Holistic Framework for Monitoring Quality in Higher Education Institutions in the Kingdom of Saudi Arabia using Business Intelligence Dashboards

Ali Sorour MSc, MBA

A thesis submitted in partial fulfilment of the requirements of Staffordshire University for the degree of Doctor of Philosophy

May 2022

Abstract

Quality Assurance (QA) in Higher Education Institutions (HEIs) is a challenging issue as it requires continuous improvement to cope with operational and financial difficulties. Governments impose QA standards to guarantee a minimum level of service quality that HEI should provide. HEIs in the Kingdom of Saudi Arabia (KSA) face challenges in monitoring QA as they are required to report on their compliance with the National Centre for Academic Accreditation and Evaluation (NCAAA) QA standards by measuring 23 Key Performance Indicators (KPIs). HEIs typically use interactive spreadsheets and surveys to measure the degree of compliance through annual audit. This practice is time consuming, requires significant personnel, and the results are not reported in a timely manner.

If an institution fails to comply with a certain standard at any period in the academic year, top management may not be notified until the next audit takes place. This affects the accreditation status of the institution. HEIs also tend to develop their own performance metrics and institutional specific KPIs to keep track of strategic planning processes. HEIs in KSA are making increasing use of Social Media. Public opinions expressed in Social Media can result in negative impact on the HEI's reputation, and consequently, affect their financial standing. The literature suggests that HEIs should monitor public opinion on Social Media to be able to obtain valuable feedback on user satisfaction and quality of services.

Frameworks for monitoring QA in HEIs, as described in the current literature, were not developed for the KSA environment, and so do not meet the needs of KSA HEIs. Current frameworks do not take into consideration the mandatory requirements of NCAAA 2018, monitoring of institutional specific KPIs, and sentiment analysis of Social Media data. There was also a need to provide guidance to HEIs as to which factors should be included in QA systems to provide a systematic approach to QA monitoring in KSA. This research provides a novel solution to these challenges by developing a Holistic Framework for monitoring Higher Education Quality using Business Intelligence dashboards (HF-HEQ-BI). The HF-HEQ-BI provides a mechanism for determining the requirements for QA monitoring in HEIs in KSA and enables the factors to be mapped to support visualisation through Business Intelligence dashboards. A Framework Utilisation Tool was also developed to show how HF-HEQ-BI factors can be visualised for the purpose of developing BI dashboards. The HF-HEQ-BI framework was developed from a literature review and Gap Analysis. The developed framework addresses the factors that HEIs should consider when designing QA systems and takes into consideration the role of Social Media in monitoring service quality. To validate the selection of the factors on which the framework was based, the factors were validated with a panel of domain experts and a survey of QA practitioners was also carried out. The use of qualitative and quantitative approaches provided triangulation. A prototype dashboard was developed from the HF-HEQ-BI framework for the purpose of monitoring QA in HEIs in KSA using a case study based on HEI in Saudi Arabia. An evaluation tool for BI systems in HE was developed, and the prototype dashboard was evaluated by practitioners. The proposed dashboard was based on the underpinning framework utilisation tool which provides visualisation reporting utilising the 8 NCAAA standards and 23 KPIs, institutional specific KPIs, and sentiment analysis of Social Media data.

Acknowledgements

First and foremost, thanks to God Almighty, Most Gracious, Most Merciful, for allowing me to reach this stage of my studies.

I would like to give my kindest regards to all people who supported me during my studies. There are no words to express my gratitude to my principal supervisor Prof. Anthony Atkins, who was supportive throughout all my studies. His comments, encourages, guidance, and support were invaluable. I would never reach this stage without his guidance and constructive comments. Many thanks to Dr. Clare Stanier who had been my second supervisor at earlier stage of this research project and continued to support me during my research and for her useful insights and constructive comments. I would like also to thank my second supervisor who joined us later Assoc. Prof. Russell Campion for his support and constructive comments and Dr. Fawaz Alharbi, my local supervisor, who was supportive and encouraging throughout my research journey.

I would like to express my deep thanks to my beloved wife Sarah for being patient, encouraging, and supportive at every stage of my studies.

Lastly, I would also like to express my gratitude and appreciation to my parents Prof. Sorour Ali and Dr. Azza Zaki, and my sisters Sara and Hala who were always supportive.

Dedication

This thesis is dedicated to

My Father Prof. Sorour

My Mother Dr. Azza Zaki

My wife Sarah

My son Sorour Jr.

My sisters Sara and Hala

Publications

Publications in Conference Proceedings: 5

- Sorour, A., Atkins, A. S., Stanier, C., Alharbi, F. and Campion R. C., (2022) 'The Development of Business Intelligence Dashboard for Monitoring Quality in Higher Education Institutions in Saudi Arabia Including Sentiment Analysis from Social Media', *16th International Technology, Education and Development Conference*, pp. 1391-1399. DOI: 10.21125/inted.2022.0413
- Sorour, A., Atkins, A. S., Stanier, C., Alharbi, F. and Campion R. C., (2021) 'Quality Monitoring with Business Intelligence Dashboards in Higher Educational Institutions using NVivo Approach to Support Qualitative Analysis', *14th annual International Conference of Education, Research and Innovation*, pp. 897-904. DOI: 10.21125/iceri.2021.0280
- Sorour, A., Atkins, A. S., Stanier, C., Alharbi, F. and Campion R. C., (2020) 'Integrated Dashboards with Social Media Analysis Capabilities for Monitoring Quality in Higher Education Institutions', *12th International Conference on Education and New Learning Technologies*, pp.2862-2870. DOI: 10.21125/edulearn.2020.0861
- Sorour, A., Atkins, A. S., and Stanier, C., (2020) 'Comparative Frameworks for Monitoring Quality Assurance in Higher Education Institutions using Business Intelligence', *International Conference on Computing and Information Technology,* Tabuk University (September) pp.20-24. DOI: 10.1109/ICCIT-144147971.2020.9213808
- Sorour, A., Atkins, A. S., and Stanier, C., (2019) 'The Role of Business Intelligence and Analytics in Higher Education Quality: A Proposed Architecture', *International Conference on Advances in the Emerging Computing Technologies (ACET),* Islamic University (February 10-12). Madinah: IEEE, pp.24-40. DOI:10.1109/AECT47998.2020.9194157. Corpus ID:221718159

Book Chapters: 1

Alsulami M. H., Atkins A. S., Sorour A., Campion R. C., (2021) **'**Ageing Population Supported by Ambient Assisted Living in the Kingdom of Saudi Arabia' in Choukou, M.-A. and Syed-Abdul, S. (eds) *Smart Home Technologies and Services for Geriatric Rehabilitation*. Academic Press**.** ISBN: 9780323851732

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List of Abbreviations

API	Application Programming Interface
AQIP	Academic Quality Improvement Programme
AQTF	Australian Quality Training Framework
BI	Business Intelligence
BSC	Balanced Scorecards
BV	Best Value
CAQDAS	Computer Assisted Qualitative Data Analysis Software
CFA	Confirmatory Factor Analysis
CI	Continuous Improvement
DM	Data Mart
DOI	Diffusion of Innovation
DW	Data Warehouse
ENQA	European Network for Quality Assurance
ETEC	Education and Training Evaluation Commission
ETL	Extract, Transform, Load
FUT	Framework Utilisation Tool
HCI	Human-Computer Interaction
HE	Higher Education
HEI	Higher Education Institution
HESA	Higher Education Statistics Agency
HF-HEQ-BI	Holistic Framework for monitoring Higher Education Quality using Business Intelligence dashboards
HOT-fit	Human-Organisation-Technology fitness
ICT	Information and Communications Technology
IoT	Internet of Things
IS	Information Systems
ISST	Information Systems Strategic Triangle
KPI	Key Performance Indicator
KSA	Kingdom of Saudi Arabia
LSS	Lean Six Sigma
NCAAA	National Centre for Academic Accreditation and Evaluation
NLP	Natural Language Processing
NQF	National Qualifications Framework
NZQA	New Zealand Qualifications Authority
OLAP	Online Analytical Processing
PDCA	Plan-Do-Check-Act
QA	Quality Assurance
QAA	Quality Assurance Agency
QC	Quality Control
QM	Quality Management
SA	Sentiment Analysis
SaaS	Software as a Service
SACS	Southern Association of Colleges and Schools
SLR	Systematic Literature Review
SoBI	Service Oriented Business Intelligence
SQA	Scottish Qualifications Authority
SSBI	Self Service Business Intelligence
TAM	Technology Acceptance Model

TOE	Technology-Organisation-Environment
TOS	Technology-Organisation-Social
TQM	Total Quality Management
UNP	Unified National Platform
UTAUT	Unified Theory of Acceptance and Use of Technology
VO	Visualised Outputs
XML	Extensible Markup Language

Chapter 1 : Introduction

1.1 Introduction

This chapter discusses the background and motivation for this research together with the contribution to knowledge which it provides regarding the issues of quality monitoring in Higher Education Institutions (HEIs). The research aim, objectives, and research questions are also defined in this chapter. The research philosophy, approaches, methods, and strategies are discussed in the chapter. This chapter outlines the methods and strategies employed, which include the literature review, qualitative analysis, and quantitative analysis to provide triangulation using interviews and surveying techniques. The validation and evaluation approaches are also outlined in the chapter. Ethical considerations of this research project are also outlined. Finally, the structure of the thesis is discussed which concludes the chapter.

1.2 Background and Motivation for Research

As Higher Education Institutions (HEIs) are operating in a dynamic world, they require continuous improvement to cope with operational and financial difficulties, also governments impose Quality Assurance (QA) standards to guarantee a minimum level of quality of services that HEIs should provide. In the Kingdom of Saudi Arabia (KSA), Higher Education Institutions (HEIs) face particular QA challenges as they are required to monitor and report on an annual basis on their compliance with National Centre for Academic Accreditation and Evaluation (NCAAA) standards. HEIs in KSA typically use interactive spreadsheets and surveys to measure the degree of compliance with the NCAAA requirements through annual audits which are: time consuming; require significant personnel, and the results are not reported in a timely manner. Reports issued by HEIs to determine their compliance with the NCAAA standards are usually generated by QA Deanships or QA units in HEIs in KSA. HEIs find difficulties in obtaining up to date documents from programme directors and QA personnel in faculties to collect, analyse, and generate reports. This process is time consuming and requires sophisticated training of QA personnel to understand clearly the NCAAA requirements. If a HEI fails to comply with QA standards, top management may not be informed in a timely manner, and so will not be able to take corrective action on issues, until they receive HEI QA reports, which usually can take several weeks or months until they are generated after a QA audit. Consequently, HEI resources may not be appropriately utilised, and the accreditation status of the HEI may be jeopardised as top management are unaware of the status of their QA compliance.

Traditionally, HEIs use statistical quality control tools such as satisfaction surveys and checklists to measure satisfaction of stakeholders such as QA agencies, parents and students, and other stakeholders. For the purpose of measuring their compliance with the mandated QA standards, HEIs measure the degree of compliance with a set of pre-defined Key Performance Indicators (KPIs) which are usually measured through annual audits.

In the Kingdom of Saudi Arabia, the National Centre for Academic Accreditation and Evaluation (NCAAA) (previously known as National Commission for Academic Accreditation and Assessment) is the responsible party for evaluation and assessment of HEIs quality (NCAAA, 2018, 2009; Albaqami, 2015). The NCAAA is regulated under the supervision of the Education & Training Evaluation Commission (ETEC). The NCAAA is responsible for granting academic accreditation for public and private HEIs in the KSA.

All HEIs in the KSA are required to comply with 8 NCAAA Quality Assurance (QA) standards. The compliance with the 8 QA standards guarantees the minimum level of quality expected from the HEIs in KSA. In order to assess compliance with the NCAAA QA standards, the NCAAA established 23 Key Performance Indicators (KPIs) in 2018. All HEIs in KSA are required to monitor these 23 KPIs and report on them on an annual basis. The HEIs conduct annual audits for data gathering, documentation, and analysis of QA data for the purpose of calculating the degree of compliance. These annual audits determine the degree of compliance with the 23 QA standards. If the institutions do not comply with specific KPIs, top management will not be notified of non-compliance until the next audit period, which is usually conducted at the end of the academic year. This practice for monitoring QA does not allow decision makers to monitor the degree of compliance in a timely manner.

As HEIs are considered service providers, their profitability and reputation are highly affected by the stakeholders' satisfaction with services provided. It was suggested that public opinions expressed on Social Media can assist in assessing the quality of services provided by HEIs (Qiu et al., 2015, 2016). HEIs in KSA are making increasing use of Social Media. KSA is considered among the top countries in the Arab World in terms of Twitter users (OKAZ, 2020). Kingdom Holding Incorporation (Saudi Arabian holding company) owns 4.45% of Twitter shares (Paul & Merriman, 2022). According to UNIRANK (2021), 17 Saudi Arabian HEIs appeared in the top 200 universities based on Twitter followers count. Consequently, top management of HEIs in KSA are giving considerable attention to opinions expressed on Social Media (Al-Khalifa & Garcia, 2013). Public opinions expressed on Social Media can result in negative impact on the HEI's reputation, and consequently, affect its financial standing. The literature suggests that HEIs should monitor public opinion on Social Media to be able to obtain valuable feedback on stakeholders' satisfaction with quality of services.

Frameworks for monitoring QA in HE, as described in the current literature, have not been developed for the KSA environment, and so do not meet the needs of KSA HEIs. These existing frameworks do not take into consideration the mandatory requirements of NCAAA 2018 standards, monitoring institutional specific KPIs, and sentiment analysis of Social Media data. There is also a need to provide guidance to HEIs as to which factors should be included in QA systems to provide a systematic approach to QA monitoring in KSA. This research project provides a novel Holistic Framework for monitoring Higher Education Quality using Business Intelligence dashboards in the Kingdom of Saudi Arabia (HF-HEQ-BI) to provide a foundation for determining the QA factors that need to be monitored and considered while developing BI dashboards that will assist decision makers in monitoring QA compliance in accordance with NCAAA standards with the potential to run in a real time environment (NCAAA, 2018, 2009).

1.2.1 Context of Higher Education in the Kingdom of Saudi Arabia

According to the Ministry of Education in the KSA, there are a total of 67 Higher Education Institutions in the Kingdom (Ministry of Education, 2022b, 2022a). Among these institutions, there are 29 public institutions comprising 43% of the total number of HEIs in the KSA and 38 private institutions consisting 57% of the HEIs as illustrated in Figure 1.1.

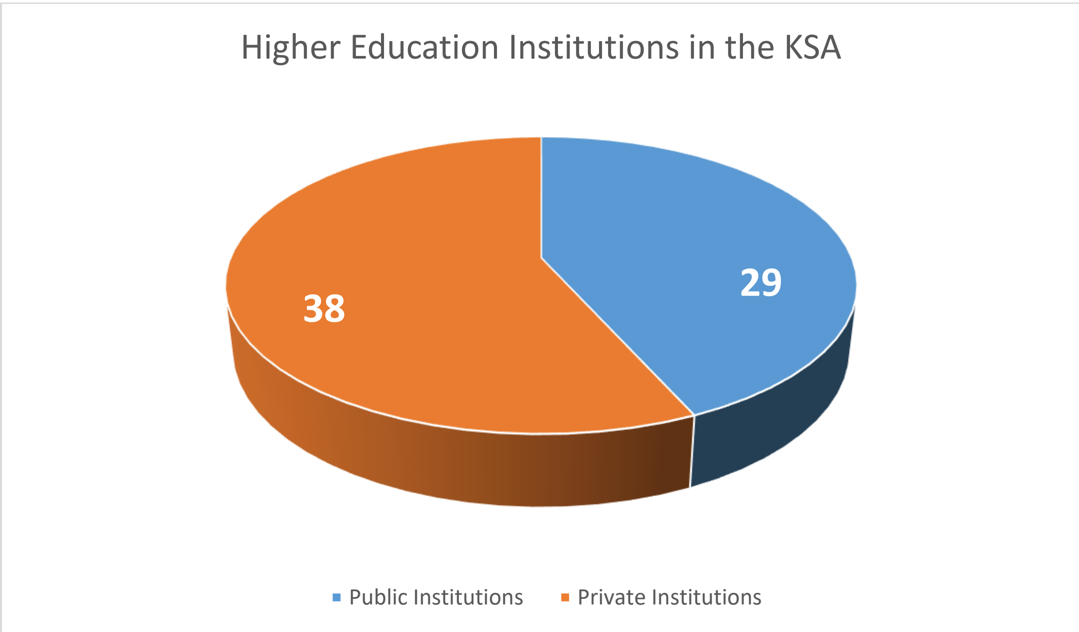


Figure 1.1: Higher Education Institutions in the Kingdom of Saudi Arabia

In 2019, there were a total of 1.37million students enrolled in HEIs in KSA (General Authority for Statistics, 2019). In some Public HEIs in KSA, the number of enrolled students is more than 100,000. For example, there were 176,488 students at Imam Muhammed bin Saud Islamic University and 145,751 students at King Abdulaziz University as of 2019 (General Authority for Statistics, 2019). HEIs are required to monitor compliance with QA standards for all courses provided to these students. QA activities require considerable resources, time, and effort in determining compliance with QA standards. For example, calculating the achievement of learning outcomes and satisfaction with institutional resources will require significant time for analysis and reporting.

1.2.2 Accreditation in Higher Education Institutions in the Kingdom of Saudi Arabia

In 2022, 37 HEIs received full institutional accreditation from the NCAAA (55% of total HEIs). Only 11 HEIs received conditional institutional accreditation (17% of total HEIs), which means that there are some HEIs with minor requirements that need to be fulfilled by the institution and require rectification of their QA system. Additionally, 19 HEIs in the KSA have not yet received the institutional accreditation (28% of total HEIs) (Education & Training Evaluation Commission, 2022). Figure 1.2 illustrates the percentage of accredited institutions and non-accredited institutions in the KSA.

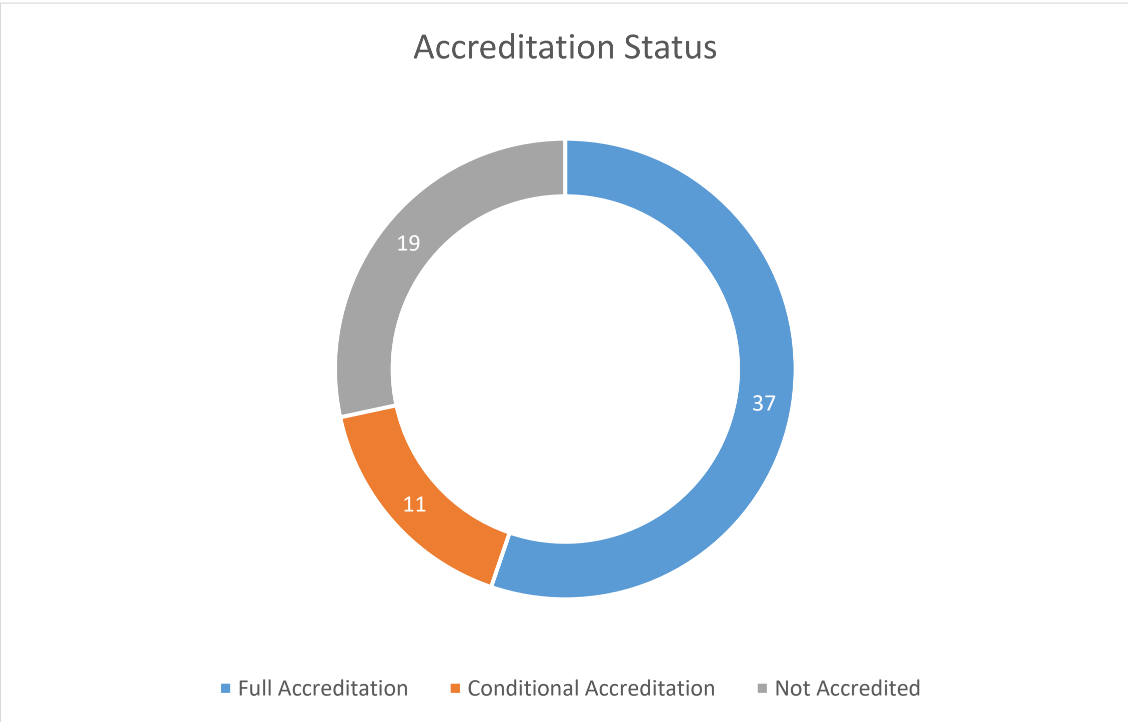


Figure 1.2: Accreditation Status in KSA in 2022

Accredited institutions are required to maintain their accreditation while non-accredited institutions are required to obtain the accreditation by applying NCAAA standards. It has been suggested that Business Intelligence (BI) can be utilised to assist decision makers in monitoring their compliance with QA standards (Colbran & Al-Ghreimil, 2013).

1.3 Research Aim and Objectives

The main aim of this research project is to *Develop a Holistic Framework for Monitoring Quality in Higher Education Institutions Using Business Intelligence Dashboards in the Kingdom of Saudi Arabia.* In order to achieve the main aim of the research project, the following objectives have been developed:

1. Conduct a literature review on Higher Education quality and Business Intelligence in Higher Education
2. Identify frameworks for monitoring quality in Higher Education Institutions discussed in current literature
3. Identify factors that affect the design of Business Intelligence systems for monitoring quality in Higher Education Institutions
4. Develop a Holistic Framework that covers the factors that affect the design of Business Intelligence systems for monitoring quality in Higher Education
5. Validate the Holistic Framework using interviews with a panel of experts
6. Validate the Holistic Framework through surveys
7. Develop a Framework Utilisation Tool to show how to visualise the holistic framework factors for building a prototype Business Intelligence dashboard
8. Evaluate the prototype dashboard through a case study
9. Critically review the research process and identify future research work

1.4 Research Questions

In order to achieve the research, aim and objectives, this research project will address the following questions:

1. How a Holistic Framework assist in identifying the factors that affect the design of Business Intelligence Dashboards for Monitoring Quality in Higher Education Institutions in the Kingdom of Saudi Arabia?

2. How a Holistic Framework for Monitoring Quality in Higher Education in the KSA using Business Intelligence Dashboards assist in monitoring quality in HEIs?

1.5 Contribution to Knowledge

The main contribution to knowledge of this study is to develop a Holistic Framework for monitoring Higher Education Quality using Business Intelligence dashboards in the Kingdom of Saudi Arabia (HF-HEQ-BI). The HF-HEQ-BI provides a novel contribution to knowledge as it identifies the factors required for monitoring QA in HEIs in the KSA context. In addition, the framework will support the development of BI dashboards which will assist decision makers in tracking their performance in relation to achieving accreditation by the National Centre for Academic Accreditation and Evaluation (NCAAA). Dashboards developed on the basis of the proposed framework will allow the institutions to keep track of the NCAAA mandatory Key Performance Indicators (KPIs) which all institutions are required to monitor and report on annually. The HF-HEQ-BI recognises the importance of Social Media which is considered an important element for monitoring quality in HE (Sorour et al., 2019; Qiu et al., 2016, 2015). Dashboards developed on the basis of the framework will be able to give real-time feedback on the degree of compliance with QA standards as well as the satisfaction rate in Social Media through sentiment analysis of Social Media data. The HF-HEQ-BI framework is an original contribution to knowledge since, to the best of the researcher's knowledge, a similar theory based, holistic approach has not currently been developed and/or applied to the challenge of monitoring quality in Higher Education in the context of KSA. The factors identified in the HF-HEQ-BI framework assist in capturing the visualisation requirements for dashboard reporting by taking into consideration the NCAAA 2018 requirements for QA monitoring, institutional specific KPIs, and Social Media Analytics while determining the requirements for developing BI dashboards.

Additionally, an evaluation tool for the prototype dashboard was provided in this research project. The evaluation tool is based on the BI Scorecard and Technology Acceptance Model (TAM) usability criteria.

The main contribution to knowledge of this research project is the development of the holistic framework for monitoring quality in Higher Education Institutions using Business Intelligence dashboard in the Kingdom of Saudi Arabia. In order to achieve this contribution, several sub-contributions are addressed throughout this research project as follows:

a. The Holistic framework identifies factors that need to be considered for the purpose of developing Business Intelligence dashboards for monitoring quality in HE which covers:

i. Monitoring compliance with NCAAA quality assurance KPIs

ii. Monitoring institutional specific performance metrics KPIs

iii. Monitoring public opinions on Social Media through sentiment analysis

b. A Framework Utilisation Tool was developed in this research project. The Framework Utilisation Tool outlines how the QA factors identified in the holistic framework can be utilised for the purpose of building BI dashboards

c. A BI dashboard evaluation tool was developed for use in Higher Education in KSA

1.6 Research Process

Information Systems (IS) is considered a socio-technical field which requires the use of different research methods to cover multiple aspects of IS studies (Gonzalez, 2007; Mushore, 2017). In this research project, different research methods were used to cover multiple areas of IS studies.

This section discusses the research philosophy, methods, and strategies used together with an outline of the process of conducting the research project. The different data collection methods used in this research project are outlined. In addition, the ethical considerations of the research project are also outlined. Saunders et al. (2016) suggested that the research process follows a research onion model as illustrated in Figure 1.3.

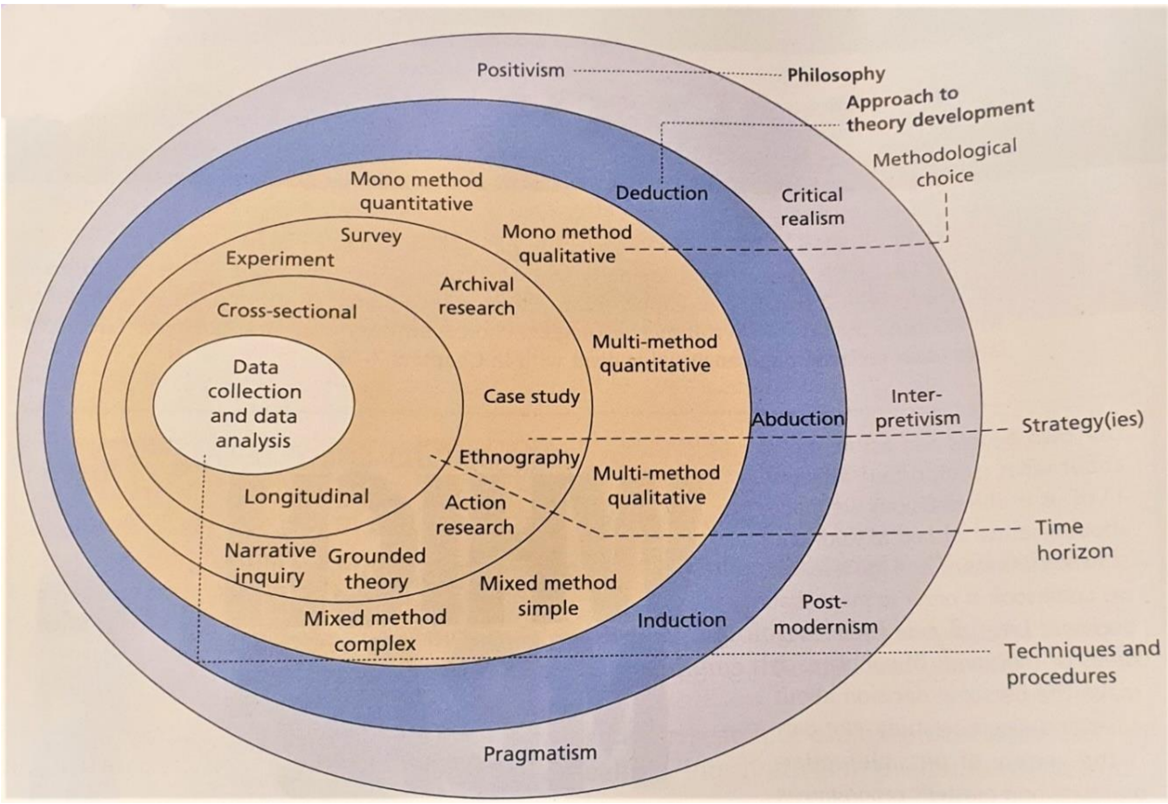


Figure 1.3: Research Onion Model (Saunders et al., 2016)

The research onion model describes how the research process is affected by the research philosophy, which drives the researcher through the research process and affects their decisions regarding the research methods and strategies that will be followed throughout the research process.

The choices that the researcher makes for the purpose of achieving the research aims are driven by their beliefs and assumption (Saunders et al., 2016). Therefore, research philosophy and research design are both affected by the beliefs and assumptions of the researcher. Figure 1.4 outlines the relationship between research philosophy, research design, and beliefs and assumptions.

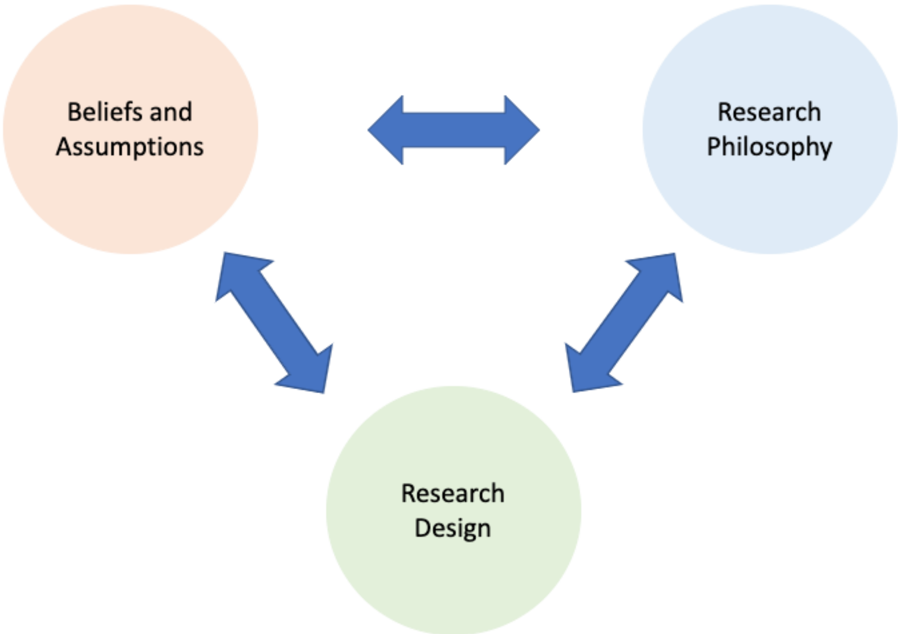


Figure 1.4: Relationship between Research Philosophy, Research Design, and Beliefs and Assumptions (Modified by author after Saunders et al., 2016)

1.6.1 Research Philosophy

Research philosophy refers to the '*system of beliefs and assumptions about the development of knowledge*' (Saunders et al., 2016). Research philosophy is guided by epistemology and ontology, where epistemology refers to the nature of knowledge and ontology refers to the nature of reality. The main types of research philosophy are pragmatism, positivism, realism, or interpretivism (Saunders et al., 2016; Mushore, 2017). Information Systems (IS) are considered to belong to the socio-technical field, which requires research approaches that cover many subjects (Gonzalez, 2007). The intention in this research is to adopt a pragmatic approach to conducting research, which includes positivism and interpretivism practices of conducting research (Venkatesh et al., 2013; Saunders et al., 2016). Positivism uses scientific methods that provide the opportunity to establish truth about the subject of knowledge whereas in the interpretive paradigm the researcher seeks understanding of phenomena through accessing the meaning assigned to things by participants (Mushore, 2017). In adopting the pragmatic approach, a holistic understanding of the quality assurance process will be obtained for the purpose of developing the framework. A holistic understanding of QA and BI will be determined initially before developing the proposed framework and the validation of the framework will then be undertaken (Sekaran & Bougie, 2016). Therefore, for the reasons outlined above, this research follows a deductive approach.

1.6.2 Research Methods and Strategies

A research methodology is used for the purpose of achieving the study goal, the methodology constitutes a set of tools and activities that contribute to generate valid reliable research results (Chen, 2012b). There are three main research approaches; quantitative, qualitative, and mixed approach (Saunders et al., 2016). This research adopts a mixed methods approach as qualitative methods will improve the understanding of the phenomena under study while quantitative methods will be needed to study the numerical relationship between variables of the study. The rationale for choosing mixed method is that this approach is more suited to explore confirmatory and exploratory research questions and provide improved interpretations than use of a single method in the field of Information Systems research (Venkatesh et al., 2013). Mixed methods can be simple or complex. Simple mixed methods can be understood as applying qualitative and quantitative analysis on a single level of the organisation (e.g., University/ College/ Department) or using a single strategy. Complex mixed methods involve applying qualitative and quantitative analysis on several levels of the organisation or using several research strategies (Schoonenboom & Johnson, 2017). In this research project, several quantitative methods have been used for the purpose of reaching conclusions, for example, Confirmatory Factor Analysis, and t-test. Quantitative methods have been applied to determine whether differences exist among the different populations in HEIs (i.e., Public and Private HEIs). Consequently, this research project adopts complex mixed methods as outlined by Saunders et al. (2016). Strategies that have been applied in this research project are discussed in the following sections.

1.6.2.1 Interviews

According to Saunders et al. (2016, p.388), a research interview is a '*purposeful conversation between two or more people, requiring the interviewer to establish rapport and ask concise and unambiguous questions, to which the interviewee is willing to respond'*. Interviews are considered a qualitative data collection method that provide depth in scientific research (Venkatesh et al., 2013). Interviews can be conducted face-to-face, online, or through telephone. Additionally, interviews can be conducted on an individual basis or as group (Saunders et al., 2016). According to Nigel (2004), the interview process is divided into four main parts; (1) identifying research questions, (2) creating the interview guide, (3) participant selection and recruitment, and (4) conducting the interview.

Interviews can be structured, unstructured, or semi-structured interviews (Sekaran & Bougie, 2016; Saunders et al., 2016). In unstructured interviews, the interviewer conducts the interview without having planned a set of questions that will be asked to participants. Interviews are considered to be structured when the interviewer prepares standard questions to be asked to participants (Sekaran & Bougie, 2016). In semi-structured interviews, the interviewer prepares a set of questions, but these questions may vary in their order while conducting the interview. In addition, new questions may be asked during the interview based on the situation (Saunders et al., 2016).

For the purpose of this research project, semi-structured interviews were used as discussed in Chapter 5. As HEIs differ in their size and type (Public or Private HEIs), open ended questions were also used in the interview for the purpose of gathering more detailed responses regarding QA and BI in HEIs (Paulussen, 2019; Saunders et al., 2016).

1.6.2.2 Convergent Interviews

The convergent Interviewing protocol involves interviewing participants in a sequential order. The outcomes from interviewing one participant are discussed with the next participants in the interviews. Additionally, the participant may be interviewed or contacted in a later stage to confirm the results obtained (Williams & Lewis, 2005; Angell et al., 2008). Convergent interviewing protocol is useful when the research topic is new and lacks theoretical underpinning (Williams & Lewis, 2005). Carson et al. (2001) suggests that convergent interviews are most appropriate form of interviews in early stages of research.

For the purpose of validating the HF-HEQ-BI framework, it was decided to conduct the panel of experts' interviews before the quantitative analysis using a questionnaire which is outlined in Chapter 5. As there was limited research on QA in Higher Education in the KSA (Albaqami, 2015; Al Suwailem, 2018; Abdullah, 2017), convergent interviews were found to be the most appropriate form of interviews as discussed in Chapter 5.

1.6.2.3 Thematic Analysis

Thematic analysis is the foundation for conducting qualitative analysis (Saunders et al., 2016). It involves searching for themes or patterns in the responses gathered through qualitative approaches such as interviews (Saunders et al., 2016). Sekaran and Bougie (2016) suggested that themes can be used for coding qualitative data. While coding the data, a common expression is looked for in the responses gathered through qualitative data tools such as interviews.

Thematic analysis is used in this research project for the purpose of coding the factors identified through literature review as discussed in Chapter 4. The factors were themed, according to their relevance, into the pillars derived from underpinning theoretical frameworks. In addition, thematic analysis was used for theming responses from participants in the interviews as discussed in Chapter 5. Computer Assisted Qualitative Data Analysis Software (CAQDAS) was used for conducting thematic analysis to generate codes (Welsh, 2002; Feng & Behar-Horenstein, 2019; Saillard, 2011).

1.6.2.4 Surveys

Surveys are defined by Saunders et al. (2016, p.728) as a '*research strategy that involves the structured collection of data from a sizeable population*'. Surveys are used for exploratory and descriptive research which allows quantitative data to be analysed using descriptive and inferential statistics (Saunders et al., 2016). Electronic questionnaires are the most popular type of surveys (Sekaran & Bougie, 2016). Electronic questionnaires are easy to administer, it is easy to reach a targeted audience, inexpensive, and can be delivered easily through web links (Sekaran & Bougie, 2016). However, using surveys involves some challenges such as obtaining sufficient data for analysis as response rates may be low. This issue is discussed further in Chapter 6.

Questionnaires may contain open-ended questions, closed questions, or both (Saunders et al., 2016; Sekaran & Bougie, 2016). For the purpose of this research project, an online electronic questionnaire was administered to collect data for statistical analysis as discussed in Chapter 6. The questionnaire included both open-ended questions and closed questions.

1.6.3 Time Horizon of Research Project

There are two main types of studies according to the time horizon, cross-sectional and longitudinal. In cross-sectional studies a sample drawn from a population is studied only for one time period. This technique is considered time-saving and more effective in Information Systems (IS) studies as it allows data to be obtained from larger sets of participants in a relatively short period of time (Owino et al., 2014; Mushore, 2017; Gonzalez, 2007). Longitudinal studies involve including the same participants in all samples drawn throughout the study. Using the same participants among the different stages of the study allows the identification of changes in their responses. However, longitudinal studies require more resources and time compared to cross-sectional studies (Owino et al., 2014; Mushore, 2017; Saunders et al., 2016; Gonzalez, 2007). This research project is considered a cross-sectional study as it collects data from a single set of participants at each stage of the research. The use of different set of participants allows the research to access different levels of experience and opinions to confirm the research results and achieve triangulation as discussed in Section 1.7.

Figure 1.5 illustrates the Research Onion Model modified to reflect this research. The modified model shown in Figure 1.5 illustrates the choices of research philosophy, approach, methods, and strategies followed in this research project.

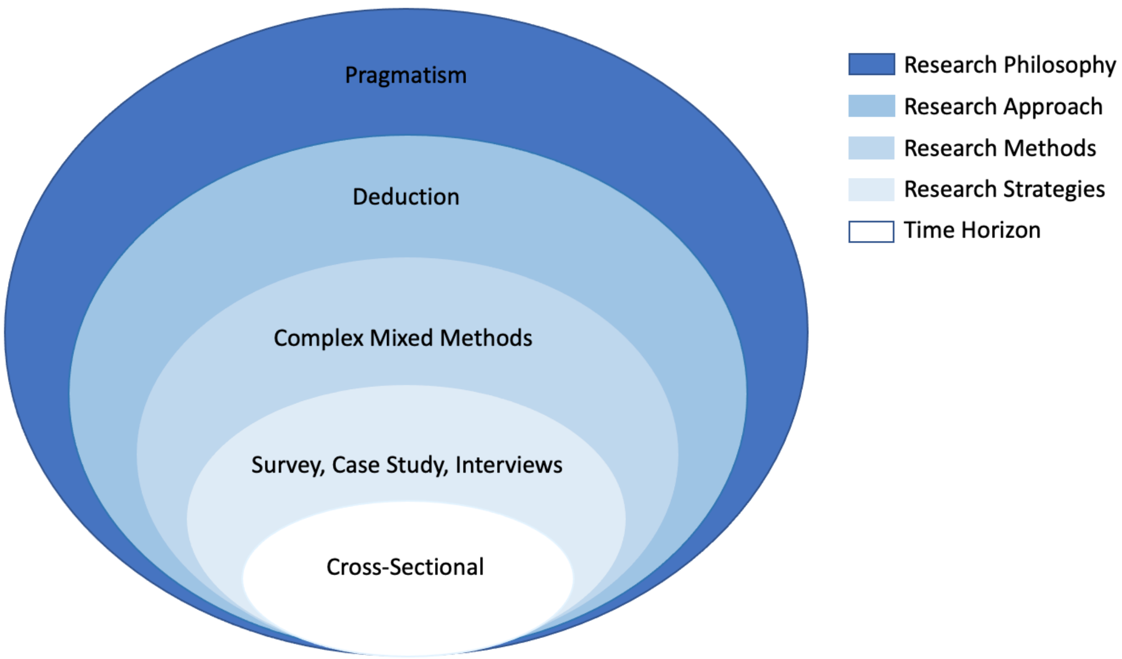


Figure 1.5: Modified Research Onion Model (Modified to reflect author's choices after Saunders et al., 2016)

1.6.4 Participants and Sampling

This research project included conducting interviews with experts as discussed in Chapter 5 and then a quantitative analysis using a questionnaire which is discussed in Chapter 6.

Convergent interviews were conducted with a panel of experts. It was suggested from the literature that the optimal size for panel of expert interviews is 5-8 participants (Lazar et al., 2017; Nielsen, 1994). Hwang and Salvendy (2010) suggest 10±2 participants as a general rule. In addition, it was suggested that a panel of experts interviews may be conducted with 8-10 participants (Beecham et al., 2005; Belbin, 1981). The panel of experts' interviews described in this research were conducted with 10 participants as outlined further in Chapter 5. The academic level of the participants ranged from Lecturer to Professor. Additionally, their managerial level ranged from Head of Department to Vice Chancellor.

As this research project is a cross-sectional study as discussed in Section 1.6.3, the experts interviewed were different individuals from the practitioners who took part in the survey. This allows the use of a larger set of participants to draw conclusions for this research in shorter period of time (Owino et al., 2014).

An online questionnaire was administered for the purpose of collecting quantitative data. The sample size was calculated based on information obtained from General Authority for Statistics in KSA to determine the population size as discussed in Chapter 6. A snowball sampling technique was used for administering the questionnaire (Sadler et al., 2010; Parker et al., 2019; Saunders et al., 2016). The total number of responses obtained was 188 and statistical analysis was conducted as discussed in Chapter 6.

1.6.5 Research Design

This research project is divided into three main parts. The first part is concerned with conducting secondary research on the project subject. During this phase, a holistic understanding of the topic was obtained through an extensive literature review. The first version of the HF-HEQ-BI Framework was developed during this phase. Primary research was conducted in the second part of the research project. During this phase, the HF-HEQ-BI Framework was validated and revised through qualitative and quantitative analysis. The last part of this research project involved the evaluation of the research project, drawing conclusions and suggesting future work. Figure 1.6 illustrates the research design.

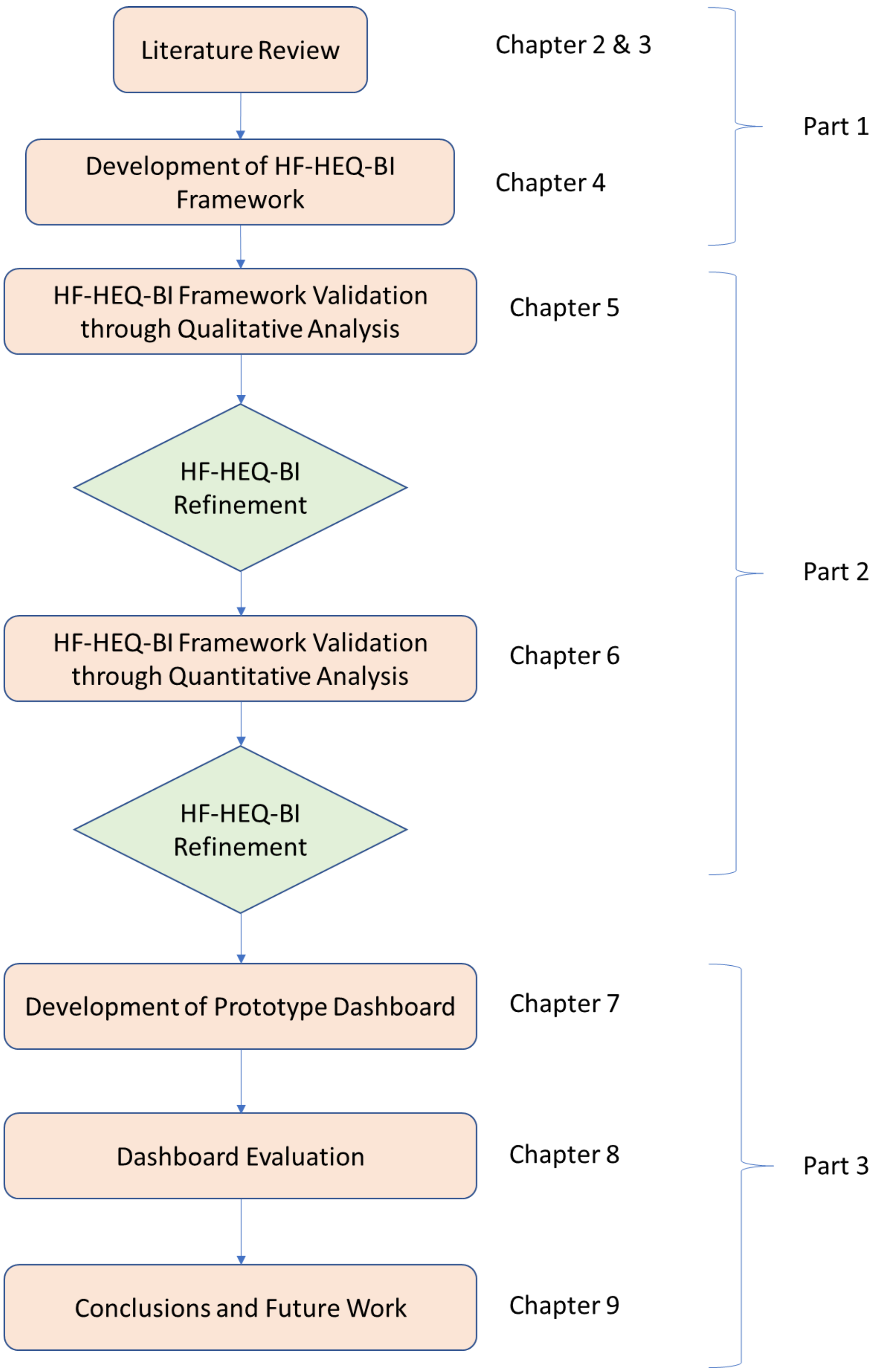


Figure 1.6: Research Design

1.6.5 Ethical Issues

This research project follows the Staffordshire University code of ethics. For the purpose of gathering data for qualitative and quantitative analysis conducted in this research project, ethical approval processes were followed, and ethical approval was obtained from Staffordshire University Ethics Committee.

During the research process, the outcomes of qualitative analysis conducted in Chapter 5 resulted in a change in the proposed framework. Therefore, additional ethical approval was obtained for the modified questionnaire to reflect the changes in the framework.

All participants in this research project were fully informed about the research aims and objectives. They were given the opportunity to withdraw from participation at any stage of the research process. Additionally, their personal information was anonymised. All information provided for this research project was anonymised; the case study used for the evaluation was based on a real institution but was anonymised to protect confidentiality.

1.7 Research Validation, Triangulation, and Evaluation

Validation of the framework is a '*process of ensuring that the framework is sufficiently accurate for the purpose for which it is designed*' (Kabaale & Kituyi, 2015). Validation of research findings is considered an important element in social studies (Venkatesh et al., 2013). Venkatesh et al. (2013) suggest that validation in Information System studies can be achieved through the use of mixed methods. Throughout this research project, qualitative analysis and quantitative analysis have been used for the purpose of validating the HF-HEQ-BI Framework which was developed from the literature review. As there were limited studies on this research topic (Albaqami, 2015; Al Suwailem, 2018; Abdullah, 2017), factors were themed to the relevant HF-HEQ-BI framework pillars (Technology, Organisation, Environment, Business, and Social) based on their relevance as suggested in the literature, and the researcher's experience and discussed in Chapter 4. The primary research started with interviewing a panel of experts to obtain their opinions regarding the developed framework and QA factors before surveying a wider audience of practitioners. The validation approaches used in this research project were as follows:

- Qualitative methods included conducting convergent interviews with a panel of experts in QA in HEIs. The use of convergent interviews allows experts to understand the topic of the study and confirm the changing outcomes of the research as it evolves (Angell et al., 2008; Williams & Lewis, 2005).

- Quantitative methods included the use of multiple statistical tests for the purpose of analysis of collected data. The purpose of using multiple statistical analysis tests is to confirm the results obtained from different points of view. For example, Confirmatory Factor Analysis has been used to confirm the relationship between study variables and associated pillars of the HF-HEQ-BI Framework. Additionally, t-test was used to determine whether significant differences are found in the results that can be attributed to the type of HEI where participants work.

The use of the mixed-methods approach achieves triangulation of results (Schoonenboom & Johnson, 2017; Venkatesh et al., 2013; Jick, 1979). Data Triangulation refers to the use of different data sources for the purpose of confirming the research results (Krey et al., 2012; Saunders et al., 2016; Jick, 1979). For the purpose of validation of research outcomes, triangulation can be achieved through using more than one research method (Krey et al., 2012; Jick, 1979). Triangulation has been achieved in this research project as follows:

- The proposed HF-HEQ-BI Framework was developed through a literature review of the factors that affects the design of BI and QA systems in HE as discussed in Chapter 4. The HF-HEQ-BI framework was validated through qualitative and quantitative methods as discussed in Chapter 5 and Chapter 6, respectively.
- Participants in the expert interviews (Chapter 5) were different to the participants in the survey (Chapter 6).

The developed framework was further validated through utilising the factors identified in the framework to build a prototype dashboard. The HF-HEQ-BI Framework Utilisation Tool was developed to assist in utilising the HF-HEQ-BI factors in determining the requirements for BI dashboards. The development of the prototype dashboard went through several iterations. Throughout the development process, a Community of Practice (COP) approach was used to develop the prototype dashboard, and this is discussed in Chapter 7. A usability evaluation of the prototype dashboard was conducted through an anonymised case study as discussed in Chapter 8. A usability evaluation is '*any analysis or empirical study of the usability of a prototype or a* system' (Poropat, 2014).

1.8 Thesis Outline

As discussed in Section 1.6.5, this research project is divided into three main parts. The first part is concerned with a literature review of the research topic. The HF-HEQ-BI framework was developed at this stage. In addition, the factors that affect the design of QA and BI systems in HE were addressed.

The second part involves the validation process of the HF-HEQ-BI framework. Finally, the third part involves evaluation of the HF-HEQ-BI framework through development of prototype dashboard and the use of an appropriate tool for validating the usability of the prototype dashboard. The thesis outline is shown in Figure 1.7 and a summary of the chapters is outlined as follows:

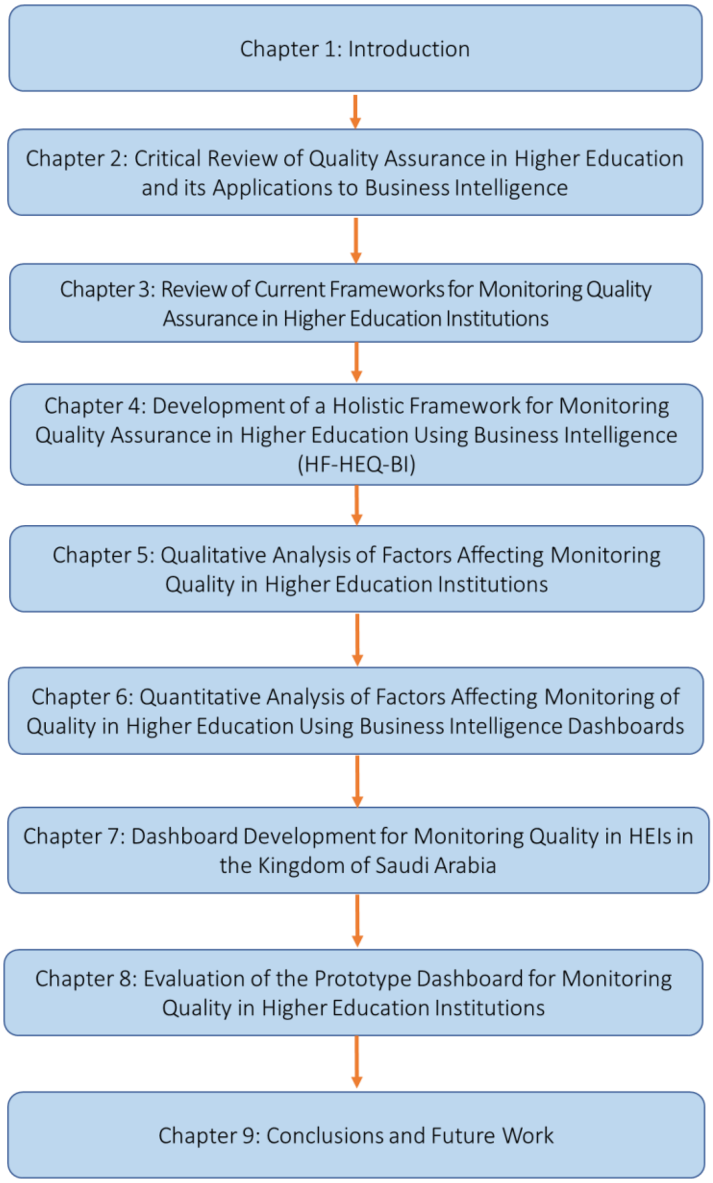


Figure 1.7: Thesis Outline

- Chapter 1 outlines the background and motivation for research. This chapter discusses the research aim and objectives and the strategies that were followed for the purpose of conducting the research. The chapter also outlines the research structure and research methods that were applied to each part of the research project and describes the ethical issues that applied to the research.

