

Comparative Frameworks for Monitoring Quality Assurance in Higher Education Institutions using Business Intelligence

Ali Sorour

*School of Computing and Digital Technologies
Staffordshire University
United Kingdom
s033335e@student.staffs.ac.uk*

Clare F. Stanier

*School of Computing and Digital Technologies
Staffordshire University
United Kingdom
clarestanier@gmail.com*

Anthony S. Atkins

*School of Computing and Digital Technologies
Staffordshire University
United Kingdom
A.S.Atkins@staffs.ac.uk*

Fawaz D. Alharbi

*Huraymila College of Science and Humanities
Shaqra University
Kingdom of Saudi Arabia
fawazharbi@gmail.com*

Abstract— This paper aims to identify existing frameworks for monitoring Quality Assurance in Higher Education Institutions. A literature review has been conducted in order to identify the components covered by existing frameworks as well as the deficiencies they share. Firstly, a literature review was conducted to identify previous frameworks that discussed Quality Assurance (QA) or Performance Monitoring in Higher Education (HE). The second stage was to filter these frameworks into those that provided means for monitoring outputs of performance using Business Intelligence (BI) tools using data visualization and reporting. The findings from the research work identified five frameworks which use BI in the monitoring of Quality Assurance in Higher Education Institutions (HEIs). The frameworks have different orientations and focus but all support the use of data to measure performance in Higher Education Institutions and there is a consensus that BI tools, such as dashboards, may be useful in providing real-time feedback about QA performance in Higher Education Institutions

Keywords — *data visualization, business intelligence, higher education, quality assurance, performance monitoring*

I. INTRODUCTION

Higher Education Institutions (HEIs) are giving increasing attention to Quality Assurance (QA) to give assurance to their stakeholders that they are operating efficiently and that their mission and objectives are meeting the expectations of these stakeholders [1], [2]. Additionally, HEIs realize that focusing on quality of services provided by them can set them apart from other institutions. The absence of QA may hinder HEIs from achieving long-term survival [3]. As part of the assurance process, there is an identification of the role of monitoring performance indicators against a set of quality standards [4], [5]. The monitoring process aims to ensure that the service quality of the HEI is aligned with these standards and the objectives of the institution are being met.

Information systems are utilized by HEIs in monitoring performance for supporting decision making [6], [7]. Business Intelligence (BI) tools help in supporting top management with real-time information regarding the performance of the organization [6], [8]. BI is widely used to

help organizations such as HEIs in accessing and managing the increasing large volumes of data (e.g. social media). BI enables managers to make accurate and effective decisions in an appropriate timescale and format as it manages organization data to make it more accessible, clear and useful. It also visualizes valuable information using an appropriate tool [6]. Business Intelligence tools have been used for monitoring performance in HEIs in many studies. For example, [9] and [7] studied Monitoring Managerial performance of HEIs. Scholtz et al [10] showed how BI can support strategic sustainability for HEIs. Guitart and Consea [11] studies providing analytical systems for teachers using BI. Burke et al [12] discussed how to visualize library analytics in HEI for decision makers using BI dashboards. Qiu et al [13] also showed how aggregated public opinion from social media can be visualized for decision makers in HEIs.

Although there are many studies discussing BI in the HEI context, the use of BI in monitoring QA activities still requires further investigation [14]. This study aims to explore the literature in order to identify current frameworks which discuss QA monitoring in HEI using BI tools to provide visualized outputs for decision makers. To achieve this, an extensive review of existing literature was conducted in order to identify the current QA frameworks. Additionally, indexes of journals have been reviewed and related articles investigated using a snowball methodology.

II. RESEARCH METHOD

For the purpose of conducting the literature review, Staffordshire University Library has been used for retrieving articles from different databases (e.g., IEEE Xplore, Pubmed, Science Direct, ProQuest, ACM Digital Library, Wiley Online Library). In addition, Google Scholar has been used for supplementing the searching process as well because the initial methodology tends to limit the results which may give concern for potential bias.

