards these technologies.

- **Cultural Barriers:** Culture has an important function in the acceptance and effectiveness of QA activities in institutions. Implementing a culture that promotes quality and the use of quality tools is a responsibility that is best addressed through the use of leadership commitment, clear communication, as well as training for all stakeholders.

C.Role of Business Intelligence in Education QA

Measuring the overall quality assurance in the education system requires keeping track of each step of the process and accumulating large amounts of information regarding the Institution. During this process, Information, Communication, and Technology (ICT) can also be of much significance [17][18].

1) Data-Driven Decision Making:

Business intelligence technologies help educational institutions to collect, process, and comprehend large amounts of data. It assists in decision-making for resource mobilization, curriculum development and student services that support the enhancement of the quality of education being offered.

2) Performance Monitoring and Reporting:

Business intelligence helps in generating daily updates in the form of a dashboard and reports on areas such as student performance, attendance, graduation, and faculty performance. This continuous monitoring assists in the identification of areas that requires enhancement and the institution of timely action.

3) Predictive Analytics for Student Success:

BI also makes it easy to point out vulnerable students at this level because it uses forecasts, outcomes of past learner performance, and records of attendance among others. This makes it possible for institutions to support and intervene and get improved retention and success figures amongst students.

4) Enhancing Accreditation Processes:

BI tools help to automate and accelerate the preparation of data commonly used for accreditation and submission to accreditation bodies. Timely presentation of accurate information enables the institutions to meet their accreditation requirements and portray concern in delivery of quality education.

5) Resource Optimisation:

BI is effective in the management of resources that include faculty, classroom space, and funding mechanisms. By analysing utilisation patterns and forecasting future needs, educational institutions can optimise resources, reduce waste, and ensure that they are adequately supporting quality educational experiences.

IV. BUSINESS INTELLIGENCE PROCESS OF QUALITY ASSURANCE

The Gartner Group first used the phrase "Business Intelligence" in the middle of the 1990s. Though the concept is not new, it originated in the 1970s with the reporting systems used in Management Information Systems (MIS). At the time, reporting systems were flat and unimaginative, lacking the capacity to analyse data. The idea of EIS, or executive information systems, first surfaced in the 1980s. This idea broadened the scope of computerised help to include executives and managers at the highest levels. Critical success factors (CSFs), trend analysis, drill-down to details, status access, forecasting and prediction, and dynamic multidimensional (ad hoc or on-demand) reporting were among the features that were implemented. Hundreds of commercial items have these characteristics up to the mid-1990s. Subsequently, BI emerged with the same features, plus a few more. Executives no longer need any other information than what is included in a strong BI-based corporate information system. What started out as EIS is now known as BI. BI systems began to include AI and robust analytics capabilities by 2005[19][20].

A.Component of Business Intelligence

From a purely technical standpoint, the majority of publications highlight the following as an essential aspect of Business Intelligence [21]:

1) Data Sources

BI systems rely on data as their primary component. A BI system's data may originate from a number of places, but the two most common are "inside" the company and "outside," or data created by other entities. The majority

of the data is internal and comes from the several systems that handle processing transactions. No matter what a contemporary company does, transaction processing systems are now an integral part of its operations. The primary motivation for using them is to streamline data collecting and processing for the purpose of enhancing corporate operations and producing superior outcomes[22].

2) Data Warehouse

Information that is difficult to get from operational transaction systems is often required by management. Because of this, data warehouses have emerged; these databases, in contrast to traditional transaction databases, are used for business research and to aid top-level management in making decisions. The phrase "Data Warehouse" refers to a collection of records kept in a separate database from the transaction databases. As part of the process of creating data warehouses, transaction databases are getting rid of complicated queries and loaded with less data, which improves their speed [23]. The data warehouse is defined by his description, which outlines four major features[24]:

- **Subject-oriented:** A data warehouse may be used for segment-specific analysis; for instance, a retail organisation might choose to analyse just its sales department.
- **Integrated:** For example, data from many sources is combined in a data warehouse. When the data is summarised in the data warehouse, there will be only one method of product identification, even if sources A and B may employ multiple techniques to identify the same product.
- **Time-variant:** Historical data is stored in data warehouses. For instance, we may get data that is 3, 6, or twelve months old or older from the data warehouse. The data warehouse will retain all of the addresses associated with a client, in contrast to the transaction system, which only keeps up-to-date information. As an example, the transaction system would only record the buyer's most recent address.
- **Nonvolatile:** There will be no way to modify the data after it is entered into the data warehouse. The only data that may be added to a data warehouse are new records; old records are kept in their original format.