- Chapter 2 outlines a literature review of the research topic which includes Quality Assurance and Business Intelligence in HE. The chapter outlines the accreditation process and requirements in KSA. Quality Assurance standards in KSA are mapped to several international QA standards. In addition, Business Intelligence architectures in HE is also discussed.
- Chapter 3 discusses current frameworks for monitoring quality in HE. A critical literature review was conducted for the purpose of identifying current studies that discussed QA monitoring in HE through BI. A Gap Analysis was conducted for the purpose of determining the missing components in the current frameworks.
- Chapter 4 outlines the process and justification for a novel HF-HEQ-BI framework development. Throughout the chapter, a critical literature review was conducted for the purpose of determining the factors that affect the design of BI and QA systems in HE. The first version of the HF-HEQ-BI was developed through literature review. The factors identified from literature were themed to pillars derived from underpinning theoretical frameworks for the proposed HF-HEQ-BI framework.
- Chapter 5 outlines the qualitative analysis validation of the HF-HEQ-BI framework. In this chapter, interviews with a panel of experts were conducted. A Computer Assisted Qualitative Analysis Software (CAQDAS) was used for the purpose of conducting thematic analysis of interviews responses. Modifications on the HF-HEQ-BI were incorporated based on interviews outcomes.
- Chapter 6 outlines the quantitative analysis validation of the HF-HEQ-BI framework. In this chapter, an online survey was administered for the purpose of validation. The responses gathered through the online survey were statistically analysed to draw results from these responses.
- Chapter 7 addresses the use of the HF-HEQ-BI framework for the purpose of building a prototype dashboard. A HF-HEQ-BI framework utilisation tool was developed to show how to utilise the framework factors in capturing QA visualisation requirements for building a dashboard.
- Chapter 8 outlines an evaluation of the HF-HEQ-BI framework through evaluating the prototype dashboard based on an anonymised case study. An evaluation tool was developed based on BI Scorecards and Technology Acceptance Model (TAM) usability criteria. The evaluation process is outlined, and the results of evaluation are presented in this chapter.
- Chapter 9 presents a summary of the research project and describes the limitations encountered, and outlines suggested future work. In this chapter, the research process is evaluated to determine whether the research aim, and objectives have been met.

1.9 Conclusion

This chapter provided an introduction to the thesis and discussed the background and motivation of this research project. The research aim and objectives were outlined together with the research questions. The research contributions to knowledge were discussed together with the research philosophy, methodology, and strategies. The choices of research methods and strategies used in the research were discussed and justified regarding the different aspects of this research project. The chapter also outlined the validation and evaluation process chosen for this research together with the ethical considerations of the research. Additionally, the thesis outline was addressed to briefly discuss the structure of thesis.

The next chapter provides a literature review of the research topic in terms of Quality, Quality Assurance, and Business Intelligence concepts used in Higher Education together with the different system architectures used to support BI dashboards.

Chapter 2 : Critical Review of Quality Assurance in Higher Education and its Applications to Business Intelligence

2.1 Introduction

In this chapter, a definition of quality and Quality Assurance (QA) will be discussed in the context of Higher Education (HE). QA, Quality Management (QM), and Best Value (BV) will also be defined and differentiated in this chapter. In addition, the role of accreditation, ranking, and quality monitoring bodies will be addressed during the discussion of QA in Higher Education Institutions (HEIs). Total Quality Management (TQM) will also be outlined in relation to its application in the HE context. As HEIs are considered service providers, this chapter will also include a discussion of service quality measurement tools such as SERVQUAL and HEdPERF.

The QA system in HEIs in the Kingdom of Saudi Arabia (KSA) context will be outlined and there will be a reflection on the challenges that HEIs will face while adopting QA systems as well as using Key Performance Indicators as performance benchmarks. QA monitoring and QA activities in HEIs in KSA will also be outlined in this chapter. Additionally, KSA quality assurance standards in HE have been benchmarked with some International standards to reflect the degree of similarity between these standards. The challenges of implementing quality assurance monitoring systems using dashboards will be addressed throughout this chapter.

The second part of this chapter discusses the role of Information and Communication Technologies (ICT) in QA management as well as the use of Business Intelligence (BI) in the HE context. Several BI architectures will be discussed to review different options for the implementation of BI solutions in organisations of different sizes. Business Intelligence applications in the context of HE will be discussed alongside the challenges of implementation, especially those related to reporting and visualisation of performance. The implications of the application of BI tools are discussed at the end of this chapter. In addition, an architecture for developing BI systems in the HE context is introduced in this chapter.

BI dashboards together with design characteristics are discussed in this chapter. Since 2016, the use of dashboards applications in KSA has grown significantly and this is discussed in the context of HEI.

2.2 Quality and Quality Assurance

This section discusses quality and Quality Assurance and the differences between Quality Assurance, Quality Management, and Best Value. The literature review approach used in this chapter encompasses searching for existing research in scientific databases including PubMed, ACM digital library and IEEE Xplore, which have been accessed online through the Staffordshire University Library. Additionally, Google Scholar was also used to retrieve research papers and articles to supplement the literature review. During the review process, the focus was on obtaining current literature and identifying research that focused on quality and service quality measurements in HE.

2.2.1 Definitions of Quality and Quality Assurance

The definition of quality has evolved over the passage of time due to changes in customers' needs and demands (Hasan & Al-Kassem, 2014). Schindler et al. (2015) suggested that quality has several definitions and that defining quality '*continues to be difficult*' because some researchers assert that quality can be neither defined nor quantified while others suggest that quality is subjective and depends on individual perspectives.

According to Venkatraman (2007), quality was defined by Crosby in 1979 as '*conformance to requirement*' and by Juran and Gryna in 1980 as '*fitness for use*', or alternatively, '*fitness of purpose'* (Jarvis, 2014). In 1986, Edward Deming defined quality as '*a predictable degree of uniformity and dependability at low cost and suited to the market*'. Juran and Godfrey (1998) suggested that across these definitions, the two most important elements of quality are: (1) quality as a '*features of products*' that meet customer needs and therefore provide customer satisfaction; and (2) quality as a '*freedom from deficiencies*' that would require doing work over again. There are some common characteristics shared by all previous definitions which are the conformance with pre-defined standards, which can be understood as the customers' needs. The fulfilment of customers' needs is the key input for achieving quality of product or service (Juran & Godfrey, 1998; Almurshidee, 2017).

Defining quality is a prerequisite for defining Quality Assurance (QA). Schindler (2015) suggests that there is a need to understand what is meant by quality in order to know how to 'assure' quality. The previous discussion indicates that there is no exact definition of quality, and consequently, there are several definitions of QA in the literature. According to Juran and Godfrey (1998), QA and Quality Control (QC) are very similar as each stimulates corrective action when needed. The main difference is in the prime purpose to be served. While QC concerns the activities of those who are directly involved in the operational processes, QA is carried out by those not directly involved in the operations, to provide assurance that operations are being carried out as expected. This is reflected in the definition by Al-Shafei et al. (2015) who defined QA as a '*preventive strategy aimed to ensure compliance of products/outputs/services of a particular system with a predefined quality standards and specifications*'. Seyfried and Pohlenz (2018, p.269) suggested that QA in HE refers to '*the goals, strategy and methodology of assuring and/or developing quality in higher education'.* Quality

Assurance can be achieved through the implementation of specific steps including audits, issuing reports and other measures (Al-Shafei et al., 2015).

2.2.2 Quality Management, Best Value, and Quality Assurance

While QA aims to assure that the operations of a particular system comply with specific standards, Quality Management (QM), is considered part of management and is intended to achieve quality goals through planning, monitoring, assuring, and improving quality (Vlasic et al., 2013; Seyfried & Pohlenz, 2018). The main difference between QA and QM is that QM is a managerial function that sets quality goals which need to be achieved in a certain time period. QM encompasses the main managerial functions from planning to monitoring the outcomes through comparing performance to a predefined goal in order to decide whether these goals have been achieved.

QM encompasses QA features to ensure the process of meeting minimum standards, which is a major concern of QA, but also extends the role of Quality Assurance to ensure that quality improves over the time through Continuous Improvement (CI) mechanisms (Nies et al., 2010).

Yu et al. (2013) suggested that quality is tied to the value provided by the product/service. It was suggested that although organisations, especially in the construction field, are always concerned with suppliers providing raw materials at the lowest cost, there is a trade-off between the lowest cost and the quality of materials; the lowest cost product may provide the least durability over time or may reduce the overall quality when used in constructing the product/service, which, in turn, may lead to lower customer satisfaction or may even damage the organisation's reputation. Therefore, focusing on low-priced products/services may not meet the quality requirements of modern projects, which in turn leads to a new process of selection of vendors, called Best Value (BV) (Yu et al., 2013).

The BV system focuses on improving quality by eliminating waste. BV improves client decision-making and eliminates the need for redundant client management through transferring the risk to another party that can address the risk more efficiently (Sullivan, 2011). Inefficient decision making is improved by replacing the manual process for contractor selection with an automated process that aligns the owner with the party that best fulfils their needs. The elimination of redundant client management activities is concerned with the elimination of those activities that do not add value such as inspection of the quality of products that a vendor is providing. The BV system transfers the responsibility and accountability of the project from the owner to the contractor. In particular, the BV system makes the contractors responsible for determining risks for failure to meet requirements, disseminating critical information about unforeseen events that affect the project and budget, and being accountable for the final project results (Sullivan, 2011). BV can be linked to QA as the organisations are seeking the solution that best matches their need to provide the best value to the organisation rather than looking for the lowest cost solution for achieving organisational goals.

2.3 Emergence of Quality Assurance in Higher Education

This section discusses the role and importance of Quality Assurance in Higher Education as well as its approaches and tools. Total Quality Management (TQM) in Higher Education, the measurement of service quality in Higher Education, strategic orientation of Quality Management in Higher Education, and the role of ranking and accreditation are also addressed. This section also outlines the role of Key Performance Indicators (KPIs) in Higher Education.

2.3.1 Role and Importance of Quality Assurance in Higher Education

Like many organisations, HEIs operate in a dynamic world. As a result, HEIs are changing rapidly in response to those changes. This has led to a consensus on the importance of service quality issues in HE (Jager & Gbadamosi, 2010; Blanco-Ramírez & Berger, 2014; Komotar, 2020). The Higher Education sector differs from industrial quality management operations since it provides services rather than delivering tangible products (Soomro & Ahmad, 2012). Therefore, quality management in HE is an important and challenging issue.

While there is no consensus on the definition of quality, as discussed in Section 2.2.1, Schindler et al. (2015) provided several definitions of quality in the context of HE based on a review of literature. Schindler et al. (2015) suggested that there are four broad conceptualisations of quality in HE; quality as purposeful, transformative, exceptional, and accountable. Table 2.1 summarises those orientations of quality in HE.

Table 2.1: Classifications of Quality in Higher Education (Modified by author after Schindler et al., 2015)

Classification	Definition
Purposeful	Conformance of product/service to the stated mission/vision or a set of requirements, specifications, or standards including those defined by accrediting bodies
Exceptional	Products/services are distinct and fulfil the highest standards
Transformative	Institutional products/services positively affect the change in student learning and personal and professional potential
Accountable	Institutions are accountable to stakeholders for the optimal use of resources and for delivering accurate educational products with zero defects

The nature of HE systems encompasses various internal and external stakeholders, and HEIs are supported by extensive government funding. This has led to stakeholder demands for assurance that resources are used in the most efficient way. Thus, QA plays an essential role in assuring that the organisational mission and objectives are aligned to meet the expectations of stakeholders (Soomro & Ahmad, 2012; Alzamil, 2014; Lucander & Christersson, 2020).

Consequently, it is not surprising that the classifications of QA in HE as discussed in Table 2.1 are focused on meeting the expectations of stakeholders such as external agencies for monitoring quality as well as addressing the accountability issues of HEIs' management.

From a government perspective, the focus on HE operations is mainly concerned with efficiency, cost-effectiveness, community satisfaction and accountability (Lucander & Christersson, 2020; Jung & Latchem, 2011). However, institutions are more interested in the assurance and improvement of quality of courses, learning processes and outcomes, management and staffing, while the main concerns for students are focused on costs and career opportunities (Tsinidou et al., 2010). This range of stakeholder needs, and perspectives means that HEIs are under pressure to demonstrate that they are in conformance with these requirements. HEIs have consequently realised that the quality of their services and the degree of customer satisfaction are factors which can set them apart from other universities as well as achieving long-term survival (Tsinidou et al., 2010).

Mokhtar et al.(2012) suggested that QA in the context of HE is not limited to quality improvement and sustainability, but also cover the implementation of effective quality management systems in HE, providing a dynamic process of monitoring, continuous improvement, and change. QA should also help in determining the extent of improvements made, ensuring compliance with specifications, requirements and standards. In addition, QA should also include the identification of monitoring performance indicators against those standards (Hamdatu et al., 2013).

2.3.2 Quality Assurance Approaches and Tools in Higher Education

There are many approaches to QA in organisations. Total Quality Management (TQM) is perhaps one of the widely used approaches. Juran and Godfrey (1998) describe Total Quality Management as a set of methods and concepts used for QA. Savov et al. (2017) describe TQM as being a globally recognised tool that provides companies with a competitive advantage through the achievement of sustainable Continuous Improvement (CI), based on deployment of the TQM culture. TQM implementation failures may be attributed to the lack of attention from individuals involved in the quality process, i.e., the failure to deploy the quality culture. Quality culture is a *'product of behaviours, skills, tools, and* *methods as they are applied to the work'* (Juran & Godfrey, 1998, p.16.3). Therefore, quality culture encompasses the involvement of all levels of management as well as individuals in the organisation throughout the whole quality management process (Lucander & Christersson, 2020).

Continuous Improvement (CI) tools associated with the deployment of quality culture, and accordingly, concerned with the successful implementation of TQM include Six Sigma, Failure Mode Effect and Analysis (FMEA), Plan-Do-Check-Act (PDCA), lean tools (Kaizen), control charts and Statistical Process Control (SPC), 5S, Design of Experiment (DOE), Quality Function Deployment (QFD), and Quality Control (QC) (Savov et al., 2017). However, these tools are typically associated with supply chain operations (Savov et al., 2017). In addition, Fissuh et al. (2016) added tools such as the Malcolm Baldridge National Quality Award (MBNQA), ISO 9001, Strategic Planning, Balanced Scorecards (BSC), and Continuous Quality Improvement (CQI) used in the quality management industry.

The launch of BS5750, and later, the ISO 9000 standards in the 80s led to the introduction of the idea of self-assessment against pre-defined criteria such as the Malcolm Baldrige National Quality Award (MBNQA) and the European Foundation for Quality Management (EFQM) quality excellence models, as outlined in Figure 2.1. This enabled organisations to use these sets of tools to help them to manage quality through benchmarking, six sigma, business process reengineering, and policy deployment (Dale et al., 2000). In HE context, TQM has the largest number of applications among HEIs compared to any other tool (Fissuh et al., 2016).

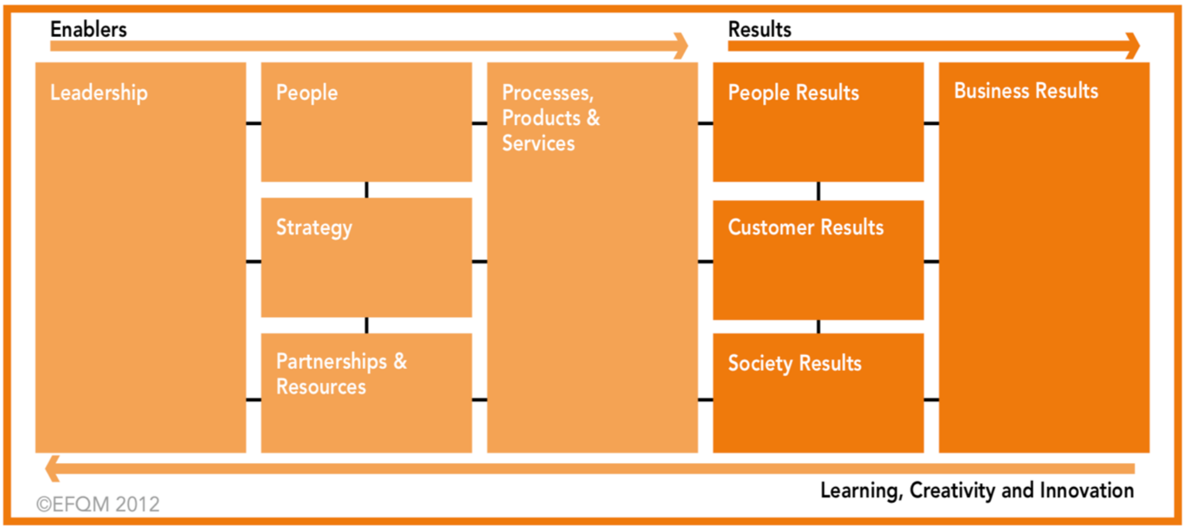


Figure 2.1: EFQM Excellence Model (EFQM, 2013)

2.3.3 Total Quality Management in Higher Education

TQM was first introduced after World War II when Deming and other scientists helped to revive the Japanese economy (Fissuh et al., 2016; Dale et al., 2000). When discussing TQM, it is helpful to begin with the results expected from its implementation. Figure 2.2 outlines the four main benefits of TQM which may include one or more of the following (Juran & Godfrey, 1998):

- Lowering costs: achieved when work is done perfectly from the beginning, lowering costs associated with rework and rectifying errors
- Higher revenues: can be achieved when customers are more satisfied and, therefore, greater market share is achieved
- Empowered employees: as employees become empowered in the organisation, they will bring new ideas that serves the organisational goals and will be committed to the achievement of organisational goals.
- Delighted customers: customers who are delighted by high quality products are likely to be repeat customers and this compares to the cost related to attracting new customers. In addition, customers play an important role in advertising the organisation's products through the word-of-mouth

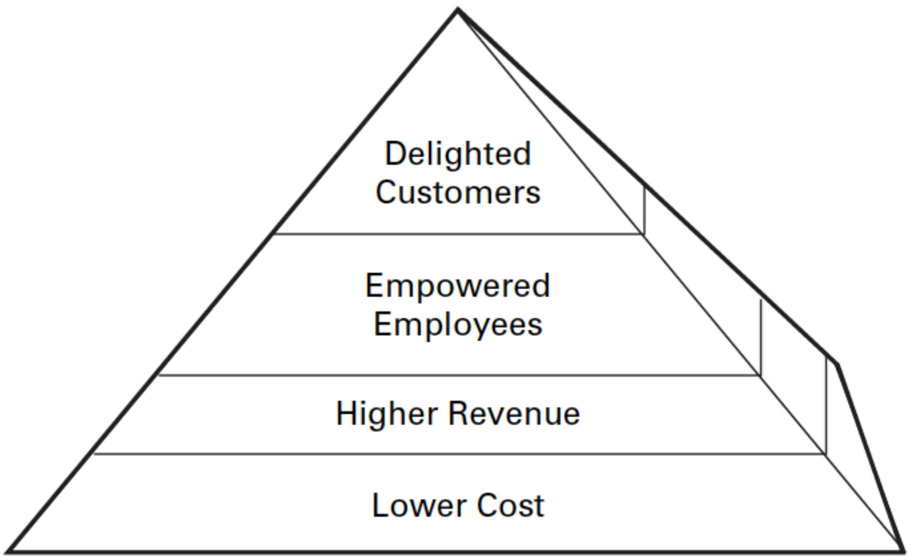


Figure 2.2: TQM Benefits (Juran & Godfrey, 1998)

As discussed in Sections 2.3.2 and 2.3.3, the TQM approach takes into consideration the perspectives of different stakeholders, both internal and external. This enables the organisation to develop a comprehensive approach for assuring quality and facilitating change and innovation (Abdous, 2009).

TQM is a managerial philosophy that aligns systems and processes to meet and exceed customers' expectations (Soomro & Ahmad, 2012). Since the main focus of TQM, beside deploying quality culture within the organisation, is not merely to meet the expectations of customers, but to exceed their expectations, some researchers consider TQM '*customer oriented*' (Owlia & Aspinwall, 1996, 1997; Mehralizadeh & Safaeemoghaddam, 2010). In HE, the TQM philosophy has been credited with improving morale, reducing costs and improving performance and responsiveness to customers' needs (Elmuti et al., 1996; Almurshidee, 2017).

In the HE context, TQM was first applied by American and British HEIs during the 1980s when they faced the commercial pressures of a competitive market. As a commercial organisation, they were required to improve quality, increase the number of students, and reduce costs (Aljanobi, 2015). Fissuh et al. (2016) suggested that the adoption of TQM in HE has many advantages for institutions such as achieving cost efficiencies, gaining competitive edge and student loyalty, responding to government needs to achieve the highest quality, and providing better services. Additionally, Fissuh et al. (2016) suggested that TQM can be measured in HEIs through use of self-assessment tools and benchmarking. However, Pratasavitskaya and Stensaker (2010) attributed unsuccessful implementation of TQM in HE to resistance to change, insufficient administrative commitment, the huge amounts of time spent on training, and lack of experience. On the other hand, Alzhrani et al. (2016) suggested that TQM, as a philosophy of modern management, has proved successful in many implementations in HEIs. Alzhrani et al. (2016) introduced a new model, as shown in Figure 2.3, for the adoption of TQM in HE based on success stories of the use of TQM in HE in the Kingdom of Saudi Arabia.

As shown in Figure 2.3, TQM implementation is based on the adoption of the Plan-Do-Check-Act cycle (Venkatraman, 2007; Abusa & Gibson, 2013; Alzhrani et al., 2016) which encompasses the cycle of Continuous Improvement which is a part of the implementation of TQM. In Higher Education, this Continuous Improvement cycle is oriented toward educational activities including teaching and support activities such as administration and regulatory control, which leads to improvement in the HE.

In conclusion, TQM is a management philosophy that may incorporate one or more of the above-mentioned approaches and tools in order to assure Continuous Improvement (CI) in organisational processes. These tools and approaches demonstrate the main objective of the TQM philosophy, that is, the whole organisation focuses on Continuous Improvement. Aljanobi (2015) suggested that while TQM was the dominant tool during the 90s, this is not the case today and some commentators consider TQM to be outdated (Dale et al., 2000). In more recent approaches, the focus has shifted toward approaches and tools for measuring service quality such as SERVQUAL which measures customers' perception of the quality of service provided (Randheer, 2015; Abdullah, 2006). This is discussed in detail in the next section (Section 2.3.4).

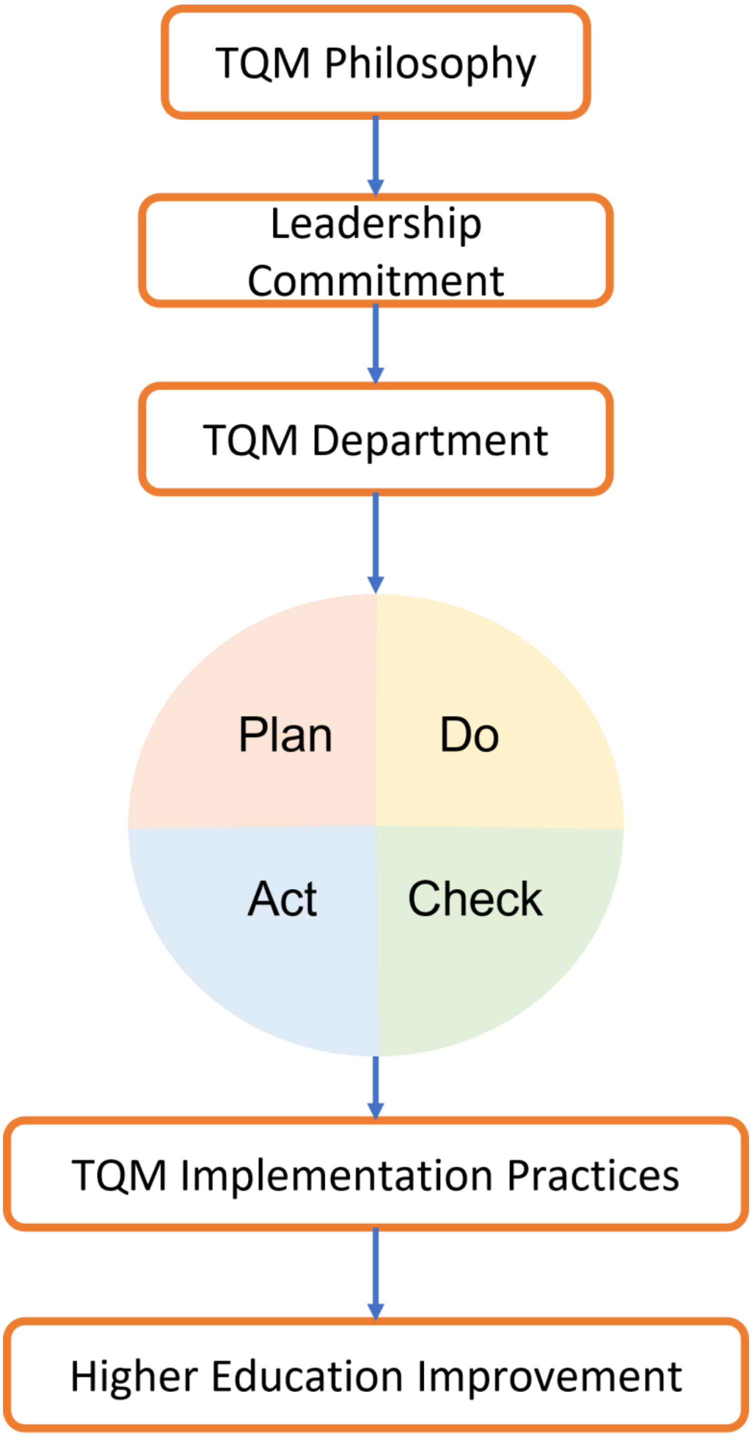


Figure 2.3: TQM implementation in HE - (Modified by author after Alzhrani et al., 2016)

2.3.4 Service Quality

As discussed in Section 2.3.3, HEIs are considered as service providers. Teeroovengadum et al. (2016) suggest that sustainability and improvement of service quality in HEIs is an important prerequisite for survival in increasingly competitive world. Therefore, universities need to maximize their efforts for CI of their services. There are a number of studies examining the development of tools for measuring the quality of services provided by the HEI (Silva et al., 2017; Abdullah, 2006; Randheer, 2015). These tools have been developed from existing tools for measuring service quality. The first, and perhaps the most popular tool, for measuring service quality, was developed by Parasuraman et al. (1988) who introduced the SERVQUAL model for measuring the gap between perceived and actual quality of service.

The SERVQUAL model was further developed to be applied in specific industries. Table 2.2 summarises some of the models developed from SERVQUAL according to Randheer (2015) and Ibrahim et al. (2012). In the HE context, one of the most relevant tools for measuring service quality is HEdPERF, which was developed by Abdullah (2006). HEdPERF is intended to measure and improve service quality using 41 scales. Ibrahim et al. (2012) have also discussed tools for measuring quality performance in HE. In addition to SERVQUAL, SERVPERF, and HEdPERF, they suggested that EduQUAL, SQM-HEI, and EDUSERVE are also helpful in measuring HE service quality.

Table 2.2: Service Quality scales (Modified by author after Ibrahim et al., 2012; Randheer, 2015)

Author(s)	Scale Developed	Industry
Parasuraman et.al (1988)	SERVQUAL	General
Knutson et.al (1991)	LODGSERV	Hospitality
Cronin and Taylor (1992)	SERVPERF	General
Getty and Thompson (1994)	LODGQUAL	Hospitality
Dabholkar et.al (1996)	RSQS Retail	Retail
Evangelos Christou and Athina Nella (1999)	SQ WINE	Wineries
A. Parasuraman et.al (2005)	ES-QUAL	Online Shopping
Firdaus (2006)	HEdPERF	Higher Education
Evangelos Tsoukatos, Evmorfia Mastrojianni (2010)	BANKQUAL-R metric	Banking
Mahapatra & Khan (2007)	EduQUAL	Higher Education
Senthilkumar & Arulraj (2011)	SQM-HEI	Higher Education
Ramseook-Munhurrun et al. (2010)	EDUSERVE	Higher Education
Randheer (2015)	CUL-HEdPERF	Higher Education

Randheer (2015) extended the HEdPERF tool by adding Arabian cultural aspects and developed CUL-HEdPERF. In addition, Randheer (2015) suggests that CUL-HEdPERF can measure service quality in the context of HE, especially in the KSA context, more efficiently than SERVPERF and HEdPERF.

2.3.5 Quality Assurance Agencies, Rankings, and Accreditation in Higher Education

As educational services are intangible and difficult to measure, national accreditation agencies try to assess the quality of the services provided by institutions by evaluating and accrediting the qualifications provided by the HEIs (Tsinidou et al., 2010; Komotar, 2020). The role of accreditation agencies is to ensure that HEIs are in compliance with quality standards; a HEI which meets these standards, is awarded accreditation as a recognition of the achievement of a certain level of QA. Almost every country has its own accreditation system for measuring quality in HEIs (Blanco-Ramírez & Berger, 2014; Komotar, 2020). In addition, Abou-Zeid and Taha (2014) suggested that some HEIs seek national or international accreditation in order to assure quality in their operations.

2.3.6 Quality Assurance and Organisational Strategy

HEIs are operating in a changing environment which requires the adoption of strategic management in order to be able to meet the demands of society (Papadimiriou, 2014). There is a strong link between QA and HE strategic orientation (Dugarova et al., 2015). Quality of education is one of the fundamental factors when determining the mission and strategy of HEI.

As many HEIs are adopting the TQM philosophy to manage QA activities, Almurshidee (2017) suggested that implementing a TQM approach should be viewed as an *'organisational strategy'* that leads to the provision of higher quality products and services. This is a top-down approach starting from tuning the top management orientation.

Quality in HE is mission driven which requires support and involvement from the top management of all stakeholders in order to achieve quality goals, and therefore, to achieve the HEI mission. The institution is the body which sets the goals or standards that should be met and it also measures the degree of achievement of each goal through self-evaluations. (Francisco et al., 2011; Dumond & Johnson, 2013).

2.3.7 Quality Monitoring and Key Performance Indicators

Performance indicators have been defined by Fitz-Gibbon as *'an item of information collected at regular intervals to track the performance of a system'* (Law, 2010, p.68). Educational services are intangible and difficult to measure since the outcome is reflected in the improvement in knowledge, characteristics, and behaviours of individuals (Tsinidou et al., 2010). This suggests that there should be different approaches to measure these performance indicators to determine the level of quality.

Key Performance Indicators (KPIs) are used by HEIs to benchmark performance in certain areas. The actual performance is measured and compared to reference KPI in order to determine the level of satisfaction or compliance with the target. As KPIs are directly related to the organisational mission, the degree to which KPIs are achieved can predict whether the HEI is aligned with its mission and strategic objectives (Albaqami, 2015). Colbran and Al-Ghreimil (2013) suggested that, for the purpose of decision-making, good decisions require good information and datasets, therefore, metrics and KPIs can be relevant to learning and teaching as well as research in terms of quantifying performance of these areas to be monitored. Basic datasets can include time-series on achievement and attrition, student evaluations, and electronic assessment of submissions and reporting. The results from these data sets may be aggregated at the individual, school, discipline, faculty, university, or system level (Colbran & Al-Ghreimil, 2013).

Schindler et al. (2015) reviewed the literature on quality indicators in HE and identified four main quality indicators. Table 2.3 shows these categories.

Table 2.3: Quality Indicators Categories (Schindler et al., 2015)

Categories	Definitions
Administrative Indicators	A set of quality indicators related to institutional administrative functions, including developing mission and vision, establishing legitimacy, achieving internal/external standards and goals, and resources procurement for optimal institutional functioning
Student Support Indicators	A set of indicators related to the availability and responsiveness of student support services
Instructional Indicators	Quality indicators related to the relevance of educational content and instructors' competence
Student Performance Indicators	Quality indicators related to students' engagement with curriculum, faculty, and staff, and the gain in knowledge, skills, and abilities which leads to employment

2.4 Quality Assurance in KSA Higher Education

This section discusses the QA process in HEIs in the context of KSA including a review of QA requirements. A comparison between the National Centre for Academic Accreditation and Evaluation (NCAAA) standards and some international standards shows the similarity between KSA standards and international standards adopted in some other countries. This section also discusses the challenges that HEIs face in KSA while adopting NCAAA standards.

2.4.1 Review of KSA Quality Assurance System for Higher Education

Quality Assurance is a relatively new concept in Higher Education in KSA. The adoption of QA is affected by challenges such as lack of knowledge of QA systems (Albaqami, 2015) and the lack of supporting technology for maintaining the required documentation (Colbran & Al-Ghreimil, 2013).

In recent years, the Government of the KSA has undertaken a number of initiatives to improve quality in HEIs in response to perceived low quality in the system, which affected graduates in terms of employability (Alshayea, 2012). Among those actions, the National Commission for Academic Accreditation and Assessment (NCAAA) was established in order to contribute to the continuing improvement of quality in HE in KSA by ensuring that quality standards are applied (Alshayea, 2012; Alsaleh, 2016). The NCAAA has developed and imposed quality standards that all public and private universities and colleges in the KSA are required to follow (Onsman, 2010; NCAAA, 2009; NCAAA, 2018). The NCAAA standards were first issued in 2009 and subsequently revised in 2018. The NCAAA has not specified a date by which the 2018 standards and KPIs should be used by HEIs in KSA (NCAAA, 2018). It is expected that all HEIs in KSA will in due course use the 2018 standards. However, HEIs which implemented their QA systems before the 2018 regulations were released and have already received institutional approval, may still be using the older standards and KPIs. For this reason, and also because the 2018 standards are based on the 2009 standards, the following sections discuss both the 2009 standards and the 2018 standards.

2.4.1.1 NCCAA Standards, 2009 Version

The 2009 standards cover 11 main areas in the context of HEIs. NCAAA has developed 'Self-Evaluation Scales for Higher Education Institutions' in order to assist those institutions to evaluate performance against standards (NCAAA, 2009). The 11 quality standards and a brief description of each standard is reviewed in Table 2.4. The table uses different colour codes which have been used for the individual standards to make it easier to show consistency in subsequent tables outlined in this section. In subsequent chapters, these colours codes will be also used for mapping the standards and related

KPIs to the proposed holistic framework. For example, blue is used to identify Standard 1 on the NCAAA standards and all KPIs related to Standard 1 will also be shown in blue.

Table 2.4: Quality Standards in Higher Education explained after (Modified by author after Alsaleh, 2016)

Standard No.	Quality Standards	Definition
1	Mission Goals and Objectives	Define the institution's principal purpose and priorities clearly and appropriately as guidance for planning.
2	Governance and Administration	Providing effective leadership in the interest of the institution as well as the clients. However, management should work under a framework of sound policies to ensure accountability.
3	Management of QA and Improvement	QA processes must involve all levels of the institution and be integrated in the normal activities of planning and administration.
4	Learning and Teaching	Aims to deployment of an effective system that ensures that all programmes meet the highest standards for learning and teaching through initial approvals, monitoring performance, and institutional-wide support services.
5	Student Administration and Support Services	All processes that concern student such as admission and rights and responsibilities should be clearly defined and understood
6	Learning Resources	All learning resources such as libraries should be planned to meet the university requirements
7	Facilities and Equipment	Adequate facilities and equipment must be available to support learning and teaching processes
8	Financial Planning and Management	Financial resources must be sufficient and available to support programmes, and budgetary and planning requirements must be met.
9	Employment Processes	All staff members should have sufficient qualifications for their job and should meet the HEI's requirements of development, improvement, and evaluation processes held by the HEI.
10	Research	A research strategy should be developed consistently with the organisational mission.
11	Institutional Relationships with the Community	The HEI should make significant and appropriate contributions to the community.

The accreditation process includes a requirement for HEIs to self-evaluate using self-evaluation scales which aim to measure whether the institution meets NCAAA standards (NCAAA, 2009). Alzamil (2014) established self-evaluation standards for HEIs in KSA to assess QA activities within the HEI. These standards were benchmarked against NCAAA standards and some international standards such as the New Zealand Qualifications Authority (NZQA), the European Network for Quality Assurance in Higher Education (ENQA), the Southern Association of Colleges and Schools (SACS) in the United States of

America, the Australian Quality Training Framework (AQTF) and the Scottish Qualifications Authority (SQA) as this information was available in the literature. Using the same approach as Alzamil (2014) used for vocational training, this research compares the NCAAA standards to international standards.

Table 2.5 shows how NCAAA standards (2009) can be mapped to international standards. A tick mark indicates that an element in the NCAAA standard matches an element in the relevant international standard while a cross mark indicates that there was no corresponding element. Table 2.5 uses the 11 standards of the NCAAA rather than the categories used by Alzamil (2014) as the Alzamil study focuses on vocational training in KSA and excludes research. The comparison given in Table 2.5 includes two additional sets of standards, those used by the Quality Assurance Agency (QAA), the governing body of quality in HE in the UK (QAA, 2018) and the Academic Quality Improvement Programme (AQIP) in the USA as well as the standards used by Alzamil.

Table 2.5: Benchmarking NCAAA standards (2009) with international standards

No.	NCAAA Standard (2009)	AQIP USA	SACS USA	SQA Scotland	ENQA Europe	AQTF Australia	NZQA New Zealand	QAA UK
1	Mission Goals and Objectives	✓	✓	✓	✓	X	✓	✓
2	Governance and Administration	✓	✓	✓	✓	✓	✓	✓
3	Management of QA and Improvement	✓	✓	✓	✓	✓	✓	✓
4	Learning and Teaching	✓	✓	✓	✓	✓	✓	✓
5	Student Administration and Support Services	✓	✓	✓	✓	✓	✓	✓
6	Learning Resources	✓	✓	✓	✓	✓	✓	✓
7	Facilities and Equipment	✓	✓	✓	✓	✓	✓	✓
8	Financial Planning and Management	✓	✓	✓	✓	✓	✓	✓
9	Employment Processes	✓	✓	✓	✓	✓	✓	✓
10	Research	✓	✓	✓	✓	✓	✓	✓
11	Institutional Relationships with the Community	✓	✓	X	✓	✓	✓	✓

The comparison in Table 2.5 shows that there is considerable similarity between the NCAAA standards and international standards. This indicates that in terms of QA, HEIs complying with the NCAAA standards in the KSA can be seen as comparable to other institutions that comply with international standards. Additionally, the comparison also shows that there are no significant differences in quality practices in the Higher Education sector as the NCAAA standard can be mapped to other international standards.

The NCAAA standards are designed to ensure that HE quality in KSA is equivalent to international standards. All HEIs in the KSA are required to be accredited by NCAAA (Abou-Zeid & Taha, 2014). There are two types of accreditation that the NCAAA provides to HEIs (NCAAA, 2009);

> (1) Institutional Accreditation, where the entire institution is expected to meet the eleven standards of quality, and
>
> (2) Programme Accreditation, which applies the 11 standards to programmes that are provided at the post-secondary level, excluding military education which is administered differently.

The process of NCAAA accreditation starts with the design of curriculum compliant with the National Qualifications Framework (NQF) (Darandari et al., 2009). In the 2009 version of the NCAAA standards, there are 11 standards, which are divided into five main domains according to orientation. These standards are the measurement criteria against which the HEI must self-evaluate itself in order to determine the level of achievement for each category. Additionally, KPIs are used in the planning and review cycle for measuring the degree of achievement (Darandari et al., 2009; NCAAA, 2009).

The NCAAA 2009 standards identify 33 KPIs. The NCAAA mandates HEIs to adopt these 33 KPIs in order to measure their performance toward Quality Assurance. Each standard has one or more associated KPIs that measure achievement and compliance with the standard. Some of these KPIs are applied at institutional, college, or programme level, or across all levels. While the NCAAA provided these KPIs as guidelines for developing specific KPIs for each institution, they require that at least 70% of the specified KPIs are used by institutions and programmes (NCAAA, 2009, 2015).

Table 2.6 shows the 33 KPIs and associated definitions as stated by NCAAA (2009) as well as the corresponding standard to which each KPI relates. While some standards are associated with only one KPI, some standards are associated with more than one KPI.

Table 2.6: NCAAA 2009 KPIs – (Modified by author after NCAAA, 2015)

NCAAA Standard Numbering	NCAAA KPI	Related Standard
1.1	1. Stakeholders' awareness ratings of the Mission Statement and Objectives	1
2.1	2. Stakeholder evaluation of the Policy Handbook, including administrative flow chart and job responsibilities	2
3.1	3. Students' overall evaluation on the quality of their learning experiences.	3
3.2	4. Proportion of courses in which student evaluations were conducted during the year	3
3.3	5. Proportion of programs in which there was an independent verification, within the institution, of standards of student achievement during the year	3
3.4	6. Proportion of programs in which there was an independent verification of standards of student achievement by people (evaluators) external to the institution during the year.	3
4.1	7. Ratio of students to teaching staff.	4
4.2	8. Students overall rating on the quality of their courses	4
4.3	9. Proportion of teaching staff with verified doctoral qualifications.	4
4.4	10. Retention Rate	4
4.5	11. Graduation Rate for Undergraduate Students	4
4.6	12. Graduation Rates for Post Graduate Students	4
4.7	13. Proportion of graduates from undergraduate programs who within six months of graduation who are either (a) employed, (b) enrolled in further study, or (c) not seeking employment or further study	4
5.1	14. Ratio of students to administrative staff.	5
5.2	15. Proportion of total operating funds	5
5.3	16. Student evaluation of academic and career counselling	5
6.1	17. Stakeholder evaluation of library and media center	6
6.2	18. Number of web site publication and journal subscriptions as a proportion of the number of programs offered.	6
6.3	19. Stakeholder evaluation of the digital library	6
7.1	20. Annual expenditure on IT budget	7
7.2	21. Stakeholder evaluation of the IT services	7
7.3	22. Stakeholder evaluation of a) Websites, b) e-learning services c) Hardware and software d) Accessibility e) Learning and Teaching f) Assessment and service g) Web-based electronic data management system or electronic resources	7
8.1	23. Total operating expenditure (other than accommodation and student allowances) per student.	8
9.1	24. Proportion of teaching staff leaving the institution in the past year for reasons other than age retirement	9
9.2	25. Proportion of teaching staff participating in professional development activities during the past year	9
10.1	26. Number of refereed publications in the previous year per full time equivalent teaching staff	10
10.2	27. Number of citations in refereed journals in the previous year per full time equivalent faculty members	10
10.3	28. Proportion of full time member of teaching staff with at least one refereed publication during the previous year	10
10.4	29. Number of papers or reports presented at academic conferences during the past year per full time equivalent faculty members	10
10.5	30. Research income from external sources in the past year as a proportion of the number of full time faculty members	10
10.6	31. Proportion of the total, annual operational budget dedicated to research	10
11.1	32. Proportion of full time teaching and other staff actively engaged in community service activities	11
11.2	33. Number of community education programs provided as a proportion of the number of departments	11

2.4.1.2. NCCAA Standards, 2018 Version

In 2018, the NCAAA developed a newer version of the accreditation standards. The 2018 version merged some of the standards defined in the 2009 version, resulting in a total of 8 standards (NCAAA, 2018) rather than 11 standards as previously (NCAAA, 2009). The 2018 regulations also reduced the number of KPIs used to measure HEI performance from 33 to 23. Table 2.7 shows a comparison of the previous standards (2009 Standards) and the new standards (2018 Standards).

Table 2.7: Comparison of NCAAA 2009 Standards and 2018 Standards

<table>
<tr><th>No.</th><th>NCAAA 2009 Standards</th><th>No.</th><th>NCAAA 2018 Standards</th></tr>
<tr><td>1</td><td>Mission Goals and Objectives</td><td>1</td><td>Mission, Vision, and Strategic Planning</td></tr>
<tr><td>2</td><td>Governance and Administration</td><td rowspan="2">2</td><td rowspan="2">Governance, Leadership, and Management</td></tr>
<tr><td>3</td><td>Management of QA and Improvement</td></tr>
<tr><td>4</td><td>Learning and Teaching</td><td>3</td><td>Teaching and Learning</td></tr>
<tr><td>5</td><td>Student Administration and Support Services</td><td>4</td><td>Students</td></tr>
<tr><td>6</td><td>Learning Resources</td><td rowspan="3">5</td><td rowspan="3">Institutional Resources</td></tr>
<tr><td>7</td><td>Facilities and Equipment</td></tr>
<tr><td>8</td><td>Financial Planning and Management</td></tr>
<tr><td>9</td><td>Employment Processes</td><td>6</td><td>Faculty and Staff</td></tr>
<tr><td>10</td><td>Research</td><td>7</td><td>Research and Innovation</td></tr>
<tr><td>11</td><td>Institutional Relationships with the Community</td><td>8</td><td>Community Partnership</td></tr>
</table>

The 23 KPIs associated with the 2018 standards are outlined in Table 2.8 which shows the KPIs and the related standard to which the KPI is linked.

Table 2.8: NCAAA 2018 KPIs (NCAAA, 2018)

NCAAA Standard KPI Numbering	NCAAA KPI	Related Standard
KPI-I-01	Percentage of achieved indicators of the institution strategic plan objectives	1
KPI-I-02	Proportion of accredited programs	2
KPI-I-03	Students' evaluation of quality of learning experience in the programs	3
KPI-I-04	First-year students retention rate	3
KPI-I-05	Graduates' employability and enrolment in postgraduate programs	3
KPI-I-06	Graduation rate for Undergraduate Students in the specified period	3
KPI-I-07	Satisfaction of beneficiaries with learning resources	3
KPI-I-08	Employers' evaluation of the institution graduates' proficiency	3
KPI-I-09	Annual expenditure rate per student	4
KPI-I-10	Students' satisfaction with the offered services	4
KPI-I-11	Ratio of students to teaching staff	5
KPI-I-12	Proportion of faculty members with doctoral qualifications	5
KPI-I-13	Proportion of teaching staff leaving the institution	5
KPI-I-14	Percentage of self income of the institution	6
KPI-I-15	Satisfaction of beneficiaries with technical services	6
KPI-I-16	Percentage of publications of faculty members	7
KPI-I-17	Rate of published research per faculty member	7
KPI-I-18	Citations rate in refereed journals per faculty member	7
KPI-I-19	Number of patents, innovations, and awards of excellence	7
KPI-I-20	Proportion of the budget dedicated to research	7
KPI-I-21	Proportion of external funding for research	7
KPI-I-22	Satisfaction of beneficiaries with the community services	8
KPI-I-23	Rate of community programs and initiatives	8

The new standards (2018 Standards) have been benchmarked against international standards and the comparison is shown in Table 2.9. Table 2.9 shows that each of 2018 standards can be mapped to similar international standards. This was expected as the 2018 NCAAA standards are a revision of the 2009 standards and contain many of the same elements.

Table 2.9: Benchmarking 2018 Standards to International Standards

No.	NCAAA Standard	AQIP USA	SACS USA	SQA Scotland	ENQA Europe	AQTF Australia	NZQA New Zealand	QAA UK
1	Mission, Vision, and Strategic Planning	✓	✓	✓	✓	X	✓	✓
2	Governance, Leadership, and Management	✓	✓	✓	✓	✓	✓	✓
3	Teaching and Learning	✓	✓	✓	✓	✓	✓	✓
4	Students	✓	✓	✓	✓	✓	✓	✓
5	Institutional Resources	✓	✓	✓	✓	✓	✓	✓
6	Faculty and Staff	✓	✓	✓	✓	✓	✓	✓
7	Research and Innovation	✓	✓	✓	✓	✓	✓	✓
8	Community Partnership	✓	✓	X	✓	✓	✓	✓

As noted in 2.4.1, some HEIs in KSA may not yet have adopted the 2018 NCAAA standards but it is expected that all HEIs will in due course move to the 2018 version of the standards. For this reason, the holistic framework presented in Chapter 4 is used to support the development of a prototype dashboard which supports the 2018 NCAAA standards. It is also noted that some institutions (e.g., King Saud University) treat the NCAAA KPIs as a minimum requirement and may use additional, institution-specific KPIs. The holistic framework developed in this thesis, and the prototype dashboard developed from the framework must therefore also be able to support additional KPIs if required by the institution.

2.4.1.3. The NCAAA Accreditation Process

The accreditation process involves setting up strategic objectives and identifying the Key Performance Indicators (KPIs) that will be used as a reference to measure performance. The curriculum is designed, and courses are specified according to the requirements of the National Qualifications Framework (NQF). The institution is required to benchmark itself using the self-study report before the process of external review. The whole process should reflect the implementation of the NCAAA 2018 Quality Assurance standards as shown in Figure 2.4

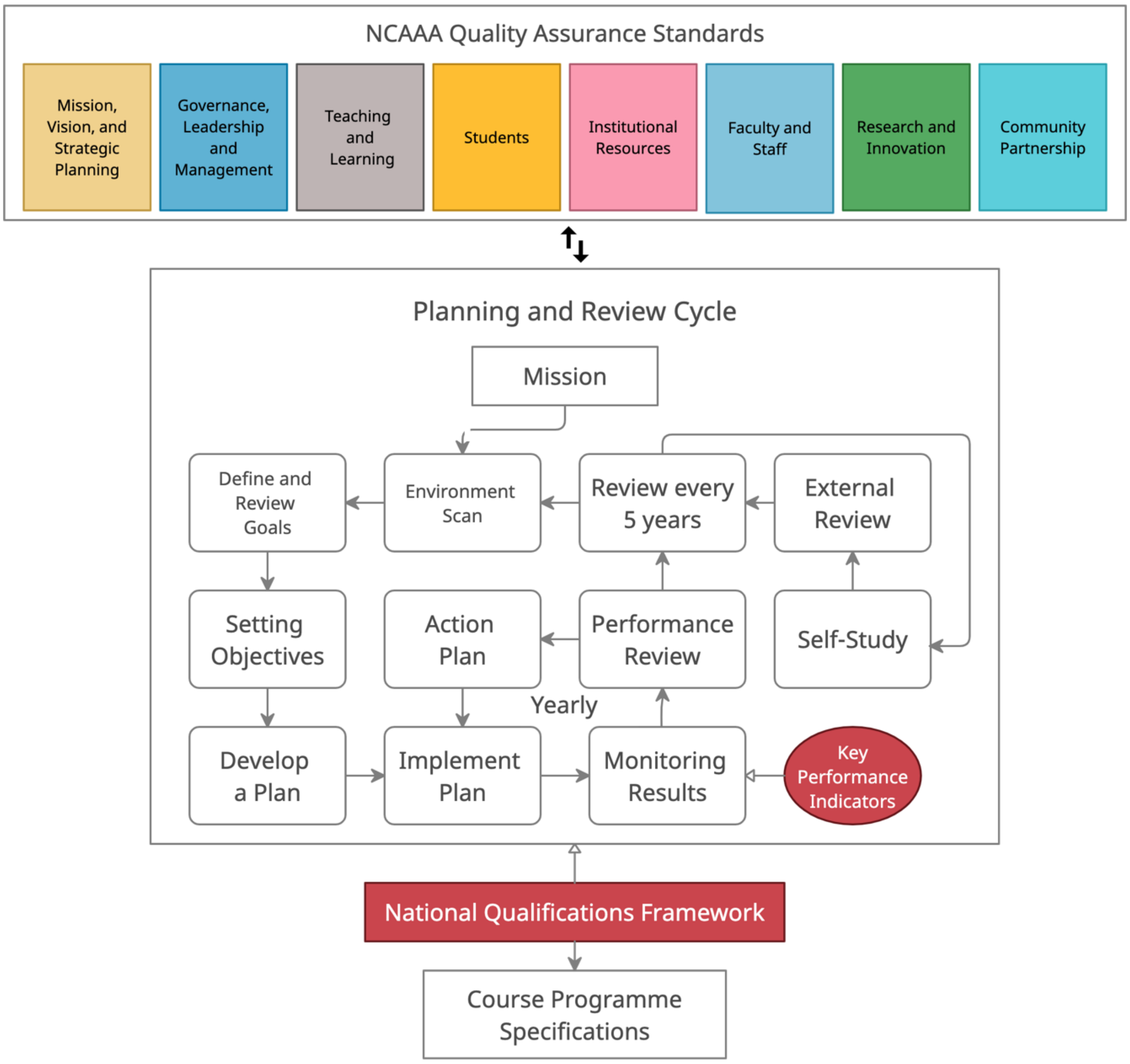


Figure 2.4: NCAAA 2018 Accreditation Process (Modified by author after Darandari et al., 2009)

2.4.2 Challenges of KSA Quality Assurance in Higher Education

The NCAAA quality system expects that HEIs will develop their course and programme descriptions according to National Qualifications Framework (NQF). The NCAAA system also expects that HEIs will conduct the plan and review cycle which is intended to help HEIs to achieve their goals and meet the NCAAA 2018 Quality Assurance standards (NCAAA, 2018). All HEIs in the KSA are required to be accredited by NCAAA.