During the review, the three main categories used during the searching process were as follows; (1) Quality monitoring in HEIs, (2) Business intelligence in HEIs; and (3) Dashboard development in HEIs. To be included in the analysis, the

studies were required to meet the following criteria for inclusion:

- Those studies must present a framework for monitoring QA in the context of Higher Education and represent visualized outputs for decision makers.
- It is preferred if the study is applied in Saudi Arabian HEI, but given the limited resources of application of this topic in the HEI context other international studies will also be included.
- The study must be a primary research study that represents findings from primary data sources generated by the original authors.
- The study publication date should be from 2007 to 2019 to make sure that information is current and up to date.
- The study must be written in either Arabic or English.
- The study must be retrieved electronically as full text.
- The study must be an academic thesis, peer-reviewed study, or a chapter from a book

III. REVIEW OF EXISTING QUALITY ASSURANCE MONITORING FRAMEWORKS

The results from the search on scientific databases indicated that there are 52 studies discussing QA in HEI. Among these studies, only 18 of them had represented frameworks for QA monitoring in HEIs or frameworks for monitoring general performance in HEIs. They also include frameworks that provided data visualization of outputs for decision making through BI tools or data analytics in the context of HEIs. Only five frameworks out of the 18 studies discussed Visualised Outputs (VO) and these are outlined in Table 1. These five frameworks were selected for analysis since visualized outputs and analytics are the main output provided from a BI system for supporting decision making.

IV. ANALYSIS OF SELECTED FRAMEWORKS

This section will provide analysis of selected frameworks including the evaluation of each framework to determine whether or not it can be used for monitoring QA in HEIs using BI tools. Table I shows the 18 studies that have discussed QA frameworks in HE according to the criteria of studies selection.

These frameworks had been analyzed to determine what components they cover, i.e. whether they cover QA in HE or measuring general performance in HE. Additionally, VO were the main component to investigate to determine whether the framework is useful for assisting decision makers in HE by providing data analytics through BI technologies.

V. ANALYSIS OF SELECTED FRAMEWORKS

This section will provide an analysis of selected frameworks from Table I. Five frameworks were selected based on the previous criteria of providing visualized outputs for monitoring. The analysis was conducted as follows:

TABLE I. REVIEWED STUDIES

Framework Name	Research Criteria			Exclusion Reason
	QA	HE	VO	
An architectural framework for a Performance Management System for universities [9]		✓	✓	This study is included
Integrated model of Total Quality Management in Higher Education [15] ^a	✓	✓		The model discusses TQM in HE but was not intended to show the outputs of quality system in terms of automated reports or dashboards
The Business Intelligence framework [16] ^a		✓		This framework shows DW architecture of HEI however its main focus was not on the development of dashboards but rather for decision support in HEIs.
HESQUAL Model [17] ^a	✓	✓		Based on the SERVQUAL framework for measuring quality in HEIs, not intended for providing visualized outputs for decision support
Quality management system in pediatrics training programme [18] ^a	✓	✓		Based on PCDA quality cycle, and does not provided visualized solution for decision support and its focus on medical programmes
Conceptual framework of Measuring Institutional Quality [19] ^a	✓	✓		The framework does not appear to identify information systems that are intended to measure and visualize QA outputs for decision makers
LSS model for HEIs [20] ^a	✓	✓		Focused on adopting Lean Six Sigma in HEIs QA systems but not for monitoring through dashboard or report generations
Basic business intelligence architecture with decision making process [21] ^a		✓		Not focused on QA in HEI together with presentation of outputs through dashboards
The Quality framework for any Higher Education Institution [22] ^a	✓	✓		Does not appear to focus on decision support nor visual representation of outputs
A proposed model for TQM implementation in HE [5] ^a	✓	✓		While the model discusses the KSA case, however it focused on the application of TQM in the context of HE but not dashboards design and development
Sustainable BI Framework [10]		✓	✓	This study is included

Framework Name	Research Criteria			Exclusion Reason
	QA	HE	VO	
The High-level Design of TheDB Framework [7]	✓	✓	✓	This study is included
A framework for developing LIONLENS [13]		✓	✓	This study is included
The proposed TQM model for engineering education excellence in India [23] ^a	✓	✓		The model does not show-representation of visualized outputs and is focused to engineering education in India
The Architecture of Higher Education Quality Monitoring and Evaluation System [24]	✓	✓	✓	This study is included
TQM framework in higher education [25] ^a	✓	✓		The framework discusses TQM in Higher Education but not QA dashboard representation of outputs
Business Process Model for Course Improvement [26] ^a		✓		The model does not discuss QA monitoring in HEI
A Theoretical Framework for Quality Assurance in Higher Education of Bangladesh [27] ^a	✓	✓		The model is focused on TQM adoption in HEIs in Bangladesh and not the QA monitoring