The data warehouse receives its data from a variety of sources, and such data is often diverse. Data storage systems rely on ETL processes, which include extracting, transforming, and loading data. These processes provide the link between operational transaction systems and data warehouses that are developed for analysis and reporting. There are three stages to the data import process from source systems to the data warehouse [25][26]:

- **Step 1:** Data extraction is the process of selecting and retrieving operational data that is valuable from a storage standpoint,
- **Step 2:** Data transformation involves merging disparate data sets and then inspecting, cleaning, remodelling, and adjusting them before putting them into the data warehouse.
- **Step 3:** The load phase involves bringing in the target data warehouse with data that has already been prepared.

3) Online Analytical Processing

It has become clear that traditional methods of electronic data processing are inadequate in light of the ever-increasing volume of available data and the subsequent rise in stringent standards for high-quality decision support. As a result, we must establish new methods of data processing that are tailored to these new demands. When it comes to multidimensional analysis and other forms of Online Analytical Processing (OLAP), one of the most popular and effective methods is to use these tools. While OLAP solutions are best suited for providing context for specific business events, traditional reporting was formerly the go-to method for presenting the company's data housed in various databases. Multidimensional analysis, which allows data to be seen concurrently via a number of filters or dimensions, is the foundation of OLAP tools and is one of its most essential and useful features [27][28].

4) Data Mining

We often resort to more sophisticated methods of data analysis while doing information research. In essence, data mining is the process by which businesses generate BI by utilising the information they already possess to enhance its accessibility and transform it into actionable insights. Researchers use a variety of automated and human techniques to track data mining's progress throughout its iterative process. Its typical use is scenario analysis and research in which the consequences are uncertain. Actually, at each given instant, it shows a quest for fresh, valuable, nontrivial knowledge. That is an example of human and computer collaboration[29].

5) Client Tools.

Inspecting and searching for data is accomplished with the help of several Client tools. By mimicking human thought processes, data warehouse and OLAP access tools offer a vivid picture of the data housed therein. Applications that do not need software installation on the end user's machine are the norm for current tools. Internet browsers, business websites, and integration with other office products make them conveniently accessible[30][31].

B. Business Intelligence Architecture In Education

The three primary levels of business intelligence (BI) architecture at higher education institutions have been the subject of several studies. These layers are as follows: 1) data source, 2) extract, transform, and load (ETL), and 3) data display, which includes a dashboard for tracking the learning process [32].