Research has shown that most faculty members are not enthusiastic about the accreditation process and the data collection requirements, document and form preparation, data aggregation, data analysis, evidence collection, and the development of corrective actions (Abou-Zeid & Taha, 2014).

The NFQ is an important element of Quality Assurance Standards (QAS) in the KSA as the NCAAA is designed to ensure that the quality of HE in KSA is equivalent to international standards. As discussed in Section 2.4.1, institutions are required to comply with at least 22 of the 33 KPIs, while programmes are required to comply with at least 17 of them (Abdullah, 2017; NCAAA, 2009). The 2018 standards require institutions to meet all the 23 KPIs.

Onsman (2010) discussed some barriers in applying NQF in KSA and suggested that the challenge of monitoring academic performance and evaluating academic outcomes whilst maintaining positive learning and teaching environments will hinder the implementation of the NCAAA framework. Onsman (2010) suggested that quality of graduates needs to be monitored over the next decade.

According to Elhoseny et al. (2016), the procedures for planning, implementation, evaluation and development of education and teaching constitute a significant part of QA measures in HEIs. Almurshidee (2017) suggested that the optimal use of feedback and speedy delivery of information required by decision makers in a timely manner could help in saving time, efforts, and money. Hamdatu et al. (2013) suggested that HEIs must have an assessment mechanism for quality such as evidence-based performance indicator with high external standards. Alkathiri (2020) suggested that HEIs are required to show evidence of successful practices of QA before the academic accreditation is being granted in the KSA.

2.5 Role of ICT in Quality Assurance in the Higher Education Context

The emergence of the digital era and Information and Communication Technologies (ICT) has influenced HEIs in terms of how they operate (Haris et al., 2017). Many researchers and studies have shown that ICT could be utilised to improve QA in HEIs (Haris et al., 2017; Colbran & Al-Ghreimil, 2013). QA requires collection of large amounts of information related to the institution's activities and the documentation of each QA activity in the HEIs. ICT can play a significant role during this process (Haris et al., 2017).

According to Guaman et al. (2013), the use and implementation of ICT in quality management contributes to the improvement of the quality of products and services and the reduction of quality costs. It can also affect the improvement of operational performance of companies such as the reduction of production costs, speeding up deliveries, increasing flexibility and reduction in production cycles. Guaman et al. (2013) suggest that ICT can also support Quality Management in terms of increasing process control, facilitating team work, facilitating information flow among different departments, and improving process design, measuring quality costs, and decision making.

Although HEIs have realised the importance of QA, the ambiguity related to QA concepts and requirements constitute important challenges when implementing an information system (Elhoseny et al., 2016). Nookabadi and Middle (2001) suggest that the objective of an effective QA system is to assist a company in satisfying customers' needs and expectations while helping in protecting the company's interests. In addition, planning for quality control should recognise the need to provide a network of information for all decision makers at all levels. In the context of HE, the success of a QA system is dependent upon the support of management (Juran & Godfrey, 1998; Alzhrani et al., 2016). The QA system should also cover strategic management, process management, and measuring and monitoring; these systems interact with each other in order to enable improvement in the processes of the institutions (Kahveci, 2012). At some levels in the organisational hierarchy, there is a need for real-time information for detection and correction of nonconformance to goal activities. At other levels, the emphasis is on summaries that provide control over vital areas (Juran & Godfrey, 1998). Kahveci (2012) suggested that QA information provided to higher management may include sensitive and important information for decision makers. Therefore, real-time access may be required in order to take corrective actions to ensure that the HEI remains on track (Kahveci, 2012).

Business Intelligence (BI) can support QA by providing real-time information to assist HEI top management in keeping track of performance as BI can provide effective capabilities in generating and delivering different kinds of reports (Zulkefli et al., 2015). In the context of the KSA, Colbran and Al-Ghreimil (2013) suggested that BI systems and QA goes 'hand in hand' as BI reporting provides summarised dashboards and reports for teaching and learning quality indicators. These reports can be generated easily by the utilisation of BI tools, and this information can improve teaching and learning outcomes (Colbran & Al-Ghreimil, 2013). The reports can be aggregated to provide individual and sector-wide benchmarks. Furthermore, the Colbran and Al-Ghreimil (2013) study suggested that KSA universities have some datasets that can be used as the backbone of BI systems such as student evaluation and attrition.

The following section discusses Business Intelligence in the context of HEI reporting and Quality Assurance.

2.6 Business Intelligence

Business Intelligence (BI) plays an important role in decision making in the HE context (Alnoukari, 2009). This section discusses the definition of Business Intelligence, and reviews Business Intelligence concepts and Business Intelligence approaches and tools.

2.6.1 Business Intelligence Definitions

Business Intelligence has been defined by Loshin (2003, p.4) as '*a set of tools and methodologies designed to exploit actionable knowledge discovered from the company's information asset*'. Bogza and Zaharie (2008, p.146) stressed the importance of currency of information, defining Business Intelligence as '*getting the right information to the right people at the right time*'. Presthus and Bergum (2015, p.2) defined Business Intelligence as '*a process and a set of technologies where data is gathered, stored and transformed (known as ETL process) into information and analysed to knowledge used for taking action*'. The Prethus and Bergum (2015) definition, discussed the technologies utilised to get benefits from data stressing the Extract, Transform, and Load (ETL) process as a key mechanism of Business Intelligence. Additionally, they addressed the transformation of data into knowledge that is beneficial for '*taking action*'.

Dedić (2017) broadened the definition of Business Intelligence to stress the presentation and dissemination aspect of business information, therefore, Business Intelligence is defined according to Dedić (2017, p.19) as '*a holistic umbrella term, which includes the concept, strategies, processes, applications, data, products, technologies and technical architectures used to support the collection, analysis, presentation and dissemination of business information'.* Laudon and Laudon (2018) defined Business Intelligence as '*a contemporary term for data and software tools for organising, analysing, and providing access to data to help managers and other enterprise users make more informed decisions'.* This definition recognises the requirement for Business Intelligence systems to provide information to different stakeholders. The Laudon and Laudon (2018) definition also stressed that such systems provide assistance in taking '*more informed decisions'.*

Based on these previous definitions, the definition of Business Intelligence which has been developed for this thesis is: '*the set of tools that includes the concept, strategies, processes, applications, data, products, technologies and technical architectures used to support collection, analysis, presentation and dissemination of business information to different stakeholders to support decision making*'.

This definition emphasises the role of stakeholders and the decision-making component of Business Intelligence systems. It also recognises the requirement for tools and technologies but does not limit Business Intelligence to a specific approach or technology. Prethus and Bergum (2015) definition, for example, includes a reference to ETL which is traditionally associated with data warehouse development. Newer approaches to Business Intelligence, such as Somya et al. (2018) and Bentley (2017) discuss the impact of ETL on the performance of the system and the costs and complexity associated with an implementation of such technology and suggest alternatives to traditional approaches such as Self-Service Business Intelligence and Service oriented Business Intelligence. These approaches are discussed further in Section 2.10.

2.6.2 Data Warehouse Infrastructure for Business Intelligence

Business Intelligence tools support managers in making decisions more effectively and accurately (Zulkefli et al., 2015). One widely used Business Intelligence infrastructure is based on the development of a Data Warehouse (DW). The concept of the Data Warehouse was defined by Inmon (1995) as '*a subject-oriented, integrated, time-variant and non-volatile collection of data in support of management's decision making process*'. Later, Loshin (2003, p.47) defined a Data Warehouse as '*a centralized, non-volatile repository of enterprise information, gathered and integrated from multiple sources and placed in a data model that is suitable for analytical process*'. It can be seen from the definitions of Data Warehouse by Inmon (1995) and Loshin (2003) that the main purpose of Data Warehouses is to create a non-volatile collection of information from multiple sources. A Data Warehouse environment uses data sources from which information is gathered; the information is then integrated into a Data Warehouse (DW), and used to support query and reporting tools, and analytical and monitoring tools (Haupt et al., 2015; Ranjan, 2009). The system supports retrieval and storage to enable analytics which are presented to the user using Business Intelligence visualisations such as reports, graphs, and notifications (Dedić, 2017; Chaudhuri et al., 2011; Pinheiro, 2014). Figure 2.5 presents a BI architecture based on the concept of a Data Warehouse.

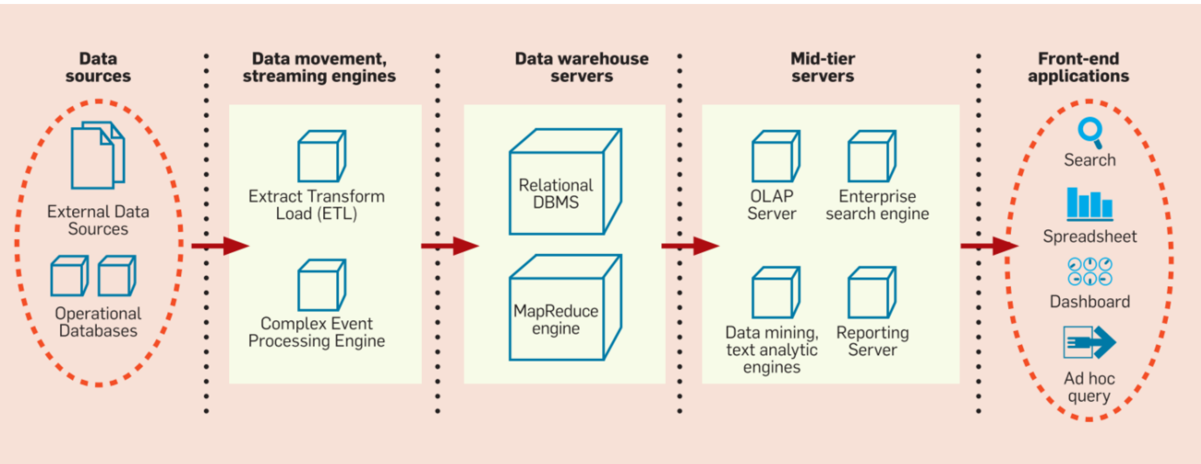


Figure 2.5: Business Intelligence Architecture (Chaudhuri et al., 2011)

Pinheiro (2014) identified key components of Business Intelligence systems as shown in Figure 2.6. The Pinheiro (2014) diagram does not show the linkage between components in the system and how they interact with each other.

Figure 2.6: Business Intelligence components (Pinheiro, 2014)

The components shown in Figure 2.6 represent the main elements of a Data Warehouse based Business Intelligence system. In this approach, Extract, Transform, Load (ETL) plays an important role in the acquisition of data, as the ETL stage ensures that data is transformed into compatible formats before it is loaded into the DW (Hughes & Dobbins, 2015) or other data storage mechanism. The information contained in the Data Warehouse is retrieved as required. The data in the Data Warehouse can then be processed in several ways such as Online Analytical Processing (OLAP). OLAP data cubes are used to support OLAP operations such as roll-up, drill-down, slice and dice, and pivot (Scholtz et al., 2018). The data in the Data Warehouse can be further analysed through the use of data mining algorithms which support data exploration and the finding of patterns in the data (Chaudhuri et al., 2011; Pinheiro, 2014).

Data Warehouses (DW) were originally developed to store transactional data (Inmon, 1995) but there is a recognition of the need to extend the data to include feedback and opinions obtained through Social Media channels (Saura, 2019; Qiu et al., 2016; Bentley, 2017; Liang et al., 2018). Sentiment Analysis may be used to analyse data coming from Social Media and clean it to prepare it for use in the system (Kamisli Ozturk et al., 2017). Additionally, web services allow organisations to develop BI systems without the need to invest in DW. This approach is known as Service oriented Business Intelligence (SoBI) (Somya et al., 2018). The emergence of cloud services such as Microsoft Azure, Amazon AWS, Google Cloud, and other cloud services allowed some Business Intelligence providers such as Tableau and Microsoft Power BI to allow users to connect to cloud services. This approach will allow users to get the benefits of real-time update of the data coming from Cloud systems and avoid costs of implementing local server for databases. These data and analytics are then represented to decision makers in terms of reports and graphical representation that is known now as Dashboards (Scholtz et al., 2018; Pinheiro, 2014; Chaudhuri et al., 2011).

Data Marts (DM) are usually associated with Data Warehouses and are sometimes considered the access layer of the DW environment as it is used to provide data to the users (Bentley, 2017). Additionally, they are used as a basis for BI reporting (Dedić, 2017). Data Marts, as opposed to Data Warehouses, focus on a subset of the data in the DW (Teixeira et al., 2018). One strategy for Data Mart development is to create the DW and then develop Data Marts from the data in the DW (Inmon, 2005). In this approach, a DW may contain separate Data Marts which are used to make data queries and analytical processes from the DW more efficient (Scholtz et al., 2018). An alternative approach proposes developing Data Marts first and then developing the DW from the Data Marts (Kimball & Ross, 2013). Data Marts may also be developed independently and a Data Mart may function as a smaller DW created to deal with a specific aspect of the organisation's data needs (Teixeira et al., 2018). Some organisations may find that independent Data Marts are a cheaper and simpler solution as the data mart covers a single subject area, thus, they take less time to build and require limited memory compared to Data Warehouses (Bentley, 2017). Data Marts are often built and controlled by a single department within the organisation while Data Warehouses typically handle enterprise-wide data (Bentley, 2017).

2.7 Business Intelligence in Higher Education

This section describes Business Intelligence implementation in the context of HEI based on a literature review and shows its similarities with traditional Business Intelligence implementation.

2.7.1 Business Intelligence Architecture in Higher Education

Zulkefli et al. (2015) suggested that HEIs are required to consider components of their BI systems in order to achieve their strategic vision and mission. These components are shown in Figure 2.7. BI systems can support HEIs in achieving their strategic goals and institutional mission/vision by measuring and reporting on factors such as performance against KPIs.

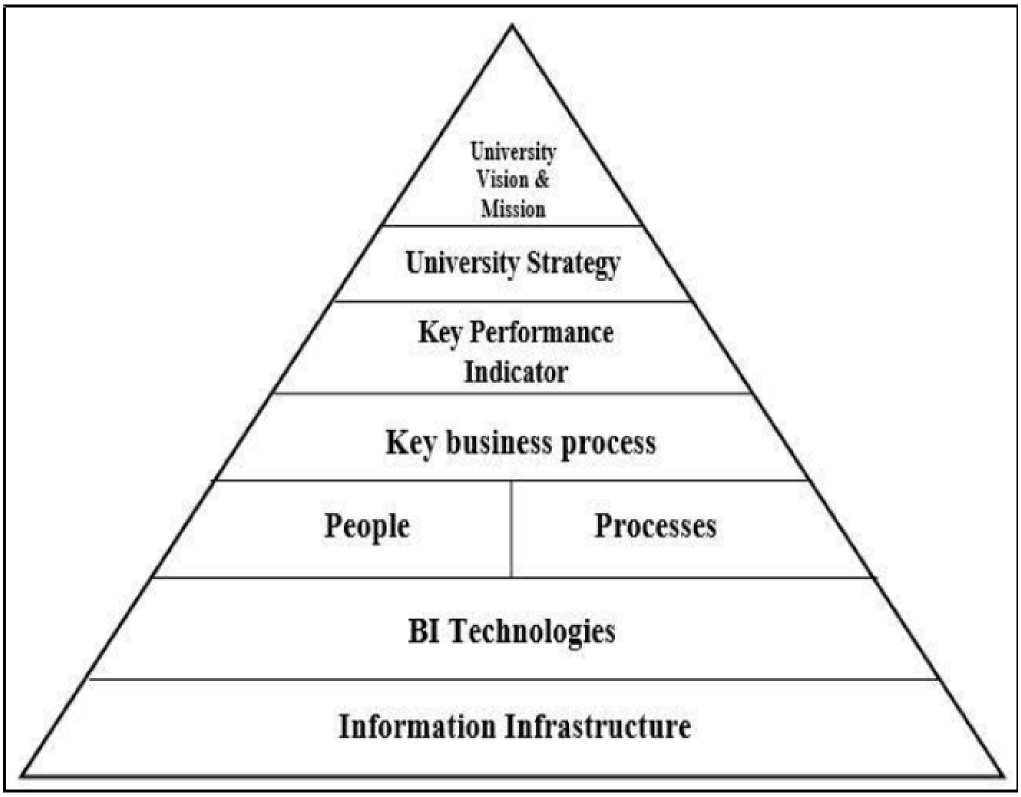


Figure 2.7: Business Intelligence Framework in HEIs (Zulkefli et al., 2015)

Bentley (2017) suggests that successful implementation of a BI system needs senior management commitment, a business need for BI implementation, and appropriate quality of available data. A study by Persson (2017) also suggested that Business Intelligence systems in HEI share a number of characteristics as shown in Figure 2.8. As compared to Figure 2.7, it can be seen that one of the main items that is shared between the Business Intelligence framework and key components addressed in Figure 2.8 is 'Strategic Alignment'. The HEI Quality Assurance systems share the same characteristic of focusing on strategic orientation as discussed in Section 2.3.6 which emphasised the importance of 'Strategic Alignment' factor. The human aspect, referred to as 'People' in Figure 2.7, is also considered one of the key components of successful Business Intelligence system.

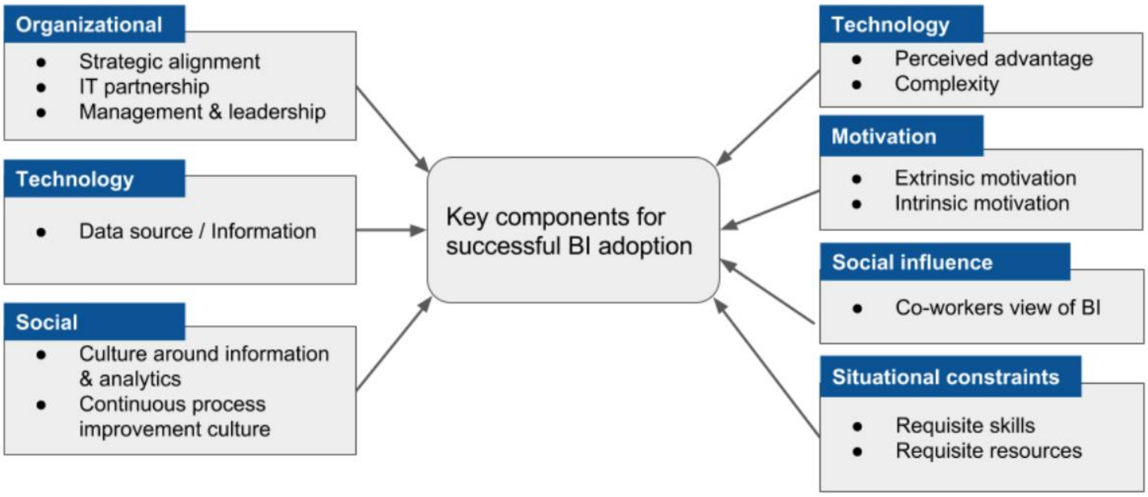


Figure 2.8: Key Components for Business Intelligence successful implementation (Persson & Sjoo, 2017)

Figure 2.9 depicts a Business Intelligence architecture in HE (Guitart & Conesa, 2016). The architecture shown in Figure 2.9 is very similar to the traditional 3-layers BI architecture as it includes data sources, ETL and a presentation layer (dashboards in this case). Compared to this more traditional approach, the newer SoBI architecture suggested by Somya et al. (2018), which has also been applied to HEI, reduces the resources required for ETL although there is still a significant technical implementation challenge. As HEIs differ in size and capabilities, different organisations will have different implementation requirements.

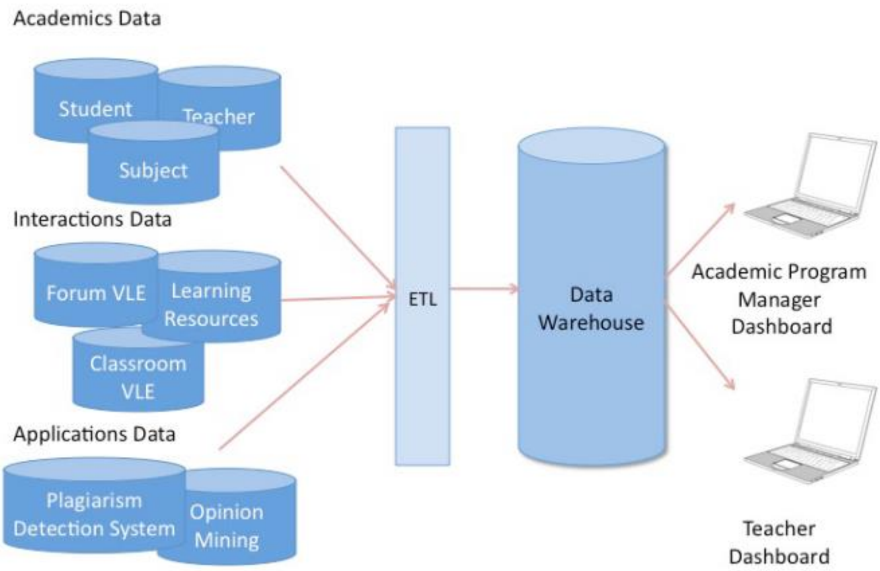


Figure 2.9: Business Intelligence Architecture in Higher Education (Guitart & Conesa, 2016)

2.7.2 Business Intelligence Applications in Higher Education

Business Intelligence (BI) is used in almost all industries (Ranjan, 2009; Chen, 2012b) including telecommunications, healthcare providers, and the banking sector (Chen, 2012b). In the HE context, Business Intelligence plays an important role in supporting decision making especially in areas concerned with teaching performance and financial aspects (Dyk, 2008; Scholtz et al., 2018; Pinheiro, 2014). Sinaga (2017) discussed the development of a Data Warehouse to support university accreditation.

As there are many pressures on HEI management in terms of accountability and the large amount of data that HEI handles, BI can assist with monitoring financial and operational performance and identifying areas that need management attention (Chen, 2012b). Business Intelligence applications identified for HEIs include Student Relationship Management (SRM), adopting OLAP techniques for obtaining information about student achievements and conducting descriptive analysis (Chen, 2012b), and supporting decision making (Persson & Sjoo, 2017). Scholtz et al. (2018) proposed a Business Intelligence framework for sustainability information management in HE and suggested that dashboards can assist management in determining whether strategic goals have been achieved. Schultheis (2016) suggests that adopting Business Intelligence in the context of HE can have a positive effect on strategic decision making. Lapura et al. (2018) discussed the development of a university financial Data Warehouse and visualisation tool. The UK Higher Education Statistics Agency (HESA) introduced in 2017 a business intelligence service for UK Higher Education Institutions, which is called '*Heidi Plus Service'*. Heidi Plus allows HEIs in the UK to view live data for benchmarking and monitoring purposes through visualised dashboards (Burke et al., 2018; Higher Education Statistics Agency (HESA), 2017).

Scholtz et al. (2018) found that one of the limitations of many Business Intelligence solutions for HEIs is that the systems deal mainly with historical data, therefore, the system does not support forecasting nor predictive capabilities but requires the user to make them based on the results given by the system. Forecasting and predicting capabilities means that these dashboards provide analytical data. However, this does not provide any interpretation about what the level of performance means. In response to this finding, Scholtz et al. (2018) suggested that there is a need for a BI tool that provides current and accurate strategic sustainability information to decision makers in HEIs. Scholtz et al. (2018) identified through a literature review the main requirements of such a tool as follows:

- Performance dashboards: which provide visualised information using dynamic and interactive dashboards
- OLAP: information should be aggregated into the highest level according to its associated KPIs, but should also support drill down for further analysis

- Filtering: at different levels of the HEI
- Forecasting: which allows decision maker the capability of forecasting for predictive modelling
- Reporting: to support sharing of information

2.7.3 Sentiment Analysis for Quality Monitoring

Liu (2012, p.1) has defined Sentiment Analysis (SA) as '*the field of study that analyses people's opinions, sentiments, evaluations, attitudes, and emotions from written language*'. SA analyses text-based data coming from the internet to discover differentiated feedback using various methodologies (Saura & Bennett, 2019). Additionally, Tarmazdi et al. (2015, p.166) provided a definition of sentiment analysis as the field of study that '*analyses people's opinions, sentiments, evaluations, attitudes and emotions in written text using natural language processing (NLP) and text analysis*'. Therefore, as Social Media data encompasses public opinions that are written in sentences and words, Sentiment Analysis may be useful for the purpose of analysing data on Social Media (Zhang & Vos, 2014; Qiu et al., 2015; Maryska & Doucek, 2017).

The main aim of SA is to obtain comprehensive and accurate information at an early stage before the information spreads in Social Media (Zhang & Vos, 2014). Zhang and Vos (2014) describe two possible approaches for monitoring conversations to be prepared to respond earlier. The first approach is through identifying themes and how they are discussed in Social Media. The second approach is through focusing on expressed sentiments (i.e., positive and negative phrases that represents satisfaction and dissatisfaction toward quality of service). In the context of HE, sentiment analysis can be used for the purpose of aggregating public opinions on Social Media in order to monitor the quality of service provided by the HEI (Qiu et al., 2015).

2.8 Design Considerations for Business Intelligence Applications

This section discusses some issues that should be taken into consideration by organisations when developing Business Intelligence systems.

1. <u>*Managerial Issues*</u>

   Persson (2017) suggests that successful Business Intelligence implementation requires management commitment, deploying a culture that utilises information and analytics, and making the required resources available. Tutunea and Rus (2012) suggested that when adopting Business Intelligence solutions, the organisation should consider the benefits provided in decision making support in relation to factors such as: the quality of business information provided, the availability of powerful tools for data analysis and visualisation, lower cost of decision making, web-based accessibility, and increased efficiency and effectiveness of decisions.

As discussed in Section 2.10, there are several approaches and architectures for Business Intelligence. As large organisations have different capabilities compared to SMEs, different applications could be used according to the organisation's needs. Additionally, user acceptance of the Business Intelligence system that will be introduced to the organisation is an important success factor for Business Intelligence systems (Chen, 2012b; Bentley, 2017)

2. *Social Media*

   Social Media is increasingly important as a source of data for HEIs as it provides feedback on the quality of services provided (Qiu et al., 2016, 2015). There are challenges in working with Social Media data in Business Intelligence (Hajli & Laroche, 2019). Hajli and Laroche (2019) suggests that there is a need to explore how data coming from Social Media can be utilised to capture consumer thoughts and insights from Social Media platforms. This thesis recognises the importance of addressing the Social Media aspect.

3. *Data Volumes Challenge*

   The increasing volumes of data generated from traditional sources and through Social Media has implications for Business Intelligence. There is a desire to architect low-cost data platforms that will be able to handle this increased amount of data. This is sometimes known as the Big Data challenge (Chaudhuri et al., 2011; Laudon & Laudon, 2018).

4. *Quality of Data*

   Quality of data is one of the key concerns of Business Intelligence systems implementation since, as discussed in Section 2.10, BI systems receive data from different data sources such as Social Media, databases, and cloud services. The quality of the source data will affect the reliability of the information produced to support decision making. Therefore, a quality audit of the data that feeds the Business Intelligence system is essential to ensure the quality of the analysis based on the data.

2.9 Data Visualisation and Communication

This section discusses dashboards and communications in BI systems. It focuses on how data should be represented in BI applications in the context of HE as well as on the characteristics of data that will be visualised in the BI systems. It also discusses the importance of data communication and the role of dashboards in supporting decision making.

Monitoring performance through the use of BI capabilities and dashboards is seen as an important application for BI in HEI (Wyne, 2015; Zulkefli et al., 2015; Muntean et al., 2010; Pinheiro, 2014). BI dashboards are seen as an effective tool for visualising data and communicating HE related real-time performance information to assist decision making (Muntean et al., 2010; Scholtz et al., 2018; Denwattana & Saengsai, 2016).

2.9.1 Data Visualisation in Higher Education

Data visualisation describes the process of presenting data to decision makers (Few, 2013; Denwattana & Saengsai, 2016; Williamson, 2018). Noonpakdee et al. (2018) considers visualisation to be an important part of Business Intelligence which supports the presentation of data after processing and analysis. Dashboards are seen as a crucial tool for communicating information clearly at a glance.

In a Higher Education context, several studies have discussed the importance and the role of data visualisation in decision making and monitoring managerial and academic performance of the HEI such as Dyk (2008), Chen (2012b), Qiu et al. (2015), Denwattana and Saengsai (2016), Qiu et al. (2016), Li et al. (2017), and Scholtz et al. (2018). Denwattana and Saengsai (2016) suggested that dashboards can assist decision making in HEIs by monitoring performance activities related to the achievement of the institutional mission. Scholtz et al. (2018) discussed the development of dashboards to assist in taking sustainable strategic decisions for HEIs.

Muntean et al. (2010) discussed the importance of having dashboards for use in monitoring performance for HEIs. They suggested that HEIs need accurate and timely information about their marketplace to:

- Make more informed decisions in the short-term
- Plan for the long-term
- Provide educational opportunities that are relevant for students
- Meet reporting requirements
- Attract and retain students

2.9.2 Dashboard Definitions and Design Characteristics

Scholtz et al. (2018, p.273) identified three main guidelines to be followed while designing dashboards;

- ‘*interaction, media, visualization and feedback;*
- *Aesthetics; and*
- *Information detail, relevance and purpose’.*

Scholtz et al. (2018) also suggested that dashboards should deliver the message to the decision maker through visual cues that requires minimal efforts for interpretation. Few (2004, p.3) has defined dashboards as a *'visual display of the most important information needed to achieve one or more objectives; consolidated and arranged on a single screen so the information can be monitored at a glance'*. Few (2004) suggested that the characteristics of dashboards include:

- Providing all critical information needed at a glance
- The information displayed contains high-level summaries
- Using display mechanisms that states their message clearly without taking much space, i.e., in a single screen
- Tailoring information specifically to the requirements of the user

Sakys and Butleris (2011, p.130) defined dashboards as '*an interactive user interface designed to deliver user-specific information relating to the health of the business'*. They suggested that dashboards could use several types of visual presentations such as scorecards or pivot-like tables to display KPIs, graphs, charts, maps, dials, gauges, stoplights, and many other analytical visualisations.

Muntean et al. (2010) outlined Eckerson's definition of performance dashboards as a '*multilayer application built on a business intelligence and data integration infrastructure that enables organisations to measure, monitor, and manage business performance more effectively'*. This definition is slightly different to the definitions provided by Few (2004) and Sakys and Butleris (2011) in terms of stressing the effectiveness of the measuring and monitoring role. Muntean et al. (2010) identified the main characteristics of dashboards as follows:

- Dashboards use visual components like chart, gauges, maps, and stoplights
- Dashboards gather data from variety of sources
- Dashboards enable drill-down or drill-through to underlying data sources
- Dashboards present dynamic, single view of the business with timely data refreshes
- To be effective, dashboard needs to present more than pure financial data
- Dashboards present KPIs in concise and intuitive format
- Dashboards support the monitoring of several hierarchical levels in the organisation

Muntean (2010) also suggested that Dashboards are not always portal based. Therefore, a dashboard may be presented independently rather than as a portal of the organisation's ERP system. For example, SSBI tools allow the use of dashboards even if the organisation does not have a reporting system that is part of the BI system.

Comparing these lists of the dashboard characteristics, it can be concluded that dashboards need to be relevant and as informative as possible while displaying the minimum required information. There are many forms of visualisation components that can be used for visualisation purposes and different information requirements can be met through different visualisations of data.

The most important feature that all dashboards share is the provision to provide the user with a quick overview of the current situation of the monitored area (Few, 2013; Presthus & Bergum, 2015). In addition, dashboards also present data from several sources and allow drill-down and drill-through to applicable data. The next sections describe the visualisations and annotations and drilldowns in the dashboards.

2.9.2.1 Visualisations and Annotations

The main characteristic of dashboards is that they visualise the KPIs through the use of simple graphics such as gauges, charts, and tables (Few, 2004). Visualisations are important part of the BI system as they present the data after being analysed (Noonpakdee et al., 2018). The visualisations alone may be difficult to understand for some users. Therefore, annotations are used with the visualisations in order to help users in understanding the visual graphic (Elias, 2014). Figure 2.10 shows screenshot obtained from a visual on Microsoft Power BI showing an annotation. Information shown in the annotation box can be customised according to the user needs to present additional information such as whether the level of performance is satisfactory.

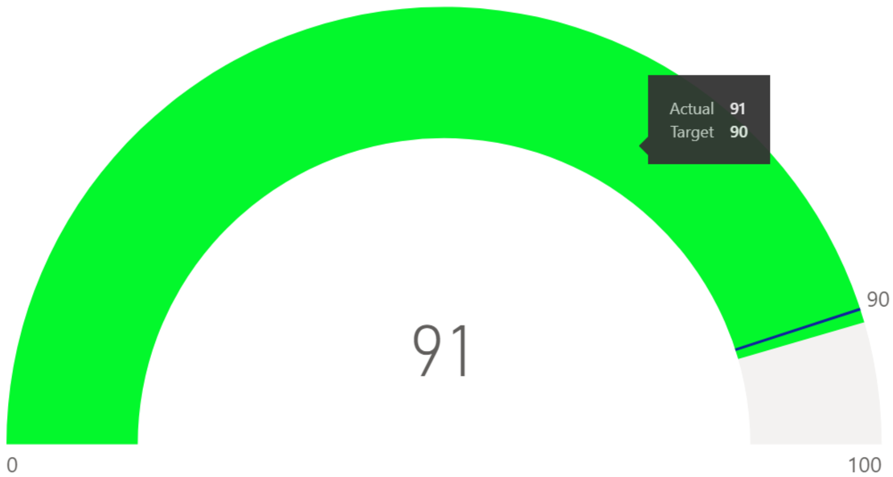


Figure 2.10: Annotation Example - Microsoft Power BI

2.9.2.2 Filters and Drilldowns

BI systems allow users to present data in an abstract form in the dashboards. Decision makers might need to get access to data on several levels below in order to identify the root of the risks. Therefore, BI systems offer the ability to drill-down data and apply filters in order to allow users to inspect the details of specific problem or events (Williamson, 2018). Filtering allows the user to zoom the data and select the desired information to focus on (Presthus & Bergum, 2015).

In the context of monitoring HE quality, Top Management may desire to drill down specific measurements such as 'Retention Rate'. As the user drills down, they will be able to view 'Retention Rate' for each College/ Department/ Programme. Upon applying filters, information presented in the dashboard will be changed to reflect the filter criteria.

2.9.3 Business Intelligence Dashboard Definition for Quality Assurance

As Business Intelligence dashboards provide an interactive interface to deliver information related to the performance of business activities (Sakys & Butleris, 2011; Few, 2004). QA addresses the preventive strategy followed by the HEI for the purpose of complying with particular quality standards through the implementation of specific steps including audits, issuing reports and other methods (Al-Shafei et al., 2015). Therefore, BI dashboards for monitoring quality in HE are defined in this thesis as *'an interactive interface that visualises the most important metrics to monitor quality assurance key performance indicators to assist decision makers in tracing the institution's performance and to determine their compliance with quality assurance standards'*.

2.9.4 Dashboards Applications in HEI

This section discusses examples of dashboard applications in the context of HEI for the purpose of outlining the level of detail provided by dashboards to decision makers. HEIs may use BI dashboards for monitoring performance (Scholtz et al., 2018; Williamson, 2018; Denwattana & Saengsai, 2016). In the UK, the HEIDI Plus service allows UK HEIs to gain institutional and sector insights in the form of BI dashboards (Jisc, 2021). BI dashboards may be used for purposes such as predicting student performance in Massive Open Online Courses (MOOC) (Hughes & Dobbins, 2015), monitoring the achievement of Malcolm Baldrige Quality Management System compliance (Abell, 2013), monitoring students satisfaction, teaching excellence and financial management (Stocker, 2012). Haupt et al. (2015) suggested that BI dashboards may be used in HEIs for managing sustainability in HEIs. Sluijter and Otten (2017) suggested that BI dashboards might be utilised by students to allow them to monitor their own KPIs after setting them, such as monitoring compliance with Personal Development Plan (PDP).

At Staffordshire University, all staff members have access to dashboard which provides 'live data' about several metrics related to the university's KPIs. Among these metrics, the decision maker can access performance measures, student demographics and several performance measurements needed for supporting decision making (Staffordshire University, 2020). Pennsylvania's State University provided BI dashboard based on Tableau (an SSBI tool) that shows demographics related to diversity, equity and inclusion (Pennsylvania's State University, 2021).

2.9.5 Dashboard Applications in KSA

In this section, dashboards applications in KSA are presented to show that there has been an increasing use of dashboards for visualising information to the public within the last few years. Several government agencies started to visualise information to the public through dashboards within the last 5 – 6 years. Government agencies and the private sector in the KSA are increasingly using dashboards as the government has tended to use them particularly during the Covid-19 pandemic to disseminate public information.

Dashboards have been found in several sectors in the KSA. The Unified National Platform (UNP) provided Performance Dashboard shows several metrics related to services provided by Saudi Arabian Ministries and government agencies (Saudi National Portal for Government Services - GOV.SA, 2021). Figure 2.11 illustrates the high-level dashboard of the UNP.

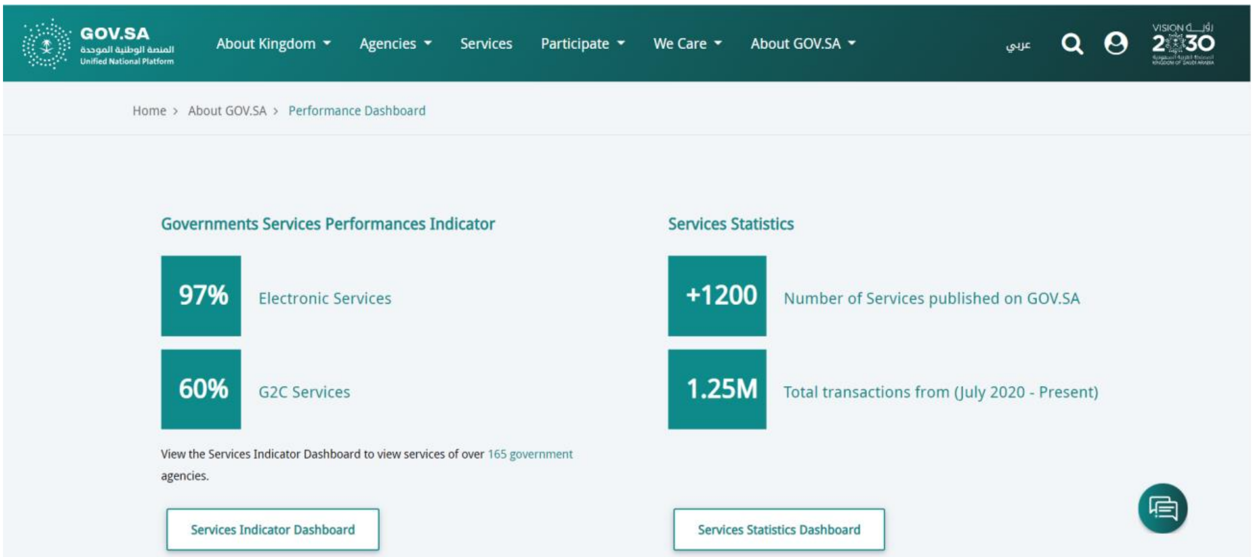


Figure 2.11: Unified National Platform Dashboard (Saudi National Portal for Government Services - GOV.SA, 2021)

As seen in Figure 2.12, the published dashboard shows the electronic transformation of services and the percentage of electronic services in comparison to traditional manual services provided. The user can drill down by selecting a specific government agency to obtain the metrics related to this specific agency.

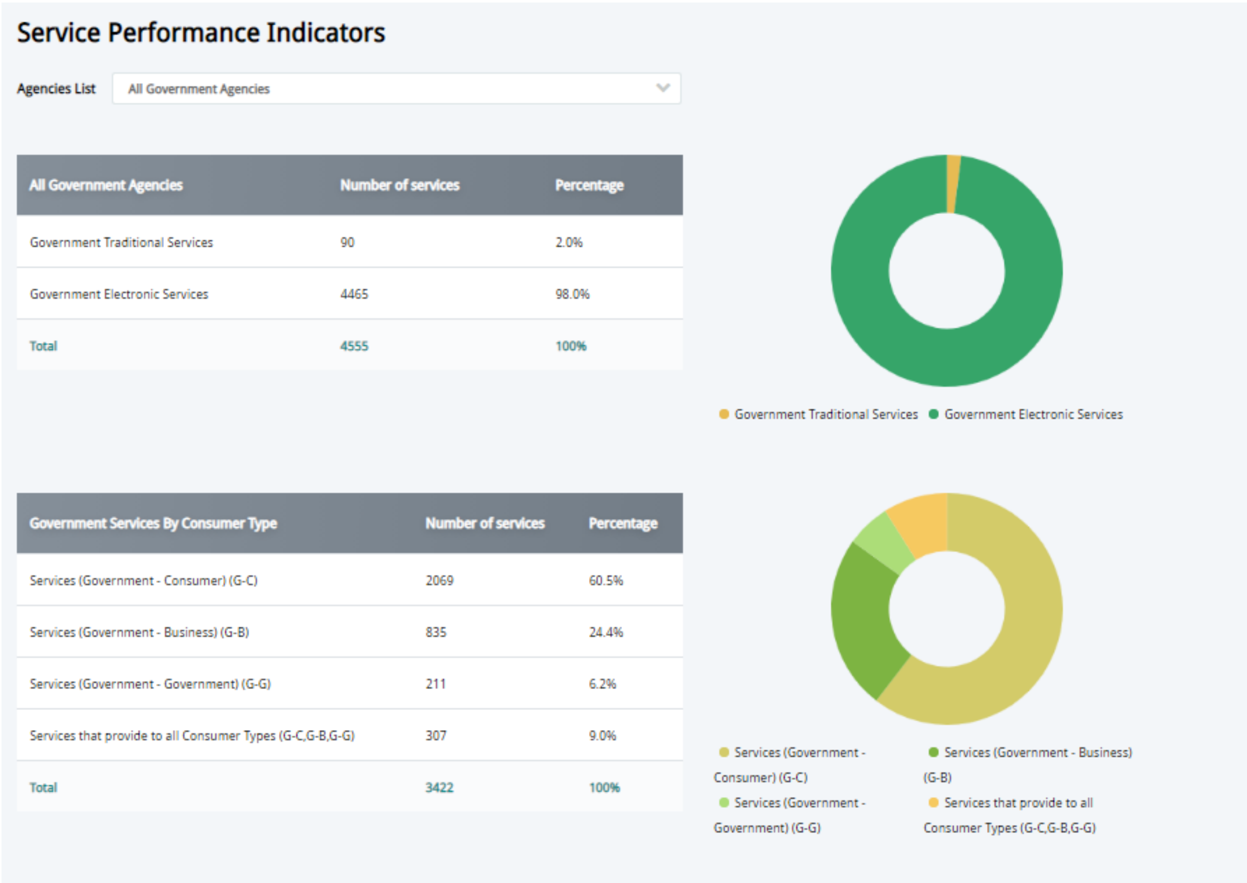


Figure 2.12: UNP Service Performance Indicators (Saudi National Portal for Government Services - GOV.SA, 2021)

During the COVID-19 pandemic in late 2019, the Ministry of Health in the KSA developed the COVID-19 dashboard, which shows the spread of new COVID-19 cases in the KSA according to the regions where the new cases were diagnosed (Saudi Arabian Ministry of Health, 2020a, 2020b). The dashboard has been further developed to show the number of Polymerase Chain Reaction (PCR) tests conducted daily, critical cases, and total number of COVID-19 vaccine shots given to residents as shown in Figure 2.13.

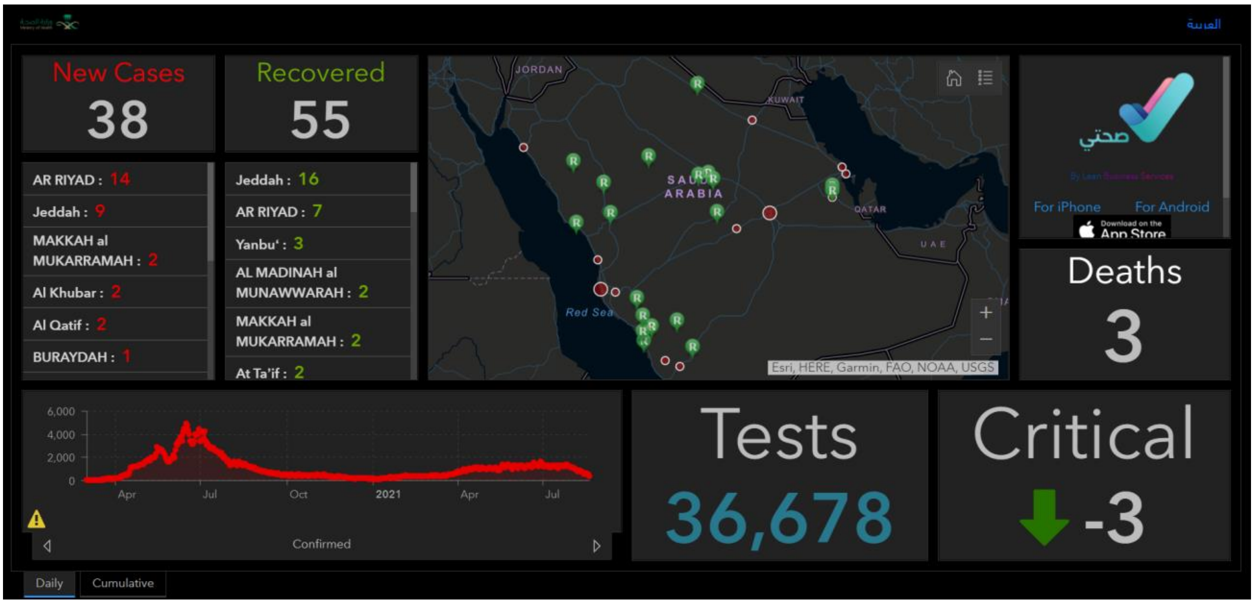


Figure 2.13: COVID-19 Dashboard in KSA (Saudi Arabian Ministry of Health, 2020a)

The Saudi Centre for Disease Prevention and Control (CDC) offered an interactive dashboard that shows the total confirmed cases around the world as illustrated in Figure 2.14. The dashboard allows users to access live data of new confirmed cases as well as recovery percentages and total death cases.

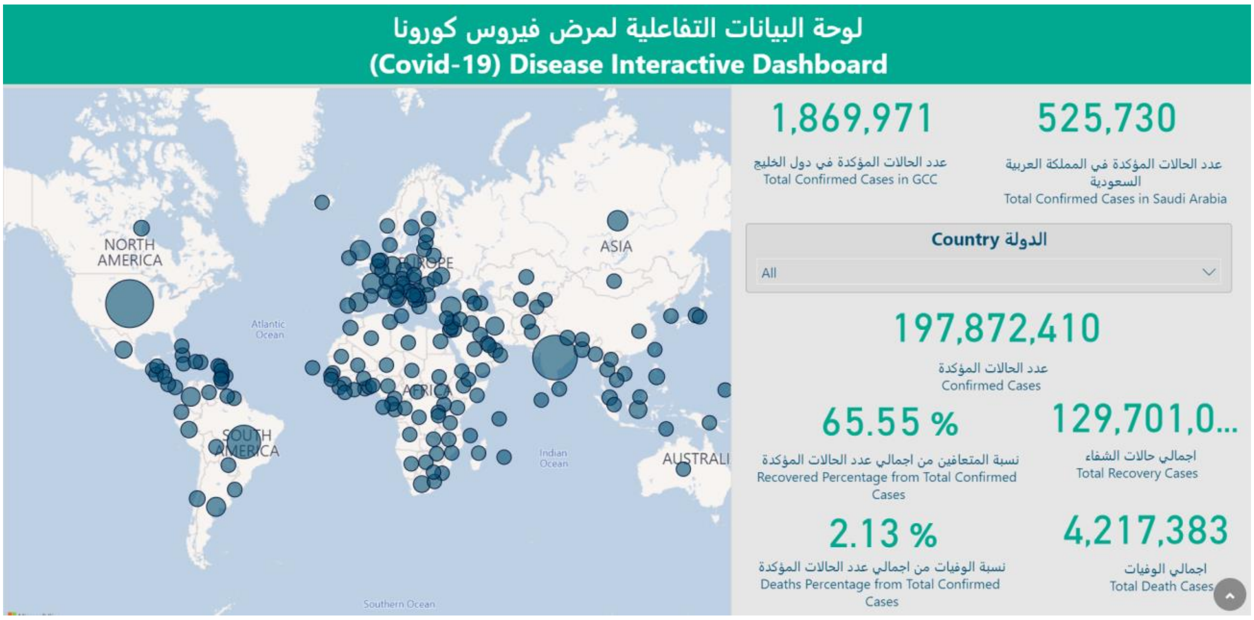


Figure 2.14: Saudi CDC Dashboard (Saudi Center for Disease Prevention and Control, 2021)

2.10 Business Intelligence Architectures in Higher Education

Based on the discussion in Section 2.6 and Section 2.7, Business Intelligence systems may have different implementation requirements based on the capabilities, finances, and resources which the organisation intends to develop. Business Intelligence systems fall under three main architectures; Data Warehouse based Business Intelligence Architecture, Service Oriented Business Intelligence Architecture, and Self-Service Business Intelligence Architecture. This section outlines these architectures based on the literature review in Sections 2.6 and 2.7 to incorporate the authors' perception of the architectures for Data Warehouses by modifying Chaudhuri et al. (2011) as illustrated in Figure 2.15. These ideas have been further developed by the author to include Service oriented Business Intelligence (SoBI) architecture as shown in Figure 2.16 and Self-Service Business Intelligence (SSBI) architecture illustrated in Figure 2.17. Figure 2.18 shows a composite diagram of DW based BI architecture, SoBI architecture, and SSBI architecture to illustrate the three different alternatives for implementing BI system in HE.

2.10.1 Data Warehouse-Based Business Intelligence Architecture

The traditional Data Warehouse based Business Intelligence architecture has three main layers: data source layer; data movement, storage, and processing layer; and data visualisation and reporting layer as shown in Figure 2.15. The data source layer includes all the data sources used by the system. The Extract, Transform, Load (ETL) layer handles the extraction of data from the data sources, cleansing and loading this data, usually into a staging area and then loading the data into the Data Warehouse. In the presentation layer, data is presented to the decision maker using a range of formats to support data understanding and decision making.