^a Excluded Studies

A. An architectural framework for a Performance Management System for universities

This study represents an architectural framework for a performance management system for universities. The framework identifies that the main source of data that feeds the system is the University Data Warehouse (DW). The university portal will then be the output source of data that the decision maker is concerned with. The researchers determined that monitoring could be in form of dashboards or scorecards in conjunction with query tools and the University Data Warehouse (DW). The framework identifies dashboards and/or scorecards for users to monitor HEI performance and uses queries from the DW to allow managers to display a variety of analysis and trends. However, the framework lacks information on the process for developing a dashboard. In addition, its main focus is on monitoring HEI performance in general, but not on the QA related performance. This means it may not take into consideration the design aspects of QA such as Key Performance Indicators (KPIs) for QA processes and the main inputs for such systems like the National Qualifications Framework (NQF) for curriculum design.

B. Sustainable BI Framework

This framework was developed to address sustainability information for HEIs. The researchers presented BI as a tool for HEI sustainability management monitoring. Their proposed framework also incorporates the six-step process for dashboard design and development of [28] which encompasses: 1. Setting objectives, 2. Defining tasks, competencies and responsibilities, 3. Setting indicators, 4. Collect information based on indicators, 5. Developing

dashboard, and 6. Evaluating the dashboard. This framework encompasses operational data sources, the ETL process, data layer, reporting, analytical and monitoring layers as the main components for monitoring BI dashboard for HEI. However, as this framework is based on [9] framework, the main purpose of it is to monitor HEI performance but not QA related processes, and therefore shares the same limitations as [9] framework.

C. The High-level Design of TheDB Framework

This framework is intended to show the design of a dashboard for monitoring QA in Thailand HEIs according to their QA standards. In their high-level design of the framework, they showed the information systems required to be implemented for the purpose of monitoring HEI, QA related performance in Thailand. The lower level of their design shows the infrastructure of the system such as internet provider as well as networks and operating systems. The second level classifies information systems into three main parts which are as follows:

- Foundation application software; provides essential data to other applications (HR and Planning Management System)
- Application software tools; facilitates other applications (user management system and data services tools)
- Transaction processing systems; the functional application that is based on the main mission of Higher Education.

The top level of the framework shows different kinds of forms of outputs. It represents the executive dashboards that decision makers use for monitoring performance as well as the profiles system that is related to monitoring academic and support staff performance.

While this framework shares the main components that need to be taken into consideration when designing dashboard system for monitoring QA performance in HEI, it lacks some of the main characteristics that are considered important in the design process. Among those components, there is no indication of where and when the use of KPIs should be incorporated into the design of the system. In addition, there is no indication of the main QA inputs for monitoring academic curriculum design and monitoring learning outcomes such as National Qualifications Framework (NQF).

D. A framework for developing the LIONLENS

This framework discusses how to show big data-mediated public opinion for use in addressing service assessment problems. They showed how big data technologies, mobile computing, and social media can be leveraged to facilitate college performance monitoring and visualization of educational service quality in real time.

The aggregated public opinions are then analysed in order to rank public service providers in relation to meeting the needs of the stakeholders. The main components for computing that enables the ranking system according to their framework are as follows:

- Data Capturing and retrieving modules
- Sentiment Analyzer

- Big Data computing clusters or platforms
- Ranking modeler

It is apparent that the main idea behind this framework is to assess the quality of service providers, particularly for HEIs, and to rank them according to public opinion aggregated and analysed through sentiment analysis. Therefore, this framework is focused mainly on public opinion aggregation for assessing quality, which means that the main operations for QA in HEI are not being assessed against National or International QA standards.

E. The Architecture of Higher Education Quality Monitoring and Evaluation System

In this framework, the authors combined the characteristics of Higher Education monitoring and evaluation with big data processing to form a multi-functional system of big data acquisition, data processing, and results usage. The system architecture of this framework consists of the following components: 1. Data Acquisition system, 2. Data Cleaning system, 3. Comprehensive Quality system, 4. Education DB, 5. Data Analysis system, and 6. Report Generation system. This framework assumes that quality monitoring system in HEI is based on Big Data. Furthermore, it shows that the system is fed by human assisted inputs for the quality system which incorporates human element in the QA process. However, it did not indicate the dashboards for monitoring the process as it was not intended to design the dashboard through this framework.