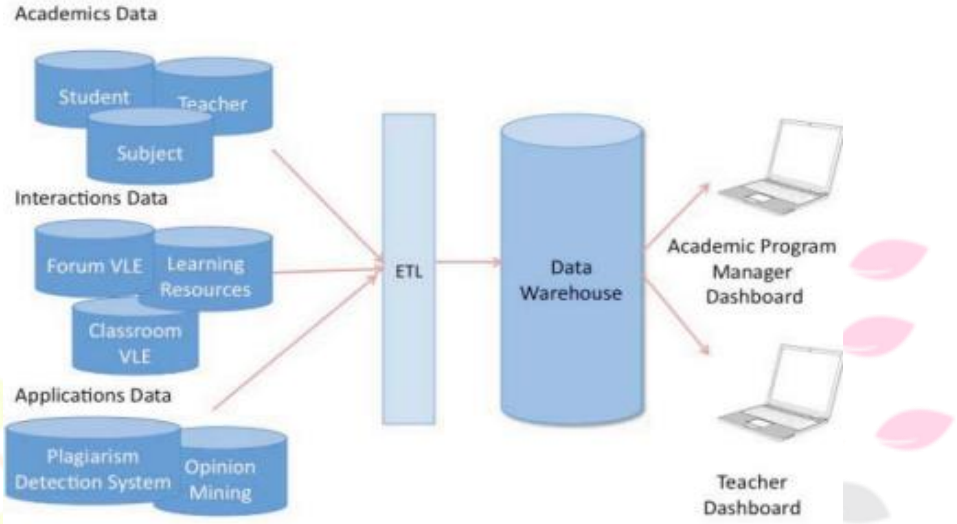

Fig. 4. BI Architecture in Education [33]

These layers are shown in Figure 4, which also serves to demonstrate the data's origins from various databases. Data Warehouse (DW) storage is accountable for storing data for further analysis, while ETL is liable for collecting and transforming this data. To aid decision-makers in analysing learning goals and monitoring the success of learning Key Success Indicators (KPIs), dashboards are used to display these insights in summary form with drill-down functionality [34][35].

V. LITERATURE REVIEW

The literature study on quality assurance for BI processes in the education sector is provided in the next part. A survey of the literature has been done to determine the elements that are included in current frameworks and the shortcomings that they all have.

In, Sorour et al., (2020a) seeks to discover current systems for keeping an eye on university quality assurance programs. Research on the use of BI in HEI quality assurance monitoring yielded five distinct frameworks. Although the frameworks differ in their approaches, they can all agree that data should be used to gauge performance in universities. Additionally, everyone seems to agree that BI tools, like dashboards, could be helpful in giving universities immediate feedback on their quality assurance efforts[36].

In, Mishra, (2023) EFQM and ISO are globally recognised methods that help improve corporate performance, and this study aims to clarify their relevance. The report will also compare and contrast the two concepts and how they were put into practice, pointing out their parallels and differences. The purpose of this comparison is to examine the similarities and differences between the ISO and EFQM frameworks with respect to quality assurance and company excellence[37].

In, Alwan et al., (2023) this paper proposes the Global Quality Improvement (GQI) paradigm to bridge the gap between data management and information technology's integrated quality assurance and data mining concepts. The research concluded that GQI is associated with the knowledge needs of businesses, which might vary from very sophisticated to management-driven misunderstandings. The results of the trial suggest that, when compared to the methods presently in use, GQI is the most effective[38].

In, Isbandi and Albarda, (2013) Design and Engineering Methodology for Organisations (DEMO) is used to implement Enterprise Ontology. As a means of synthesising transactional patterns and services grounded on the organisation's fundamental idea and communication, generic organisational design makes use of ontological construction models. Design outcomes stand in for LPMP's information components, including actors, data, and transactional services. A conceptual model for information traceability may be used to depict the space of information flows as relations of information items[39].

Managers and other staff should have access to disaster management training and seminars, according to the researcher's recommendation[21]. Disaster management simulations should be made available to all members of the organisation. The main contribution of this study is the conclusion that organisations should include catastrophe planning and communication in their strategic planning. This proactive approach is more successful than the reactive one. One way to learn more about disaster preparation is via formal education.

In, Sorour et al., (2021) provides an overview of the validation process for the proposed framework, which included conducting expert-panel qualitative interviews to determine what elements impact the development of business information dashboards used to track quality in the academic sector. The interview data was examined using NVivo 12, a program that is part of Computer Assisted Qualitative Data Analysis Software (CAQDAS). The findings from the qualitative study have informed the presentation of a revised holistic framework (HF-HEQ-BI) for employing business intelligence dashboards to track quality in higher education[40].

In, Mishra, (2019) contributes to the area of interest regarding how and what HEIs can apply data analytics and AI in order to maintain quality. They present additional quality assurance and contribute to the happiness of students as well as more money in the university's account. KPIs and application of big data & AI for HEI's can enhance student satisfaction, program quality, & compliance[10].