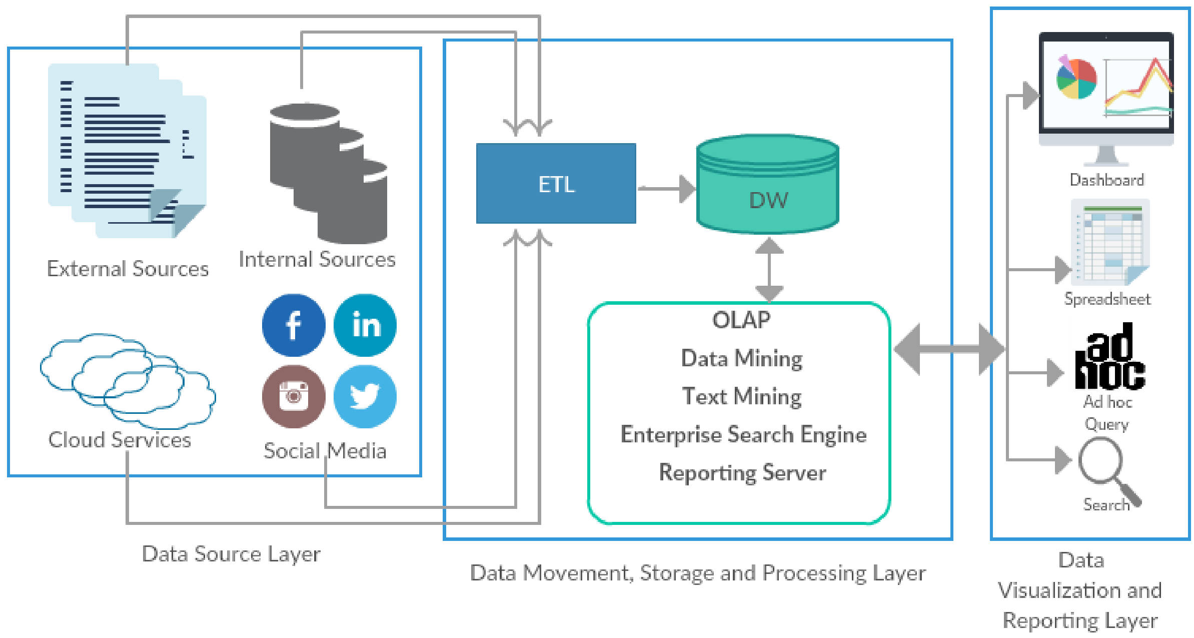


Figure 2.15: Data Warehouse based Business Intelligence Architecture (Based on Chaudhuri et al., 2011)

2.10.2 Service Oriented Business Intelligence

In a recent study, Somya et al. (2018) suggested that the ETL process can be handled differently by using Service Oriented Business Intelligence (SoBI). Figure 2.16 describes the process of SoBI through Web Service. Web Services may be used to retrieve data directly from data sources and process them in Extensible Markup Language (XML) format. Data is then processed using the dashboard application that will store them in the DW. The dashboard application stores data into the DW in order to allow further processing of the data to transform it into appropriate information for marketing analysis using data mining techniques. The Web Service approach will allow the retrieval of the latest data from the data sources directly instead of using traditional ETL processes. This process may provide an easier and faster manner of data processing in comparison to traditional Business Intelligence infrastructure in circumstances where organisation cannot afford the costs and expertise associated with the development of DW or ETL process (Somya et al., 2018). Web Services can be used to bridge the information from different sources and overcome the difference between technologies used in data sources (e.g., some data sources may use Oracle databases while other may use MySQL). Web Services provide the ability to deal with the challenge of different data sources as it uses Extensible Markup Language (XML) to encode the data.

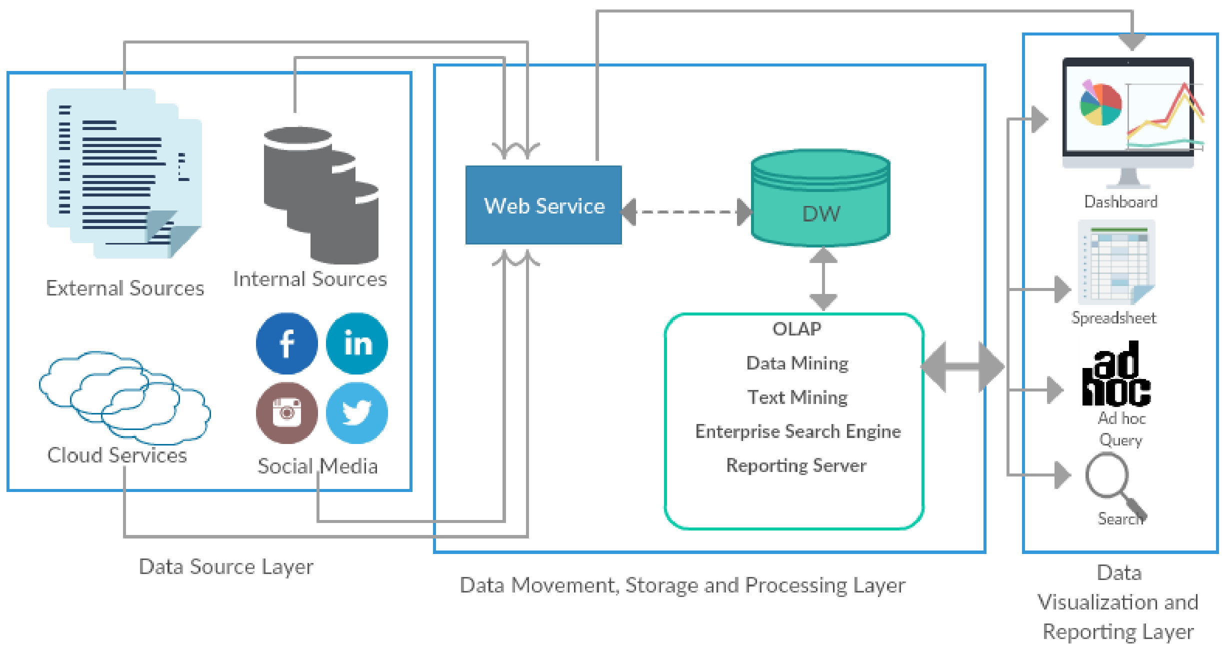


Figure 2.16: Service Oriented Business Intelligence (SoBI) Architecture

2.10.3 Self-Service Business Intelligence

According to Bentley (2017), Embedded Analytics is designed to make data analytics and Business Intelligence more accessible for all kinds of users. It allows more real-time autonomy and self-service of data visualisation and customisation. Some authors consider this approach of allowing business users to access corporate information without the involvement of IT team as Self-Service Business Intelligence (SSBI) (Prem & Shimla, 2015).

There are many tools that Small and Medium-sized Enterprises (SMEs) may use in order to get the benefits of data analytics without building complex Business Intelligence structures or building DW (Paulussen, 2019; Van Damme, 2002; Maryska & Doucek, 2017). Among these tools, Tableau, Microsoft PowerBI, QlikView, and Brist (Paulussen, 2019) are available from specialised vendors. This approach involves gathering data from data sources and inserting them directly into the tool, which enables the user to clean the data and process the data to prepare it for visualisation and reporting. The tools allow the user to further process data or visualise it through Business Intelligence Dashboards as well as producing reports (Tutunea & Rus, 2012; Bentley, 2017; Paulussen, 2019). This approach is presented in Figure 2.17, which identifies the ways in which an organisation can benefit from commercial tools for data analytics. Large firms may choose to adopt conventional BI as seen in Figure 2.15 as they have the financial capabilities for implementation, but SMEs may find that using SSBI approach more affordable for them (Ayoubi & Aljawarneh, 2018; Maryska & Doucek, 2017). Additionally, conventional BI implementation may require high level of knowledge and expertise that may not be available in SMEs (Ayoubi & Aljawarneh, 2018). This is relevant to KSA as private universities and some of the public universities in KSA are considered SMEs. Technologies such as cloud computing and, in particular, Software as a Service (SaaS) provide smaller organisations with access to BI systems without the requirement to own or implement complex infrastructures.

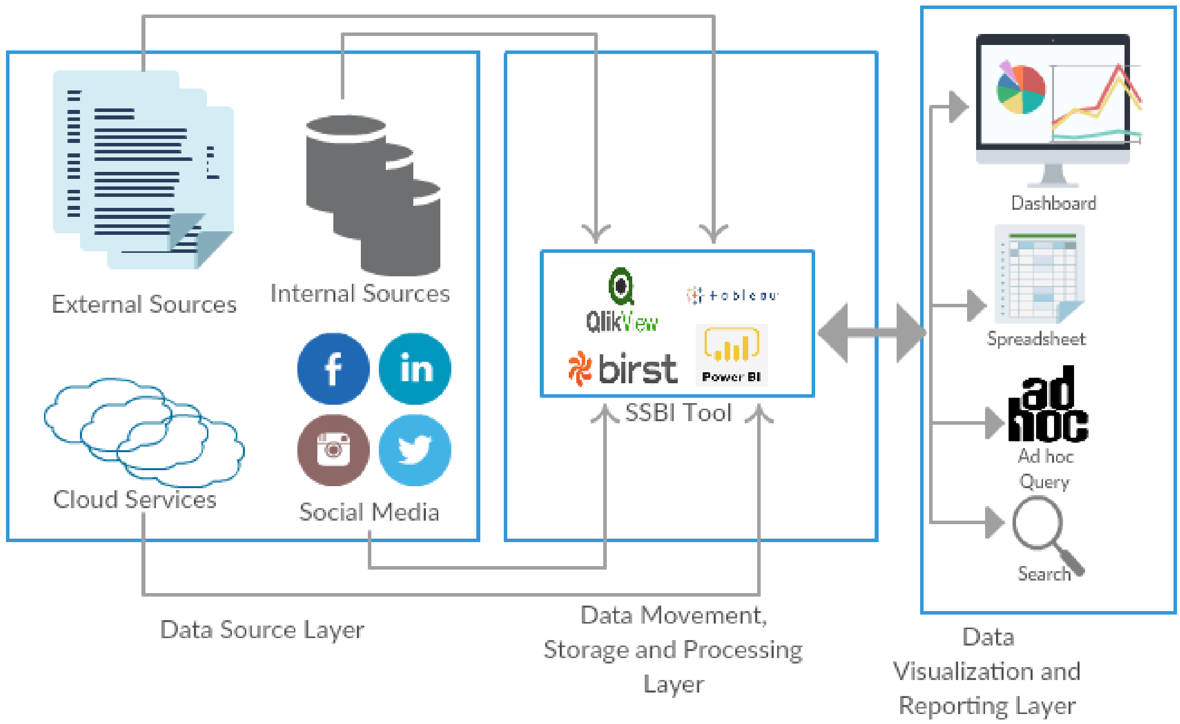


Figure 2.17: Self-Service Business Intelligence (SSBI) Architecture

The discussion shows that there are many possibilities for the implementation of Business Intelligence systems. The needs of each organisation determine the requirements of the Business Intelligence system as well as the capabilities of organisation to implement the system. Thus, organisations that can afford the implementation costs of complex Business Intelligence system may choose to implement a Data Warehouse based approach. Organisations that cannot afford the implementation costs and abilities of DW or cannot handle complex ETL process may benefit from Web Service or Self Service tools to visualise data into the dashboards. Figure 2.18 shows a proposed diagram for Business Intelligence architectures to support this research based on the fact that HEIs in the KSA differ in size and technical capabilities, for example, large public universities have more capabilities and resources comparing to small public/private universities/colleges. As part of the approach developed in this thesis, it is proposed that each organisation should select the BI solution most suited to the organisation's needs and requirements. Figure 2.18. shows the alternative BI solutions.

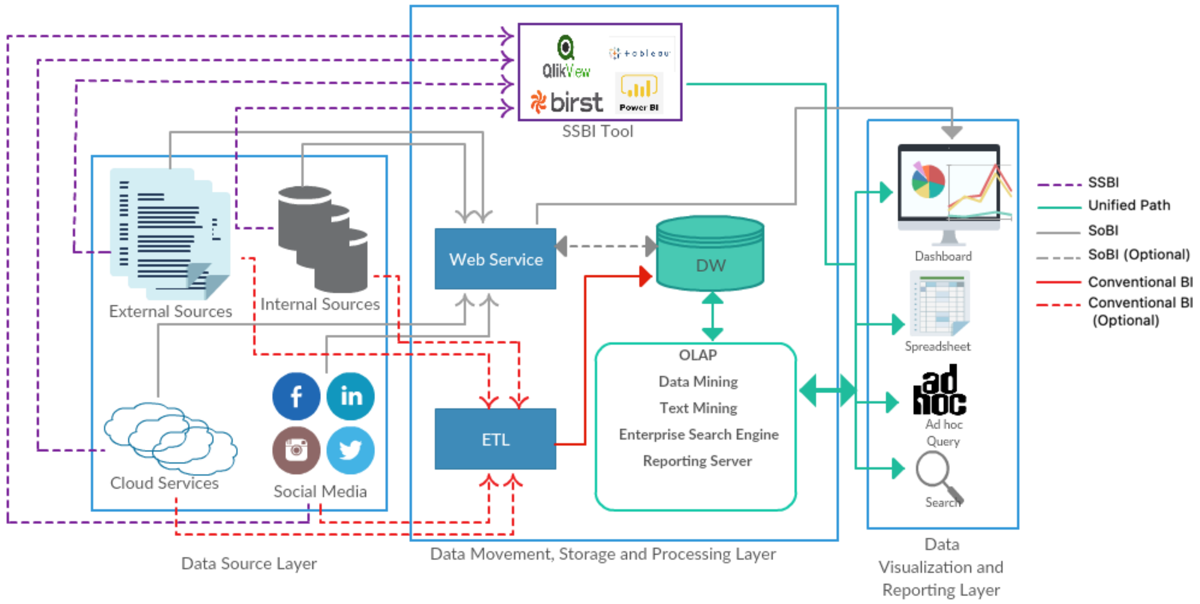


Figure 2.18: Alternative Business Intelligence Architecture

The proposed alternative Business Intelligence architecture presented in Figure 2.18 shows three paths (Grey Path, Red Path, and Purple Path). Grey path shows an implementation that does not require traditional data warehouse, while the red path shows a traditional ETL and Data Warehouse implementation for organisations that can afford the associated costs and for which this approach is appropriate. The purple path shows the Self Service Business Intelligence approach, which is an alternative for SMEs or users who do not have capabilities to afford to implement complex Business Intelligence architectures that include DW. The dashed line in Figure 2.18 indicates an optional route for HEIs to implement BI systems.

2.11 Discussion of the Quality Assurance and Business Intelligence Implementation

The literature review showed a lack of information concerning Business Intelligence implementation in HE in the context of monitoring QA, especially in terms of data visualisation and presentation. There are several challenging issues that can affect the implementation of Business Intelligence tools in HE for monitoring QA activities; these issues are summarised as follows:

- There is a lack of information regarding QA visualisation and presentation of data for monitoring purposes. The literature review showed that some studies discussed BI implementation for monitoring the managerial performance and this can be extended to apply to cover QA. A study in KSA Higher Education indicated that there is a lack of evidence regarding data reporting using Business Intelligence in HEI and suggested that

Business Intelligence should be utilised to support decision makers by providing reports related to students and performance in HEIs.

- The literature tends to focus on the use of Data Warehouses for development of Business Intelligence systems in the context of HEI. There appears to be limited information about, and investigation of, alternative ways of developing BI systems. This is an important issue as organisations differ in size, capabilities, and resources available for implementing Business Intelligence solutions.
- As organisations differ in size and capabilities, the costs and benefits of implementing Business Intelligence solutions using different architectures need to be considered by decision makers to make sure that benefits outweigh the costs of implementation.
- It was concluded from the literature review that the human aspect is considered one of the important key components for the successful implementation of Business Intelligence.
- The literature review of Business Intelligence in HE context indicated that there are several frameworks that can be used for implementing Business Intelligence solutions for monitoring QA performance. These frameworks are discussed in Chapter 3.
- The literature review did not identify any holistic approach regarding the implementation of Business Intelligence tools in the context of HE, especially for monitoring QA performance.

2.12 Conclusion

In this chapter, a critical review of Quality Assurance and Business Intelligence was presented. Quality Assurance standards in the context of KSA have been discussed and the role of ICT in HE has been reviewed. The literature review indicates that Business Intelligence plays an important role in the context of HE in terms of monitoring performance. Different types of Business Intelligence architectures have been discussed and this discussion demonstrated that there are many ways to implement Business Intelligence in organisations of different sizes and capabilities and that a one-size-fits-all approach is not appropriate. Business Intelligence Dashboards have been discussed in the chapter. A definition of BI dashboards for QA monitoring in HE was provided. BI dashboard characteristics and applications in HE has been discussed. In addition, BI dashboards examples in KSA were outlined.

During the period of this research in 2018 the NCAAA developed a new accreditation standard in the Kingdom of Saudi Arabia. The 2018 version merged some of the standards, resulting in a total of 8 standards (NCAAA, 2018) rather than 11 standards as previously (NCAAA, 2009). The 2018 regulations also reduced the number of KPIs used to measure HEI performance from 33 to 23. Some institutions treat the NCAAA KPIs as a minimum requirement and may use additional institution specific KPIs such as King Saud University. These proposed changes in 2018 NCAAA standards and KPIs have been incorporated into the design of the proposed development of a holistic framework and dashboard for QA monitoring in KSA and are discussed further in Chapter 4.

The next chapter documents a literature review and evaluation of existing QA frameworks in Higher Education and includes a Gap Analysis.

Chapter 3 : Review of Current Frameworks for Monitoring Quality Assurance in Higher Education Institutions

3.1 Introduction

This chapter aims to discuss the development process of a framework for monitoring Quality Assurance (QA) in Higher Education Institutions (HEIs) using Business Intelligence (BI) dashboards in the context of the Kingdom of Saudi Arabia (KSA). In Chapter 2, a detailed investigation of QA in HEIs and Business Intelligence was presented. The investigation in Chapter 2 also discussed the specific requirements imposed upon HEIs in KSA by the National Centre for Academic Accreditation and Evaluation (NCAAA). Chapter 2 shows that there are many ways of monitoring QA and why it is essential for an HEI to keep track of its performance, and how dashboards can help in achieving this objective. This chapter explains why none of the existing QA frameworks would meet the requirements of HEIs in the context of KSA and shows that there is a need for a novel holistic framework to support the monitoring of QA performance of HEIs in KSA.

Chapter 3 describes the extensive literature review conducted to examine existing QA frameworks. The literature review identified 52 studies. Among these studies, it was found that only 18 studies discussed frameworks and models for monitoring performance in HE and all these 18 frameworks and models were reviewed. Five frameworks that provided visualised performance outputs were then selected from the 18 frameworks to be analysed using a Gap Analysis technique. A Gap Analysis was conducted, and the conclusions reached from the analysis are discussed in this chapter. The chapter also shows how the results from the Gap Analysis influenced the development of the holistic framework for monitoring the QA performance of HEIs in KSA.

3.2 Review of Existing QA Monitoring Frameworks

For the purpose of identifying current frameworks that have discussed monitoring of QA in HE through the use of BI dashboards, an extensive literature review was conducted in this chapter. This literature review identified 18 frameworks which are outlined in this chapter. The review outlined the elements that have been used in the design of the existing frameworks regarding QA regulations and performance measurement in HEIs, and whether they comply with the NCAAA 2018 standards regarding the 8 QA standards and 23 mandatory KPIs used in the KSA. The intention of the literature review was also to identify frameworks which contained visualised outputs of performance measurements in HE which could be incorporated in a BI dashboard. The purpose of the literature review was to identify whether existing frameworks could be used or modified for the purpose of visualise QA performance in HE.

An extensive review of existing literature was conducted in order to identify current frameworks for monitoring quality in Higher Education. Additionally, indexes of journals were reviewed, and related articles were identified using a snowball approach (Haris et al., 2017).

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 also been used in the search process.

For the purpose of this search process, the following keywords were used to retrieve the results. The first set of keywords were used to search in the context of KSA, and the second set of keywords were used to search worldwide.

1. ((("NCAAA") OR ("accreditation") OR ("national qualifications framework") OR ("NQF")) AND (("higher education") OR ("universities") OR ("higher education institutions")) AND (“saudi arabia”) AND (("quality") OR ("quality assurance") OR ("QA")) AND ((“dashboards”) OR (“business intelligence”)))

2. (("accreditation”) AND (("higher education") OR ("universities") OR ("higher education institutions")) AND (("quality") OR ("quality assurance") OR ("QA")) AND ((“dashboards”) OR (“business intelligence”)))

The first set of results retrieved from the data sources showed that there was limited discussion of the topic in the context of Saudi Arabia. Therefore, the search was expanded to include worldwide results that discussed this topic. The NCAAA, NQF, and accreditation keywords were subsequently removed to provide more results.

3.2.1 Inclusion criteria for selected studies:

The three main categories used during the search process were as follows: (1) Quality monitoring in HEIs, (2) Business Intelligence in HEIs, and (3) Dashboard development in HEIs. The studies should at least meet the following criteria in order to be considered for the analysis, which are outlined as follows:

1. Those studies must present a framework for monitoring QA in the context of Higher Education and represent visualised outputs for decision-makers
2. Studies based on Saudi Arabian HEIs were preferred, but the literature on QA in HEIs in KSA was limited, and for this reason, international studies were also included. This had the advantage of extending the range of concepts and approaches reviewed
3. The study must be a primary research study that represents findings from primary data sources generated by the original authors
4. The study publication date should be from 2007 to make sure that information is current and up to date
5. The study must be written in either Arabic or English language.
6. The study must be retrieved electronically as full text
7. The study must be an academic thesis, peer-reviewed study, or a chapter from a book.

The following exclusion criteria have also been applied to the studies to be excluded from the analysis, which are outlined as follows:

1. The text is not written in English or Arabic language
2. Abstracts and PowerPoint slides
3. Duplicate studies.

3.2.2 Studies Selection

In order to identify whether there are any duplicates in the results retrieved from this search, refworks.proquest.com was used to identify any duplications based on title, author, and/or publication year. Among 52 studies identified through the literature review, only 18 presented frameworks or models for monitoring quality in HEIs or data visualisation of HEI performance. The 18 studies which were identified are outlined in this section as follows:

1. **Total Quality Management (TQM) Framework in Higher Education (Venkatraman, 2007)**

   Venkatraman (2007) introduced a framework for implementing the Total Quality Management (TQM) philosophy in HE. Figure 3.1 illustrates the framework and shows the six main elements considered core quality elements as suggested by the author.

Figure 3.1: TQM Framework in Higher Education (Venkatraman, 2007)

2. The Business Intelligence Framework (Dyk, 2008)

Dyk's (2008) framework shows Business Intelligence architecture in HE. The framework focused on the type of data that can be stored in the Data Marts such as 'Alumni' and 'Student Data Mart', as shown in Figure 3.2. The framework is based on a traditional Business Intelligence architecture which shows data sources and the Extract, Transform, Load (ETL) process as well as the Data Warehouse. The framework focused on the types of outputs that are related to reporting rather than a visual representation of performance.

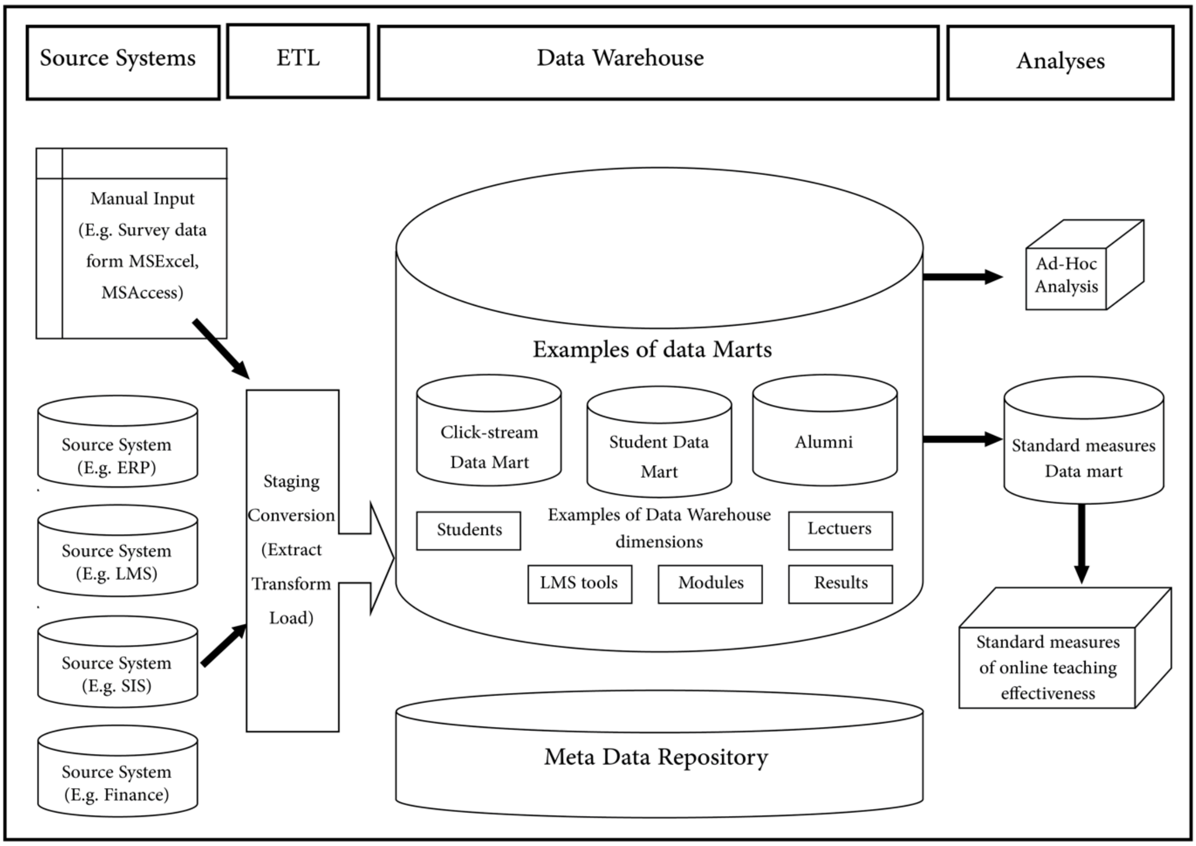


Figure 3.2: The Business Intelligence Framework (Modified by author after Dyk, 2008)

3. A Theoretical Framework for Quality Assurance in Higher Education of Bangladesh (Bhuiyan et al., 2009)

Bhuiyan et al. (2009) introduced a theoretical framework for QA in HEIs in Bangladesh as shown in Figure 3.3. The framework addresses the main factors and sub-factors that contribute to the measurement of service quality in HE.

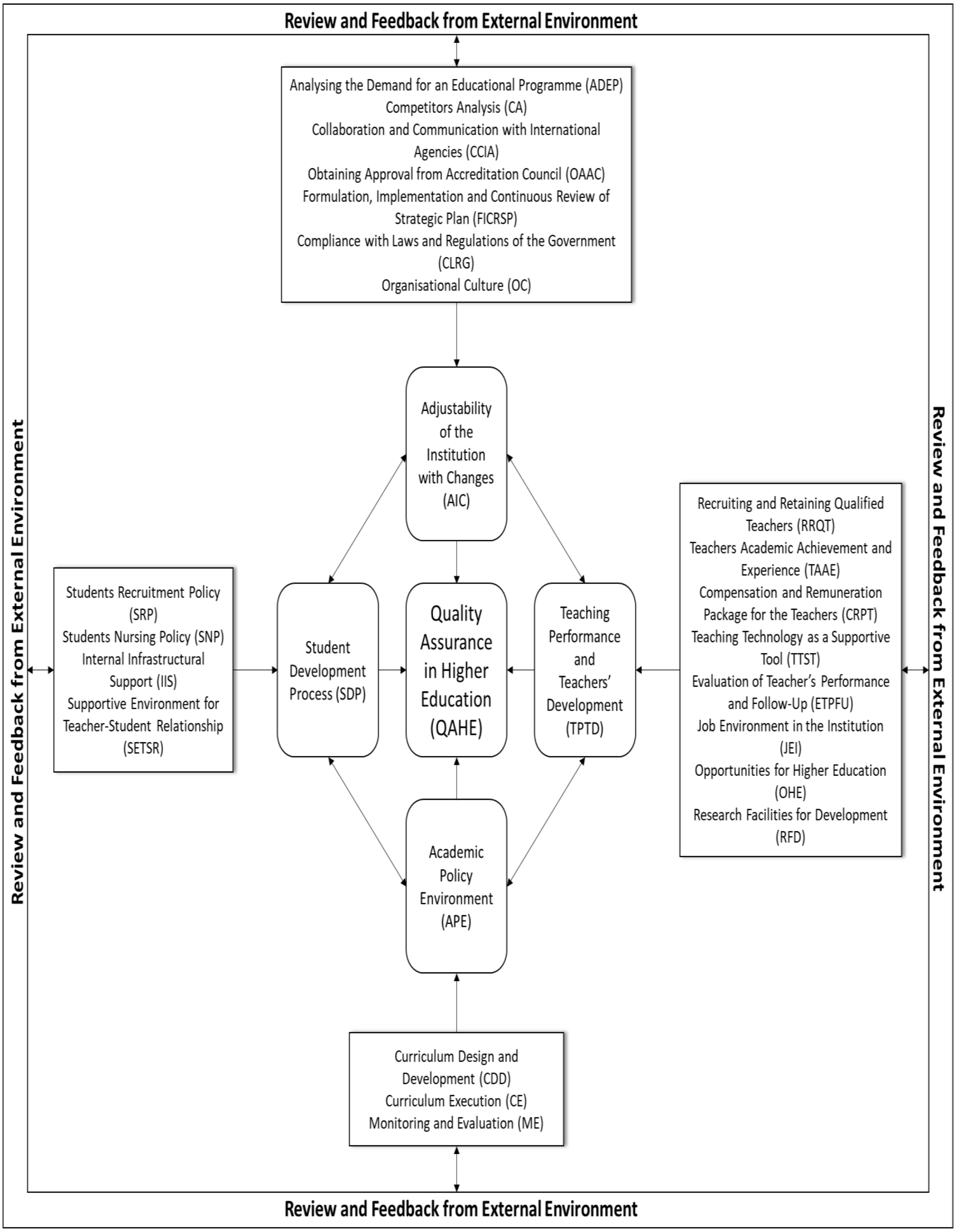


Figure 3.3: A Theoretical Framework for Quality Assurance in Higher Education of Bangladesh (Modified by author after Bhuiyan et al., 2009)

4. An Architectural Framework for a Performance Management System for Universities (Muntean et al., 2010)

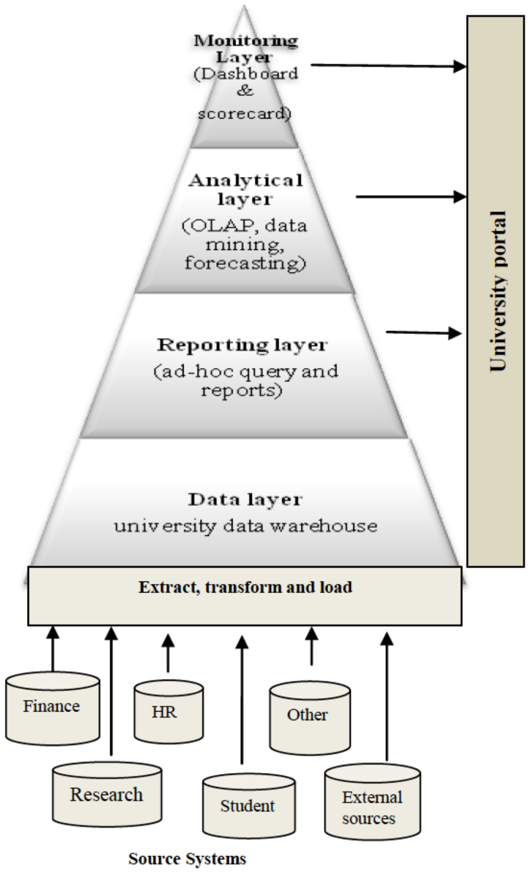


Figure 3.4: An Architectural Framework for a Performance Management System for Universities (Muntean et al., 2010)

Muntean et al. (2010) framework discusses the different layers of Business Intelligence systems in HE as illustrated in Figure 3.4. The bottom layer shows the different data sources from which data is retrieved. Data is then processed through the Extract, Transform, Load (ETL) layer which makes data ready for storage in the university Data Warehouse (DW). The Reporting, Analytical, and Monitoring layers display performance level results through the university's portal. The researchers identified the components of performance management systems as follows:

- Data Warehouse
- Reporting layer
- Analytical layer
- Monitoring layer
- University portal.

5. **Quality Management System in Paediatric Training Programme (Da Dalt et al., 2010)**

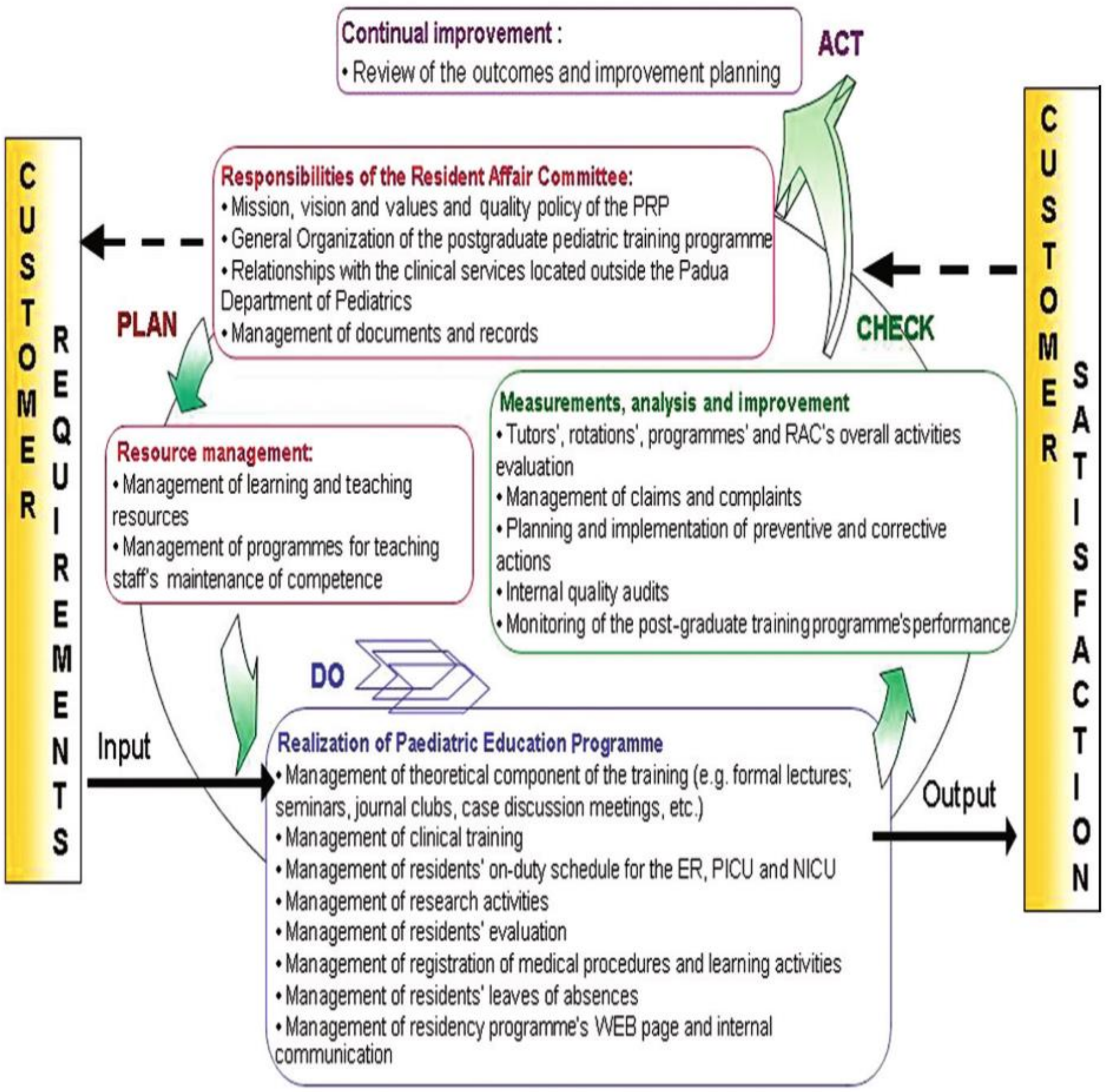


Figure 3.5: Quality Management System in Paediatric Training Programme (Da Dalt et al., 2010)

Da Dalt et al. (2010) framework illustrated in Figure 3.5 addresses the system model (Input-Process-Output) and adopts the Plan-Do-Check-Act (PDCA) cycle of quality management. It suggests that following the PDCA cycle in corporation with the system model can achieve customer satisfaction through addressing customer requirements. It also incorporates the tools that assure quality in HEI to achieve customer satisfaction.

6. Total Quality Management Model for Engineering Education Excellence in India (Burli et al., 2012)

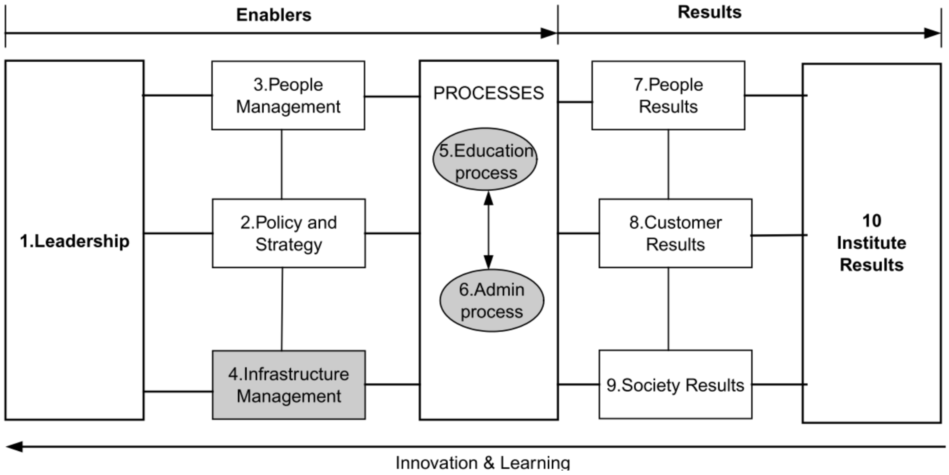


Figure 3.6: TQM Model for Engineering Education Excellence in India (Burli et al., 2012)

Burli et al. (2012) introduced a model that adopts TQM in HE in India. It shows the ten dimensions of TQM that are essential for managing quality in Engineering institutions. This model determines the relationship between TQM dimensions and ISO certificate for Engineering institutions in India. However, it is not considered a theoretical framework as it lacks theoretical underpinning.

7. Conceptual Framework of Measuring Institutional Quality (Ballard, 2013)

The Ballard (2013) framework illustrated in Figure 3.7 addresses the factors that contribute to measuring institutional quality for the purpose of assuring quality based on the Academic Quality Improvement Programme (AQIP). It stresses the importance of Key Performance Indicators (KPIs) in measuring the quality of service provided by the HEI.

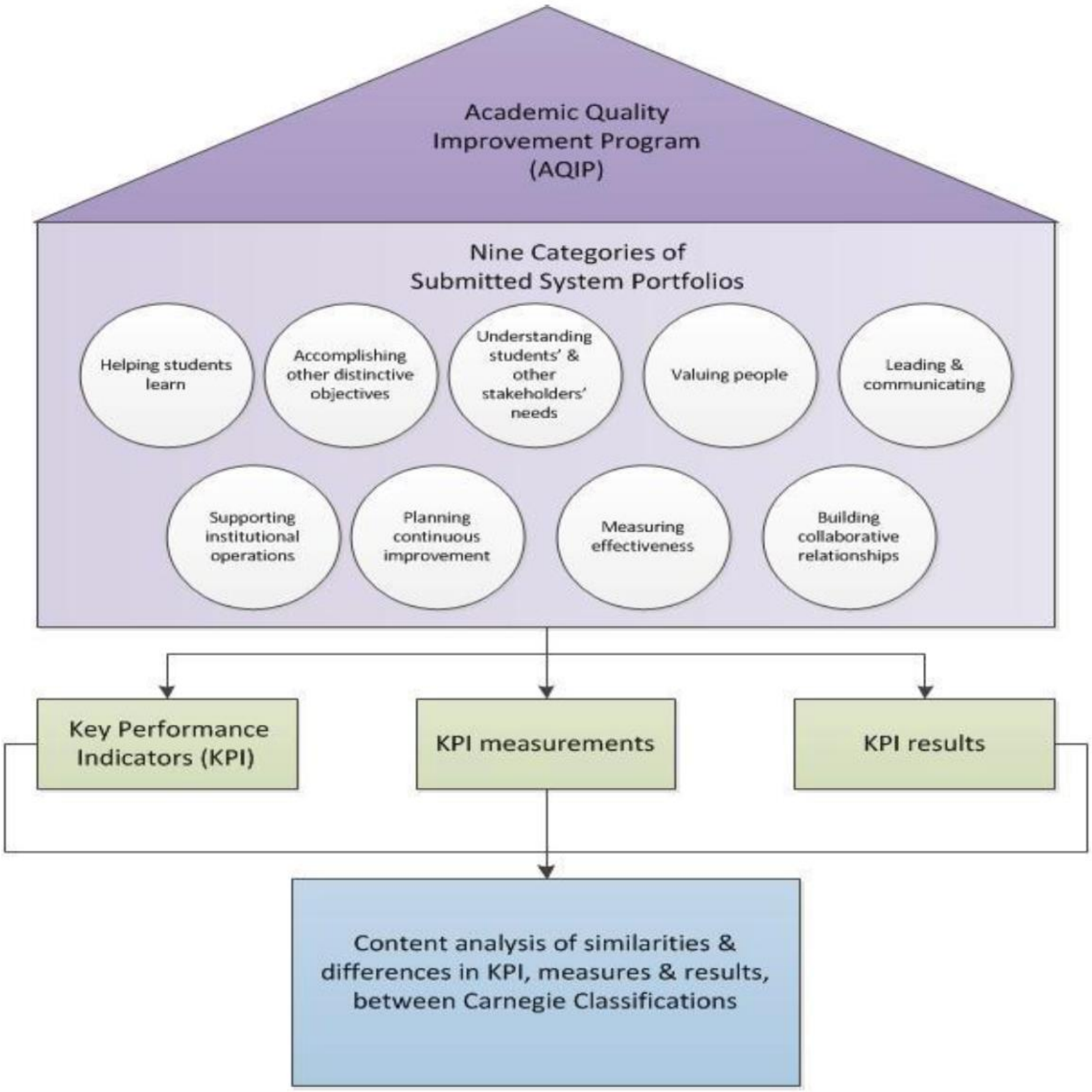


Figure 3.7: Conceptual Framework of Measuring Institutional Quality (Ballard, 2013)

8. Business Process Model for Course Improvement (Drăgan et al., 2014)

Dragan et al. (2014) introduced a model for quality management in HE based on Business Process Modelling. It presents a flowchart that addresses the roles associated with the main actors of the quality management process which are: the Quality Management Team, the Coordinators of a Study Programme, and the Professors. However, the model lacks theoretical underpinning.

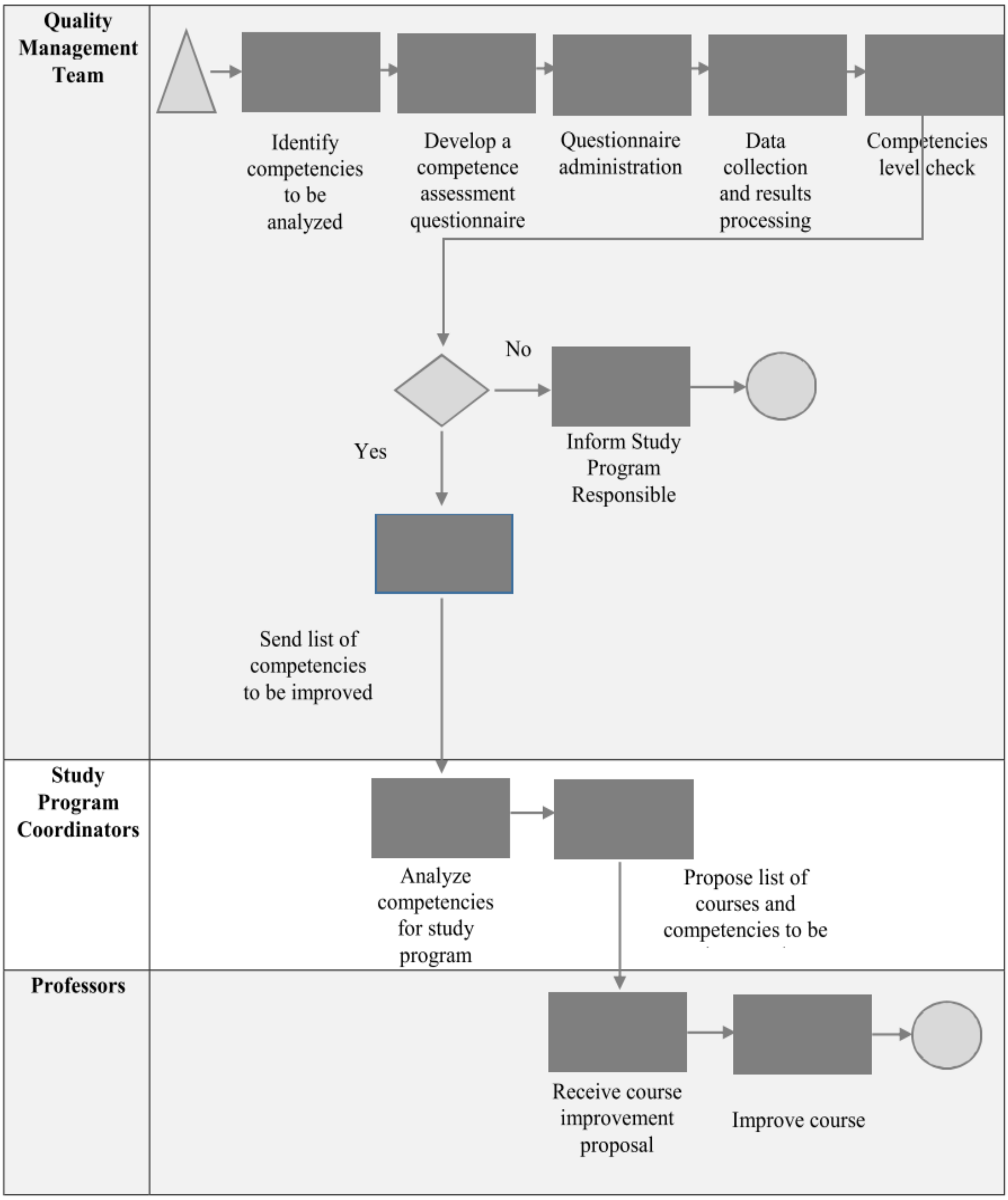


Figure 3.8: Business Process Model for Course Improvement (Drăgan et al., 2014)

9. Integrated model of Total Quality Management in Higher Education (Sahney, 2016)

This conceptual framework shown in Figure 3.9 applies the Total Quality Management philosophy in the HE context. It uses the system model (Input-Process-Output) to represent the quality management process and focuses on internal and external customers of the educational system.

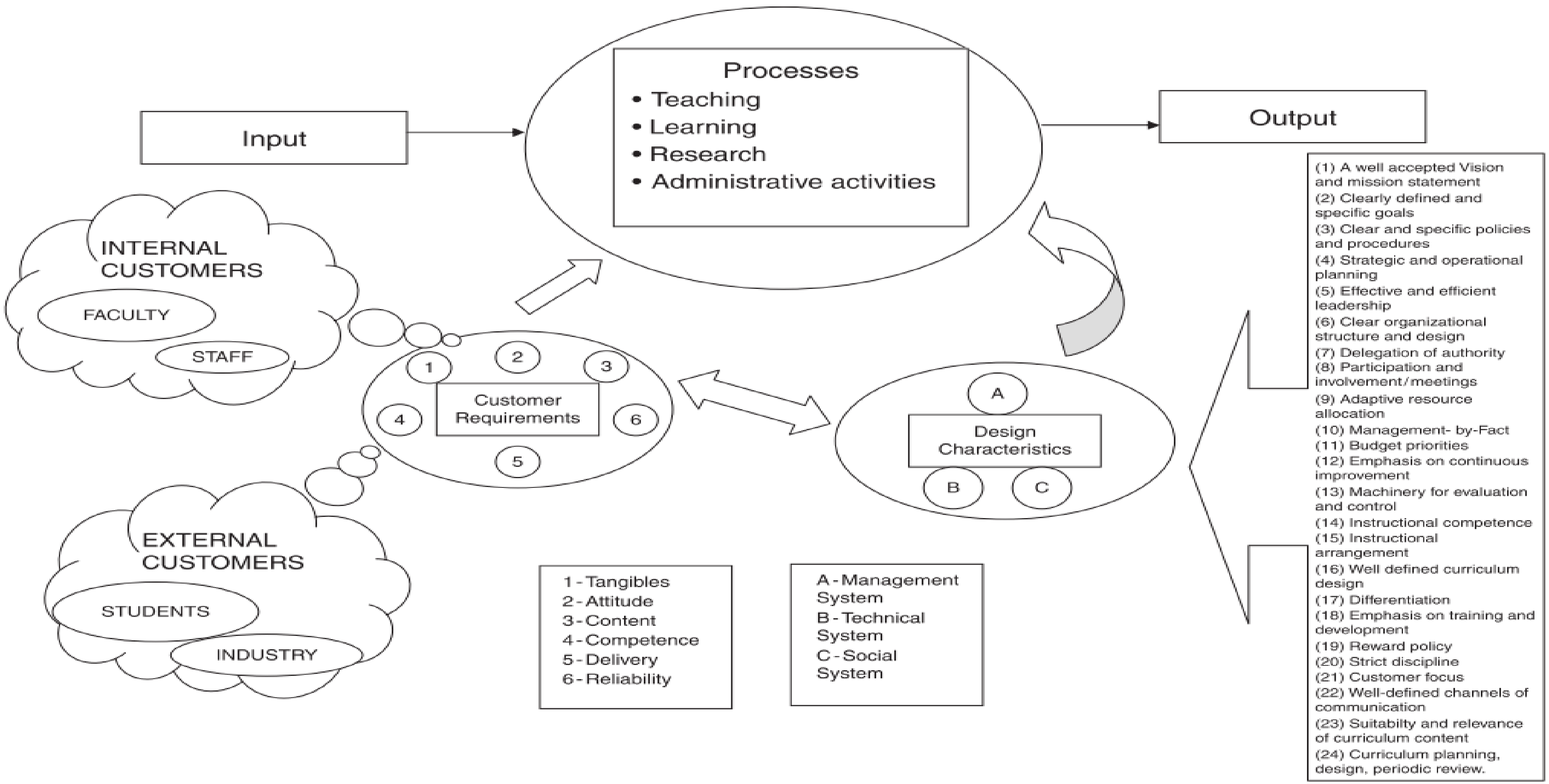


Figure 3.9: Integrated model of Total Quality Management in Higher Education (Sahney, 2016)

10. The HESQUAL Framework (Teeroovengadum et al., 2016)

The HESQUAL framework illustrated in Figure 3.10 addresses five main factors associated with measuring the quality of services provided by the HEI. The framework also identifies sub-factors associated with the five main factors for measuring service quality. The framework is adapted from the SERVQUAL model that was initially introduced by Parasuraman et al. (1988).