VI. DISCUSSION

This review showed that there are many points-of-views for measuring performance for HEIs, and especially, QA performance. While [9] showed the key requirements for University dashboards, their framework seems to be insufficient for identifying key components needed to be considered while designing such system, which led to further development of the framework by [10]. However, [10] is not intended to measure QA related performance and represent this data to decision makers. This may need to be further reviewed to understand the requirements for QA monitoring systems.

Denwattana and Saengsais [7] and Li et al [24] provided frameworks that are intended to directly measure QA performance in HEIs. However, there is no indication of factors that need to be considered when designing such systems. They missed some key inputs for this kind of systems such as KPIs and National Qualification Frameworks (NQF). Although [13] provided a framework for measuring QA performance, they focused on aggregating public opinion, which is an important aspect in gathering feedback during assuring quality process. This practice did not appear to provide a detailed picture for decision makers about in-house quality activities performance and focused only on opinions aggregated through social media.

From this analysis, it can be found that these frameworks need to be further investigated in order to determine the components that they share. Additionally, the analysis should identify the missing components that need to be included in frameworks for monitoring QA in HEIs using BI technologies.

VII. CONCLUSION AND FUTURE WORK

As stakeholders of HEIs are becoming more concerned about the quality of services provided by HEIs, there are many attempts to provide frameworks and tools for using BI in monitoring QA performance. Our study investigated current frameworks that discussed monitoring QA in HEIs. Identified frameworks showed that there is a movement toward measuring HEI performance in recent years, despite the fact they appear to be using different orientations and focus. However, there is a consensus that BI tools, such as dashboards, may be useful in providing real-time feedback about QA performance in HEI.

Current attempts for developing frameworks for monitoring Higher Education performance do not seem to be sufficient for monitoring QA wide activities and processes. However, they cover some essential aspects which are crucial for BI system design for performance monitoring in HEIs. Current frameworks need to be further assessed in order to determine the optimal components that are required to be considered while designing BI system for monitoring QA performance. A gap analysis may be useful in this situation as it compares the desired state with the actual state. Future work will include a gap analysis to identify any missing components required to support QA in HEIs.

REFERENCES

- [1] T. R. Soomro and R. Ahmad, "Quality in Higher Education: United Arab Emirates Perspective," *High. Educ. Stud.*, vol. 2, no. 4, pp. 148–152, 2012.
- [2] Z. A. Alzamil, "Quality improvement of technical education in Saudi Arabia: self-evaluation perspective," *Qual. Assur. Educ.*, vol. 22, no. 2, pp. 125–144, 2014.
- [3] M. Tsinidou, V. Gerogiannis, and P. Fitsilis, "Evaluation of the factors that determine quality in higher education: an empirical study," *Qual. Assur. Educ.*, vol. 18, no. 3, pp. 227–244, 2010.
- [4] M. A. M. Hamdatu, A. G. Siddiek, and F. A. Al-Olyan, "Application of Quality Assurance & Accreditation in the Institutes of Higher Education in the Arab World (Descriptive & Analytical Survey)," *Am. Int. J. Contemporary Res.*, vol. 3, no. 4, pp. 104–116, 2013.
- [5] K. M. Alzhrani, B. A. Ali Alotibie, and A. Abdulaziz, "Total Quality Management in Saudi Higher Education," *Int. J. Comput. Appl.*, vol. 135, no. 4, pp. 975–8887, 2016.
- [6] N. A. Zulkefli et al., "A business intelligence framework for Higher Education Institutions," *ARN J. Eng. Appl. Sci.*, vol. 10, no. 23, pp. 18070–18077, 2015.
- [7] N. Denwattana and A. Saengsai, "A framework of Thailand higher education dashboard system," *20th Int. Comput. Sci. Eng. Conf. Smart Ubiquitous Comput. Knowledge, ICSEC 2016*, 2016.
- [8] B. Gupta, M. Goul, and B. Dinter, "Business intelligence and big data in higher education: Status of a multi-year model curriculum development effort for business school undergraduates, MS graduates, and MBAs," *Commun. Assoc. Inf. Syst.*, vol. 36, pp. 449–476, 2015.
- [9] M. Muntean, G. Sabau, and A. Bologa, "Performance Dashboards for Universities," *Proc. 2nd International Conference*, pp. 2014–2015, 2010.
- [10] B. Scholtz, A. Calitz, and R. Haupt, "A business intelligence framework for sustainability information management in higher education," *Int. J. Sustain. High. Educ.*, vol. 19, no. 2, pp. 266–290, 2018.
- [11] I. Guitart and J. Conesa, "Adoption of business strategies to provide analytical systems for teachers in the context of universities," *Int. J. Emerg. Technol. Learn.*, vol. 11, no. 7, pp. 34–40, 2016.
- [12] S. Burke, R. MacIntyre, and G. Stone, "Library data labs: using an agile approach to develop library analytics in UK higher education," *Inf. Learn. Sci.*, vol. 119, no. 1–2, pp. 5–15, 2018.