In, Sorour et al., (2020b) is to show how BI is used to monitor Quality Assurance operations in higher education institutions. This article focuses on some troublesome issues that are related to quality assurance in higher education and challenges that organizations are facing. The article goes on to talk about how analytics and BI might help with decision-making in the academic setting. The article describes how Business Intelligence systems relate to the fundamentals of Quality Assurance. In order to solve the primary problems with quality assurance performance assessment and monitoring, this article proposes a business intelligence solution for use in Saudi Arabian higher education[33].

In Javed and Alenezi (2023) highlight the significance of KPIs in accreditation and the need for a strong data management system to guarantee sustainability by providing a case study on sustainable quality assurance in higher education. The importance of providing high-quality education and the function of a long-term quality management system in accomplishing this goal are also emphasised [1].

TABLE II. RELATED WORK SUMMARY FOR QUALITY ASSURANCE FOR BUSINESS INTELLIGENCE PROCESS IN EDUCATION SECTOR

Reference	Focus	Findings	Deficiencies	Future Work
[36]	Frameworks for QA Monitoring in HEIs	Effective for real-time QA monitoring	Data availability and integration challenges	Integrate frameworks to enhance QA in HEIs. Explore additional BI tools for improved real-time monitoring.
[37]	Business Excellence Models (EFQM and ISO)	Comprehensive models for QA and performance	Requires customisation for HEIs	Develop customised models combining elements from EFQM and ISO for HEIs. Investigate the impact of these models on various types of educational institutions.
[38]	Global Quality Improvement (GQI) Model	High efficacy in IT and data management	Complexity in implementation	Simplify the GQI model for broader applicability. Test the model in diverse

				educational settings to validate its efficacy.
[39]	Enterprise Ontology through DEMO	Effective in organisational design and traceability	Requires thorough organisational understanding	Refine ontological models for specific organisational contexts. Enhance information traceability features in DEMO.
[21]	Disaster Management Integration	Proactive disaster planning approach	Limited direct relation to QA in education	Expand disaster management training to include simulations and drills. Integrate disaster planning with other strategic planning aspects in organisations.
[40]	Validation of BI Dashboards for QA	Modified framework for QA monitoring	Needs ongoing validation and updates	Continuously update and validate the HF-HEQ-BI framework. Implement and test the framework in different HEIs to refine its applicability.
[10]	AI and Data Analytics in QA for HEIs	Enhances QA and student satisfaction	Dependent on data quality and AI capabilities	Explore advanced AI techniques for QA in HEIs. Assess the long-term impact of AI and data analytics on educational outcomes.
[33]	BI Utilization in HEIs for QA	Effective for performance evaluation in HEIs	Region-specific adaptations needed	Adapt the proposed BI solution for use in other regions beyond Saudi Arabia. Develop additional BI features based on user feedback.
[1]	Sustainable QA in Higher Education	Importance of KPIs and robust data management	Continuous monitoring and adjustment required	Monitor and adjust KPIs for continuous improvement. Develop guidelines for implementing sustainable QA systems in various educational institutions.

VI. CONCLUSION AND FUTURE WORK

An integral part of any effective education system's QA monitoring infrastructure should be BI. Education system decision-makers may get insight into QA activity monitoring with the use of BI and analytics by receiving real-time feedback. Though the educational system is the focus of this paper's discussion of BI architecture, the architecture's applicability extends beyond the deployment of a QA monitoring system to include the monitoring of other institution-wide KPIs as well. The suggested BI architecture incorporates developing technologies such as social media and cloud computing to gather data that may help decision-making, given their importance in the education system. This integration supports better management of educational quality and resource optimisation. However, the study acknowledges limitations such as the potential resistance to change among faculty,

challenges in data management, and the resource-intensive nature of implementing BI systems. Future work should focus on addressing these limitations by exploring strategies to overcome resistance, developing cost-effective BI solutions, and enhancing training for stakeholders. Additionally, further research could investigate the long-term impacts of BI integration on educational outcomes and explore advanced BI technologies like AI and machine learning for even greater improvements in QA processes.

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