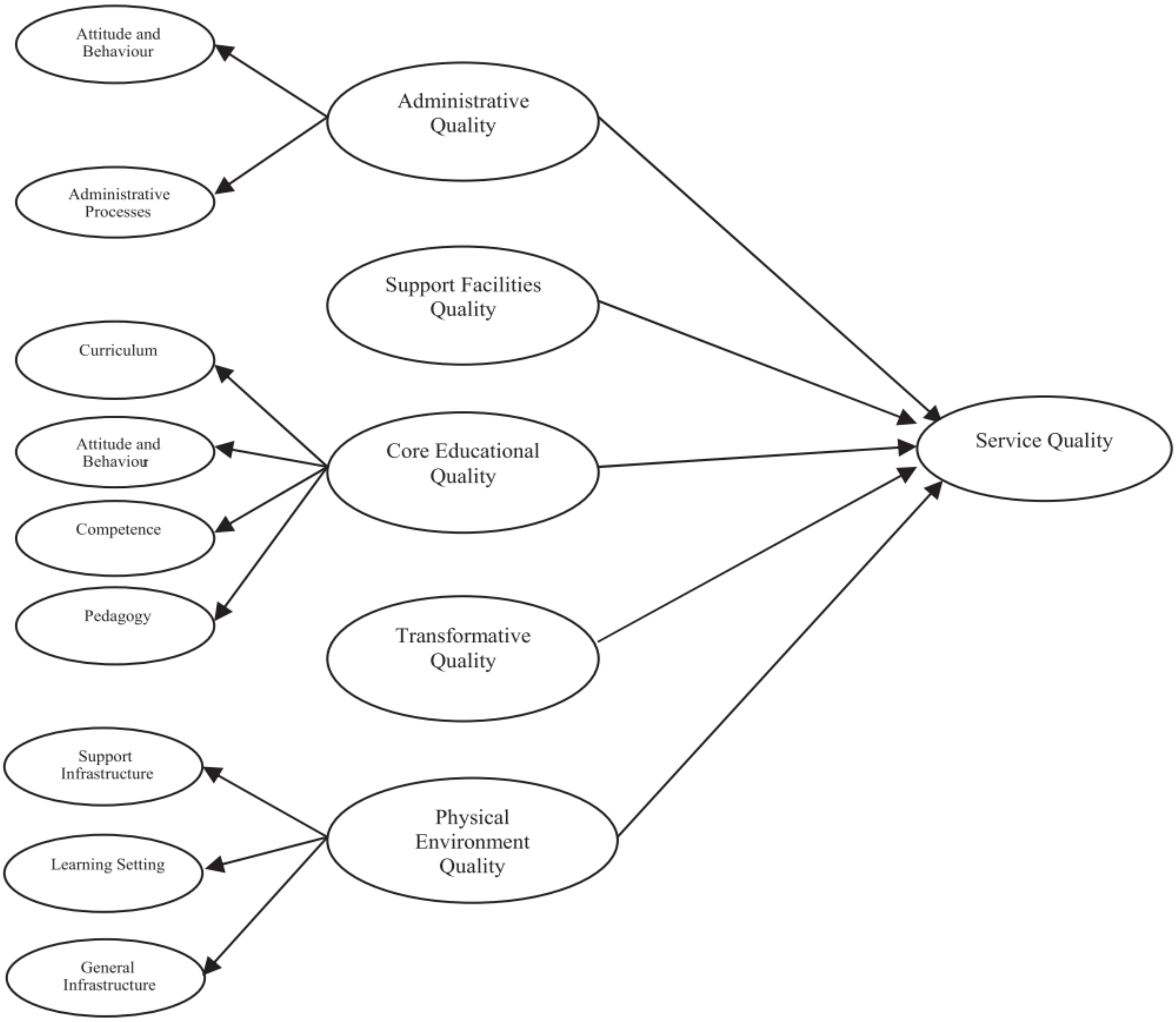


Figure 3.10: The HESQUAL Framework (Teeroovengadum et al., 2016)

11. Basic Business Intelligence Architecture with Decision Making Process (Kumaran et al., 2016)

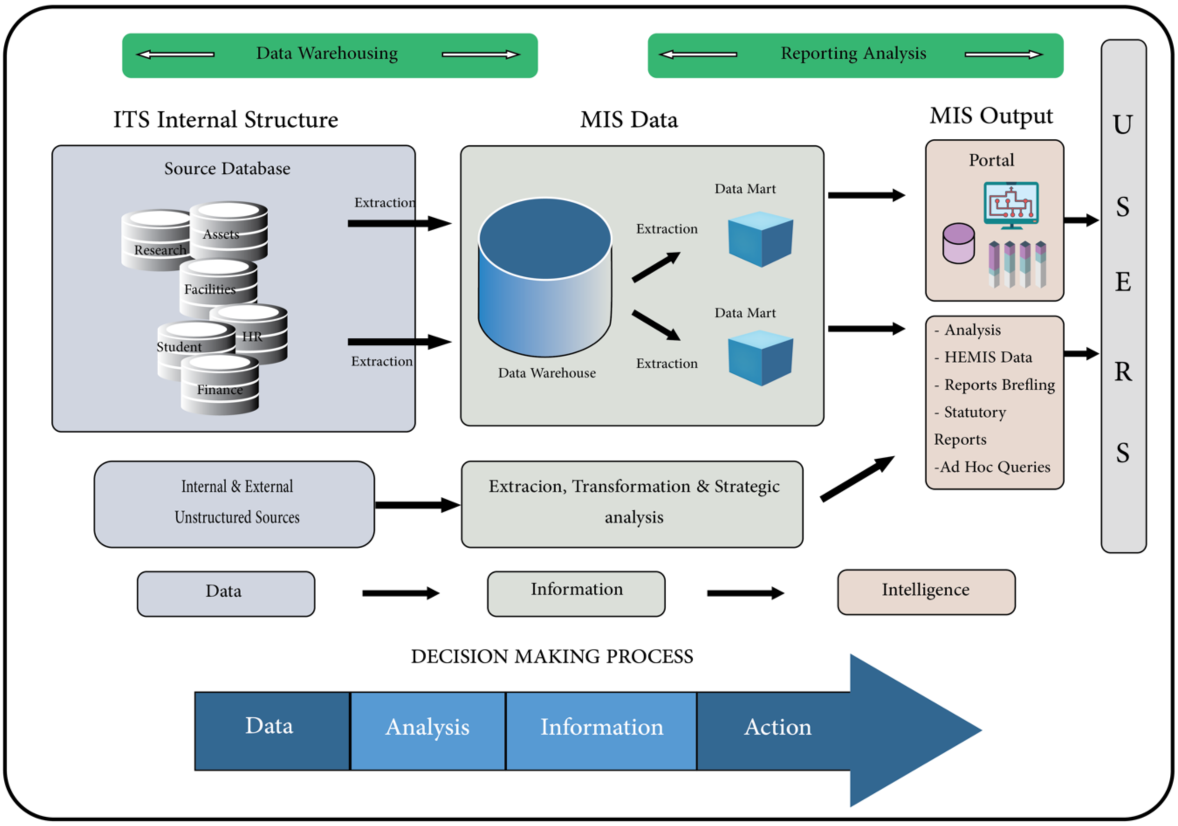


Figure 3.11: Basic Business Intelligence Architecture with Decision Making Process (Modified by author after Kumaran et al., 2016)

Kumaran et al. (2016) present a Business Intelligence Architecture that addresses the constraints that have an impact on HEIs while implementing a BI system, as shown in Figure 3.11. This architecture applies the Theory of Constraints (TOC) to show the constraints that limit HEI management's ability to use BI systems and the effect on the decision making process.

12. The Quality Framework for Higher Education Institutions (Elhoseny et al., 2016)

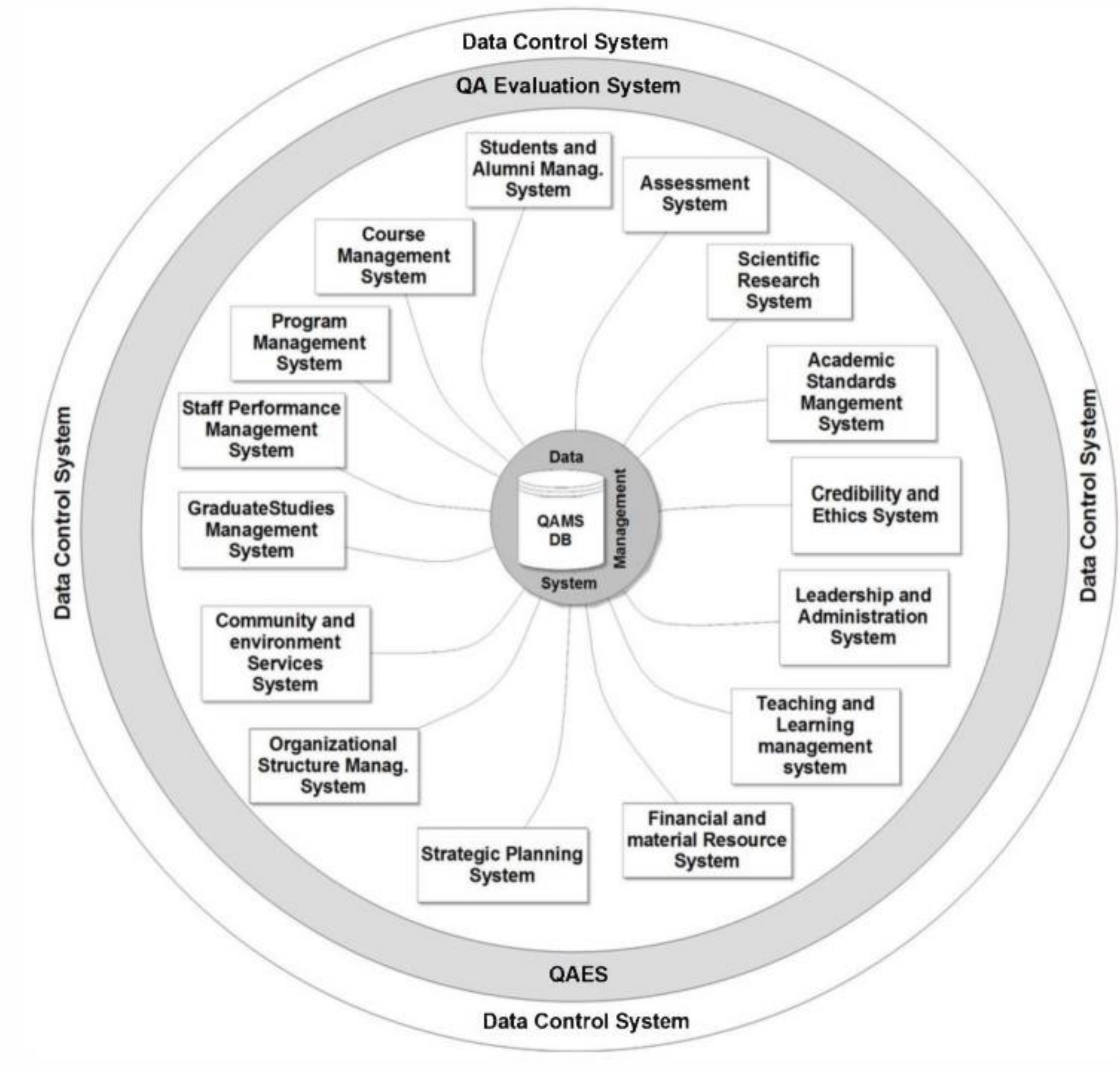


Figure 3.12: Quality Framework for Higher Education Institutions (Elhoseny et al., 2016)

Elhoseny et al. (2016) developed Quality Framework for Higher Education Institutions. This framework, as illustrated in Figure 3.12, addresses the internal components that are required by an automated system for Quality Assurance in HEIs.

13. Total Quality Management Implementation Framework in HE (Alzhrani et al., 2016)

Alzhrani et al. (2016) proposed a framework for TQM implementation in the context of HEIs in the KSA. The framework shown in Figure 3.13 addresses the main elements that are considered basic requirements for TQM in HE. The framework stressed the role of PDCA as a tool for implementing TQM practices.

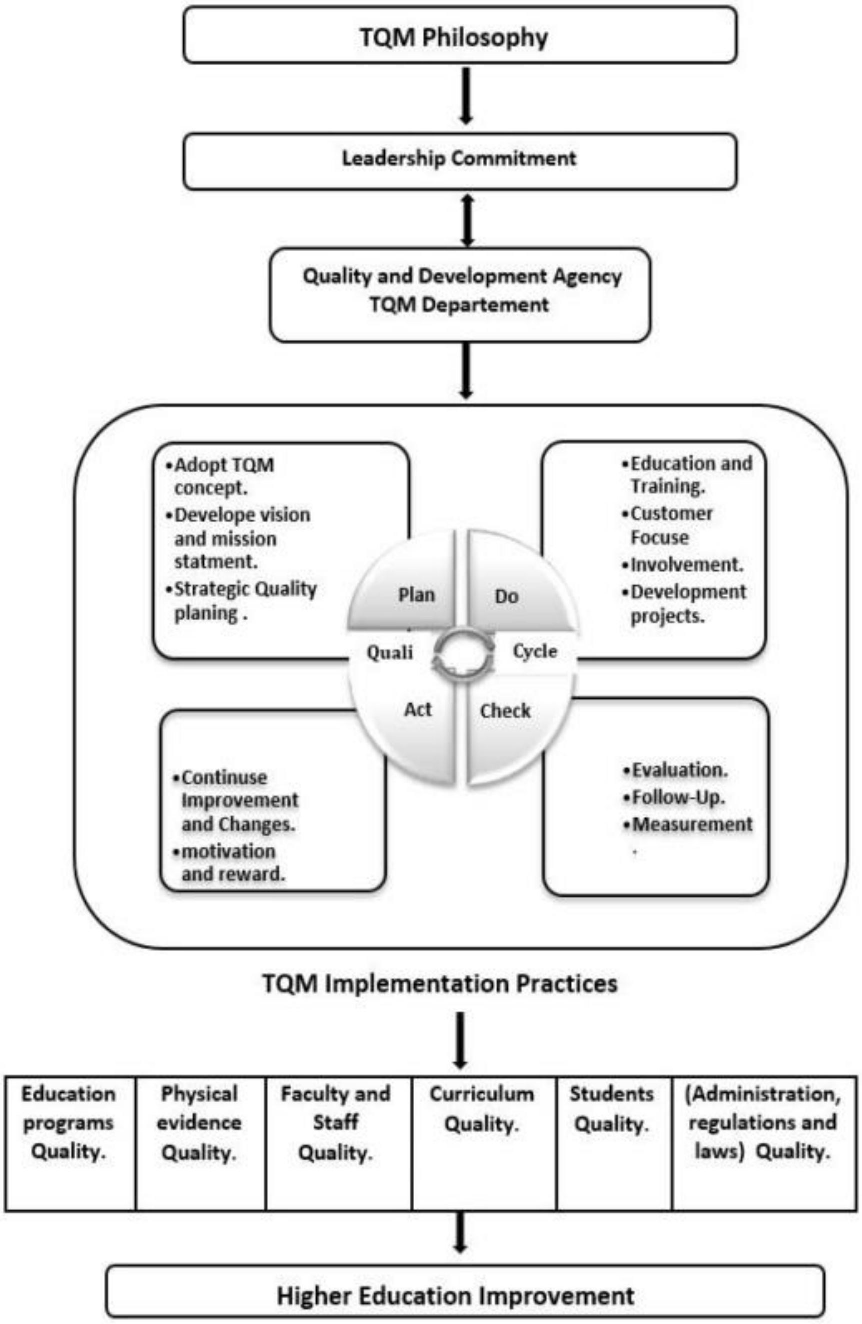


Figure 3.13: TQM Implementation Framework in HE (Alzhrani et al., 2016)

14. **A Framework for Developing LIONLENS (Qiu et al., 2016)**

Qiu et al. (2016) developed a framework for capturing and visualising public opinion from Social Media channels. The framework shown in Figure 3.14 determines the elements and steps required to develop Leveraging Innovative Online Networks to Learn Education Networks and Systems (LIONLENS) which is part of a system that allows aggregating public opinions expressed on Social Media. The aggregated public opinions are then analysed in order to rank public service providers to determine whether they meet the needs of different stakeholders.

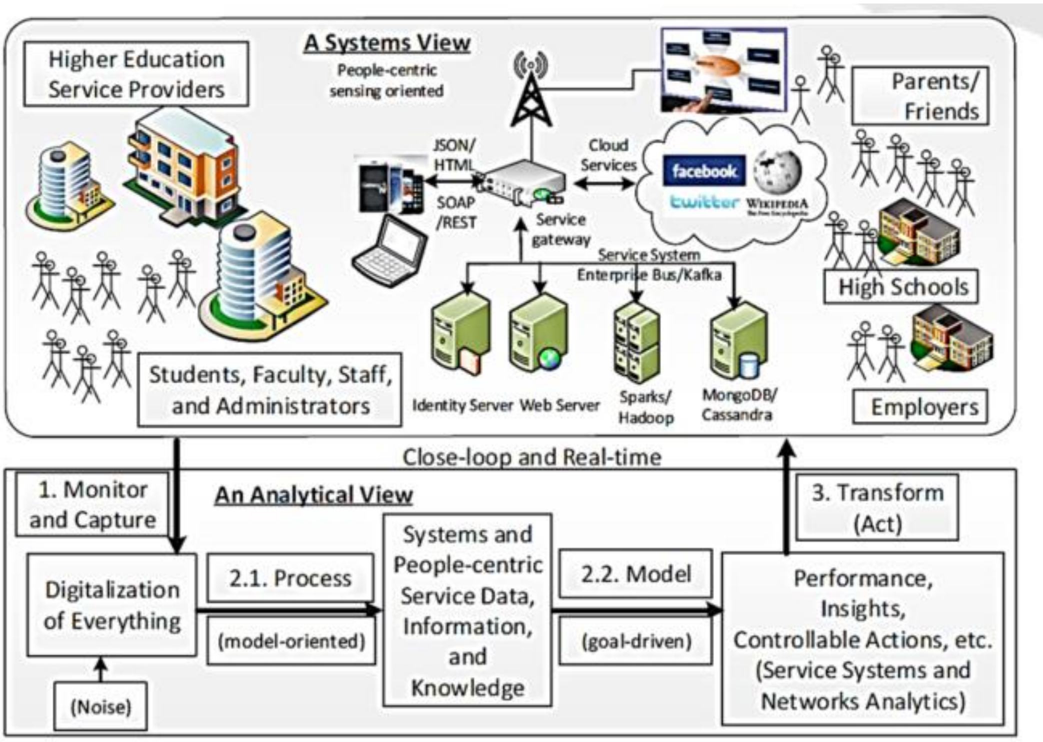


Figure 3.14: A Framework for Developing LIONLENS (Qiu et al., 2016)

15. **The High-level Design of TheDB Framework (Denwattana & Saengsai, 2016)**

Denwattana and Saengsai (2016) introduced a framework that addresses the main components that HEIs are required to consider while designing dashboards for monitoring quality as shown in Figure 3.15. The framework stresses the role of Strategic Management and Human Resource Management in the dashboard development process.

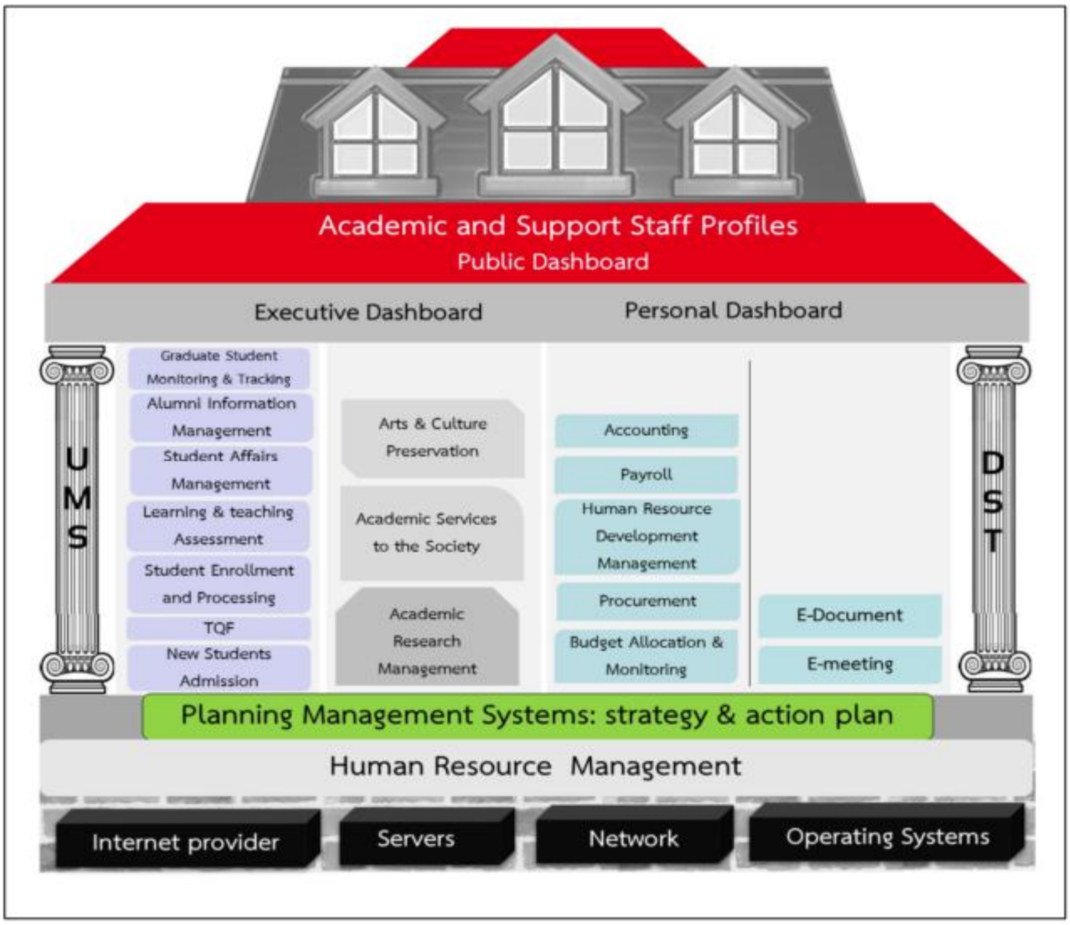


Figure 3.15: The High-Level Design of TheDB Framework (Denwattana & Saengsai, 2016)

16. The Architecture of Higher Education Quality Monitoring and Evaluation System (Li et al., 2017)

Another framework developed by Li et al. (2017), shown in Figure 3.16, which represents an architectural framework for developing a quality monitoring and evaluation system based on Big Data. The framework does not cover all the components that are seen as essential for developing quality monitoring systems and how these components interrelate to each other.

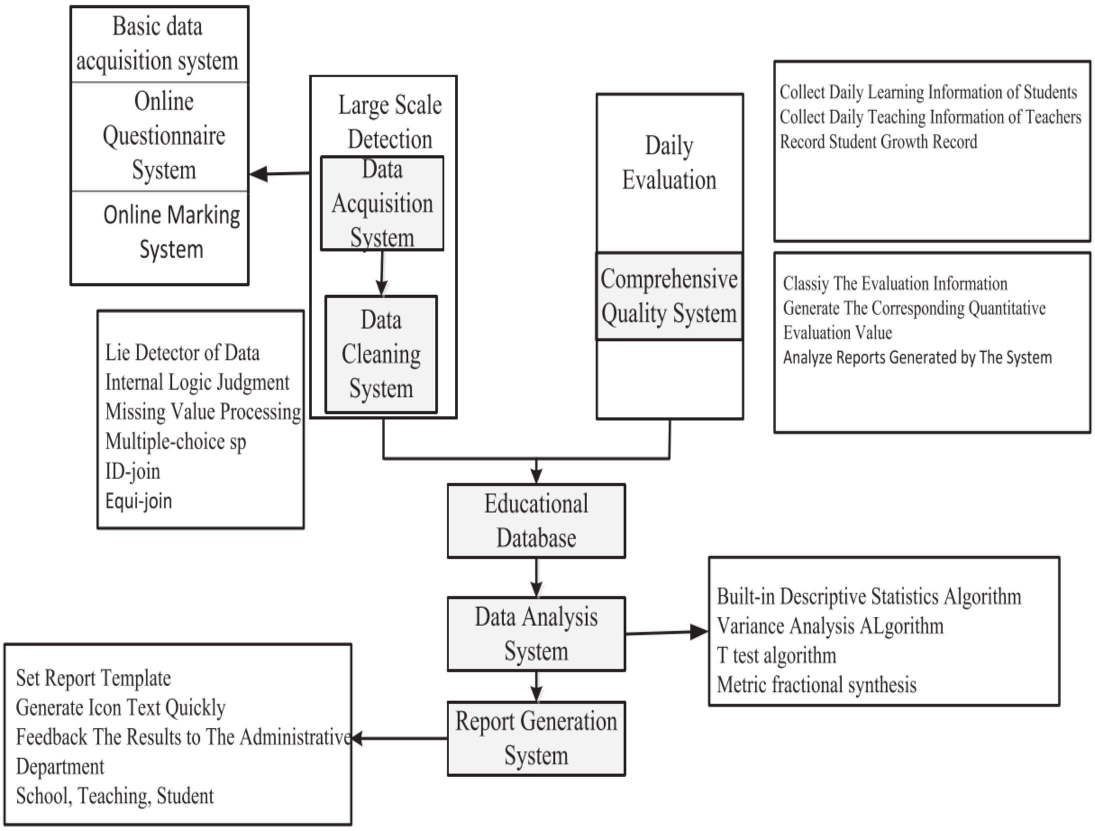


Figure 3.16: The Architecture of Higher Education Quality Monitoring and Evaluation System (Li et al., 2017)

17. A Conceptual Lean Six Sigma Framework for Quality Excellence in Higher Education Institutions (Sunder M. & Antony, 2018)

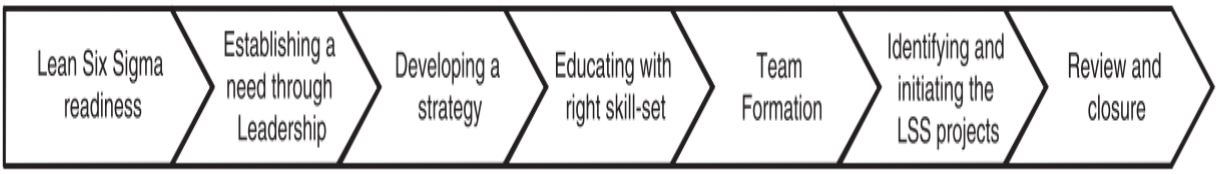


Figure 3.17: Lean Six Sigma Framework for Quality Excellence in Higher Education (Sunder M. & Antony, 2018)

Sunder and Antony (2018) introduced a framework for applying Lean Six Sigma (LSS) for quality monitoring in HEIs as shown in Figure 3.17. The study suggests that HEIs' readiness to apply LSS is the most important step in applying LSS in HE. It stressed the importance of leadership and team work as well as the development of institutional strategy throughout the quality assurance process.

18. **Sustainable Business Intelligence Framework (Scholtz et al., 2018)**

Scholtz et al. (2018) adapted and extended the work of Muntean et al. (2010), as shown in Figure 3.18, to present a framework for monitoring performance in HE. The framework addresses the steps that HEIs must follow for the purpose of monitoring strategic performance.

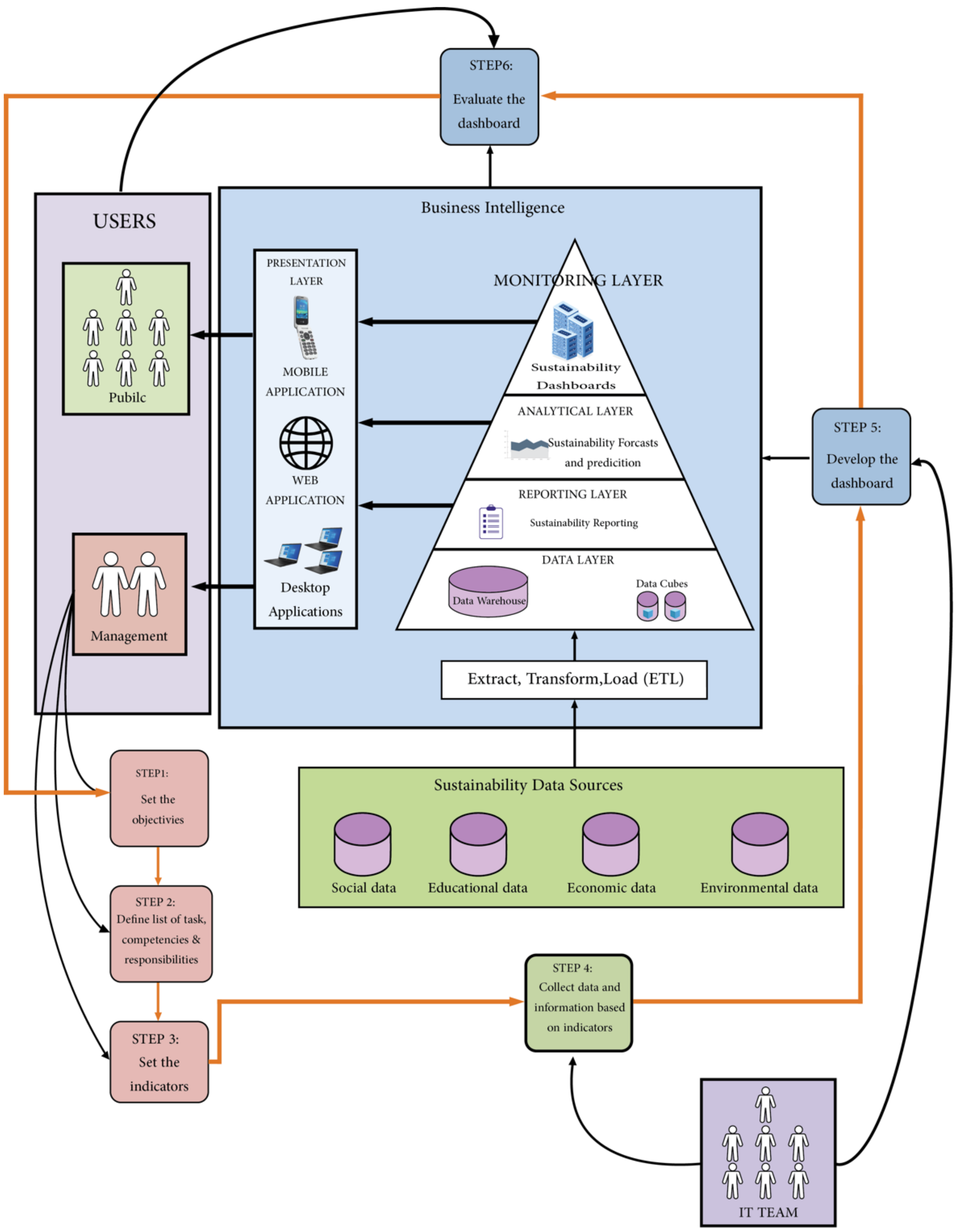


Figure 3.18: Sustainable Business Intelligence Framework (Modified by author after Scholtz et al., 2018)

3.2.3 Review of Identified Frameworks

In this section, a review of the selected frameworks is presented. Since Visualised Outputs (VO) are the main outcome provided from dashboards, an emphasis is given to those frameworks that discuss the design of systems that provide Visualised Outputs. Table 3.1 shows the 18 frameworks discussed in Section 3.2.2. The frameworks selected for more detailed analysis in this study have been highlighted (Blue) in the Table. There were only five frameworks that discussed visual representation of HEI performance. Due to the limited number of studies, the frameworks selected for analysis include both frameworks that measure quality in HE and frameworks that measure other aspects of performance in HE. In Table 3.1, QA refers to frameworks that specifically address Quality Assurance; HE refers to frameworks designed for use in an HE environment, and VO refers to frameworks that include Visualised Outputs.

Table 3.1: Identified Frameworks from the Literature Review

No.	Framework Reference	Research Criteria			Reason for Inclusion/Exclusion
		QA	HE	VO	
1	(Venkatraman, 2007)	✓	✓		While the framework discussed TQM in Higher Education, it is excluded from further analysis because it does not address visualising outputs on quality assurance performance in HEI.
2	(Dyk, 2008)		✓		This framework shows the Data Warehouse Business Intelligence framework for Higher Education. The framework is excluded from further analysis as it does not address visualising outputs for performance measurement and is not oriented to measure Quality Assurance performance.
3	(Bhuiyan et al., 2009)	✓	✓		This framework represented the implementation of TQM for Quality Assurance in Higher Education, but it was excluded from further analysis because it does not represent visualised outputs of Quality Assurance performance.
4	(Muntean et al., 2010)		✓	✓	This framework was selected for further analysis because it identifies several layers for BI systems in HE. Although this framework does not focus on quality assurance, it has been selected for analysis because it includes visualised outputs for performance measurements.
5	(Da Dalt et al., 2010)	✓	✓		While this framework addressed Monitoring Quality based on the Plan-Do-Check-Act cycle, it has been excluded from further analysis because it does not represent visualised outputs of Quality Assurance performance measurements.
6	(Burli et al., 2012)	✓	✓		This model is excluded from further analysis because it lacks theoretical underpinning and has not discussed visualised outputs of Quality performance measurements in Higher Education.
7	(Ballard, 2013)	✓	✓		While this framework addressed components that contribute to the achievement of Academic Quality Improvement Programme (AQIP) accreditation, the framework was excluded from further analysis because it does not represent how to monitor Quality Assurance progress through any visualised outputs.

8	(Drăgan et al., 2014)		✓		This model was excluded from further analysis because it lacks theoretical underpinning and does not represent Quality Assurance in Higher Education. In addition, it does not address visualised outputs of performance measurements.
9	(Sahney, 2016)	✓	✓		This model discussed the implementation of TQM in HEIs, but it has been excluded from further analysis because it does not represent visualised outputs of quality performance measurements.
10	(Teeroovengadum et al., 2016)	✓	✓		This framework has been excluded from further analysis because it does not represent visualised outputs of the service quality measured using the tool it provides.
11	(Kumaran et al., 2016)		✓		This architecture has been excluded from further analysis because it lacks theoretical underpinning and does not measure Quality performance in Higher Education.
12	(Elhoseny et al., 2016)	✓	✓		This framework has been excluded from further analysis because it does not represent visualised outputs of Quality performance measurements.
13	(Alzhrani et al., 2016)	✓	✓		This framework is focused on the Quality Assurance process in the KSA, but it has been excluded from further analysis because it does not represent visualised outputs of Quality performance measurements.
14	(Qiu et al., 2016)	✓	✓	✓	This framework was selected for further analysis because it discussed visualising opinions gathered from Social Media to measure the service quality of Higher Education Institutions.
15	(Denwattana & Saengsai, 2016)	✓	✓	✓	This framework was selected for further analysis because it addressed the essential requirements for building dashboards for monitoring quality based on Thai quality assurance standards.
16	(Li et al., 2017)	✓	✓	✓	This framework was selected for further analysis because it presents a Quality Monitoring and Evaluation System which includes a reporting generation system that discussed visual representations as one of the outcomes for monitoring Quality in Higher Education.
17	(Sunder M. & Antony, 2018)	✓	✓		This framework was excluded from further analysis because it does not represent visualised outputs of Quality performance measurements.
18	(Scholtz et al., 2018)		✓	✓	This framework was selected for further analysis because it shows the process of developing Business Intelligence dashboards for monitoring performance in Higher Education.

As seen in Table 3.1, only five frameworks discussed visualising outputs of performance measurements in Higher Education. In Section 3.3, these frameworks are further analysed through Gap Analysis to determine whether they can be used for monitoring Quality in Higher Education in the context of the KSA. Table 3.2 summarises key missing elements in the frameworks selected for gap analysis.

Table 3.2: Missing Features in Current Frameworks

Framework Reference	**Missing Features**
(Muntean et al., 2010)	● The framework does not address the process for developing a dashboard. ● It does not focus on monitoring Quality Assurance performance ● It does not outline the main components used in monitoring performance such as measuring Key Performance Indicators (KPIs) ● It does not take into consideration any Quality Assurance standards for designing a monitoring system
(Qiu et al., 2016)	● This framework is not designed to measure all aspects of Quality Assurance such as measuring learning outcomes and financial performance, but it limits performance measurement to the aggregation of public opinion expressed on Social Media. ● It does not outline the main components used in monitoring performance such as measuring Key Performance Indicators (KPIs) ● It does not take into consideration any Quality Assurance standards for designing a monitoring system
(Denwattana & Saengsai, 2016)	● This framework does not indicate where and when the use of KPIs should be incorporated into the design of the system. ● The framework does not consider the National Qualifications Framework for curriculum design
(Li et al., 2017)	● It does not outline the main components used in monitoring performance such as measuring Key Performance Indicators (KPIs) ● The framework does not consider the National Qualifications Framework for curriculum design
(Scholtz et al., 2018)	● It does not focus on monitoring Quality Assurance performance ● It does not outline the main components used in monitoring performance such as measuring Key Performance Indicators (KPIs) ● It does not take into consideration any Quality Assurance standards for designing a monitoring system

3.3 Gap Analysis

A Gap Analysis was used to give a detailed specification of the key differences between the current and the desired situation (Rosenberg, 2001). Gap Analysis is defined by Mannocci et al. (2018, p.2) as '*the process of assembling various datasets over a desired study area to identify where or when knowledge is lacking*'. From a managerial perspective, Dimarchopoulou et al. (2017, p.3) suggested that Gap Analysis is used in management literature to answer the question '*Where we are and where we want to be*'. Thus, Gap Analysis compares the actual/current performance with the desired/potential performance.

In this study, current frameworks have been reviewed using Gap Analysis for the purpose of assessing the need for developing a new framework. Gap Analysis is a widely used approach for QA processes for organisations providing services as it is used for determining the gap between the actual performance and desired performance (Hrnčiar & Madzík, 2013). The Gap Analysis process that will be addressed throughout this chapter is outlined in Figure 3.19, which addresses the sequence of steps conducted.

The Gap Analysis shows the current state and expected state of the subject under study. The gaps are addressed in order to determine the areas that need to be improved. Gap Analysis was used by Hrnčiar and Madzík (2013) for its ability to provide deeper analysis and its ability to cover all components, processes and resources of education. Mineraud et al. (2016) used Gap Analysis when comparing IoT platforms. In addition, Su et al. (2016) used Gap Analysis to analyse stream reasoners for IoT.

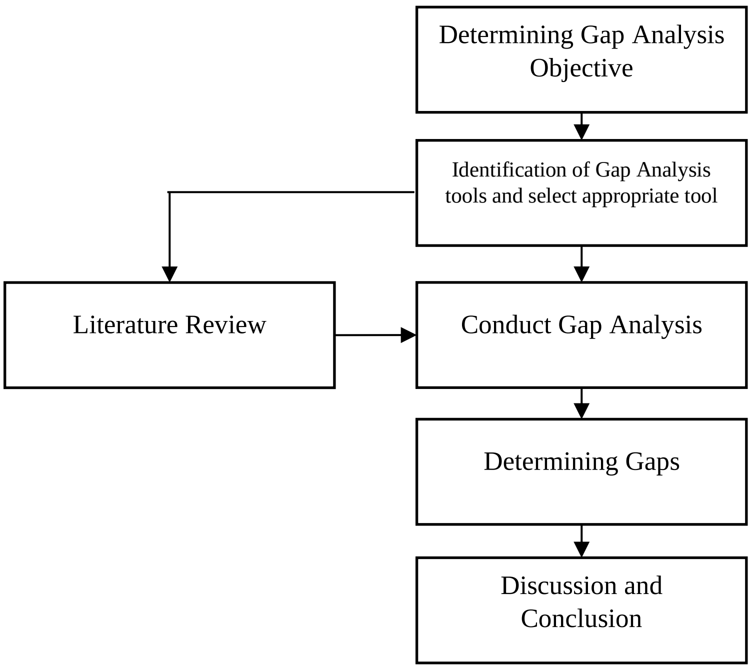


Figure 3.19: Analysis Process (Adapted from: Hrnčiar & Madzík, 2013)

3.3.1 Gap Analysis Objective

The main objective of this analysis is to assess current frameworks identified from an extensive literature review which discusses monitoring QA performance in HE using Business Intelligence Dashboards in the context of the KSA. The Gap Analysis aims to address components covered by current frameworks and determine missing components, if any, that are required to be presented in the current frameworks as they represent mandatory requirements of QA in the context of KSA.

3.3.2 Gap Analysis Tools Identification and Selection

There are many Gap Analysis tools that can be used for analysis purpose. For example, the Mckinsey 7-S model, Nadler-Tushman congruence model, and Burke-Litwin causal model are among the tools that can be used for organisational gap analysis (Cawsey et al., 2016). In addition, SWOT analysis and fishbone analysis are examples of the tools used for conducting Gap Analysis for organisations (Athuraliya, 2018).

In order to select an appropriate tool for conducting Gap Analysis, the Nadler-Tushman congruence model was reviewed. The congruence model is helpful in organisational analysis as it has a complete set of variables presented in a way which facilitates straightforward analysis. The model links the environmental inputs and outputs of the organisation (Cawsey et al., 2016). In addition, the model considers the organisation as an open system. The congruence model assesses the organisational performance through determining the congruence (fit) between tasks, formal organisation, informal organisation, and individuals (Nadler & Tushman, 1980).

The Nadler-Tushman congruence model provides a relatively complex organisational analysis (Cawsey et al., 2016). In addition, it considers the organisational strategy as the most important input of the model (Merlin et al., 2012). Strategic orientation is seen as an important element in Quality Assurance Systems (QAS). There are also other important elements which need to be considered in HEIs such as managing daily operations of learning. Consequently, the Nadler-Tushman model may not address the gaps in the current frameworks properly as it measures strategic achievement through measuring the organisation's ability to achieve the congruence (fit) throughout the four elements of the model.

SWOT Analysis was also reviewed to examine whether this tool fits the objective of this Gap Analysis. While SWOT analysis has been used for conducting gap analysis in the HEI context in some studies such as Zgodavová et al. (2015) and Veroijenstijn (2003), it was concluded that it does not fit the purpose of the current investigation as it is not practical to perform this analysis for each identified framework and assess them against each other in order to address the gaps. The SWOT analysis approach is intended to be used for self-assessment of the organisation but not for comparison purposes which is the aim of the current study. In addition, the output from SWOT analysis will be subjective and would need further analysis to better identify the gaps between different frameworks.

Tabular comparison has been used in order to assess current frameworks to determine the components that they cover as well as identifying missing components, as shown in Table 3.3. The tabular comparison is helpful in representing the selection of components for assessment. This method has been previously used to compare outsourcing frameworks by Ho & Atkins (2006) and was also used by Alzamil (2014) in benchmarking Quality Assurance Standards (QAS) with Kingdom of Saudi Arabia (KSA) standards and QAS in different nations and by Su et al. (2016) in analysing stream reasoners for Internet of Things (IoT). The use of a tabular approach in this thesis is supported by the fact that this approach has been used by previous researchers to identify gaps in IT-related topics (Su et al., 2016; Mineraud et al., 2016; Ho & Atkins, 2006) and for comparison purpose with HEI related topics (Hrnčiar & Madzík, 2013; Alzamil, 2014). The tabular comparison approach shows the different components that the frameworks address and compares coverage of those components by frameworks (Ho & Atkins, 2006). The components shown in Table 3.3 have been selected because of their relevance to the design of Quality Assurance systems in Higher Education and Business Intelligence systems for dashboard reporting as identified from the literature review. Comparison components are outlined in the following points:

- **Key Performance Indicators (KPIs)**: This component refers to whether the framework includes the KPIs for the QA assessment. According to Zulkefli et al. (2015), KPIs form a qualitative and quantitative evaluation index that is crucial for universities to measure performance level.
- **Stakeholder interaction**: This component refers to the extent to which stakeholders interact with the process of QA monitoring according to the framework. Stakeholders are expected to be involved in the QA planning process as well as establishing goals and objectives and reviewing achieved results; stakeholders may include students, professional bodies, industry representatives, and faculty members (Abou-Zeid & Taha, 2014).
- **Iterative feedback**: This component refers to whether the framework includes a mechanism for feedback on the monitoring process. According to Hrnčiar and Madzík (2013), ensuring feedback from the measurement of processes is essential for the improvement of quality in education.

- **Interaction with external environment**: This component refers to the inclusion of external environment variables that affects the system, and it may include government policies on funding or grants (Hill, 1995).
- **Alignment to organisation strategy**: This component refers to whether the framework addresses the alignment with the HEI strategy. The control system should provide information to assess whether the activities in the organisation are in accordance with the objectives and organisational strategy (Daromes & Ng, 2015).
- **Quality Assurance (QA) Standards**: This component refers to whether the framework is based on Quality Assurance Standards in a specific region or nation. HEIs in the KSA, for example, are required to follow National Centre for Academic Accreditation and Assessment (NCAAA) standards (NCAAA, 2009, 2018).
- **Technical information**: This component refers to technical requirements that the framework has identified for the purpose of developing the system such as the need for a Database, internet connection, IT infrastructure, etc. According to Berwouts et al. (2010), a quality management system needs to address those technical requirements and also includes training, accommodation, and equipment as key elements for such systems.
- **Data Input**: This component is related to the data input sources used in the framework in order to generate outputs. According to Aruldoss et al. (2014), data sources are considered an essential component for developing a BI system. The following examples are some of the data input sources that have been identified in the literature on the development of BI systems:
    - Social Media sources: Qiu et al. (2016) suggest that social media sources can be incorporated with traditional data sources to provide a complete picture to customers. As a data input source, Social Media refers to the use of social media channels as data input for the system.
    - Data Warehouse (DW): Muntean et al. (2010) suggested that one of the key components of the dashboard system is the DW. They suggested that all transactional and analytical reports should come from one source, which is a DW.
    - Operational DB: refers to the use of the operational DB for system data input. Operational databases are among the essential components of BI systems (Dedić, 2017).
    - Portal: refers to the use of a web portal as a data source for the system. Web portals are considered among the components required to develop dashboards for the university management system (Muntean et al., 2010).

    - Human Assisted: refers to the human role in determining which information should be added to the system. Quality Assurance systems include huge amounts of data which may require decisions as to whether it should be included in the system (Li et al., 2017; Owino et al., 2014).
    - Big Data: refers to the use of Big Data for system inputs. Big data technology has been used by Li et al.(2017) for performing data collection, cleaning, processing, and storage of teaching information in colleges and universities while building a quality monitoring platform.
- **Sentiment Analysis**: This component refers to the use of sentiment analysis within the framework for the purpose of data analysis. Sentiment analysis is usually related to analysing qualitative data gathered through Social Media (Qiu et al., 2016, 2015).
- **Online Analytical Processing (OLAP)**: This component refers to the use of Online Analytical Processing for analysing data in the system. It refers to creating a multidimensional data store from a huge set of data summarised and then analysed using fast query and calculation performance delivered in real-time (Kolhatkar et al., 2017). It can be one of the tools used in the analytical layer of dashboards (Muntean et al., 2010).
- **Data Mining**: This component refers to the use of data mining for analysing data in the system. Muntean et al. (2010) suggest that data mining can be one of the components of the analytical layer of dashboards. In addition, Elhoseny et al. (2016) suggest that quality assurance system can be considered as a data mining system as it handles QA data.
- **Data Output**: This component refers to the type of outputs provided by the frameworks. This study aims to review frameworks that are generating visualised outputs. HE dashboards can be used for monitoring student, staff, department, and research performance by setting indicators that are reported through data visualisation (Muntean et al., 2010).
    - Use of Dashboards: refers to using dashboards for outputs visualisation
    - Use of Scorecards: refers to using scorecards for output visualisation
    - Data Reports – delivery method unspecified: indicates that the system is generating detailed data reports or that the framework has not identified the output method for the system.
- **User acceptance**: This component is related to whether the framework addresses user acceptance of the system. Potential users of the system should be actively involved in the design and development processes of the system in order to ensure that their requirements have been met. Meeting users' needs may increase the likelihood of user acceptance of the system (Haupt et al., 2015).

- **Ease of Understanding**: This component refers to whether the framework is easy to understand or whether specialised or prior knowledge is required before it can be implemented (Ho & Atkins, 2006).
- **Top Management Support**: This component refers to whether the framework includes top management support in the system. Yarahmadi and Magd (2016) suggest that top management support is among the essential factors for quality assurance systems in the HE.
- **Quality dimensions in HE:** This component relates to whether the framework has taken into consideration one or more of the quality dimensions in HEIs as outlined by Cao and Li (2014a) as follows:
    - Academic Quality: refers to the quality of teaching and learning, research, and scholarship in HE
    - Administrative Quality: refers to governance and management quality at the leadership level
    - Relationship Quality: refers to the quality of interpersonal relationships among different stakeholders
- **National Qualifications Framework (NQF)**: National Qualifications Framework refers to the set of criteria that are required to be met for academic or technical awards (Smith & Abouammoh, 2013). The monitoring framework should consider the NQF while designing QA system in HE.
- **Notifications**: This component refers to whether the framework includes sending notifications when performance reaches a certain level. Ideally, dashboards should possess several key features, among them, they should provide automatic warnings when certain values have been reached (Sakys et al., 2013).

3.4 Gap Analysis Results

The comparison tabular shown in Table 3.3 addresses the comparison components outlined in Section 3.3.2 for each framework. For the purpose of this comparison, tick marks have been assigned for the areas barely covered in the framework, double tick marks assigned to areas that are clearly covered by the framework, while the greyed-out cells show areas not covered by the framework. The Red shaded cells are the mandatory requirements of the QA systems in the KSA that are not covered by any of the current frameworks. The Green cells shows a dashboard feature that is essential for decision making but not covered by all of the current frameworks.

Table 3.3: Frameworks Comparison Tabular

Components extracted from literature	**Framework Selected from Gap Analysis**					**Comparison Categories**
	Scholtz et al., 2018	**Muntean et al., 2010**	**Li et al., 2017**	**Denwattana et al., 2016**	**Qiu et al., 2016**	
KPIs	✓✓					Components included in the frameworks
Stakeholders interaction	✓✓		✓✓	✓✓	✓✓	
Iterative feedback	✓✓				✓	
Interaction with external environment	✓		✓	✓	✓✓	
Alignment to organisation strategy	✓✓			✓✓		
QA Standards				✓✓		
Technical information	✓✓	✓		✓✓	✓	
Social Media source					✓✓	Data Sources used in the frameworks
Data Warehouse	✓✓	✓✓				
Operational DB			✓✓	✓✓		
Portal			✓✓			
Human Assisted			✓✓		✓	
Big Data			✓✓		✓✓	
Sentiment Analysis					✓	Analysis methods supported
OLAP	✓✓	✓✓				
Data Mining	✓	✓	✓✓		✓✓	
Use of Dashboards	✓✓	✓✓		✓✓		Data Visualisation provided in frameworks
Use of scorecards	✓✓	✓✓				
Data Reports – delivery method unspecified			✓	✓	✓	
User Acceptance	✓✓			✓	✓	Non-functional requirements included in frameworks
Ease of Understanding	✓✓	✓✓	✓	✓	✓	
Top Management Support	✓✓					
Academic Quality			✓✓	✓✓		Quality dimensions in HE
Administrative Quality	✓	✓	✓✓	✓✓		
Relationship Quality	✓				✓✓	
Compliance with KSA Standards (NCAAA Standards)						Mandatory QA requirement in KSA
National Qualifications Framework (NQF)						Mandatory QA requirement in KSA
Dashboard Notifications to Users						Notifications on Performance Level

The Gap Analysis shown in Table 3.3 shows that there are three main components which have not been covered by any of the current frameworks, namely Compliance with KSA Standards, National

Qualification frameworks and Dashboard notifications; the first two components are mandatory QA requirements in KSA.

The results of the Gap Analysis are summarised in Table 3.4. Table 3.4 identifies components missing in the frameworks reviewed through Gap Analysis and which need to be considered while developing a new framework for monitoring quality in HE using Business Intelligence dashboards. The table shows the current and expected states of the components found in the current frameworks.

Table 3.4: Gap Analysis Summary

Category	**Current State**	**Expectations**	**Gaps**
Components Included in frameworks	Scholtz et al. and Denwattana et al. framework covers most of the comparison components in this area. While Denwattana et al. considers Thai QA standards, none of the current frameworks addressed NCAAA standards.	Measuring quality performance according to NCAAA standards	1. Quality Assurance Standards in the KSA (NCAAA)
Data Sources	Li et al. Framework covers most of the data input sources found in the current frameworks	The framework should cover most data input sources, including Social Media, to gather the highest rate of accurate information	2. Social Media Data Source
Analysis Method	OLAP and Data Mining are the most used analysis methods by the current frameworks.	Sentiment Analysis should also be used for the purpose of analysing data gathered from Social Media	3. Sentiment Analysis
Data Visualisation	Current frameworks addressed the use of dashboards, scorecards and data reports.	Present performance level using visualised outputs through dashboard	No Gaps Found
Non-Functional Requirements	Scholtz et al. framework is seen to cover all non-functional requirements addressed by current frameworks.	Framework ease of understanding, user acceptance, as well as top management support	No Gaps Found
Quality Dimensions	None of the current frameworks covers all three dimensions of quality in HEIs.	The framework must address Academic, Administrative, and Relationship quality aspects	4. Academic Quality 5. Administrative Quality 6. Relationship Quality
QA system input in KSA	None of the current frameworks considers the National Qualifications Framework (NQF) while designing a monitoring system	Consideration of the National Qualification Framework (NQF) requirements	7. National Qualifications Framework
Notifications Feature in Dashboards	None of the current frameworks discussed notifying decision-makers about the level of performance through real-time notifications	Send real-time notifications on low levels of performance that needs immediate action	8. Notifications

3.5 Discussion

Table 3.3 addresses the components that the Quality Assurance system or Business Intelligence system in Higher Education may need to incorporate. The components shown in Table 3.3 have been addressed throughout the literature review. These components were found in current studies that discussed developing frameworks for monitoring quality in HE or developing Business Intelligence systems in HE. Additionally, some of these components are mandatory requirements for the quality assurance system in KSA Higher Education.

As seen in Table 3.3, the Scholtz framework covers most of the components of visualised outputs monitoring for HEI performance. However, the Scholtz framework covers only 16 of the 28 comparison components shown in Table 3.3. There were several gaps identified and summarised in Table 3.4 showing that current frameworks do not cover some essential components.

Current frameworks do not consider QA mandatory requirements in the KSA such as compliance with NCAAA standards and National Qualifications Framework. Real-time notifications, which are essential for decision making in dashboards, were not covered by any of the current frameworks.

Figure 3.20 shows the framework review process throughout this chapter. Among 18 frameworks for monitoring performance or quality in HE, only five studies were found to provide visualised outputs of performance data.