- [13] R. G. Qiu, H. Ha, R. Ravi, L. Qiu, and Y. Badr, "A Big Data based Smart Evaluation System using Public Opinion Aggregation," *Proc. 18th Int. Conf. Enterp. Inf. Syst.*, vol. 1, no. Iceis, pp. 520–527, 2016.
- [14] S. Colbran and Al-Ghreimil, "The Role of Information Technology in Supporting Quality Teaching and Learning," *High. Educ. Saudi Arab. Achiev. Challenges Oppor.*, vol. 40, pp. 73–82, 2013.
- [15] S. Sahney and J. Thakkar, "A comparative assessment of the performance of select higher education institutes in India," *Qual. Assur. Educ.*, vol. 24, no. 2, pp. 278–302, 2016.
- [16] L. Van Dyk, "A Data Warehouse Model for Micro-Level Decision Making in Higher Education," *Electron. J. e-Learning*, vol. 6, no. 3, pp. 235–244, 2008.
- [17] V. Teeroovengadum, T. . Kamalanabhan, and A. K. Seebaluck, "Measuring service quality in higher education: Development of a hierarchial model (HESQUAL)," *Qual. Assur. Educ.*, vol. 14, no. 2, pp. 244–258, 2016.
- [18] L. Da Dalt et al., "A model of quality assurance and quality improvement for post-graduate medical education in Europe," *Med. Teach.*, vol. 32, no. 2, 2010.
- [19] P. J. Ballard, "Measuring Performance Excellence: Key Performance Indicators for Institutions Accepted into the Academic Quality Improvement Program (AQIP)," *Sante Publique (Paris)*, 2013.
- [20] V. Sunder M. and J. Antony, "A conceptual Lean Six Sigma framework for quality excellence in higher education institutions," *Int. J. Qual. Reliab. Manag.*, vol. 35, no. 4, pp. 857–874, 2018.
- [21] S. R. Kumaran, M. S. Othman, and L. M. Yusuf, "Applying Theory of Constraints (TOC) in business intelligence of higher education : A case study of postgraduates by research program," *Int. Conf. Sci. Inf. Technol.*, pp. 147–151, 2016.
- [22] M. Elhoseny, N. Metawa, A. Darwish, and A. E. Hassanien, "Intelligent information system to ensure quality in higher education institutions, towards an automated e-university," *Int. J. Comput. Intell. Stud.*, vol. 6, no. 2/3, p. 115, 2017.
- [23] S. Burli, V. Bagodi, and B. Kotturshettar, "TQM dimensions and their interrelationships in ISO certified engineering institutes of India," *Benchmarking An Int. J.*, vol. 19, no. 2, pp. 177–192, 2012.
- [24] Y. Li, P. Li, F. Zhu, and R. Wang, "Design of higher education quality monitoring and evaluation platform based on big data," *2017 12th Int. Conf. Comput. Sci. Educ.*, no. August 22-25, pp. 337–342, 2017.
- [25] S. Venkatraman, "A framework for implementing TQM in higher education programs," *Qual. Assur. Educ.*, vol. 15, no. 1, pp. 92–112, 2007.
- [26] M. Drăgan, D. Ivana, and R. Arba, "Business Process Modeling in Higher Education Institutions. Developing a Framework for Total Quality Management at Institutional Level," *Procedia Econ. Financ.*, vol. 16, no. May, pp. 95–103, 2014.
- [27] B. Bhuiyan, K. Ahmmed, and S. Molla, "A Theoretical Framework for Quality Assurance in Higher Education of Bangladesh," *J. Business, Soc. Sci. Lead. Univ.*, vol. 1, no. 1, pp. 27–51, 2009.
- [28] C. Caraiani and M. Dumitrana, "Contabilitate de gestiune & control de gestiune," *Ed. InfoMega, Bucuresti*, p. 37, 2005.