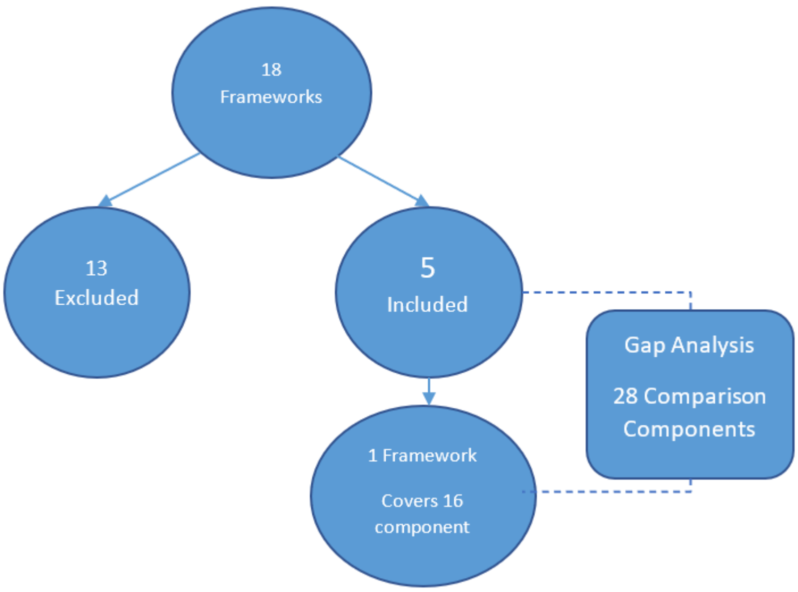


Figure 3.20: Frameworks Review Process

Although the Scholtz et al. (2018) framework represents the dashboard design and development process for HEIs, it is not intended to measure QA performance and present QA data to decision-makers. For example, there is no inclusion of QAS nor NQF as inputs for system design. However, the Scholtz et al. (2018) framework takes into consideration different stakeholders in the design process as well as the feedback from prospective users. Scholtz et al. (2018) further developed the Muntean et al. (2010) framework by integrating users' feedback and feedforward in the design process as well as showing more detail in the design process to make it easier to understand, using a six-step process.

Ideally, dashboards should have key features according to Few (2004) and Sakys et al. (2013). Among these features, they must provide an automatic warning when values of certain indicators have been reached, which is defined in this study as notifications (Few, 2004; Sakys et al., 2013).

Among the five frameworks analysed in Table 3.3, Muntean et al. (2010) was the earliest attempt to develop a framework for monitoring performance using Business Intelligence in HE. While Muntean et al. (2010) showed the key requirements for universities dashboards, their framework lacks many of the components discussed in the comparison tabular as shown in Table 3.3. The Scholtz et al. (2018) framework was developed based on the Muntean et al. (2010) framework and achieved the highest rate of coverage for the comparison components as outlined in Table 3.3. However, even the Scholtz et al. (2018) framework does not cover all the components, suggesting that developing a framework based on modifying an existing framework may not be sufficient for monitoring the desired performance for certain organisations.

The Li et al. (2017) framework addressed some components in the comparison tabular as outlined in Table 3.3. However, it did not cover some critical components, such as the KPIs, users' feedback, NCAAA, NQF and Real-time notifications. It also did not focus on the production of visualised dashboards and merely named the outputs of the system as generated reports.

The Denwattana and Saengsai (2016) framework does not explicitly show how the dashboard system is intended to measure and analyse data and benchmark them against pre-determined KPIs. The framework shows how strategic planning and Human Resource Management (HRM) are important components in the quality management system development. The framework took into consideration decision making at different levels of the organisation as well as providing outputs in terms of dashboards. The authors discussed Thai NQF (TQF) and KPIs throughout their study, but they do not reflect these main components in their framework.

The Qiu et al. (2016) framework stresses the importance of aggregating public opinion from social media for measuring QA in HE. Social media is becoming an important resource for gathering feedback on the quality of service provided by HEIs. However, Social Media by itself may not guarantee the full view of quality assessment of all processes within the HEI. For example, it would ignore other inputs for measuring quality, like learning outcomes achievement and alignment with the NQF of the country. This framework is the only one that incorporates sentiment analysis as a tool for processing the huge volumes of data gathered throughout the monitoring process.

The Gap Analysis shows that the 28 comparison components outlined in Table 3.3 are not covered perfectly by any of the current frameworks. The highest coverage rate achieved was by the Scholtz (Scholtz et al., 2018) framework, but this framework addressed only 16 out of 28 of the components. None of the current frameworks is seen to consider the mandatory requirements of QA systems in the KSA such as compliance with the NCAAA standards and NQF. The National Qualifications Frameworks is one of the most important components that HEI need to consider while designing the QA system, curriculum design, and developing learning outcomes.

Consequently, the Gap Analysis results confirm that there is a need to develop a new holistic framework for monitoring quality in Higher Education Institutions using Business Intelligence dashboards in the context of the KSA. The new framework should cover the NCAAA standards and NQF as main inputs of the system design as well as providing real-time notifications for supporting decision making for different managerial levels. The new framework should cover at least the components addressed in this chapter as in Table 3.3.

3.6 Conclusion

The chapter discussion highlights the need to develop a new holistic framework for monitoring QA activities in HE according to the NCAAA standards in the KSA context. As discussed earlier in Section 3.2.2, the literature review identified 52 studies. Only 18 studies discussed HEI performance monitoring or QA monitoring in HEI. Among these studies, 5 of the frameworks used visualisations to support performance monitoring. Gap Analysis was carried out in order to identify missing components in the current frameworks and assess whether there is a need to develop a new framework.

There are a number of possible tools for the conduct of Gap Analysis as discussed in Section 3.3.2. Tabular comparison was selected for the purpose of conducting the Gap Analysis in this chapter. Current frameworks identified from the literature review were studied and assessed to determine components covered in these frameworks. In addition, the tabular comparison helped in identifying missing components and allowed easy comparison of frameworks.

The Gap Analysis indicated that there are some essential components that are not addressed by the current frameworks. In order to monitor quality in Higher Education using Business Intelligence dashboards in the context of KSA, NCAAA standards and KPIs as well as conformance with NQF need to be taken into consideration while designing the monitoring dashboard. Current frameworks have not addressed these essential components. The new holistic framework incorporates the components discussed in Table 3.3 and is developed and presented in Chapter 4.

Chapter 4 : Development of a Holistic Framework for Monitoring Quality Assurance in Higher Education Using Business Intelligence (HF-HEQ-BI)

4.1 Introduction

This chapter discusses the development process of a Holistic Framework for Monitoring Quality in Higher Education using Business Intelligence Dashboards (HF-HEQ-BI) in the context of the Kingdom of Saudi Arabia (KSA). Chapters 2 and 3 outlined the case for developing a holistic framework which included a Gap Analysis that identified, in existing frameworks, the lack of support for mandatory NCAAA standards and KPI as well as conformance with NQF requirements which are needed in designing a dashboard for Quality Assurance (QA) monitoring in the context of KSA. Chapter 3 also indicated the lack of visual outputs, notifications, and social media interaction in existing frameworks for QA monitoring in Higher Educational Institutions (HEIs) using Business Intelligence (BI) applications.

This chapter outlines the concept of a holistic framework and the link between underpinning theoretical frameworks. The chapter outlines several theoretical frameworks and the justification for selecting three well-documented frameworks, namely Technology- Organisation- Environment (TOE), Human, Organisation and Technology-fit (HOT-fit), together with the Information Systems Strategy Triangle (ISST) to support the HF-HEQ-BI dashboard for monitoring QA in KSA context. Diffusion of Innovation theory (DOI), Unified Theory of Acceptance and Use of Technology (UTAUT), and Technology, Organisation, Social (TOS) model were also reviewed to support the change from 'Human' perspective to 'Social' perspective in the proposed framework. The purpose of this change is that 'Social' is considered more comprehensive than 'Human' as it includes several types of stakeholder interactions such as students and staff and the increasing use of social media. The monitoring dashboard needs to be agile to be able to reflect stakeholders' satisfaction from social media.

The perspectives used in the development of the dashboards for QA monitoring are Technology, Organisation, Environment, Business and Social. An extensive literature review was undertaken to determine the factors influencing the pillars used in the development of the holistic HF-HEQ-BI framework for quality monitoring in Higher Education in KSA. The Chapter concludes with a mapping of the HF-HEQ-BI to NCAAA 2018 standards and KPIs in the context of KSA.

4.2 Framework Structure

This section discusses the framework structure and addresses the meaning of a holistic approach and theoretical framework. This section describes how a holistic framework is developed and outlines the process of holistic framework development that will be followed throughout this chapter.

4.2.1 Holistic Approach

Holistic is defined as a philosophy '*characterised by the belief that the parts of something are intimately interconnected and explicable only by reference to the whole'* (Oxford, 2019). It can also be defined as *'an integral approach, which postulates the need for the analysis and evaluation of a system as a complex entity, whereby its individual components are in constant relation with each other, so that the system has a dynamics'* (Högler, 2012, p.25). These definitions of holistic approach can be used to identify an integrated approach that aims to be adaptable according to the different needs of each organisation. These definitions are consistent with the findings of Chapters 2 and 3 which indicated the need for developing a framework that covers multiple perspectives for monitoring QA in HEIs in the context of the KSA.

The holistic approach examines the effect of individual sub-components on each other, which allows the prediction of the expected system behaviour (Högler, 2012). This approach has been used in several studies related to information technology such as Högler (2012), Alharbi et al. (2016), Alaboudi et al. (2015), and Paulussen (2019). A holistic approach is used in studies related to Higher Education such as Patel (2003), Al-Hayani et al. (2010) and Di Pietro et al. (2015). Thus, this research uses a holistic approach for developing the framework for monitoring QA in HEI using BI dashboards in the context of KSA to allow the coverage of multiple perspectives.

4.2.2 Framework Concept

In order to start the process of developing a theoretical framework, a discussion of what is meant by framework and what is considered a framework was initially outlined. It is noteworthy to distinguish between conceptual framework and theoretical framework. Tamene (2016, p.53) defined theoretical frameworks as '*empirical or quasi-empirical theory of social and/or psychological processes, at a variety of levels that can be applied to the understanding of phenomena'*. Tamene (2016, p.51) also defined conceptual framework as a '*network, or a plane, of interlinked concepts that together provide a comprehensive understanding of a phenomenon or phenomena'*. Theoretical frameworks are based on theories that the researcher chooses to guide their research to solve a research problem; it directs the researcher to determine what things to measure and what statistical relationship to look for (Tamene, 2016; Liehr & Smith, 1999). Conceptual frameworks differ from theoretical frameworks as they are derived from concepts rather than theories. Therefore, these concepts link core components that answer research question in order to explain or predict a given event or give a broader understanding of the phenomenon (Tamene, 2016). A theoretical framework is drawn solely from theories while a set of concepts may be drawn from a theory to support the development of a conceptual framework. Figure 4.1 depicts this relationship.

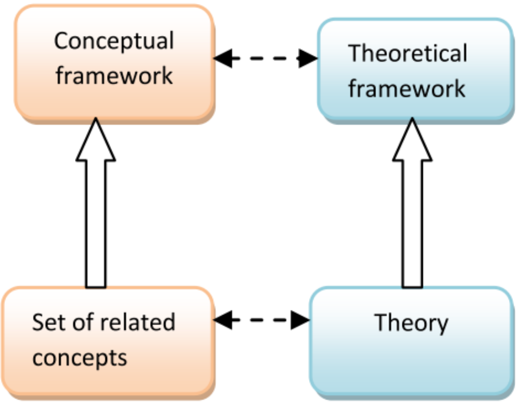


Figure 4.1: Derivation of Conceptual and Theoretical Frameworks (Tamene, 2016)

Some researchers use the term ‘model’ and ‘framework’ interchangeably. Therefore, it can be found in some studies such as Schoten et al. (2016) that they have used the term ‘model’ to describe the proposed framework. Nadler and Tushman (1980, p.36) have addressed the model or conceptual framework as the same thing and defined the model as ‘*a theory that indicates which factors (in an organisation, for example) are most critical or important*’. In addition, Nadler and Tushman (1980) have suggested that the model shows which factors are important for organisational analysis and how these factors are related to each other.

4.2.3 Holistic Framework Development Approach

From the previous discussion of framework and holistic approach, it can be concluded that the holistic framework developed in this study utilises several components that are connected together to serve a specific purpose. For the purpose of this study, the main components and sub-components identified through the literature review for the development of the holistic framework will be called ‘pillar’ and ‘factors’, respectively. The approach for developing the holistic framework will start with the findings of the Literature Review in Chapter 2 and the results of the Gap Analysis as outlined in Chapter 3. The inputs from the literature review and the Gap Analysis will be the basis for understanding the missing components in the current frameworks and will be the building block for the proposed holistic framework. Prior to developing the HF-HQE-BI, a review of theories and theoretical frameworks was conducted. The HF-HEQ-BI development process is shown in Figure 4.2.

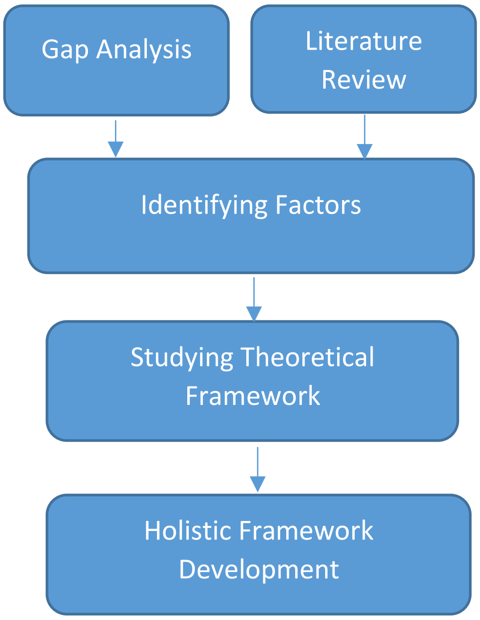


Figure 4.2: Holistic Framework Development Approach

4.3 Theoretical Background

For the purpose of developing the proposed framework, theoretical frameworks in the field of Information Systems have been selected to underpin the concepts of this research and to address the gaps identified in the Gap Analysis as outlined in Chapter 3. This chapter outlines several theoretical frameworks and models, including Technology, Organisation, and Environment (TOE) framework (Oliveira & Martins, 2010; Hatta et al., 2015; Kandil et al., 2018), Technology Acceptance Model (TAM) (Davis et al., 1989; Shore et al., 2018), Unified Theory of Acceptance and Use of Technology (UTAUT) (Ramayasa, 2015; Salah Hashim et al., 2015), Diffusion of Innovation Theory (DOI) (Rogers, 1995; Hatta et al., 2015), Human, Organisation, and Technology fitness (HOT-fit) framework (Kandil et al., 2018; Marques et al., 2010; Ashtari & Eydgahi, 2017), Information System Strategy Triangle (ISST) (Chen, 2012a), and Technology, Organisation, Social model (Hasan et al., 2016). The frameworks and theories reviewed are outlined as follows:

4.3.1 Technology-Organisation-Environment (TOE) Framework

Technology-Organisation-Environment (TOE) framework describes how new innovations in technology that are adopted by organisations are affected by these three aspects. TOE was-initially developed by Tornatzky and Fleischer in 1990 to describe the three main elements that impact the adoption and implementation of new technology innovations (Oliveira & Martins, 2010; Alharbi et al., 2016). The TOE framework is suggested by Hatta et al. (2015) to be used in many aspects outlined as follows:

1. Identifying the application's perceived relative advantage, compatibility, and complexity. In addition to how the BI system supports the main business operation.
2. Studying possible enabling factors that impact enabling of technological innovation.
3. Studying key determinants of organisational innovation adoption.
4. Identifying instrumental determinant candidates for adopting BI systems in the SMEs by leveraging semi-structured interviews with experts.
5. Studying the adoption of different types of IT innovation specified within any of the three aspects of the TOE framework.

There are many studies in the IT field, and in the BI context specifically, that have adopted the TOE framework for the purpose of underpinning the concepts related to the building of the proposed framework. TOE has many implementations in the IT context. Tashkandi and Al-Jabri (2015) developed a model for Cloud Computing in Higher Education adoption based on TOE. Rokanta (2017) used TOE with Porter 5 Forces model to build a competitive advantage model for HEIs.

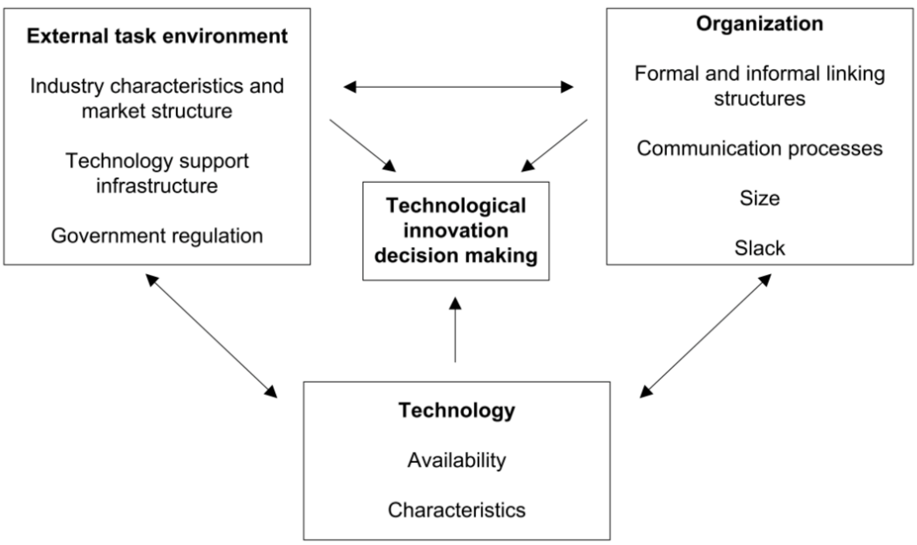


Figure 4.3: Technology, Organisation, and Environment Framework (Oliveira & Martins, 2010)

The three elements presented by TOE are illustrated in Figure 4.3 which describes the adoption of technological innovations in an organisation. These elements are described as follows (Rokanta, 2017):

1. Technology context, which explains the relevant technology that can be used by the organisation, whether internally or externally.
2. Organisation context, which refers to the type and size of the organisation as well as managerial structure. Management's role in communicating the organisational strategy and core values to both internal and external stakeholders is addressed through this context.
3. Environment context, which refers to the business scope in where the company operates, which may include suppliers, competitors, industries, government, and customers.

4.3.2 Technology Acceptance Model

Technology Acceptance Models (TAMs) were developed to describe the users' degree of acceptance of new innovations of technology (Shore et al., 2018). These models are aimed to describe how users of new technologies tend to behave and whether they accept the new technology and use it as intended (Sagan & Grabowski, 2017; Shore et al., 2018). One of the best known of these models, is the Technology Acceptance Model (TAM) introduced by Davis et al. (1989). TAM has been further developed and modified several times by adding external variables and constructs (Sagan & Grabowski, 2017).

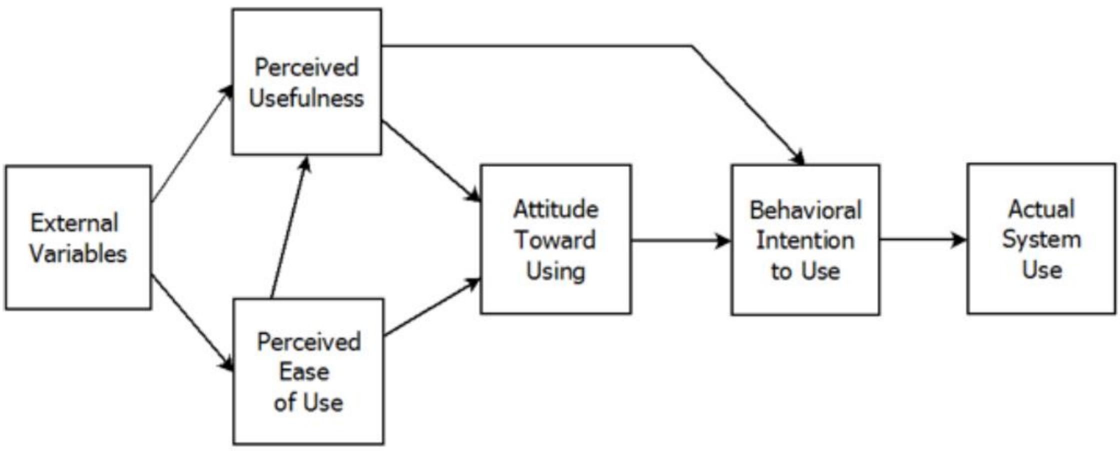


Figure 4.4: Technology Acceptance Model (Davis et al., 1989)

As illustrated in Figure 4.4, TAM shows that actual system use is directly determined by the intentional use, which is related to other determinants that influence the behavioural intentional use (Sagan & Grabowski, 2017). The Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) concepts were introduced by Davis to determine the users' attitude toward using the system and the intentional use (Shore et al., 2018).

4.3.3 Unified Theory of Acceptance and Use of Technology

The Unified Theory of Acceptance and Use of Technology (UTAUT) was extended from TAM to describe the relationship between the four primary determinants of intention and usage and behaviour intention and behaviour of usage as illustrated in Figure 4.5 (Shore et al., 2018). The UTAUT was introduced by Venkatesh et al. (2003) for the purpose of formulating a unified model that integrates elements that are seen to have an effect on the behavioural use of the information system. The UTAUT has been developed based on eight theories and models which are considered the most frequently used models for explaining users' behaviour toward using IT artefacts and their acceptance of its deployment (Sagan & Grabowski, 2017). They have addressed four main constructs, that can be seen on the left side as in Figure 4.5, which are (Shore et al., 2018; Venkatesh et al., 2003):

1. Performance Expectance: refers to the degree to which the individual believes that the system will help them in attaining their job performance.
2. Effort Expectance: refers to the degree of ease of using the system.
3. Social Influence: refers to the degree to which the user perceives using the new system is of importance to others.
4. Facilitating Conditions refers to the technical infrastructure that supports the usage of the system.

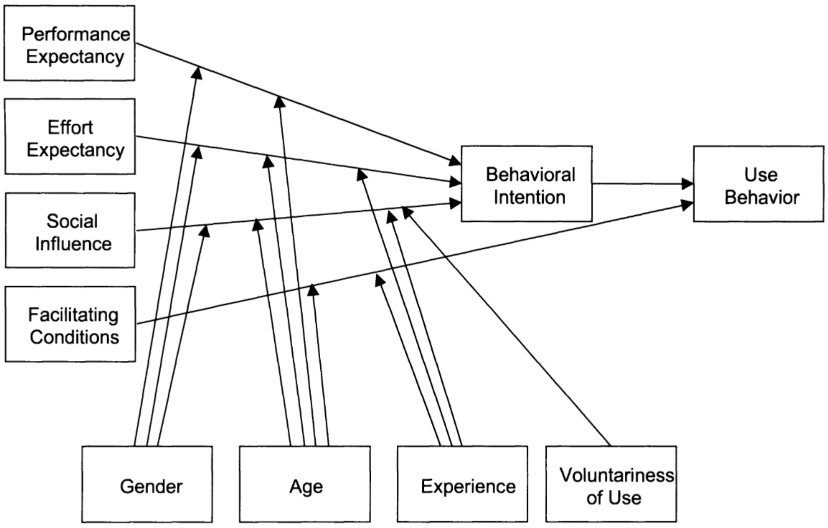


Figure 4.5: Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003)

The theory identified determinants that affects the behavioural intention of the new IT innovation and use behaviour. Gender, Age, Experience, and Voluntariness of Use are factors that affect at least three of the four main constructs of the theory as illustrated in Figure 4.5.

4.3.4 Diffusion of Innovation Theory

The Diffusion of Innovation theory has many applications in the field of BI, and it is considered one of the most significant theories used by researchers while studying adopting models at the enterprise level (Hatta et al., 2015). According to Rogers (1995, p.266), innovativeness is related to '*such independent variables as individual (leader) characteristics, internal organisational structural characteristics, and external characteristics of the organisation'*. This relationship is described in Figure 4.6. This description reflects the role of leader characteristics in adopting new innovations in the organisation. The organisational specific internal characteristics contribute to affect the degree to which the organisation can adopt new innovations in IT successfully.

The theory describes the diffusion of the new innovations that are communicated through certain channels over the time '*among the members of social systems'* (Rogers, 1995). It reflects the importance of social system as a channel of communication in the organisation that eases the spread of the new innovations of technology. External characteristics of the organisation refers, according to this theory, to the system openness (Oliveira & Martins, 2010).

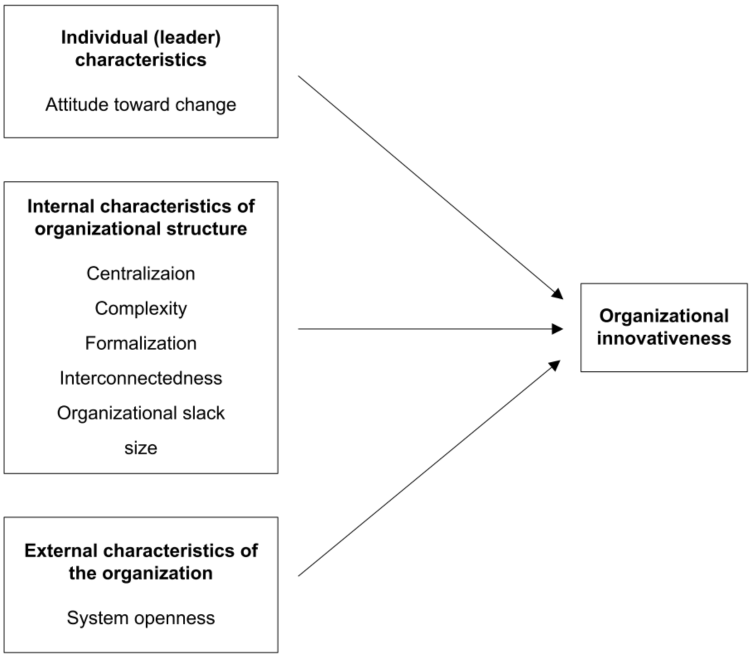


Figure 4.6: Diffusion of Innovations (DOI) Theory (Rogers, 1995)

4.3.5 Human, Organisation, and Technology Fit (HOT-fit) Framework

HOT-fit originated from the Delone and McLean Information Systems Success Model and the IT-Organisation Fit model. It describes how the organisation benefits from adopting IT solutions for healthcare providers. It defines three main factors that affect the successful implementation of Health Information Systems, which are Human, Organisation, and Technology (Erlirianto et al., 2015; Ashtari & Eydgahi, 2017). This model considers human factors as being important while adopting new technologies in the organisation as the TOE framework fails to address the role of human aspect in the IT developments (Alharbi et al., 2016).

While HOT-fit was developed for evaluating Health Information Systems, it recognises the role of the Human aspect in accepting the new innovations in IT (Ramayasa, 2015; Alharbi et al., 2016). Healthcare providers are patient-centric, which has similarities to HEIs which are student-centric organisations; the use of the HOT-fit model will be related to portraying the organisational factors that affect the acceptance of new technologies in customer-centric organisations (Marques et al., 2010). The HOT-fit model does not consider outside factors that affect the organisation while adopting new technologies, which is considered a drawback for this theoretical framework. Therefore, some researchers find that adding Environment factor to the framework can fill this gap. Marques et al. (2010) combined the TOE framework and HOT-fit to represent the Environmental issues in addition to the HOT-fit pillars. This has the advantage of including the Human aspect, which is mentioned in HOT-fit, and the Environment aspect, which is represented by TOE. Alharbi et al. (2016) did the same thing by merging HOT-fit with TOE and Information Systems Strategy Triangle (ISST) to benefit from the Business aspect represented by ISST.

4.3.6 Information Systems Strategy Triangle

The Information Systems Strategy Triangle (ISST) conveys the importance of Business strategy in IT developments for organisations (Pollack, 2010; Alharbi et al., 2016). As illustrated in Figure 4.7, the ISST triangle depicts business strategy at the top of the diagram to represent that Organisational Strategy and Information Strategy both are being developed under the influence of Business Strategy (Pollack, 2010; Rusu & Mekawy, 2010). The Business element starts with the initiation of the organisational mission as the organisational mission drives the whole business toward the achievement of a set of objectives (Pollack, 2010). One of the drawbacks of TOE framework is that it does not take into consideration the Business effect on the IT innovations (Alharbi et al., 2016). Therefore, Alharbi et al. (2016) modified ISST and integrated both the TOE and HOT-fit to cover the missing elements in these frameworks.

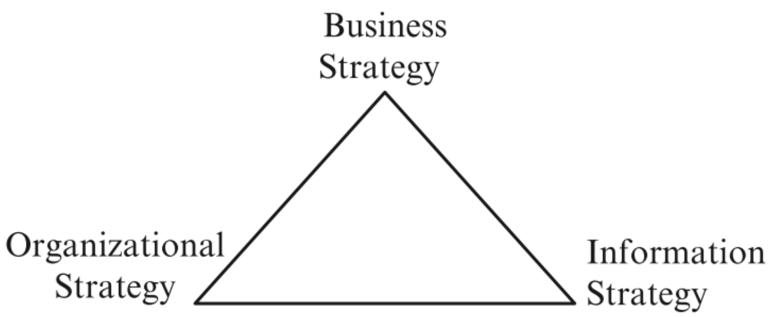


Figure 4.7: Information Systems Strategy Triangle (Rusu & Mekawy, 2010)

Business strategy is considered an essential element for QA as discussed in Chapter 2 in Section 2.3.6. The HEI needs to craft its own mission that drives the whole organisation towards the desired goals and objectives. In addition, the strategy drives the QA processes to assure that performance is in compliance with the objectives in order to realise the mission.

4.3.7 Technology, Organisation, and Social Model

The role of social software applications such as wikis, weblogs, and social media is becoming increasingly important for organisations to share knowledge and capabilities (Kügler et al., 2013). The social media discussed in Section 2.9 in Chapter 2 play an essential role in HE quality as researched by Qiu et al. (2015, 2016). The application of BI systems in the context of HE constitutes the consideration of three factors according to the model proposed by Hasan et al. (2016) as illustrated in Figure 4.8, which are Organisational factors, Technological factors, and Social factors. The idea behind this model is that the HEI should consider the connection between superior and operational levels of management in the HEI hierarchal levels. This connection ensures that the BI strategy is successful and achieves its objectives. It helps top management to influence the other levels to use BI in their practice, which develops the willingness to adopt the BI system (Hasan et al., 2016).

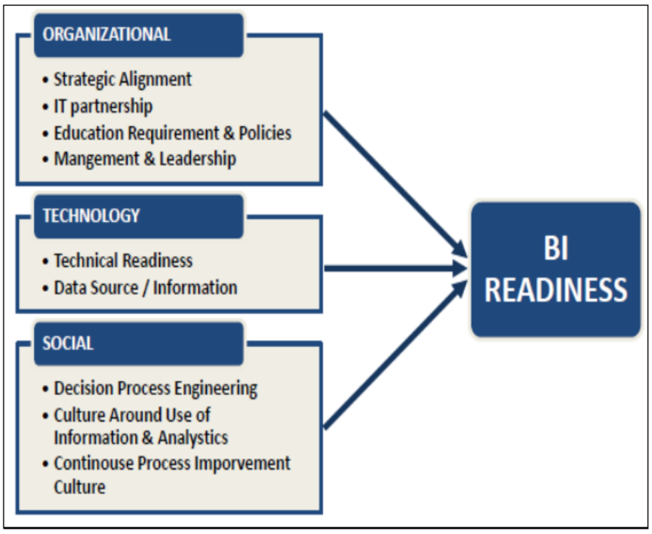


Figure 4.8: Technology, Organisation, and Social BI Readiness Model (Hasan et al., 2016)

4.4 Holistic Framework for Monitoring HF-HEQ-BI Monitoring

This section describes the main pillars that constitute the holistic framework for monitoring QA in the HEIs using BI. These pillars have been underpinned by the theoretical frameworks that have been reviewed for this purpose in Section 4.3. The pillars used to build the framework are based on the requirements of the new proposed framework which has been addressed in the literature review in Chapter 2 and in Gap Analysis in Chapter 3.

4.4.1 Framework Development

From the discussion outlined in Section 4.3, three well-documented frameworks, namely the Technology, Organisation, and Environment (TOE) framework, Information System Strategy Triangle (ISST), and Human, Organisation, and Technology fitness (HOT-fit) framework have been selected to address the issues outlined in the Gap Analysis in Chapter 3. These three theoretical frameworks cover the factors that are outlined in the NCAAA 2018 standards such as technological infrastructure, organisational strategy, and human elements. Several researchers have used a combination of frameworks, theories, and models to support the development of frameworks in related fields such as Alharbi et al. (2016) in Cloud Computing adoption framework for healthcare providers. Grandhi et al. (2019) used TOE and HOT-fit for Cloud Computing security, Maroufkhani et al. (2020), used the TOE, DOI, and Resource-Based View theoretical frameworks for SMEs. Alaboudi et al. (2015) developed a framework for supporting decision making for healthcare organisations for telemedicine networks in KSA, and Tashkandi and Al-Jabri (2015) used TOE to study the adoption of Cloud Computing in the context of Higher Education.

The Unified Theory of Acceptance and Use of Technology (UTAUT) addresses factors contributing to the acceptance of adopting new systems and how organisations are dealing with problems regarding the resistance of using new systems. The UTAUT is used to underpin the concepts for development of the holistic framework as researchers like Ramayasa (2015) used UTAUT and HOT-fit for the development of an evaluation model for the success and acceptance of E-Learning. Hatta et al. (2015) used the TOE framework with DOI theory to present Business Intelligence system adoption model in Small and Medium-sized Enterprises (SMEs).

HEIs interact with several stakeholders in society such as students and their parents and alumni (NCAAA, 2018). Stakeholders are increasingly expressing their opinions via Social Media channels toward the quality of services provided by the HEI such as Twitter platform in KSA. The traditional Human Element in innovation and adoption theories do not sufficiently reflect the increasing role of social media in organisations and how it interacts with the HEI system. Consequently, adding a social perspective (pillar) reflects a more comprehensive and inclusive perspective to represent stakeholders' interactions including those expressed through social media. The Diffusion of Innovation theory (DOI), Unified Theory of Acceptance and Use of Technology (UTAUT), and Technology, Organisation, Social (TOS) models were used to support changing 'Human' perspective in the proposed framework to 'Social' pillar. The resulting five pillars of the proposed Holistic Framework for monitoring Higher Education Quality using BI dashboards (HF-HEQ-BI) in the context of KSA is depicted in Figure 4.9. The colours assigned to each pillar of the HF-HEQ-BI in Figure 4.9 framework will be presented in subsequent tables to reflect association to the pillars.

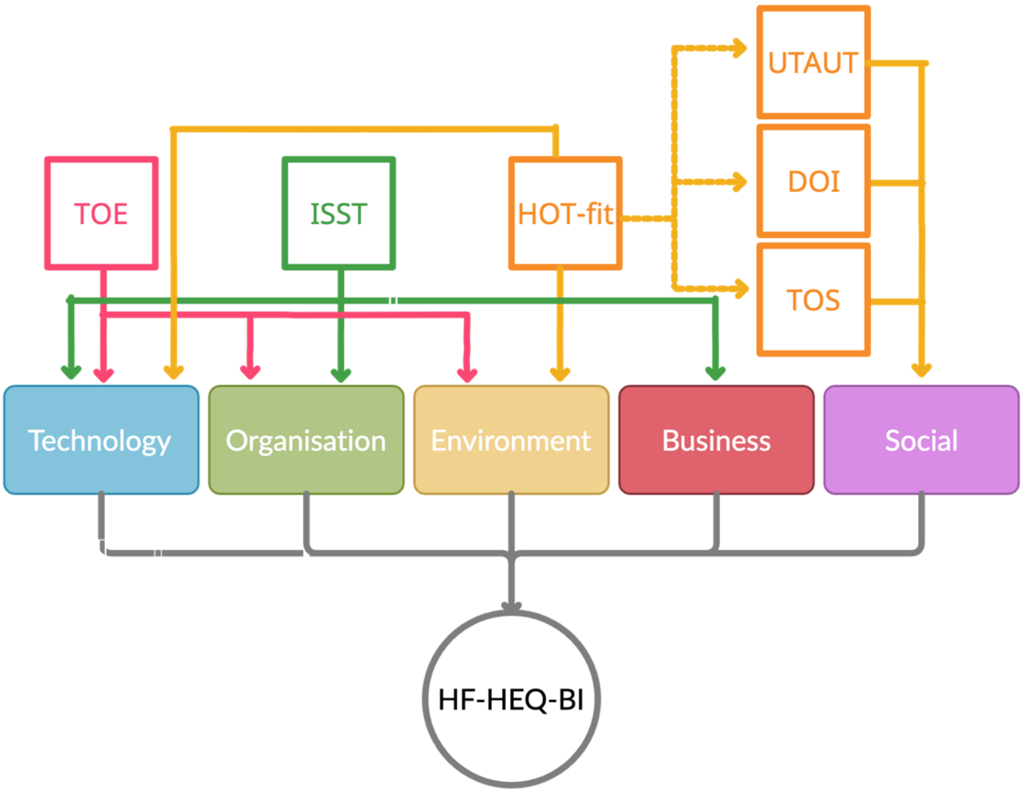


Figure 4.9: Theoretical Underpinning of HF-HEQ-BI monitoring framework

From the previous discussion in Section 4.3 and the discussion in Chapters 2 on the literature review and Chapter 3 on the Gap Analysis, the holistic framework has been developed as illustrated in Figure 4.9, and the main pillars of the framework were identified based on theoretical underpinning of well-known frameworks. The pillars which contribute to the design of BI dashboard for monitoring quality in HE in the context of KSA are outlined be as follows:

1. **Technology Pillar**
   As discussed in Chapter 3, the main purpose of the HF-HEQ-BI monitoring is to deploy BI dashboards for the purpose of assisting decision-makers to make appropriate decisions regarding the continuous development of HE quality. The use of notifications systems and dashboard monitoring that is connected to the real-time database will require investing in the technological infrastructure. As discussed in Chapter 2 in Section 2.10, there are several BI architectures that HEIs can implement for adopting BI systems. Therefore, this technological issue must be addressed by the management while deciding on the implementation of the system. In addition, data management and data quality are essential for ensuring successful BI implementation (Magaireah et al., 2017). The HEI may consider presenting the outputs of

the BI system through the use of Dashboards, which allows visualisation of the QA performance, and/or benchmarking (See Appendix A for NCAAA benchmarking example) or Balanced Scorecards (Kaplan et al., 2004), and the ability to generate specialised reports as required and discussed in the Gap Analysis outlined in Chapter 3. The HEI may choose to analyse data through Online Analytical Processing (OLAP) techniques, data mining, or even using text mining and sentiment analysis to deal with Social Media data.

2. **Organisation Pillar**

The HEI, as an organisation, needs to consider specific factors to be able to fulfil QA standards and successfully implement the BI system. Among these factors, there should be deployment of safety standards (O'Leary, 2012), assuring administrative services quality (Tsinidou et al., 2010), crafting curriculum structure (Tsinidou et al., 2010), effective management (Magaireah et al., 2017; Persson & Sjoo, 2017), innovation (Hasan et al., 2016), leadership (Persson & Sjoo, 2017), and deployment of quality culture (Magaireah et al., 2017; Persson & Sjoo, 2017).

3. **Environment Pillar**

HEIs operating in the context of the KSA are obligated to follow the standards and requirements imposed by the Ministry of Education and the NCAAA for the purpose of assuring quality. The National Qualifications Framework (NQF) is the main input for the QA system as all HEIs are required to develop their curriculums according to the NQF. The NQF is one of the main missing factors that was identified in the Gap Analysis outlined in Chapter 3. The external stakeholder's interaction is considered an important requirement of the QA system; for example, several organisations and entities from outside the HEI, such as government agencies, may interact with and influence the HEI. The challenges that the external environment present to the HEI include elements such as globalisation (Keçetep & Özkan, 2014), economic, political, and socio-cultural aspects (Brookes & Becket, 2007) as well as the fitness of the programme for its purpose (O'Leary, 2012) and the HEI location (Tsinidou et al., 2010).

4. **Business Pillar**

As discussed in Chapter 2 in Section 2.6, cost is one of the issues that HEIs need to take into consideration when implementing QA systems, particularly in the private sector. While NCAAA requires HEIs to adopt the quality standards, some institutions may find these operations to be costly and need additional financial resources. In addition, quality assurance itself requires the institution to have sound policies for financial monitoring and disbursements. The QA activities require all managerial levels in the organisation to be working together for the purpose of achieving quality. There are set of KPIs that HEIs are required to measure their performance against them in order to ensure the minimum level of quality. HEIs are operating, from a business perspective, in a competitive market where the institutions are trying to provide the best programmes and services for students. Therefore, gaining competitive advantage can give them an edge toward the achievement of the organisational mission (Rokanta, 2017). The academic quality of teaching and learning needs to be considered as part of the HEI business processes for ensuring the quality of teaching and services provided as well as the management of costs associated with the resources used for the educational process (Cao & Li, 2014a; Magaireah et al., 2017; Qushem et al., 2017b).

5. **Social Pillar**

   It is necessary to distinguish between the Social element from a psychological perspective, which includes organisational behaviour, leadership, and personal characteristics (individual level) (Ramayasa, 2015) and the Social element from an organisational perspective. Social element from an organisational perspective is wider than focusing on individual characteristics as it is concerned with the social relationship between the HEI and the environment in where it operates as well as human characteristics and the Social Media aspect (Hasan et al., 2016; Qiu et al., 2016). The purpose of replacing the Human element of HOT-fit with Social is to describe the fact that HEIs are affected by both Human elements, as described in HOT-fit, as well as the social media channels, which affect the information gathered for the purpose of monitoring QA processes. In addition, HEIs are moving toward being student-centred and community-oriented, so monitoring social interactions with individuals and with community organisations which occur both internally and externally are essential for quality processes (Hamdy & Anderson, 2006). Consequently, in the HF-HEQ-BI framework, the pillar, Social elements comprise Human characteristics that affect the acceptance of the new system as well as the social culture that also has an effect on the institutional relationship.

4.4.2 Systematic Literature Review of Factors affect the Design of Business Intelligence and Quality in Higher Education

For the purpose of reviewing the factors that affect the design of Business Intelligence dashboards and Quality Assurance systems in HE, a systematic review of literature was conducted to determine the factors that affect the design. A Systematic Literature Review (SLR) is a '*means of identifying, evaluating and interpreting all available research relevant to a particular research question, or topic area, or phenomenon of interest'* (Kitchenham, 2004). The SLR consists of several stages illustrated in

Figure 4.10. The SLR process has been used by Dzulfikar et al. (2018) in identifying the factors that affect the implementation of Enterprise 2.0 through the Information Systems adoption model.

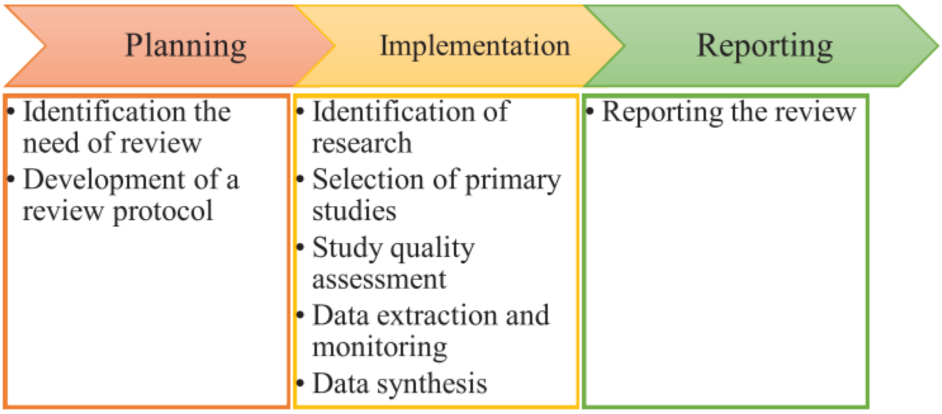


Figure 4.10: Systematic Literature Review Process (Dzulfikar et al., 2018)

1. **Planning**

As seen in Figure 4.10 Planning process encompasses the identification of the need for review and the development of a review protocol. The need of this review is to determine the factors that affect the design of quality monitoring system using Business Intelligence dashboards. The review protocol conducted throughout this chapter is to select the studies that discussed the factors that affect the design of the BI or QA systems in HE. The inclusion criteria used in Chapter 3 in Section 3.2 were used for the purpose of conducting this literature review.

This study followed the approach used in related studies such as Telford and Masson (2005), Angell et al. (2008), Teeroovengadum et al. (2016), and Kandil et al. (2018). The factors that affect the design of BI dashboards or QA systems in HE were addressed through a literature review for the purpose of developing a framework. All the factors identified through the literature review and selected for the purpose of developing the HF-HEQ-BI framework will be linked with one of the five pillars (Technology, Organisation, Environment, Business, Social) identified in Section 4.4.1 in this chapter.

2. **Implementation**

Implementation of the SLR encompasses identification of research, selection of primary studies, study quality assessment, data extraction and monitoring, and data synthesis as illustrated in Figure 4.10. A set of keywords were used to identify studies that discussed the factors that affect the design of QA and BI systems in HE; the keywords used were as follows:

((("higher education") OR ("universities") OR ("higher education institutions")) AND (“saudi arabia”) AND (("quality") OR ("quality assurance") OR ("QA")) AND ((“dashboards”) OR (“business intelligence”)) AND ((“factors”) OR (“factors affecting”)))

Staffordshire University’s Online Library, scientific databases, and Google Scholar have been used for retrieving the results. Peer-reviewed articles that discussed the factors that affect the design of QA and BI systems in HE were reviewed. All factors addressed by these studies were considered in this study.

3. **Reporting**

Table 4.1 shows a summary of the HF-HEQ-BI framework and the factors that are related to each pillar of the framework. The initial HF-HEQ-BI framework will be further improved and enhanced by validation processes that are discussed in Chapters 5 and 6 through consultation with experts in QA in HEIs and surveying practitioners of QA to reflect their opinions on the proposed framework. The colour scheme in Table 4.1 matches the HF-HEQ-BI framework pillars as outlined in Section 4.4.1 and depicted in Figure 4.9.

Table 4.1: HF-HEQ-BI Pillars and Associated Factors

HF-HEQ-BI (Theoretical Pillars)	Factors – Related to QA and BI Systems Design	References
Technology	Methods (BI Architecture)	(O'Leary, 2012)
	Technical Infrastructure	(Tsinidou et al., 2010; Magaireah et al., 2017)
	Data Management	(Scholtz et al., 2018)
	Data Quality	(Magaireah et al., 2017; Bentley, 2017)
	Data Sources	(Qiu et al., 2016; Li et al., 2017)
	Analysis Methods	(Scholtz et al., 2018)
	Notifications	(Chaudhuri et al., 2011; Pinheiro, 2014)
Organisation	Safety	(O'Leary, 2012)
	Administration Services	(Tsinidou et al., 2010)
	Library Services	(Tsinidou et al., 2010)
	Curriculum Structure	(Tsinidou et al., 2010)
	Facilities	(Tsinidou et al., 2010)
	Management	(Magaireah et al., 2017; Scholtz et al., 2018; Persson & Sjoo, 2017; Bentley, 2017; Qushem et al., 2017b)
	Innovation	(Hasan et al., 2016)
	Strategic Alignment	(Scholtz et al., 2018; Cervai et al., 2015)
	Leadership	(Persson & Sjoo, 2017; Cervai et al., 2015)
	Culture	(Magaireah et al., 2017; Persson & Sjoo, 2017)
	Partnership	(O'Leary, 2012; Cervai et al., 2015)
	Administrative Quality	(Cao & Li, 2014b)
Environment	Fitness	(O'Leary, 2012)
	Location	(Tsinidou et al., 2010)
	Career prospects	(Tsinidou et al., 2010)
	Economy	(Brookes & Becket, 2007)
	Politics	(Brookes & Becket, 2007)
	Socio-culture	(Brookes & Becket, 2007)
	Globalisation	(Keçetep & Özkan, 2014; Abu-Al-Sha'r & AL-Harahsheh, 2013)
	Competition	(Keçetep & Özkan, 2014)
	QA Standards	(Denwattana & Saengsai, 2016)
	NQF	(Smith & Abouammoh, 2013; Denwattana & Saengsai, 2016)
Business	Purpose	(O'Leary, 2012)
	Requisite resources	(Persson & Sjoo, 2017)
	Financial factors	(Keçetep & Özkan, 2014)
	Costs	(Keçetep & Özkan, 2014; Hong & Songan, 2011)
	Competitive advantage	(Rokanta, 2017)
	Process	(Magaireah et al., 2017; Qushem et al., 2017a)
	KPIs	(Zulkefli et al., 2015)
	Academic Quality	(Cao & Li, 2014b; Brochado, 2009; Silva et al., 2017)
Social	Motivation	(O'Leary, 2012)
	Team	(O'Leary, 2012)
	Academic Staff	(Tsinidou et al., 2010)
	Human elements	(Owino et al., 2014)
	Reputation	(Brochado, 2009; Silva et al., 2017)
	Social media	(Qiu et al., 2016; Hasan et al., 2016)
	Stakeholders Interactions	(Scholtz et al., 2018)
	Relationship Quality	(Cao & Li, 2014b)

4.4.2 Holistic Framework for Monitoring Quality in Higher Education using Business Intelligence Dashboards (HF-HEQ-BI)

Figure 4.11 illustrates the proposed HF-HEQ-BI monitoring framework. The framework is seen to take the Chandelier shape as the rationale behind the proposed framework is to 'light up' the decision-making through providing a monitoring dashboard for decision-makers. The HF-HEQ-BI framework identifies the main pillars of the framework and factors that are associated with each pillar according to the outputs of the literature review and the Gap Analysis.

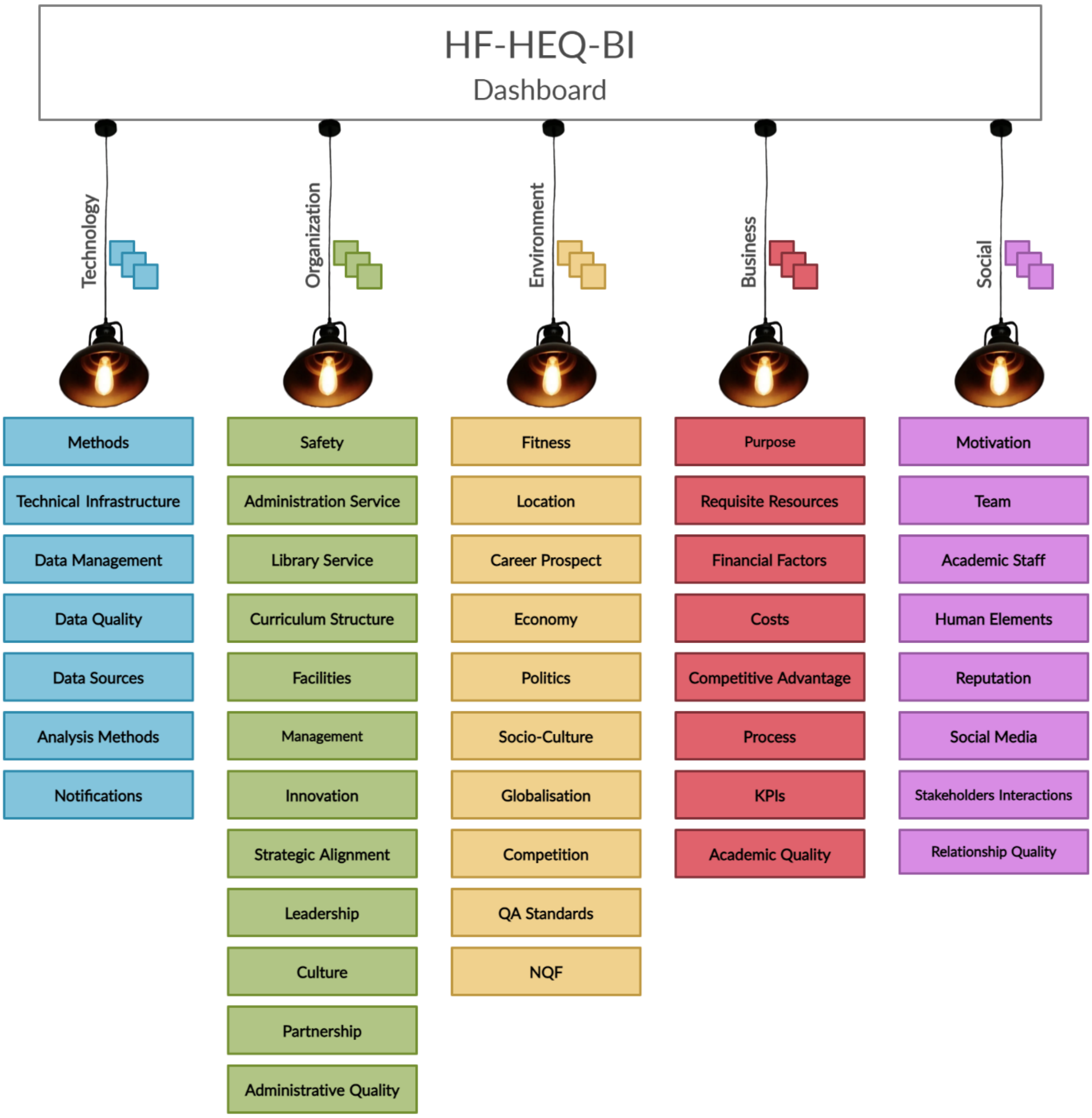


Figure 4.11: Holistic Framework for Monitoring Quality in Higher Education using Business Intelligence Dashboards (HF-HEQ-BI)

4.5 Framework Alignment to NCAAA

The proposed framework in Figure 4.10 shows the five pillars of the HF-HEQ-BI framework. These pillars were mapped to the eight mandatory QA 2018 standards which are imposed by the NCAAA (NCAAA, 2018), as discussed previously in Chapter 2. Table 4.2 shows the pillars-standards mapping.

Table 4.2: Mapping HF-HEQ-BI pillars to NCAAA standards

Standard No.	Quality Standards	Pillar
1	Mission, Vision, and Strategic Planning	Organisation
2	Governance, Leadership, and Management	Organisation
3	Teaching and Learning	Business, Environment
4	Students	Social, Business, Organisation
5	Faculty and Staff	Organisation
6	Institutional Resources	Technology, Business
7	Research and Innovation	Social, Business
8	Community Partnership	Environment, Social

After mapping the five pillars of the HF-HEQ-BI as in Table 4.2, all the standards can be mapped to one or more of the pillars of the proposed framework. In order to make the mapping more relevant to the NCAAA standards, Table 4.3 shows the mapping of the five pillars of the HF-HEQ-BI framework to the 23 KPIs that are a mandatory requirement by NCAAA in KSA context for QA monitoring.

The mapping in Table 4.3 shows that the KPIs can be mapped to the pillars and KPIs of the proposed HF-HEQ-BI framework. This mapping indicates that the pillars can cover the requirements of the KSA quality standards that are applied to the HEIs. This mapping is not intended to be a validation of the proposed framework, but it shows that the framework covers the areas that the NCAAA mandates HEIs are required to adhere to in the context of QA monitoring in KSA. Further qualitative and quantitative validation of the proposed framework will be conducted in Chapters 5 and 6.

Table 4.3: Mapping HF-HEQ-BI pillars to NCAAA KPIs

NCAAA Standard Numbering	NCAAA KPI	Pillar
KPI-I-01	Percentage of achieved indicators of the institution strategic plan objectives	Organisation
KPI-I-02	Proportion of accredited programmes	Organisation
KPI-I-03	Students' evaluation of quality of learning experience in the programs	Business
KPI-I-04	First-year students retention rate	Business
KPI-I-05	Graduates' employability and enrolment in postgraduate programs	Environment
KPI-I-06	Graduation rate for Undergraduate Students in the specified period	Business
KPI-I-07	Satisfaction of beneficiaries with learning resources	Business
KPI-I-08	Employers' evaluation of the institution graduates proficiency	Social
KPI-I-09	Annual expenditure rate per student	Business
KPI-I-10	Students' satisfaction with the offered services	Organisation
KPI-I-11	Ratio of students to teaching staff	Organisation
KPI-I-12	Proportion of faculty members with doctoral qualifications	Organisation
KPI-I-13	Proportion of teaching staff leaving the institution	Organisation
KPI-I-14	Percentage of self-income of the institution	Business
KPI-I-15	Satisfaction of beneficiaries with technical services	Technology
KPI-I-16	Percentage of publications of faculty members	Social
KPI-I-17	Rate of published research per faculty member	Social
KPI-I-18	Citations rate in refereed journals per faculty member	Social
KPI-I-19	Number of patents, innovations, and awards of excellence	Business
KPI-I-20	Proportion of the budget dedicated to research	Business
KPI-I-21	Proportion of external funding for research	Business
KPI-I-22	Satisfaction of beneficiaries with the community services	Social
KPI-I-23	Rate of community programs and initiatives	Environment

4.6 Conclusion

This Chapter presented the development of a holistic framework for monitoring QA processes in HEIs using BI dashboards, which is referred to it in the chapter as HF-HEQ-BI. The framework has been developed with underpinning from theoretical frameworks and models. The main goal was to address the gaps identified and discussed in the Gap Analysis in Chapter 3.

The developed proposed holistic framework pillars from the Systematic Literature Review outlined in this chapter are Technology, Organisation, Environment, Business, and Social. These pillars were mapped to the NCAAA standards and institutional KPIs 2018 (NCAAA, 2018). However, the holistic framework requires additional validation through gathering opinions from experts and practitioners in QA field in HE, which will be presented in Chapters 5 and Chapter 6. These factors will be validated qualitatively by seeking the opinion of experts through focus group interviews conducted and discussed in Chapter 5. The factors will be further validated and outlined throughout a quantitative survey of QA practitioners in HE in Chapter 6.

Chapter 5 : Qualitative Analysis of Factors Affecting Monitoring Quality in Higher Education Institutions

5.1 Introduction

This chapter discusses a qualitative validation of the proposed Holistic Framework for Monitoring Quality in Higher Education using Business Intelligence Dashboards (HF-HEQ-BI). The proposed HF-HEQ-BI presented in Chapter 4 outlines the main pillars as discussed in Sections 4.2.2 and 4.2.3 and the factors which are discussed in Section 4.2.1 that had been identified from the literature review. The framework validation process began with the mapping to NCAAA standards discussed in Chapter 4 and continues with qualitative validation of the framework with a panel of experts. This chapter starts by addressing the purpose of this investigation and the design of the interview questions. In addition, the chapter discusses the modifications of the factors from the perspective of the findings from the panel of experts' interviews. Finally, the Chapter addresses the modifications to the HF-HEQ-BI Framework after analysing the responses of the interviews.

5.2 Purpose of Investigation

The purpose of the investigation described in this chapter is to develop an understanding of the factors that affect the design of Business Intelligence (BI) systems for monitoring Quality in Higher Education. The findings of this investigation enhance the HF-HEQ-BI Framework by examining the factors from the experts' point of view. The HF-HEQ-BI described in Chapter 4 was developed based on underpinning theoretical frameworks, which resulted in a 5 pillars framework. The factors affecting the design of BI dashboards that are related to each pillar were identified through investigating the literature. Factors were then allocated to the appropriate pillar based on relevance as understood by the researcher. Therefore, the first step is to conduct expert interviews to understand whether each factor is associated with the appropriate pillar and whether an identified factor should be taken into consideration when designing the dashboard. Then, a questionnaire will be conducted, as outlined in Chapter 6, for the purpose of further validation of these factors through a quantitative survey of practitioners.

The validation process is defined as *'the process of ensuring that the model is sufficiently accurate for the purpose at hand'* (Carson, 1986). The purpose of validation is to assure that the components in the framework are appropriately sufficient for the intended application of the framework (Beecham et al., 2005). The process of validation of the proposed HF-HEQ-BI framework will go through two stages. The first stage will encompass conducting qualitative convergent interviews, and the second stage will consist of a quantitative survey using a questionnaire. Convergent interviews are believed to be the most appropriate form of qualitative investigation for gathering required information (Angell et al., 2008; Williams & Lewis, 2005). Starting by interviewing a panel of experts through convergent interviews is useful in the early stages of a research project when little information is known about the subject area (Angell et al., 2008). Therefore, it was considered to be more appropriate to start by interviewing a panel of experts before surveying practitioners.

The process of interviewing a panel of experts has been used by Muller et al. (2010) in identifying opportunities and limitations of using Service Oriented Business Intelligence (SoBI) architecture. In addition, Jahatigh et al. (2018) interviewed practical experts and academics to identify the main dimensions of BI. Angell et al. (2008) has also used interviewing a panel of experts in identifying factors of service quality in postgraduate Higher Education.

As the HF-HEQ-BI Framework was developed initially based on previous literature, the factors identified throughout the process had been addressed by previous research. For the purpose of determining whether these factors are related to monitoring Quality in HE while designing a BI system, a panel of experts' opinions is required. After gathering the experts' opinions on the qualitative aspects, appropriate modifications of the proposed framework will be conducted.

5.3 Investigation Design

The researcher interviewed a panel of experts to study the factors affecting the design of BI systems for monitoring quality in HE. This section discusses the process from the interview design to the results and the modifications of the proposed framework (Carson et al., 2001; Angell et al., 2008).

5.3.1 Interview Design

For the purpose of validating the framework, semi-structured interview questions were developed to seek the opinion of experts in quality in HE concerning the framework and factors. The questions are divided into four parts. The first part of the interview questions collects demographic information about the participant such as the type of HEI in which they were working and their level of experience in QA. The second part asks the participant general questions about barriers and limitations in current QA systems in HE. The third part takes the experts' opinions on the proposed framework and asks them to express their thoughts regarding the factors that affect the design of QA systems in HE. Finally, the interview ends with general questions and asks the experts for any comments they may wish to make.

The interview questions do not contain any questions that reveal any personal information or details about the participant or their organisations to ensure confidentiality. The interview questions were reviewed by two expert professors in QA in Saudi Arabian Universities to ensure the reliability and validity of interview questions. In addition, ethical approval had been obtained before conducting the interviews from the Research Ethics Committee at Staffordshire University on 18.03.2020 (See Appendix B).

The interviews were planned to be conducted in a Face-to-Face manner or through online meetings, but due to COVID-19 pandemic, the lockdown in almost all countries around the world led to all of these interviews being conducted online.

5.3.2 Participant Selection

According to Muller et al. (2010), there are several requirements that experts should possess before selecting them for the interview process. Among these requirements, they should have knowledge and experience in the area under investigation, willingness to participate, and effective communication skills. For the purpose of this research, participants had been selected based on their experience in quality in Higher Education, and some of them have used Business Intelligence dashboards for monitoring performance in general.

Experts selected for the purpose of this study have considerable experience in quality in HE, and 60% of the participants were currently working, or have previously worked, in HEIs in Saudi Arabia and have experience of quality systems in Saudi Arabia. The participants have experience of QA in HE in Saudi Arabia and the United Kingdom, Egypt, United States of America, Australia and India. All data related to the interviews have been anonymised. According to Beecham et al. (2005), only a small sample of experts is required and can be used in the early stages of work. Belbin (1981) suggested that an interviewing panel of experts from 8 to 10 is sufficient for this purpose which is also supported by Beecham et al. (2005). Nielsen (1994) suggested that five participants is the ideal number for conducting interviews while a focus group can be conducted within the range of six to nine participants. Additionally, Lazar et al. (2017) suggested that five participants in interviews would be sufficient. Therefore, ten participants were selected for interview in this research. Their academic level ranging from Lecturer to Professor while their managerial positions ranged from QA unit head to Vice Chancellor. Four of the participants were practitioners in international HEIs while six of them have experience in HEIs in the KSA. Table 5.1 summarises demographic data about the participants.

Table 5.1: Participants' Demographics

Participants' Demographics		Years
Academic Level	Professor Associate Professor Assistant Professor Lecturer	7 1 1 1
Managerial Position	Head of Department Vice Dean for Quality Assurance Other (Programme Director) Quality Assurance Unit Head Other (Vice Chancellor) Other (Not Applicable)	3 2 1 2 1 1
Quality Assurance Experience	HE related quality average years One participant also had 6 years of Non-HE related QA experience	14
HEI Type	Public University years of experience average Private University (4 participants) Private Colleges (1 participant)	19 10 7

5.3.3 Interview Procedure

For the purpose of conducting interviews in this research project, Carson et al. (2001) guidelines have been applied. Angell et al. (2008) also used these guidelines while studying service quality factors in postgraduate education in the UK. These guidelines are:

1. Planning for the interview
2. Starting the interview
3. Managing the interview
4. Follow-up interviews
5. Analysis of data

The interview started by giving a standard brief outline of the research project to describe to the interviewees what is meant by Business Intelligence dashboards. The presentation showed an example of dashboards and why dashboards are used for reporting and how this approach can assist in decision-making. The presentation showed the proposed HF-HEQ-BI framework, and the researcher described the main pillars and the factors associated with each pillar and the process of development of the framework through a literature review. Following Carson et al. guidelines, the interviews were undertaken as follows:

1. Planning for interview: The interview questions were designed to evaluate the proposed HF-HEQ-BI by interviewing a panel of experts in Quality in HE. The questions were related directly to the HF-HEQ-BI and its factors. The discussions were aimed to get their opinion regarding

the factors and framework pillars and whether these are appropriately associated. Approval for conducting the interviews was obtained from Staffordshire Ethics Committee on 18.03.2020.

2. Starting the interview: the researcher started the interview by giving a PowerPoint presentation to all participants. The researcher explained how the proposed HF-HEQ-BI had been developed through literature review and that the objective of these interviews was to validate the framework.
3. Managing the interview: the researcher described the HF-HEQ-BI main pillars (Technology, Organisation, Environment, Business, and Social) and the factors associated with each pillar. The researcher asked the demographic questions of the interviewee and showed a table which contains each pillar and the factors associated with that pillar (See Interview Questions with sample responses in Appendix C). The interviewee reviewed the factors and was given the opportunity to comment on them (addition, deletion, or modification of factors).
4. Follow-up Interviews: the interviewees were sent a transcript of their responses by email or WhatsApp (as they prefer) to give them the opportunity to either agree on the transcript or add additional comments if they needed. (See Appendix C for a sample of transcript of one participant).
5. Analysis of data: data was then transformed into NVivo12 software for analysis and the results are outlined in Section 5.4 in this chapter.

5.4 Data Analysis

This section addresses the results of data analysis and presents summaries of participants' opinions. It also describes Computer Assisted Qualitative Data Analysis Software (CAQDAS) and why the researcher used NVivo12 for the purpose of conducting data analysis of data gathered through interviews. For the purpose of analysing responses from experts, thematic analysis can be used to determine common themes in data (Cassel & Symon, 2004). However, Computer Assisted Qualitative Data Analysis (CAQDAS) can assist in conducting qualitative data analysis as it provides faster and more quantitative analysis in interpreting data and classification of data and the generation of themes (Welsh, 2002; Saillard, 2011).

5.4.1 Computer Assisted Qualitative Data Analysis Software (CAQDAS)

Computer Assisted Qualitative Data Analysis Software (CAQDAS) assists researchers in reflecting an accurate picture of their results as it provides mechanisms for auditing the data (Welsh, 2002). The qualitative data transcripts that are generated throughout the research process are compiled and coded in order to find some word frequencies (Cassel & Symon, 2004).

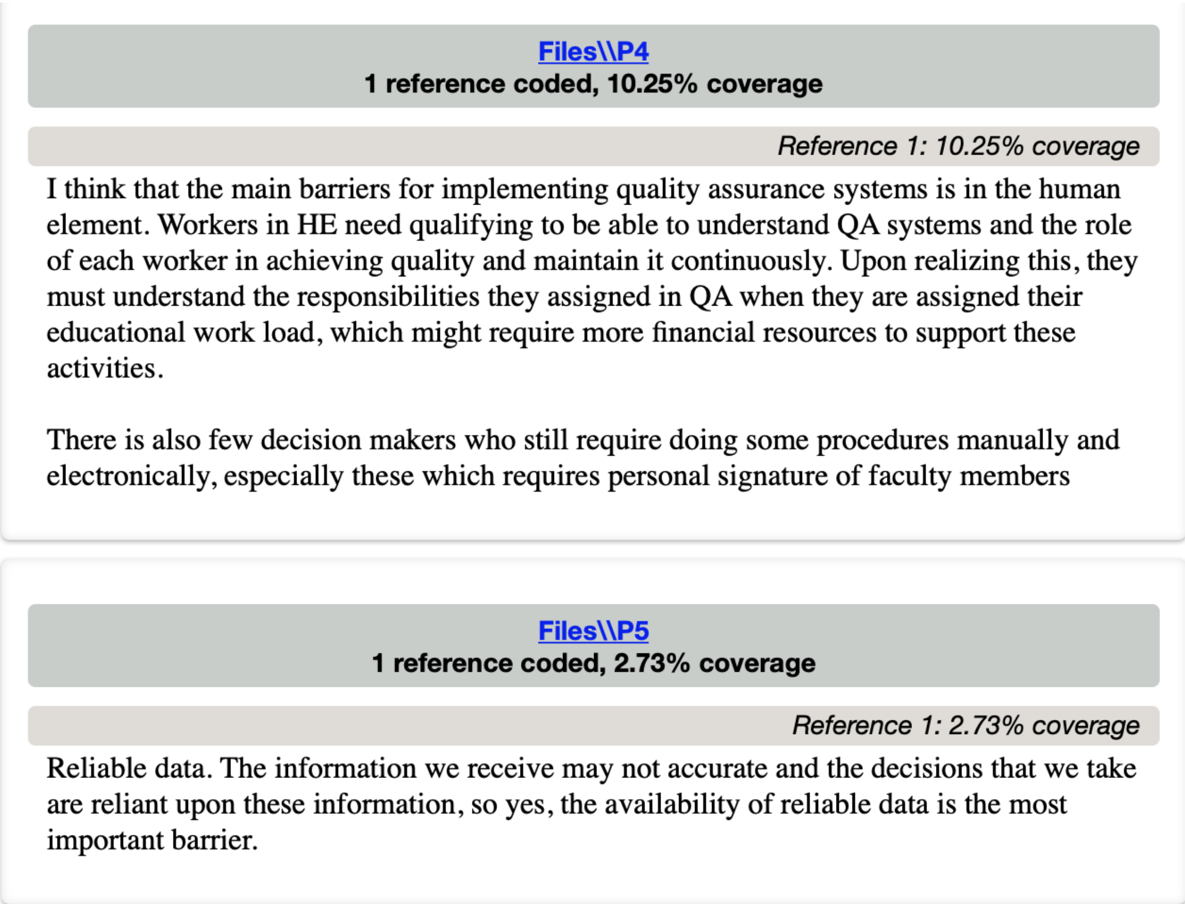
The methods that the researcher uses for gathering data should fit the research question. In addition, the use of an appropriate data collection method saves time and effort, as well as increasing the meaningfulness of research findings (Dabić & Stojanov, 2014). Computer Assisted Qualitative Data Analysis Software (CAQDAS) has been used for around forty years. CAQDAS refers to software packages that are developed to '*support qualitative approach to qualitative data'* (Saillard, 2011). Qualitative data may include text, graphics, audio or video (Lewins & Silver, 2009). CAQDAS packages must handle at least one type of qualitative data analysis, which includes the following (Lewins & Silver, 2009):

- Content search tools
- Linking tools
- Coding tools
- Query tools
- Writing and annotation tools
- Mapping or networking tools

CAQDAS packages are useful for conducting qualitative analysis whether the researcher is in the theory building stage or any other stage of the analytical process (Saillard, 2011). In addition, CAQDAS can provide quicker analysis for qualitative data as the researcher can easily count *'who said what and when, which in turn, provides reliable, general picture of the data'* (Welsh, 2002). CAQDAS reduces potential bias compared to human coding of qualitative data. In addition, it enhances the confidence of the conclusions drawn as retrieval and visualisation of data is easily accomplished in comparison with manual methods (Feng & Behar-Horenstein, 2019).

For the purpose of conducting qualitative analysis, NVivo12 software package has been selected as it is fairly intuitive to use, and the interface allows the researcher to classify and structure the database into the nodes (Saura & Bennett, 2019; Welsh, 2002). The use of NVivo12 in coding and categorising various data formats can minimise researcher bias which is one of the main advantages of CAQDAS software (Feng & Behar-Horenstein, 2019). In addition, NVivo12 has the capabilities of text mining and conducting various queries and searches (We & Shenghua, 2014).

Each response from participants that is related to a specific question is grouped into one node. The researcher was able to review all responses inside each node. Therefore, the software allowed access to the data related to each question easily as shown in a sample question in Figure 5.1. The information in Figure 5.1 shows the responses from participants (P4 and P5) that are related to ‘Barriers question’ (In your opinion, what are the most important barriers to implementing QA in the HEIs?). The coverage rate in Figure 5.1 indicates the percentage of characters from a source file that had been included in the node in relation to the total characters of the source file. In this research, this would be considered as an individual participant transcript.


Files\\P4
1 reference coded, 10.25% coverage

Reference 1: 10.25% coverage

I think that the main barriers for implementing quality assurance systems is in the human element. Workers in HE need qualifying to be able to understand QA systems and the role of each worker in achieving quality and maintain it continuously. Upon realizing this, they must understand the responsibilities they assigned in QA when they are assigned their educational work load, which might require more financial resources to support these activities.

There is also few decision makers who still require doing some procedures manually and electronically, especially these which requires personal signature of faculty members

Files\\P5
1 reference coded, 2.73% coverage

Reference 1: 2.73% coverage

Reliable data. The information we receive may not accurate and the decisions that we take are reliant upon these information, so yes, the availability of reliable data is the most important barrier.

Figure 5.1: NVivo12 Screen of Sample Question

Text search capability helps in determining whether the factors analysed have been mentioned by the participant in the participant transcript. As data has been coded according to the responses to questions, the search for factors under each pillar has been completed to identify whether or not the participant has confirmed it during the interview. Figure 5.2 shows a screenshot of sample factor search such as ‘top management’ etc. The coverage rate in Figure 5.2 indicates the percentage of characters of the word in the search field in relation to the total number of characters in the source file of participant response. The higher the rate means that the word is mentioned several times in the transcript.

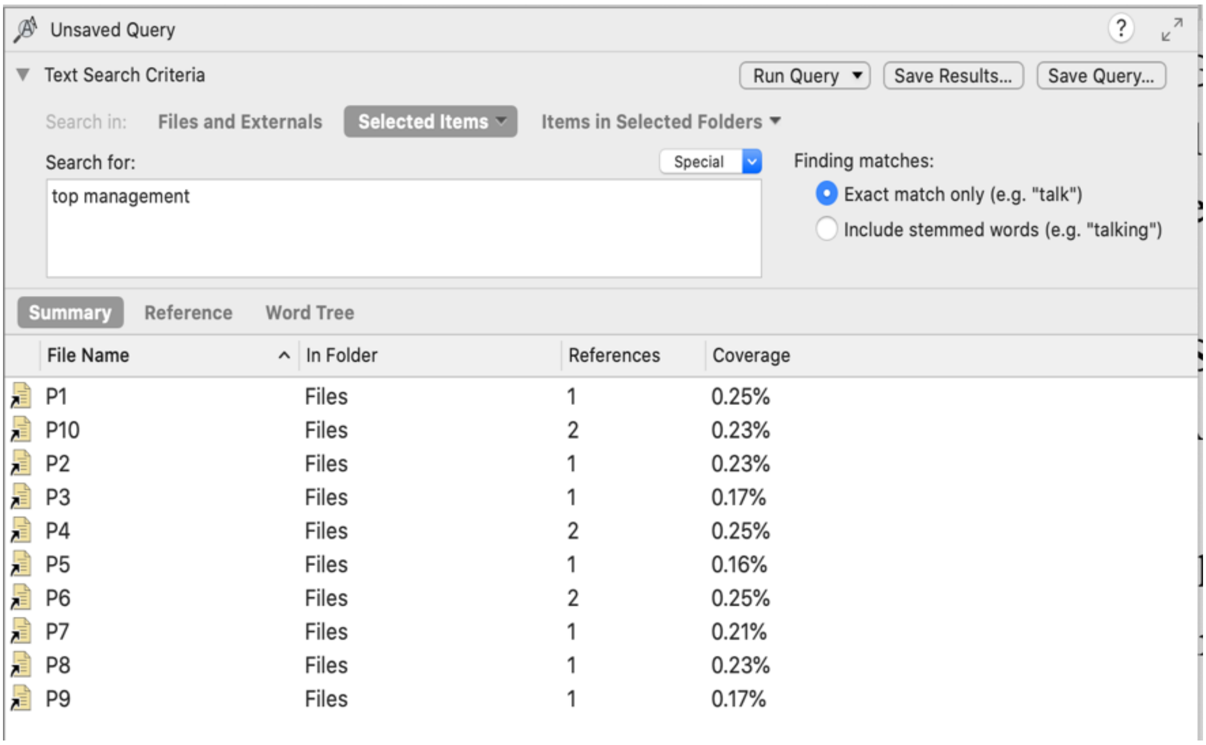


Figure 5.2: Text Search

Open-ended questions vary in responses; therefore, word frequency and word trees help in identifying patterns in participants' responses, which helped the researcher to extract information from the responses. Figures 5.3 and 5.4 show a sample of a word frequency and word tree, respectively.

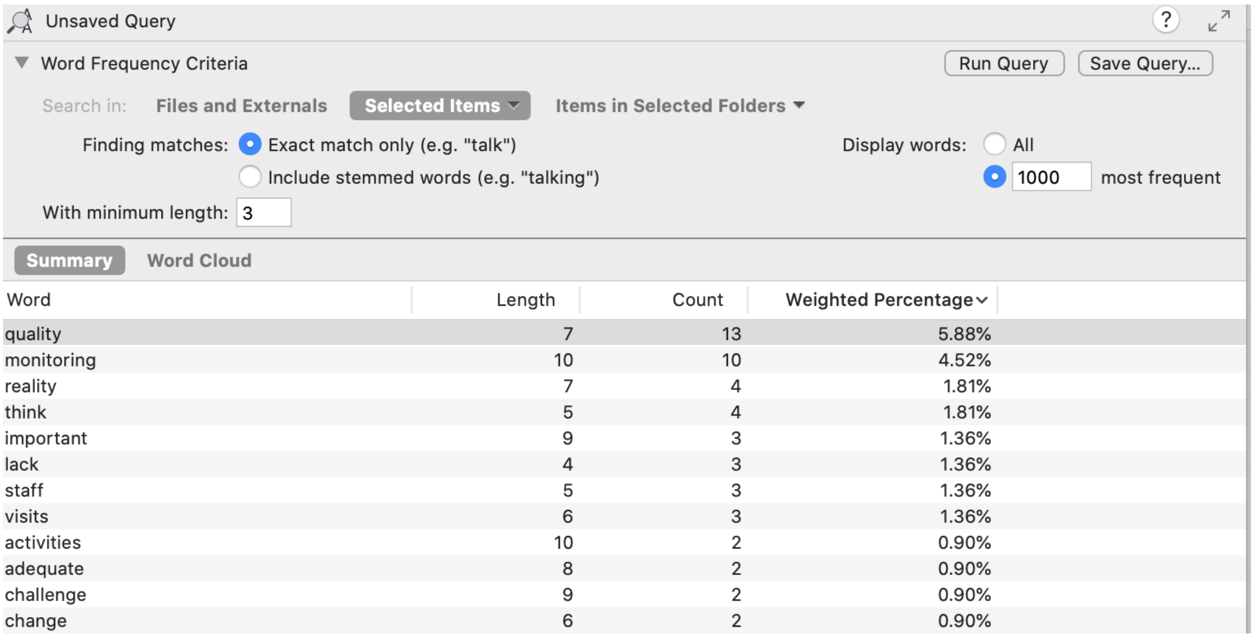


Figure 5.3: Word Frequency Example

Figure 5.4: Word Tree Example

A word tree shows how keywords have been mentioned in the transcripts of participants' responses. It gives the researcher the ability to understand how the keyword is related to each statement and to easily identify statements where the keyword has been mentioned in the participant response. Figure 5.5 shows a word tree generated after clicking on one statement.

Figure 5.5: Word Tree Example 2

5.5 Interview Results

This section discusses the results of the interviews after conducting the thematic analysis of the responses. NVivo12 software was used to generate the themes by gathering all responses from the participants that are related to each question into one node (a node for each question).

5.5.1 Interview Results

The results from the open-ended questions in the interviews indicated that there is agreement on some areas in the responses of the participants, which are outlined as follows:

1. **Barriers in Deploying QA system in HE:**
    - <u>Lack of experienced staff:</u>

      One of the most important elements that are identified as a barrier to deploying a QA system in the HE from the experts' point of view was the lack of experienced staff in Quality. One participant said, '*I think the most important barrier is having experienced staff in quality, …'* (P10). The lack of experienced human resources staff was identified as a barrier in the responses of some participants (P1, P10, P2, P4). In addition, one participant thinks that *'the existence of some unqualified administrators in leadership positions in quality'* (P2) is an important barrier that affects the whole process of QA.

- Lack of financial incentives

One of the barriers identified in the responses was the lack of financial incentives for practitioners of QA in the HE (P2, P9, P10). One participant said that *'… the lack of financial incentives for this additional work [QA work] makes teachers not willing to cooperate in fulfilling the requirements'* (P10). Another participant stressed the role of incentives by saying that '*there is no incentives for workers and practitioners of quality assurance systems'* (P2).

- Reliability of data

The data that is provided to the decision-maker in relation to quality needs to be accurate and delivered in real-time to be reliable. One participant stressed the importance of making reliable data available for decision-makers and they said *'… the information we receive may not accurate and the decisions that we take are reliant upon these information …'* (P5). Another participant stressed the limitations of the measurability of quality metrics are the most important barrier as they are all reliant on quantitative metrics while the system should be '…*based on quantitative and even qualitative measurements that needs to be quantified'* (P8)

2. Monitoring Challenges

- Cultural Change

Monitoring quality activities may require changes in the organisational culture. One participant said that '*… the main challenge is change resistance from human element as they don't understand how QA is important, which requires training workers in HE and qualify them for cooperative work for achieving quality and maintain it …*' (P4). Therefore, additional efforts will be required to deploy quality culture in the organisation (P1, P4).

- Monitoring Technique

Respondents think that monitoring techniques are among the challenges of monitoring quality. A participant said that the quality requirements to be monitored are different among the different levels of the institution. He asserted that *'… you need to distinguish several levels of monitoring. Is it a monitoring for department quality? Or is it for college? Or for the university as a whole? Because each level has its requirements and monitoring differs for each level of them …'* (P9). Another participant said that *'… the most challenging issue is students' perspective, course outcome, and programme outcomes monitoring …'* (P8). These differing levels of requirements represent a challenge for monitoring quality in HE. Additionally, traditional QA monitoring techniques are not sufficiently supporting the level of quality assurance that the institution needs to achieve (P10).

- Human Related Issues

One respondent said that *'… while monitoring, the consistency is critical. You have different students, teachers, and people who may not follow the same procedure, so the consistency in education needs to be controlled and you have to compare them all as they aren't doing things in the same manner …'* (P5). Another respondent thinks that *'… there are no adequate personnel for monitoring quality activities …'* (P2).

3. Improvement in Monitoring Quality using Dashboards

- Provide a Better View of Quality Assurance Activities

All participants in the interviews agreed that the use of dashboards will provide a better understanding of QA activities. A participant stressed that the dashboards *'… needs to be clear to users …'* (P4). Another participant said that *'… these programmes [BI dashboards] will make it [monitoring QA activities] better but it needs to be friendly, I mean they are easy to use …'* (P5). Additionally, a participant stressed that the outputs provided by the dashboards will be easier to understand *'if it's clearly provided …'* (P6).

- <u>Enhance Monitoring Challenges</u>

  All participants in the interviews agreed that the use of dashboards will enhance the monitoring of QA activities and keep track of the level of quality of the HEI. A participant said that the use of a dashboard will enhance monitoring *'… as it gives immediate view of the QA activities …'* (P4). Another participant stressed that the dashboards will allow users to *'… get stats and comparisons very quickly. You can see where the gaps are …'* (P5).

- <u>Dashboards Outputs Easier to Understand</u>

  All participants agreed that the use of dashboards provides a quality assurance performance monitoring technique that is easier to understand compared to manual monitoring techniques. One participant said that *'… in this time, the manual techniques [for monitoring] has no place'* (P9). Another participant said that the use of dashboards will be *'better than paper-based document collection methods'* (P10).

- <u>Using Dashboards to assist in Accreditation Process</u>

  All participants agreed that the use of dashboards will assist HEIs in the accreditation process and will ease the achievement of the accreditation. A participant said that *'these dashboards can be provided as an evidence'* (P6) while being reviewed for accreditation by the accreditation team.

- <u>Using Dashboards Assist in Benchmarking Process</u>

  All participants agreed that the use of monitoring dashboards will assist in the benchmarking process which is done by the HEIs to benchmark their performance with other institutions. A participant stated that these dashboards are required to provide *'continuously updated QA information'* (P4).

5.5.2 Factors Affecting the Design of Business Intelligence Dashboards for Monitoring Quality in Higher Education

The factors affecting the design of Business Intelligence Dashboards from the perspective of the experts' point of view were as follows:

Technological Factors

As discussed in Chapter 2, the definition used for BI in this thesis was '*the set of tools that includes the concept, strategies, processes, applications, data, products, technologies and technical architectures used to support collection, analysis, presentation and dissemination of business information to different stakeholders to support decision making*'. Therefore, technological factors associated with the BI system for monitoring quality in HE are directly related to this definition. Table 5.2 shows the factors that are related to the Technology pillar, as identified from the literature review, which are outlined in the first column in the table. The second column shows the factors that are related to this pillar as agreed by participants in the interviews. The third column shows the participants who agreed on these factors during the interviews.

Table 5.2: Technological Factors

Factors from Literature	Experts Factors	Participants Code
Methods (BI Architecture)	Special Requirements	P1, P2, P4
Technical Infrastructure	Technical Infrastructure	P1, P2, P3, P5, P6, P7, P8, P9, P10
Data Management	Data Management	P1, P2, P3, P5, P6, P7, P8, P9, P10
Data Quality	Data Quality	P1, P2, P3, P4, P5, P6, P7, P8, P9, P10
Data Sources	Data Sources	P1, P2, P3, P5, P6, P7, P8, P9, P10
Analysis Methods	Analysis Methods	P1, P2, P3, P5, P6, P7, P8, P9, P10
Notifications	Notifications	P1, P2, P3, P5, P6, P7, P8, P9, P10

The analysis of participants' opinion regarding the technological factors indicates that there is agreement on the factors identified from the literature except the 'Methods' factor. It was suggested that 'Methods' factor would be easier to understand if it was described as 'Special Requirements'.

Organisational Factors

Organisational factors that need to be considered for a BI system for monitoring quality in HE are identified from the literature as shown in Table 5.3. It can be seen that all factors were confirmed by the experts. However, 'Management' factor has been changed to 'Top Management Support' based on the feedback given by the participants.

Table 5.3: Organisational Factors

Factors from Literature	Experts Factors	Participants Code
Safety	Safety	P1, P2, P3, P5, P6, P7, P8, P9, P10
Administration Service	Administration Service	P1, P2, P3, P4, P5, P6, P7, P8, P9, P10
Library Service	Library Service	P1, P2, P3, P5, P6, P7, P8, P9, P10
Curriculum Structure	Curriculum Structure	P1, P2, P3, P5, P6, P7, P8, P9, P10
Facilities	Facilities	P1, P2, P3, P4, P5, P6, P7, P8, P9, P10
Management	Top Management Support	P1, P2, P3, P4, P5, P6, P7, P8, P9, P10
Innovation	Innovation	P1, P2, P3, P5, P6, P7, P8, P9, P10
Strategic Alignment	Strategic Alignment	P1, P2, P3, P4, P5, P6, P7, P8, P9, P10
Leadership	Leadership	P1, P2, P3, P4, P5, P6, P7, P8, P9, P10
Culture	Culture	P1, P2, P3, P4, P5, P6, P7, P8, P9, P10
Partnership	Partnership	P1, P2, P3, P5, P6, P7, P8, P9, P10
Administrative Quality	Administrative Quality	P1, P2, P3, P5, P6, P7, P8, P9, P10

Environment Factors

Factors that are related to the environment in which the HEI operates were identified from the literature. Table 5.4 shows that all factors were confirmed by the panel of experts except that it was suggested that the 'QA Standards' and 'NQF' factors, should be merged into a new factor 'QA Regulations'.

Table 5.4: Environment Factors

Factors from Literature	Experts Factors	Participants Code
Fitness	Fitness	P1, P2, P3, P5, P6, P7, P8, P9
Location	Location	P1, P2, P3, P5, P6, P7, P8, P9, P10
Career Prospects	Career Prospects	P1, P2, P3, P5, P6, P7, P8, P9, P10
Economy	Economy	P1, P2, P3, P5, P6, P7, P8, P9, P10
Politics	Politics	P1, P2, P3, P5, P6, P7, P8, P9, P10
Socio-culture	Socio-culture	P1, P2, P3, P5, P6, P7, P8, P9
Globalisation	Globalisation	P1, P2, P3, P5, P6, P7, P8, P9, P10
Competition	Competition	P1, P2, P3, P4, P5, P6, P7, P8, P9, P10
QA Standards	QA Regulations	P1, P2, P3, P4, P5, P6, P7, P8, P9, P10
NQF		

Business Factors

Factors related to the Business pillar were addressed as seen in Table 5.5. A participant suggested that this pillar should be deleted (P9), but most of the participants thought that this pillar is as essential as all the other pillars as it represents factors that need to be considered while designing BI dashboard for monitoring quality in HE. Table 5.5 shows the factors and modifications suggested by participants in this pillar.

Table 5.5: Business Factors

Factors from Literature	Experts Factors	Participants Code
Purpose	Continuous Improvement	P4, P6
Requisite Resources	Resources	P1, P2, P3, P5, P6, P7, P8, P10
Financial Factors	Financial Factors	P1, P2, P3, P4, P5, P6, P7, P8, P10
Costs	---	---
Competitive Advantage	Competitive Advantage	P1, P2, P3, P5, P6, P7, P8, P10
Process	Process	P1, P2, P3, P5, P6, P7, P8, P10
KPIs	KPIs	P1, P2, P3, P4, P5, P6, P7, P8, P10
Academic Quality	Academic Quality	P1, P2, P3, P5, P6, P7, P8, P10

As shown in Table 5.5 the participants agreed on merging 'Costs' factor with 'Financial Factors' as costs are financial indicators that are related to financial factors. In addition, the 'Purpose' factor was not clear to participants, and while most of the participants suggested deleting this factor, other participants suggested replacing this factor with 'Continuous Improvement' factor as this represents the heart of the quality assurance process in HE (P4, P6).

Social Factors

Factors that are related to the Social pillar are represented in Table 5.6. There was a slight modification to this pillar as seen in Table 5.6 as only 'Relationship Quality' factor was suggested for deletion as it is covered by other factors in the same pillar (P6, P10).

Table 5.6: Social Factors

Factors from Literature	Experts Factors	Participants Code
Motivation	Motivation	P1, P2, P3, P4, P5, P6, P7, P8, P9, P10
Team	Team	P1, P2, P3, P4, P5, P6, P7, P8, P9, P10
Academic Staff	Academic Staff	P1, P2, P3, P4, P5, P6, P7, P8, P9, P10
Human Elements	Human Elements	P1, P2, P3, P5, P6, P7, P8, P9, P10
Reputation	Reputation	P1, P2, P3, P5, P6, P7, P8, P9, P10
Social Media	Social Media	P1, P2, P3, P5, P6, P7, P8, P9, P10
Stakeholders Interaction	Stakeholders Interaction	P1, P2, P3, P5, P6, P7, P8, P10
Relationship Quality		

5.5.3 Suggestions to Improve the Holistic Framework for Monitoring Quality in Higher Education using Business Intelligence Dashboards

With regard to the HF-HEQ-BI framework, the participants were asked to provide their opinion concerning the framework. The results of the interviews are as follows:

a. All participants except (P9) agreed that the main pillars that affect the design of BI dashboards for monitoring quality in HE are Technology, Organisation, Environment, Business, and Social.
b. It was suggested that costs should be merged into financial factors as they represent the same thing (P4, P10).
c. It was suggested that Management factor should be changed to Top Management Support (P4, P6) as innovating such systems in the HEIs is not likely to be presented without the approval and the support of top management (P6).
d. The National Qualifications Framework (NQF) and the Quality Assurance standards were seen to be related to each other; thus, they have been merged into 'QA Regulations' which includes the NQF and QA standards (P4, P10).
e. Relationship quality was already presented in the social pillar by stakeholders' interactions and reputation, and it can be removed (P6, P10).
f. Requisite resources are better represented as 'Resources' (P10).
g. The 'Purpose' factor was not clear to most of the participants and some of them suggested replacing it with 'Continuous Improvement' as this represents the core of deploying quality culture (P4, P6)
h. The methods factor, which represents the type of BI architecture to be deployed by the HEI is suggested to be replaced by 'Special Requirements' (P1, P4).
i. Monitoring Quality in HE requires taking into consideration that there are different levels of requirements. The NCAAA KPIs indicate that some KPIs are applicable to the institution as a whole, to college, or even to each specific programme (P9).

5.6 Discussion

The purpose of developing the holistic framework for monitoring quality in HE using BI dashboards was to indicate which factors contribute to building these BI systems in HE and to achieve the goal of monitoring quality. The proposed framework was built initially from an extensive literature review. Then the opinion of a panel of experts was solicited using qualitative interviews in order to confirm that the proposed framework is valid for its purpose and to make sure that the information gathered from the literature review has been classified and organised in an appropriate manner.

The results of interviewing the panel of ten experts indicated overall agreement with the pillars and the factors associated with each pillar with slight modifications as discussed in Sections 5.5.1 and 5.5.2. The experts suggested that there are barriers to the deployment of quality assurance systems in HE such as lack of experienced staff, lack of financial incentives, and reliability of data. In addition, they identified some challenges for monitoring quality in HE such as cultural change, monitoring techniques, and human related issues. The proposed framework covers these elements through the factors that are associated with each pillar. Lack of experienced staff and human-related issues is addressed under the Social pillar in the 'Human Elements' factor and financial incentives is represented under the same pillar in the 'Motivation' factor. Reliable data is addressed under the Technology pillar in the 'Data Quality' factor. Cultural change is represented in the framework in the 'Culture' factor under the Organisation pillar. Finally, monitoring techniques are represented under the Technology pillar in 'Analysis Method' and 'Technical Infrastructure'.

The proposed framework shown in Figure 5.6 shows the five pillars developed through an extensive literature review as discussed in Chapter 4 and confirmed by the panel of experts. It can be seen that 38 factors out of 45 factors have been confirmed. Table 5.7 shows the factors that have been introduced or modified in comparison to factors that found in the literature.

Table 5.7: Factors Comparison

HF-HEQ-BI Pillar	Identified Factors from Literature	Factor Condition
Technology	~~Methods (BI Architecture)~~	Changed to 'Special Requirements'
	Technical infrastructure	Confirmed
	Data management	Confirmed
	Data quality	Confirmed
	Data Sources	Confirmed
	Analysis Methods	Confirmed
	Notifications	Confirmed
	Special Requirements	New Factor
Organisation	Safety	Confirmed
	Administration service	Confirmed
	Library service	Confirmed
	Curriculum Structure	Confirmed
	Facilities	Confirmed
	~~Management~~	Changed to 'Top Management Support'
	Innovation	Confirmed
	Strategic Alignment	Confirmed
	Leadership	Confirmed
	Culture	Confirmed
	Partnership	Confirmed
	Administrative Quality	Confirmed
	Top Management Support	New Factor
Environment	Fitness	Confirmed
	Location	Confirmed
	Career prospects	Confirmed
	Economy	Confirmed
	Politics	Confirmed
	Socio-culture	Confirmed
	Globalisation	Confirmed
	Competition	Confirmed
	~~QA Standards~~	Deleted
	~~NQF~~	Deleted
	QA Regulations	New factor instead of deleted factors
Business	~~Purpose~~	Deleted
	~~Requisite resources~~	Changed to 'Resources'
	Financial factors	Confirmed
	~~Costs~~	Deleted and merged to 'Financial factors'
	Competitive advantage	Confirmed
	Process	Confirmed
	KPIs	Confirmed
	Academic Quality	Confirmed
	Continuous Improvement	New factor instead of 'purpose'
	Resources	New factor instead of 'Requisite resources'
Social	Motivation	Confirmed
	Team	Confirmed
	Academic Staff	Confirmed
	Human elements	Confirmed
	Reputation	Confirmed
	Social Media	Confirmed
	Stakeholders Interactions	Confirmed
	~~Relationship Quality~~	Deleted

The Holistic Framework for Monitoring Quality in Higher Education using Business Intelligence Dashboards (HF-HEQ-BI), which had been represented in Figure 4.10 in Section 4.4.2 in Chapter 4 has been modified according to the results of the panel of experts interviews as discussed in the previous sections. The modified proposed HF-HEQ-BI framework as seen in Figure 5.6 represents the main pillars and related factors amended based on the feedback from experts.

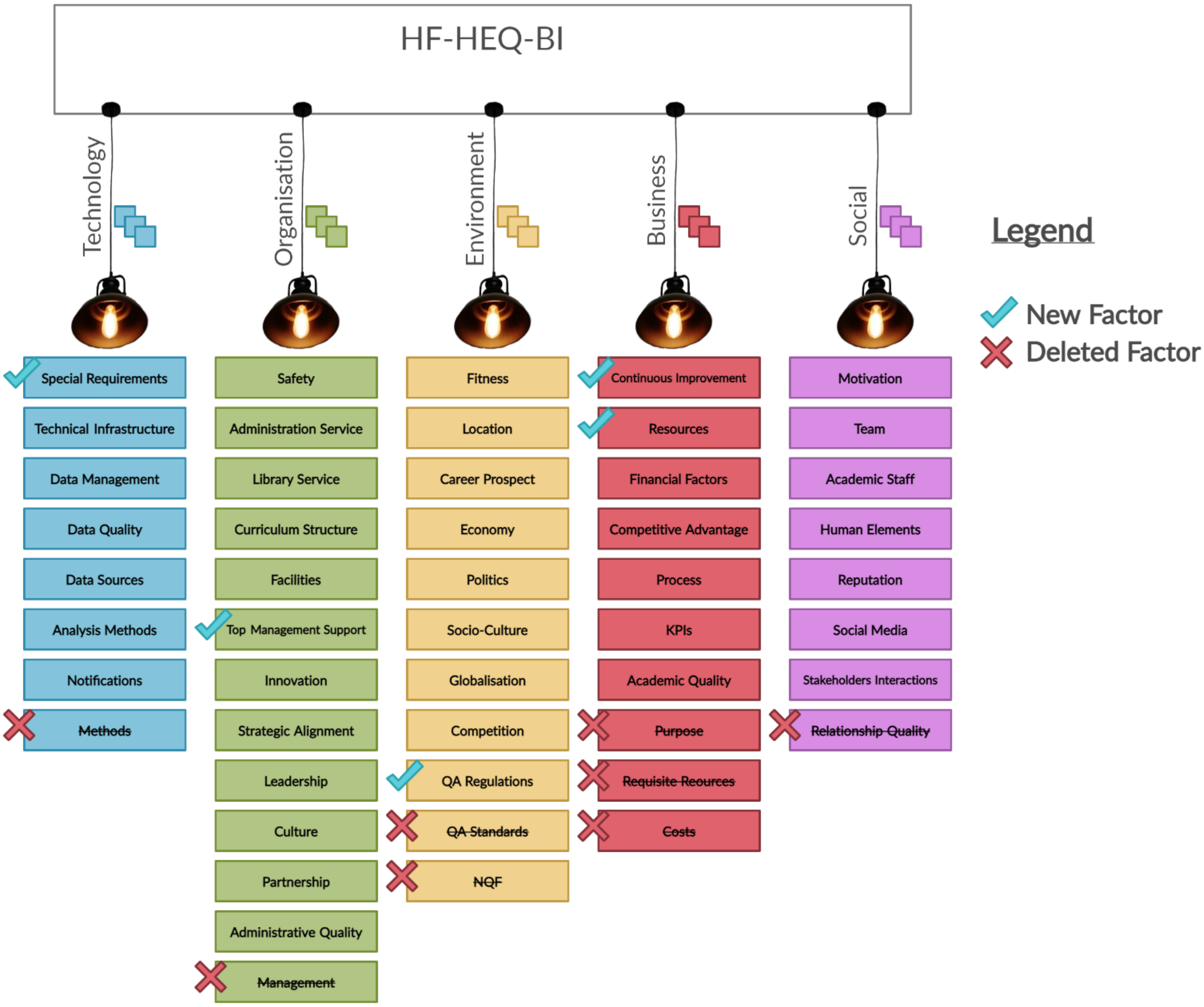


Figure 5.6: Proposed Holistic Framework for Monitoring Quality in Higher Education using Business Intelligence Dashboards (HF-HEQ-BI)

5.7 Conclusion

This chapter describes the way in which the proposed Holistic Framework for Monitoring Quality using Business Intelligence Dashboards (HF-HEQ-BI), presented in Chapter 4, was validated through qualitative interviews with a panel of ten experts from several countries. The experts who took part in the validation had experience in Quality Assurance in Higher Education ranging from 4 years to 30 years. Sections 5.5 and 5.6 discuss the opinions of experts regarding the framework, and the way in which the proposed framework has been modified following an analysis of their comments. While there was agreement on the main pillars of the framework, some factors were renamed, merged or deleted, reflecting the comments made. The resulting proposed framework in Figure 5.6 shows 42 factors grouped under 5 theoretical pillars.

The use of Computer Assisted Qualitative Data Analysis Software (CAQDAS) for qualitative analysis provides visualisation of responses from participants which enriches the analysis. This approach to qualitative data analysis could be used for handling larger sets of data for quantifying feedback on service quality, for example, questionnaires from open days and module feedback. Open-ended questions vary in responses. Therefore, word frequency and word trees help in identifying patterns in participants' responses.

The design of the dashboard should take into consideration the main pillars of the proposed HF-HEQ-BI as well as the factors that are related to each pillar in order to meet the monitoring challenges discussed in this Chapter. Institutions must comply with the NCAAA determined Key Performance Indicators (KPIs) that apply to the Higher Education Institutions.

The modified HF-HEQ-BI was evaluated qualitatively by using panel of experts' interviews. Chapter 6 will outline a further validation of the proposed HF-HEQ-BI using quantitative analysis based on a questionnaire to practitioners involved in quality monitoring in Higher Education. The intention is to use the proposed HF-HEQ-BI framework to design a prototype dashboard for monitoring quality in HEIs according to the National Centre for Academic Accreditation and Evaluation (NCAAA) which covers the mandatory KPIs used for monitoring purposes in QA in HEI in Saudi Arabia.

Chapter 6 : Quantitative Analysis of Factors Affecting Monitoring of Quality in Higher Education Using Business Intelligence Dashboards

6.1 Introduction

The Holistic Framework for Monitoring Quality in Higher Education using Business Intelligence (BI) Dashboards (HF-HEQ-BI) was proposed in Chapter 4, and the factors affecting the design of the BI dashboards for monitoring quality in Higher Education were discussed as part of the proposed framework. Chapter 5 discussed the qualitative validation of the framework which was carried out through interviews with a panel of experts. The framework was modified in accordance with their suggestions by the alteration of some of the factors that affect the design of BI dashboards for monitoring quality in HE. The changes made were reflected in Version 2 the proposed HF-HEQ-BI framework.

This chapter outlines the next phase of validation of the HF-HEQ-BI framework which used a quantitative survey of practitioners working in quality assurance in Higher Education. Faculty members in KSA Higher Education institutions were surveyed using a questionnaire and asked to express their opinion regarding the framework and the factors affecting the design of BI dashboards. In this chapter, the process of the quantitative validation regarding the development and design and the administration of the survey is outlined. The chapter discusses the various statistical analysis tests carried out on the data obtained in the survey, and the results are presented. This is followed by a discussion of the results of the factors affecting the proposed framework for quality monitoring in Higher Education

Version 2 of the HF-HEQ-BI framework was developed based on the findings of the qualitative validation. The results of the quantitative analysis presented in this chapter show that the practitioners who were surveyed support version 2 of the framework. Consequently, it is concluded that no further modification is required to the framework. Additionally, some factors were seen to have been given a higher weighting in Public HEIs compared to Private HEIs as indicated by the results of the t-test.

6.2 Purpose of the Quantitative Study

The triangulation of research findings involves using more than one source of data and methods of collection for the purpose of confirming the validity/credibility/authenticity of research data (Saunders et al., 2016). The framework development process went through three phases. The first phase was to develop the framework through a literature review which identified 45 factors as discussed in Chapter 4. The second phase encompasses validation of the framework through qualitative analysis which resulted in 42 factors as outlined in Chapter 5. The third phase of development outlined in this chapter for the HF-HEQ-BI framework was a quantitative validation which confirmed the 42 factors outlined in Chapter 5. These phases contribute to achieve the triangulation of the research results. Jick (1979) suggests that the use of multiple methods has the potential to reveal "unique variance" which may have been overlooked when applying a single method.

In the quantitative analysis phase, practitioners of QA in KSA Higher Education Institutions were surveyed in order to validate the proposed HF-HEQ-BI framework. The validation process encompasses obtaining practitioners' opinions regarding the factors that affect the design of the BI system for monitoring quality in HEIs in the KSA. This chapter discusses the process of conducting quantitative analysis for the purpose of validating the proposed HF-HEQ-BI framework. The flow of the research through this chapter is illustrated in Figure 6.1.

Figure 6.1: Quantitative Analysis Flow Process

As illustrated in Figure 6.1, this chapter addresses the quantitative analysis of the findings from a survey of practitioners. The process of calculation of the sample size and determination of the population for the qualitative analysis is discussed together with the process of distribution and administration of the questionnaire. Analysis of the survey data is presented in the chapter and a discussion of the results and their effect on the proposed HF-HEQ-BI is outlined.

Practitioners were surveyed using an online survey to assess whether each factor in the framework is relevant to the design of monitoring dashboards for Quality Assurance in Higher Educational Institutions (Questionnaire Example is shown in Appendix D.1). The outcome of the statistical analysis of responses shows the practitioners' view regarding the factors that affect the design of BI dashboards for monitoring QA in HE in the context of KSA as outlined in Section 6.6.

6.3 Questionnaire Development Process

The main objective of the questionnaire was to measure whether the factors outlined in Chapter 4 of the literature review were relevant to the proposed design of BI dashboards for monitoring QA in KSA HE. The questionnaire was designed based on factors identified through the literature review as discussed in Chapter 4. The factors were modified according to the outcome of the qualitative analysis conducted in Chapter 5. 45 factors had been identified from the literature review in the proposed HF-HEQ-BI framework but following the qualitative validation, 3 factors were deleted, 1 factor was merged into another factor ('Costs' merged into 'Financial Factors'), and 1 new factor ('QA Regulations') was introduced giving a total of 42 factors as discussed in Chapter 5. Therefore, the questionnaire was modified to reflect the modified factors as outlined in Chapter 5.

The questionnaire was discussed with six academics who have significant experience in statistical analysis, academic research, Quality Assurance in HE context in KSA. The content validity of the questionnaire was piloted with three academics and one PhD student to assure that the questions were clear and there was no ambiguity in the questions. Several revisions of the questionnaire were conducted, and all comments made by participants in the pilot study were adapted to the questionnaire.

The final version of the questionnaire was submitted to Ethics Committee at Staffordshire University for approval. Ethical approval was obtained on 18.03.2020 (See Appendix D.2). The outcomes of Chapter 5 resulted in several changes in the proposed HF-HEQ-BI framework. As a result, the questionnaire was modified based on these outcomes and submitted for approval on amendments. Ethical approval on amendments was obtained on 03.02.2021 (See Appendix D.2)

The questionnaire consisted of four main parts which are as follows: (1) questionnaire information and consent for participation, (2) general questions related to the participant experience and HEI type and where they obtained their experience, (3) Likert scale items (*questions*) measuring factors that affect the design of BI dashboards in HE, and (4) open-ended question asking whether the participants have any additional comments they want to make. Items that measure each factor in the third part of the questionnaire were presented using a Likert scale of 5-points, where 1 indicated that the participant 'strongly disagrees' to the statement while 5 indicated 'strongly agreeing' to the statement. If the participant was unable to answer a question because of insufficient knowledge, they were given the opportunity to answer the question by choosing 'I don't know' (See Appendix D.1). The 5-points Likert scale was used as it is the most universal scale rating used in scientific research (Ping et al., 2018; Sekaran & Bougie, 2016). Several studies in IT and quality management fields used 5-points Likert scale in measuring the scale of agreement on the item in the questionnaire such as Scholtz et al. (2018), Kharub et al. (2018), Ping et al. (2018) Allui and Sahni (2016), Drăgan et al. (2014), Chasalow (2009), Sahney et al. (2008), and Santarisi and Tarazi (2008). Ping et al. (2018) suggested that using 5-points Likert scale or 7-points Likert scale will not show any differences.

6.4 Population and Sample Size Calculation

For the purpose of calculating the sample size for administering the questionnaire, the population of this research was identified as all faculty members in HEIs in KSA as all faculty members in KSA are required to conduct daily activities of quality assurance. General Authority for Statistics in the KSA was contacted through an electronic querying system in order to obtain the population size of faculty members in the KSA (See Appendix D.3). The General Authority for Statistics in the KSA indicated that the total number of faculty members as in 2019 in Public and Private HEIs were 79617 and 4572, respectively (General Authority for Statistics, 2019), which means that the population size is 84189 faculty members. According to Sekaran and Bougie (2016), there are several factors that affect the decision of determining the appropriate sample size. These factors are outlined as follows (Sekaran & Bougie, 2016):

1. The study objective
2. The confidence interval desired by researcher (precise level)
3. The acceptable level of risk in predicting the preciseness of the results (confidence level)
4. The population variability
5. Costs and time constraints associated with study
6. Population size

Xi et al. (2021), Storck et al. (2016), and Oreski (2011) determined the sample size in their study to achieve 95% confidence interval of ±10% of the sample mean. Oreski (2011) suggested that sample size can be calculated using the following formula:

$$n = \frac{Z^2 p(1-p)}{c^2} \qquad \text{Equation 6.1}$$

Where:

n: Sample size, c: Confidence Interval, Z: Value obtained from table of probabilities of the normal distribution for the desired confidence interval (Z = 1.96 at 95% confidence level, see Appendix D.4). In most sciences, *P* value of 50% is considered a borderline of statistical significance (Institute for Work & Health, 2005).

Sample size can be calculated as follows:

$$n = \frac{(1.96)^2(0.50)(0.50)}{(0.10)^2} = 96.04 \qquad \text{Equation 6.2}$$

According to this calculation, a sample size of 96 participants will be enough for reaching a conclusion. Krejcie and Morgan (1970) suggested several statistical tables for determining sample size for scientific research purposes when the population size is known. There are several online calculators that were based on the Krejcie and Morgan (1970) formula for calculating sample size. The calculated sample size using Krejcie and Morgan (1970) is 96 (See Appendix D.4).

Sekaran and Bougie (2016) suggested that a sample size larger than 30 participants and less than 500 participants is appropriate for most research as a rule of thumb. Ping et al. (2018) suggested that a minimum of 100 responses are sufficient. Statisticians suggest that a sample size of more than 100 or greater completed responses will be sufficient for conducting statistical analysis (Hair et al., 1995; Williams et al., 2012).

6.5 Administration and Distribution of Questionnaire

The questionnaire was designed using an online electronic system operated by Qualtrics LLC which provides Qualtrics XM online system for administrating the surveys (Qualtrics, 2021). Qualtrics provided ExpertReview feedback, which gives recommendations for improving the questionnaire to get higher response rates. The questionnaire received 'Fair' overall score in the ExpertReview report. The report suggested that the average duration for completing the questionnaire is 8.7 minutes. A shared link was generated using the Qualtrics system. The link was distributed to faculty members in the KSA using the snowballing technique through WhatsApp and Twitter platforms. Participants were asked to forward the questionnaire link to their contacts who have experience in quality assurance to participate in the questionnaire. In addition, Face-to-Face visits to several universities and colleges in the KSA were conducted to encourage faculty members to participate in the questionnaire through iPad device.

Snowball sampling is defined by Goodman (1961, p.148) as '*a random sample of individuals is drawn from a given finite* population'. Snowball sampling is designed to overcome the challenges associated with participant recruitment in difficult to reach communities (Sadler et al., 2010). Snowball sampling can be utilised for quantitative research as well as qualitative research which falls under a wider term of 'Chain-Referral-Sampling' (Parker et al., 2019).

Snowballing was used in this study to target faculty members in KSA HEIs. A link to the questionnaire, together with an invitation letter to participate in the questionnaire, was sent to around 50 participants based on the author's personal connections. The author targeted several HEI faculty members Twitter accounts to distribute the questionnaire. The targeted audience of the questionnaire was identified in the invitation letter. Therefore, the participants were asked to forward the link to their connections who falls under the audience type identified.

6.6 Data Analysis

The outcome of Chapter 5 indicated that the HF-HEQ-BI framework consists of five main pillars (Technology, Organisation, Environment, Business, and Social). There were 42 factors associated with one of the five pillars of the HF-HEQ-BI framework. Each factor was measured by one item in the Likert scale questions in the questionnaire. The responses to the questionnaire were received during the period from 09/02/2021 to 25/07/2021. A total of 188 responses were obtained through the administration of the questionnaire. Among these responses, 124 were considered valid completed responses (66% of responses were valid). The required sample size calculated was 96 as addressed in Section 6.4. As the statistical analysis will run using 124 responses, which is over than the required sample size, the results will achieve an 8.79 confidence interval of the mean. All data were converted to Statistical Package for Social Sciences (IBM SPSS) version 27 the analysis purposes. In addition, IBM SPSS AMOS version 27 was used for Structural Equation Modelling of the data.

6.6.1 Sample Demographic Characteristics

Demographic characteristics of the sample were addressed in Table 6.1. The table shows the frequency and percentages of each sample characteristic based on choices made by participants.

Academic Level, Managerial Position, Level of Experience of participants, and Higher Education Institution Size of participants are outlined in Table 6.1.

Table 6.1: Demographic Characteristics of the Sample

Survey Demographics		**Frequency**	**Percentage**
Academic Level*	Professor	16	13.11%
	Associate Professor	25	20.49%
	Assistant Professor	45	36.89%
	Lecturer	22	18.03%
	Teaching Assistant	14	11.48%
		122	100%
Managerial Position	Dean of Quality Assurance Deanship	1	0.81%
	Vice Dean of Quality Assurance Deanship	2	1.61%
	College Dean	4	3.23%
	College Vice Dean of Quality Assurance	4	3.23%
	Quality Assurance Unit Head	9	7.26%
	Academic Department Head	29	23.39%
	Other	6	4.84%
	No Managerial Position Specified by Participant	69	55.65%
		124	100%
Current type of Institution of Participant	Public University	62	50.00%
	Private University	17	13.71%
	Vocational Training College	6	4.84%
	Private Colleges	20	16.13%
	No Response Specified by Participant	19	15.32%
		124	100%
Previous type of Institution of Participant	Public University	29	23.39%
	Private University	9	7.26%
	Vocational Training College	2	1.61%
	Private Colleges	12	9.68%
	No Response Specified by Participant	72	58.06%
		124	100%
Higher Education Institution Size*	Less than 1000 Student	16	13.56%
	Between 1000 and 5000 Students	24	20.34%
	Between 5000 and 10,000 Students	17	14.41%
	Between 10,000 and 25,000 Students	24	20.34%
	Greater than 25,000 Students	37	31.36%
		118	100%

* Non-responses from participants were excluded from the calculation of the percentages

Academic Level

Figure 6.2 illustrates the academic level of participants in the survey. It shows that majority of participants were Assistant Professors as they comprise 36.89% of the sample size.

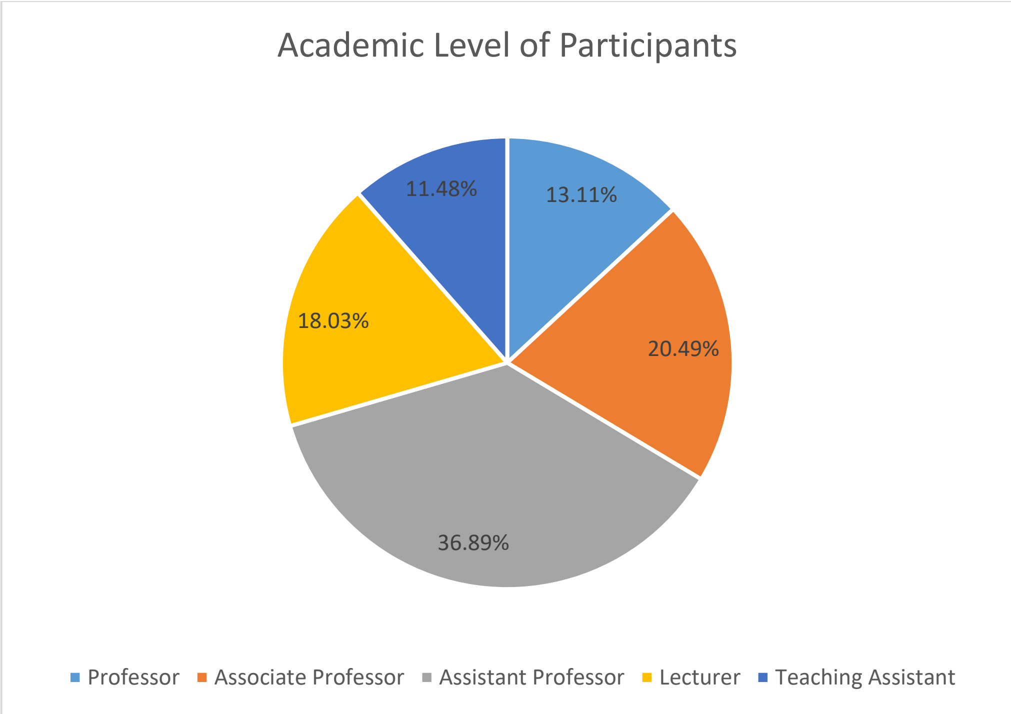


Figure 6.2: Participants' Academic Level

Figure 6.3 shows the distribution of the academic level of participants. The distribution takes the shape of normal distribution where 1 indicates the frequency of Teaching Assistants participated in the questionnaire and 5 indicates the frequency of Professors participated in the questionnaire.

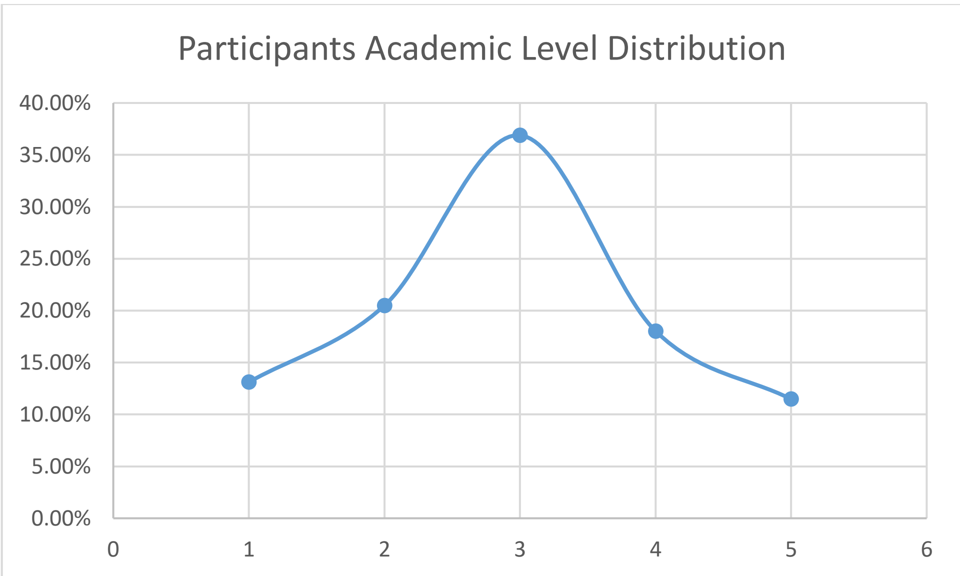


Figure 6.3: Distribution of Participants According to Academic Level

Managerial Position

This item represents the managerial position (if any) of the participants. Figure 6.4 illustrates the managerial positions held by participants. The figure shows that more than half of the participants (55.65%) did not hold any managerial position in the institution where they currently work. Around 23% of participants were head of an academic department. Only 7.26% of participants were Quality Assurance Unit Head. Figures for College Deans and College Vice Deans of Quality Assurance in the HEIs who participated in the survey were 3.23% and 3.23%, respectively. Deans of Quality Assurance Deanship and Vice Deans of Quality Assurance Deanships who participated in the survey were 0.81% and 1.61%. Only 4.84% of participants indicated other managerial positions such as College Vice Dean of Students Affairs, Managerial Consultant, Research and Human Development Centre Manager, and Institutional Quality Counsellor.

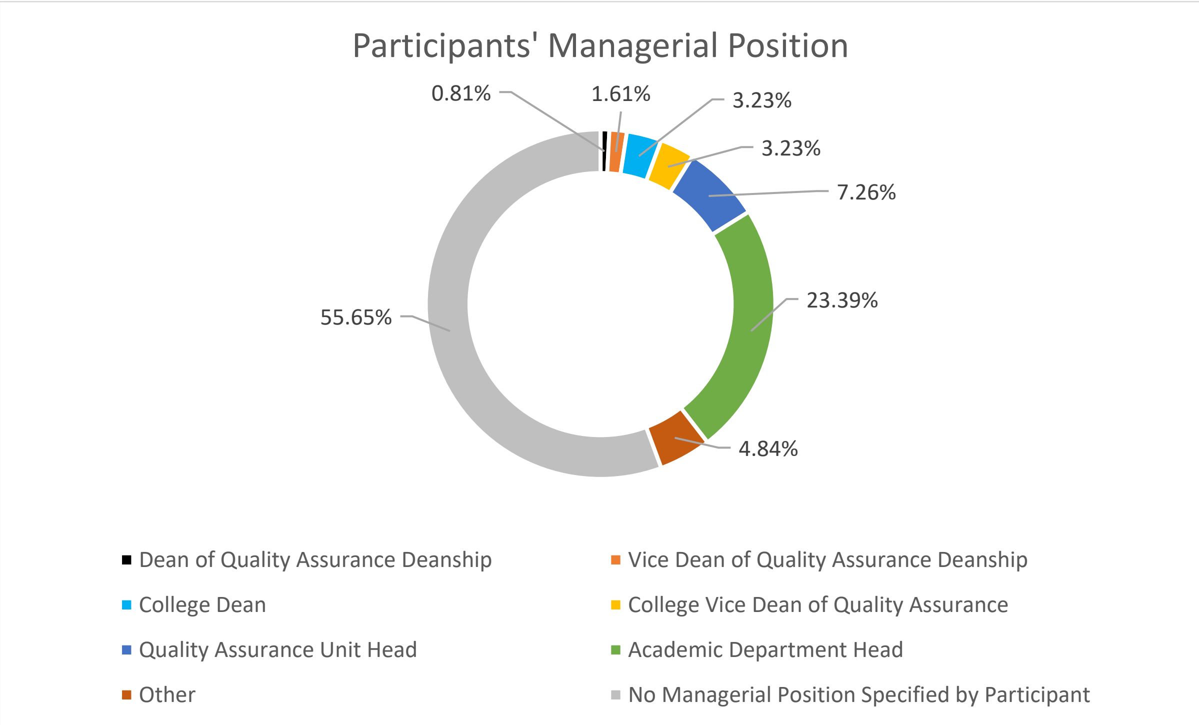


Figure 6.4: Managerial Positions of Participants

Higher Education Institution Type

The institution type indicates the type of institution where the participant currently works. Figure 6.5 illustrates the type of HEI where the participants in the survey were currently working or had previously worked. Half of the participants were working in Public Universities. Participants working in Private Universities and Private Colleges comprise 13.71% and 16.13%, respectively. Only 4.84% of participants were working in Vocational Training Colleges and around 15.32% of participants did not specify their HEI type.

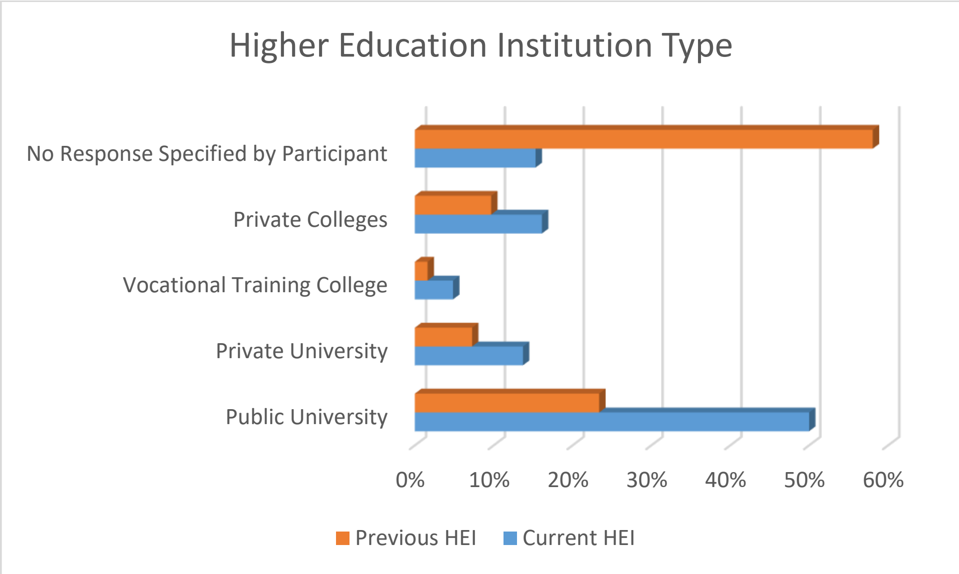


Figure 6.5: Higher Education Institution Type

Around 58% of participants indicated that they did not work previously in any HEI while 23.39% of participants worked previously in Public Universities. Participants who worked previously in Private University and Private Colleges were 7.26% and 9.68%, respectively. Only 1.61% of participants had previously worked in Vocational Training Colleges.

Level of Experience

The average level of quality assurance experience of participants is shown in Table 6.2. The table shows the average years of experience where the participants were currently working against the cumulative average years of experience in previous institutions.

Table 6.2: Participants' Average Years of Experience

Higher Education Institution Type	Average Years of Experience in the Current Institution	Average Years of Experience in Previous HE Institutions
Public University	11	6
Private University	5	5
Vocational Training College	13	5
Private Colleges	5	2

Higher Education Institution Size

The Higher Education Institution size is measured in this thesis by the number of students enrolled in the institution. The total number of enrolled students in Public Universities in the KSA as of 2019 was 1,371,701 students with an average of 48,989 students (General Authority for Statistics, 2019). Some Public Universities such as Umm Alqura University and Imam Muhammed bin Saud University have more than 100,000 enrolled students as of 2019 (General Authority for Statistics, 2019). The KSA data does not indicate whether these are Full-Time Equivalent (FTE) students. Some HEIs in the KSA provide courses for both Male and Female sections at the same time but in different locations through Video Conference Technology. In addition, the final exams and exit exams are conducted at the same time in several locations. In 2019, there were 195,099 enrolled students in vocational training colleges and 74,892 enrolled students in private HEIs (Colleges and Universities) (General Authority for Statistics, 2019). The size of HEIs in KSA ~~is~~ differs significantly from the size of UK HEIs. In 2019, there were a total of 271 HEIs in the UK with a total number of enrolled students of 2,532,385. The average number of students per institution is 9345 students in UK HEIs. The largest number of enrolled students was in the Open University where there were 129,420 distance learning (part-time students) students, although the distance learning focus of the Open University means that this data may not be comparable with other UK HEIs. Of more traditional universities, University College London comes after The Open University with a total number of enrolled students of 41,095 students. At Staffordshire University, there were 15,675 enrolled students in 2019 (Higher Education Statistics Agency (HESA), 2021). It appears from these statistics that the number of students in some KSA universities is greater than in UK HEIs. This is because some of the Saudi Arabian universities are located in multiple locations delivering the same programme, and consequently, will have quality assurance issues.

Figure 6.6 shows the responses of participants to the question about the size of the HEI where they are currently working. Around one-third of participants in this study were working in institutions with more than 25,000 students. Around 20% of participants were working in institutions with student numbers ranging from 10,000 to 25,000. 14.41% of participants were working in institutions with student numbers ranging from 5000 to 10,000. The results indicated that 20.34% of participants were working in institutions with student numbers ranging from 1000 to 5000. Only 13.56% of participants were in institutions with less than 1000 students.

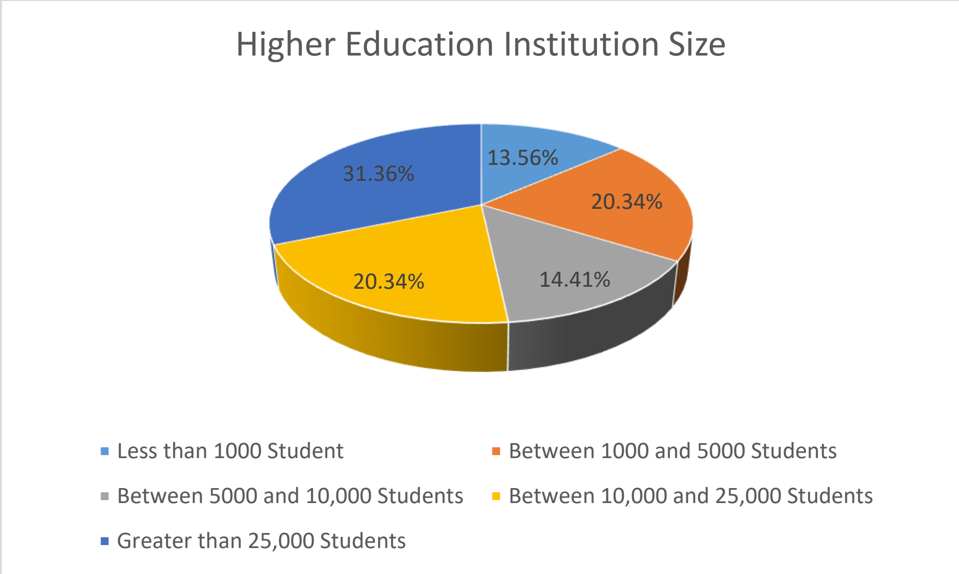


Figure 6.6: Higher Education Institution Size

6.6.2 Internal Reliability and Validity

Cronbach's alpha (α) was developed in 1951 by Lee Cronbach. It measures internal consistency, and it is used to check whether multiple choice questions in Likert Scale surveys are reliable (Glen, n.d.; Brown, 2006). Coefficient alpha is the most used measurement of reliability in social sciences and where multiple items scale such as Likert scale is used in studies, coefficient alpha is being computed (Diedenhofen & Musch, 2016). Sijtsma (2009) suggests that it is the most widely used procedure for estimating reliability in applied research.

Questionnaire reliability measures the degree of internal consistency between variables of each construct. The internal consistency indicate the degree of homogeneity of the items in the measure construct (Sekaran & Bougie, 2016). Therefore, Cronbach's Alpha test was conducted on the factors on each pillar (construct) to test the validity and internal consistency of the questionnaire (Sekaran & Bougie, 2016; Saunders et al., 2016). Cronbach's Alpha values ranges between one (perfect reliability) and zero (no reliability). Cronbach's Alpha values greater than 0.5 are considered acceptable (Williams et al., 2012). The optimum value of Cronbach's Alpha is to be greater than 0.70 (Randheer, 2015; Ardi et al., 2012).

It was recommended by statisticians (private communication) and information on ResearchGate.net (Fiolet, 2019a; Makanga, 2016) to not use a value for 'I don't know' response in the data set. The 'I don't know' response does not follow the concept of Likert Scale which uses an odd scale with a 'Neural' point. This type of question allows the participant who may not have sufficient knowledge to answer the question rather abandon the questionnaire allowing more successful completion rate

(Whitten, 2016; Namgay, 2017; Fiolet, 2019b; Makanga, 2016). Consequently, 'I don't know' responses were left blank in the analysis and not given any value while conducting statistical analysis.

The results shown in Table 6.3 indicated that all five pillars have α value ranging from 0.849 to 0.949 which indicate good reliability. Chen (2012b) suggested that items receiving *Cronbach's-Alpha-if Item-Deleted* of more than the value of the whole α then the item should be deleted. As shown in Table 6.3, none of the factors received Cronbach's Alpha *If Item Deleted* greater than the Cronbach's Alpha value for the whole pillar. Therefore, none of the factors will be deleted. For example, the Technology pillar has an average group α value of 0.849 and if the 'Technical Infrastructure' factor is removed the average group α value will then become 0.843.

Table 6.3: Reliability Measurement for HF-HEQ-BI Pillars Factors

Pillar Name	Factor	Abbreviation	Number of Factors	Group α ≥ 0.5	α if Item Deleted
Technology	Technical Infrastructure	TTI	7	0.849	0.843
	Special Requirements	TSR			0.826
	Data Management	TDM			0.827
	Data Source	TDS			0.845
	Data Quality	TDQ			0.805
	Analysis Methods	TAM			0.826
	Notifications	TN			0.827
Organisation	Strategic Alignment	OSA	12	0.919	0.916
	Administrative Services	OAS			0.913
	Top Management Support	OTM			0.917
	Culture	OC			0.917
	Safety	OS			0.913
	Administrative Quality	OAQ			0.903
	Library Services	OLS			0.913
	Curriculum Structure	OCS			0.908
	Facilities	OF			0.911
	Innovation	OI			0.910
	Leadership	OL			0.915
	Partnership	OP			0.911
Environment	Socio-Culture	ESC	9	0.939	0.933
	Economy	EE			0.935
	Politics	EP			0.935
	QA Regulations	EQA			0.932
	Fitness	EF			0.938
	Location	EL			0.933
	Career Prospects	ECP			0.928
	Globalisation	EG			0.929
	Competition	EC			0.927
Business	KPIs	BK	7	0.949	0.940
	Continuous Improvement	BCI			0.939
	Academic Quality	BAQ			0.939
	Resources	BR			0.936
	Financial Factors	BFF			0.939
	Competitive Advantage	BCA			0.945
	Process	BP			0.949
Social	Social Media	SSM	7	0.911	0.909
	Human Elements	SHE			0.908
	Stakeholders Interactions	SSI			0.900
	Team	ST			0.893
	Academic Staff	SAS			0.888
	Motivation	SM			0.890
	Reputation	SR			0.894

6.6.3 Structural Equation Model

There are two main types of factor analysis, the Exploratory Factor Analysis (EFA) and the Confirmatory Factor Analysis (CFA) (Williams et al., 2012). While using the CFA technique, the researcher has a prior awareness of a number of factors required to explain the intercorrelations among the variables measured (Sayeda et al., 2010). EFA is used when the researcher has no expectations of the number or nature of variables as it allows them to explore the main dimensions to generate theory (Williams et al., 2012). CFA is used to test a proposed theory or model as the factors are already known and there are assumptions and expectations of these factors (Williams et al., 2012). In addition, CFA is a form of Structural Equation Modelling (SEM) (Williams et al., 2012; Brown, 2006). CFA allows the researcher to test the hypothesis that there is an existence of a relationship between the observed measures (factors) and latent construct (pillar) (Shek & Yu, 2014; Igbaria et al., 1997).

A measurement model test was conducted using CFA in IBM AMOS 27. The aim of this step to find the factor loadings for each of the 42 factors in the HF-HEQ-BI framework. All the factors in the framework received factor loadings. Factor loadings ≥ 0.5 were considered very significant while factor loadings ≥ 0.3 were considered significant (Ardi et al., 2012; Jahantigh et al., 2018; Igbaria et al., 1997). After identifying the correlation between variables, the t-value test was used to determine the significance of the factor loading (Jahantigh et al., 2018; Igbaria et al., 1997). T-value of over than 1.96 indicates that the factor loading is significant at confidence level of 0.05 (5%) (Jahantigh et al., 2018; Ardi et al., 2012).

CFA is conducted through several steps (Shek & Yu, 2014). Shek and Yu (2014) addressed these steps as follows: '*literature review, model specification, model identification, data collection and primary analysis, parameter estimation, model fit assessment, model comparison and modification, and presentation and interpretation of results*'. In this study, the methodology followed by Shek and Yu (2014), Ardi et al. (2012), and Jahantigh et al. (2018) will be used for the purpose of conducting the CFA using IBM AMOS. The HF-HEQ-BI framework consists of five main pillars. There are 42 factors under these pillars as follows: Technology (7 Factors), Organisation (12 Factors), Environment (9 Factors), Business (7 Factors), and Social (7 Factors). Pillars and factors were drawn in IBM AMOS graphically (See Appendix D.5.2). It was assumed that all five pillars are intercorrelated as they measure different but related aspects of one construct (Monitoring Quality in HE using BI dashboards). In addition, each factor is regressed into a related pillar (Shek & Yu, 2014). Table 6.4 shows that all factors in the model received a significant factor loading which indicates that factor analysis can be considered as a statistical method to utilise (Williams et al., 2012).

Table 6.4: Confirmatory Factor Analysis Results

Pillar Name	Factor Name	Abbreviation	Factor Load ≥ 0.3		t-Value	*P*-Value ≤ 0.05
			Standardised Estimates	Unstandardised Estimates		
Technology	Technical Infrastructure	TTI	0.387	1.000	-	-
	Special Requirements	TSR	0.580	1.287	3.622	<0.01
	Data Management	TDM	0.412	0.993	3.091	0.002
	Data Source	TDS	0.413	0.945	3.095	0.002
	Data Quality	TDQ	0.803	1.555	3.976	<0.01
	Analysis Methods	TAM	0.507	1.248	3.426	<0.01
	Notifications	TN	0.660	1.355	3.787	<0.01
Organisation	Strategic Alignment	OSA	0.517	1.000	-	-
	Administrative Services	OAS	0.588	1.000	4.904	<0.01
	Top Management Support	OTM	0.585	0.921	4.887	<0.01
	Culture	OC	0.423	0.852	3.905	<0.01
	Safety	OS	0.598	1.435	4.953	<0.01
	Administrative Quality	OAQ	0.759	1.631	5.649	<0.01
	Library Services	OLS	0.619	1.441	5.057	<0.01
	Curriculum Structure	OCS	0.607	1.507	4.998	<0.01
	Facilities	OF	0.662	1.563	5.259	<0.01
	Innovation	OI	0.713	1.645	5.473	<0.01
	Leadership	OL	0.552	1.260	4.710	<0.01
	Partnership	OP	0.724	1.508	5.519	<0.01
Environment	Socio-Culture	ESC	0.765	1.000	-	-
	Economy	EE	0.696	1.016	8.079	<0.01
	Politics	EP	0.735	1.032	8.607	<0.01
	QA Regulations	EQA	0.828	1.057	9.937	<0.01
	Fitness	EF	0.724	0.891	8.455	<0.01
	Location	EL	0.667	0.971	7.693	<0.01
	Career Prospects	ECP	0.827	1.096	9.927	<0.01
	Globalisation	EG	0.809	1.233	9.661	<0.01
	Competition	EC	0.880	1.303	10.727	<0.01
Business	KPIs	BK	0.784	1.000	-	-
	Continuous Improvement	BCI	0.806	0.994	9.915	<0.01
	Academic Quality	BAQ	0.847	1.003	10.592	<0.01
	Resources	BR	0.870	1.051	10.982	<0.01
	Financial Factors	BFF	0.852	1.013	10.678	<0.01
	Competitive Advantage	BCA	0.805	0.906	9.910	<0.01
	Process	BP	0.712	0.941	8.493	<0.01
Social	Social Media	SSM	0.573	1.000	-	-
	Human Elements	SHE	0.584	1.252	5.263	<0.01
	Stakeholders Interactions	SSI	0.766	1.603	6.311	<0.01
	Team	ST	0.675	1.474	5.824	<0.01
	Academic Staff	SAS	0.848	1.885	6.682	<0.01
	Motivation	SM	0.823	1.687	6.575	<0.01
	Reputation	SR	0.591	1.477	5.312	<0.01

Table 6.5 shows Goodness of Fit measurements. The model is considered to have a good fit if Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), Normed Fit Index (NFI), and Comparative Fit Index (CFI) is greater than 0.9 (Jahantigh et al., 2018; Kim et al., 2016; Bentler, 1990; Shek & Yu, 2014). These measurements indicate a good fit if they have values near to 1 (Randheer, 2015). In addition, the model should also have Incremental Fit Index (IFI) between 0 and 1 (Jahantigh et al., 2018) and Root Mean Square Error of Approximation (RMSEA) should be less than 0.1 (Kim et al., 2016; Shek & Yu, 2014).

Goodness of Fit results presented in Table 6.5 indicate reasonable Goodness of Fit of the model. While some measurements achieve marginal fit such as GFI, AGFI, NFI, and CFI, the IFI and RMSEA were indicating good measurement of model fit.

Table 6.5: Goodness of Fit Measurements

Fit Index	Results
GFI	0.632
AGFI	0.590
NFI	0.641
CFI	0.794
IFI	0.797
RMSEA	0.082

6.6.4 Comparison of Means

To determine whether the HF-HEQ-BI framework fits both Public and Private HEIs, t-test was conducted to test whether there are statistically significant differences in means between responses received from participants working currently in public or private institutions. T-test is a type of statistical test that is used for the purpose of comparing the means of two groups by calculating the t-value (Kim, 2015; Brown, 2006). Therefore, the null hypothesis and alternate hypothesis are formulated as follows:

H_0: There are no significant differences between responses obtained from participants related to the factors that can be attributed to the type of institution where they work

H_1: There are significant differences between responses obtained from participants related to the factors that can be attributed to the type of institution where they work

The results of t-test are presented in Table 6.6. The results show that there are 12 factors out of the 42 factors that the means show a statistically significant difference among participants in public and private HEIs (highlighted in Grey in Table 6.6, for example, ‘Analysis Methods’ in Technology pillar) and include the following: Analysis Methods, Innovation, Partnership, QA Regulations, Location, Career Prospects, Globalisation, KPIs, Continuous Improvement, Academic Quality, Resources, and Financial Factors means were less in Private HEIs than in Public HEIs. These means were identified as statistically different among the two groups. These factors are indicated in Table 6.6 marked by an asterisk. Therefore, alternative hypothesis (H_1) will be accepted for these factors.

Participants in both Public and Private HEIs show no statistically significant differences in their answers regarding the remaining 30 factors as follows: Technical Infrastructure, Special Requirements, Data Management, Data Source, Data Quality, Notifications, Strategic Alignment, Administrative Services, Top Management Support, Culture, Safety, Administrative Quality, Library Services, Curriculum Structure, Facilities, Leadership, Socio-Culture, Economy, Politics, Fitness, Competition, Competitive Advantage, Process, Social same Reputation. Therefore, alternative hypothesis (H_1) will be rejected for these factors.

As seen in Table 6.6, all factors under Technology pillar achieved a mean ranging from 4.15 to 4.37 out of 5.00 in Public HEIs and 3.89 to 4.36 in Private HEIs. In Organisation pillar, factors achieved a mean ranging from 3.79 to 4.22 in Public HEIs and from 3.32 to 4.14 in Private HEIs. In Environment pillar, the mean for factors was ranging from 3.79 to 4.15 in Public HEIs and from 3.16 to 3.68 in Private HEIs. In Business pillar, the mean in Public HEIs was ranging from 3.92 to 4.26 and from 3.67 to 3.84 in Private HEIs. In Social pillar, the mean was ranging from 3.89 to 4.12 in Public HEIs and from 3.40 to 3.92 in Private HEIs.

Table 6.7 shows the ranking of factors in both Public and Private HEIs. Factors which share similar means have been ranked according to their Standard Deviation (SD). Therefore, if the factor has the same mean and a lower SD, it will be given a higher rank. The factors were arranged in descending order, from the most important factor to least important factor, based on the mean of participant responses. For example, in Table 6.7 under the Organisation pillar, statistical analysis indicates that 'Top Management Support' is ranked 1st in Private HEIs and drops to 5th in Public HEIs.

Table 6.6: t-test Results

Pillar Name	Factor Name	Mean ± SD		t-Value	P-Value ≤ 0.05
		Public Institution	Private Institution		
Technology	Technical Infrastructure	4.15 ± 0.870	4.36 ± 0.723	-1.215	0.227
	Special Requirements	4.26 ± 0.756	4.36 ± 0.762	-0.632	0.529
	Data Management	4.25 ± 0.985	4.24 ± 0.723	0.016	0.987
	Data Source	4.24 ± 0.978	4.19 ± 0.995	0.263	0.793
	Data Quality	4.37 ± 0.795	4.14 ± 0.976	1.346	0.181
	Analysis Methods	4.33 ± 0.751	3.89 ± 0.989	2.560*	0.012
	Notifications	4.33 ± 0.730	4.03 ± 0.957	1.823	0.071
Organisation	Strategic Alignment	4.21 ± 0.755	3.94 ± 0.924	1.579	0.117
	Administrative Services	4.22 ± 0.775	3.97 ± 0.957	1.452	0.150
	Top Management Support	4.16 ± 0.803	4.14 ± 0.976	0.150	0.881
	Culture	4.20 ± 0.948	4.08 ± 1.010	0.581	0.562
	Safety	3.92 ± 1.219	3.65 ± 1.274	1.083	0.281
	Administrative Quality	4.17 ± 1.046	3.78 ± 1.134	1.729	0.087
	Library Services	3.89 ± 1.091	3.65 ± 1.317	1.005	0.317
	Curriculum Structure	3.79 ± 1.238	3.59 ± 1.301	0.761	0.448
	Facilities	3.88 ± 1.187	3.46 ± 1.304	1.672	0.098
	Innovation	4.03 ± 1.045	3.32 ± 1.270	3.031*	0.003
	Leadership	4.04 ± 1.147	3.65 ± 1.086	1.718	0.089
	Partnership	4.15 ± 0.980	3.43 ± 1.094	3.425*	0.001
Environment	Socio-Culture	3.98 ± 1.170	3.68 ± 1.355	1.215	0.227
	Economy	3.89 ± 1.299	3.41 ± 1.443	1.737	0.086
	Politics	3.79 ± 1.297	3.24 ± 1.553	1.920	0.058
	QA Regulations	4.15 ± 1.004	3.54 ± 1.464	2.502*	0.014
	Fitness	3.93 ± 1.185	3.46 ± 1.346	1.829	0.070
	Location	3.81 ± 1.216	3.16 ± 1.424	2.411*	0.018
	Career Prospects	3.91 ± 1.164	3.32 ± 1.454	2.246*	0.027
	Globalisation	4.00 ± 1.277	3.31 ± 1.670	2.349*	0.021
	Competition	4.06 ± 1.220	3.51 ± 1.592	1.945	0.055
Business	KPIs	4.23 ± 1.020	3.68 ± 1.435	2.278*	0.025
	Continuous Improvement	4.20 ± 0.922	3.67 ± 1.434	2.272*	0.025
	Academic Quality	4.26 ± 0.940	3.78 ± 1.336	2.111*	0.037
	Resources	4.23 ± 0.932	3.70 ± 1.372	2.310*	0.023
	Financial Factors	4.26 ± 0.917	3.73 ± 1.347	2.359*	0.020
	Competitive Advantage	3.92 ± 1.027	3.70 ± 1.175	0.997	0.321
	Process	4.10 ± 0.970	3.84 ± 1.259	1.148	0.254
Social	Social Media	4.00 ± 1.030	3.92 ± 1.052	0.389	0.698
	Human Elements	4.12 ± 1.097	3.81 ± 1.309	1.288	0.201
	Stakeholders Interactions	4.00 ± 1.132	3.70 ± 1.309	1.204	0.231
	Team	3.89 ± 1.174	3.58 ± 1.381	1.189	0.237
	Academic Staff	3.97 ± 1.154	3.49 ± 1.426	1.853	0.067
	Motivation	3.89 ± 1.191	3.51 ± 1.387	1.465	0.146
	Reputation	3.90 ± 1.227	3.40 ± 1.459	1.772	0.080

Table 6.7: Factors Ranking

Pillar Name	Factors Ranking	
	Public Institution	**Private Institution**
Technology	Data Quality	Technical Infrastructure
	Notifications	Special Requirements
	Analysis Methods	Data Management
	Special Requirements	Data Source
	Data Management	Data Quality
	Data Source	Notifications
	Technical Infrastructure	Analysis Methods
Organisation	Administrative Services	Top Management Support
	Strategic Alignment	Culture
	Culture	Administrative Services
	Administrative Quality	Strategic Alignment
	Top Management Support	Administrative Quality
	Partnership	Leadership
	Leadership	Safety
	Innovation	Library Services
	Safety	Curriculum Structure
	Library Services	Facilities
	Facilities	Partnership
	Curriculum Structure	Innovation
Environment	QA Regulations	Socio-Culture
	Competition	QA Regulations
	Globalisation	Competition
	Socio-Culture	Fitness
	Fitness	Economy
	Career Prospects	Career Prospects
	Economy	Globalisation
	Location	Politics
	Politics	Location
Business	Financial Factors	Process
	Academic Quality	Academic Quality
	Resources	Financial Factors
	KPIs	Competitive Advantage
	Continuous Improvement	Resources
	Process	KPIs
	Competitive Advantage	Continuous Improvement
Social	Human Elements	Social Media
	Social Media	Human Elements
	Stakeholders Interactions	Stakeholders Interactions
	Academic Staff	Team
	Reputation	Motivation
	Team	Academic Staff
	Motivation	Reputation

6.7 Discussion of Results

The results obtained throughout Cronbach's Alpha indicated that the internal consistency of the questionnaire is very good. All items in the questionnaire that are intended to measure a factor received α if-item-deleted less than group α. All pillars achieved $\alpha > 0.8$. Cronbach's Alpha results indicated good consistency and reliability of the questionnaire.

Confirmatory Factor Analysis was performed on the data and the results indicated a good model fit. All factor loadings were > 0.30 and the t-value of all factor loadings was significant, which indicates good relationship between factors and their corresponding pillars. Some of the Goodness of Fit measurements such as GFI, AGFI, and NFI were below the margin of > 0.9, but this result was expected as the sample size was high (more than 30) and the number of factors in the model was also high (the complexity of model was high).

All factors were regarded as important according to participants' responses as all the factor-means were above 3.16 out of 5.00. It was surprising to find that although all factors were supported, some factors were regarded as having less importance in Private HEIs than in Public HEIs. The means for 'Financial Factors', 'QA Regulations' and 'KPIs' were lower for Private HEIs in comparison to Public HEIs, and these differences were statistically significant. These differences may be attributed to the awareness of quality regulations in the KSA as Private HEIs were found to give less attention to 'QA Regulation' and 'KPIs' which are mandatory requirements for quality assurance systems in HEIs. These differences may also be attributed to the composition of the sample as participants from Private HEIs comprise 35% of the sample while participants from Public HEIs comprise 65% of the sample. Therefore, different institutions rate different factors differently, which indicates a need for dashboards to be customisable, to reflect the priorities of the users.

The open-ended question at the end of the questionnaire was answered by 30 participants (24% of the sample). Among them, 16 participants (13% of the sample) indicated that they do not have any comments to make. The comments were reviewed to see if there were any relationship between the type of comments and the type of institution, but no pattern was identified. However, it was suggested by some participants that the result of the study needs to be published. They also suggested that BI Dashboards are new in Arabian culture, which will require additional training for instructors to be able to use it.

6.8 Effect on Framework

The results of quantitative analysis indicate that all factors identified from literature and qualitative analysis are important in the design of BI systems for monitoring Quality in HE in the context of KSA.

The qualitative analysis outlined in Chapter 5 which resulted in a slight change in the framework as the main pillars remain the same but some of the factors affecting the design were changed to result in a total of 42 factors. Quantitative analysis outlined in this chapter indicated that there are no more modifications required on the framework according to the opinions of participants. Figure 6.7 shows the final version of the HF-HEQ-BI framework.

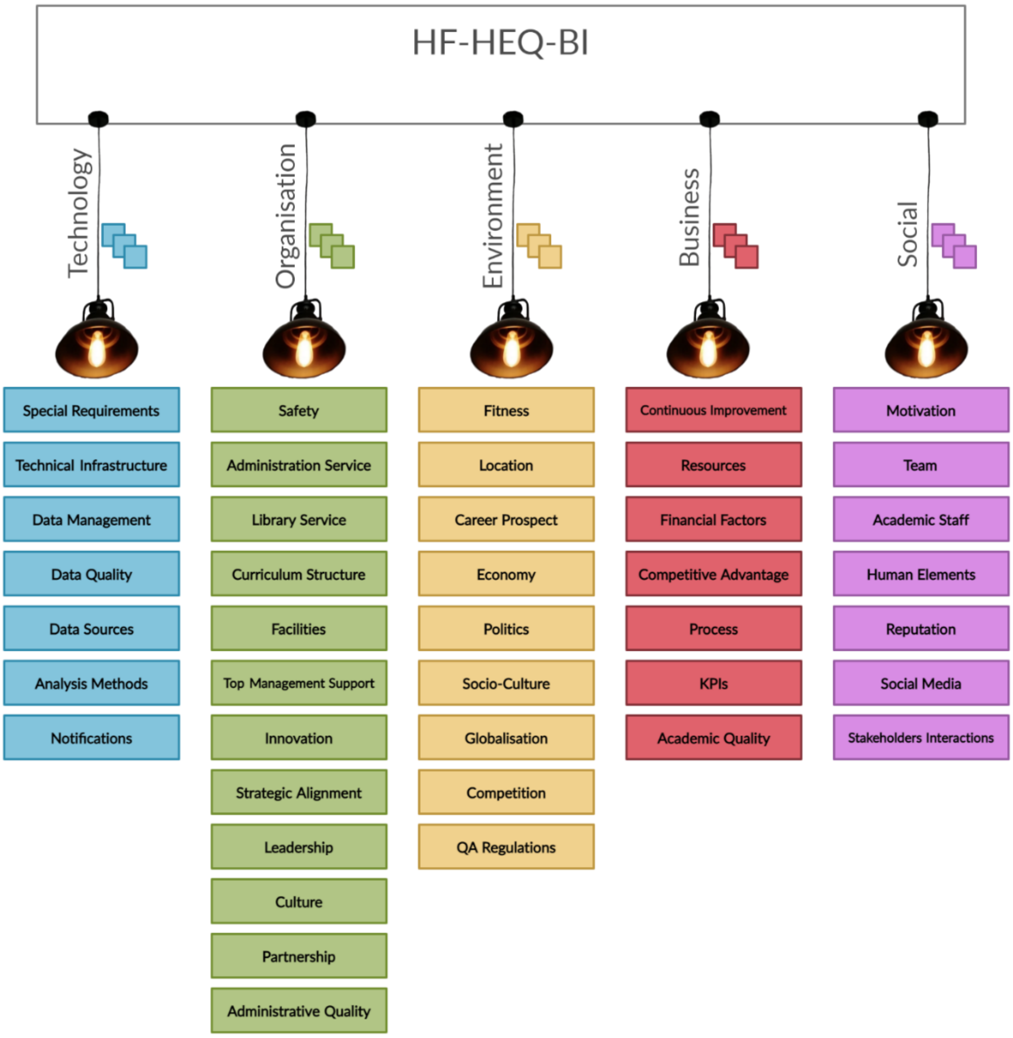


Figure 6.7: Holistic Framework for Monitoring Quality in Higher Education using Business Intelligence Dashboards in the KSA (HF-HEQ-BI) Final Version

The proposed HF-HEQ-BI framework identifies the factors that affect the design of BI systems in HE for monitoring quality. Based on the validation of the framework presented through triangulation of results obtained from literature review, qualitative analysis, and quantitative analysis, the proposed HF-HEQ-BI can assist in identifying the factors that affect the design of BI dashboards for monitoring quality in HEIs in the KSA. Therefore, the first research question: *'Can a Holistic Framework assist in identifying the Factors that affect the design of Business Intelligence Dashboards for Monitoring Quality in Higher Education Institutions in the Kingdom of Saudi Arabia?'* has been answered.

6.9 Conclusion

The aim of conducting the quantitative analysis was to validate the Holistic Framework for Monitoring Quality in Higher Education using Business Intelligence Dashboards in the KSA (HF-HEQ-BI). A questionnaire was developed for the purpose of surveying HE practitioners in Saudi Arabian HEIs. The questionnaire went through a piloting process and was administered electronically through Qualtrics XM website. Sample size was calculated and the calculations indicated that 96 participants were sufficient to draw conclusions from the study. The literature also indicates that a sample size of ≥ 100 participants will be sufficient for statistical analysis. There were 124 valid responses received from participants in the survey. Sample demographics have been presented throughout the chapter.

For the purpose of validating the HF-HEQ-BI framework, Cronbach's Alpha was calculated to measure the internal consistency of the questionnaire. The results indicated good consistency of data based on Cronbach's Alpha results. Confirmatory Factor Analysis (CFA) was conducted to measure the relationship between the factors and their pillars. The results of the CFA indicated reasonable model fit. Additionally, 12 factors were found more important in Public HEIs in comparison to Private HEIs according to participants' responses based on t-test results. T-test results indicate that there is a need for dashboards developed on the basis of the framework to be customisable.

The process of development of the holistic framework involved a literature review to identify factors that affect the design of BI dashboards for monitoring quality in HE, qualitative analysis of focus group of experts, and quantitative analysis of practitioners' opinions. Using these methods for development and validation of the framework achieves the concept of triangulation. The next chapter (Chapter 7) will discuss the validated framework in terms of a case study for Business Intelligence (BI) Quality monitoring dashboard based on a Saudi Arabian University.

Chapter 7 : Dashboard Development for Monitoring Quality in HEIs in the Kingdom of Saudi Arabia

7.1 Introduction

This Chapter discusses Human-Computer Interaction (HCI) and outlines how HCI is related to the design of Business Intelligence (BI) Dashboards. Business Intelligence Dashboards have been discussed in Section 2.9 in Chapter 2, and a definition of BI Dashboards for Monitoring Quality Assurance is introduced in this Chapter. BI Dashboard applications in Higher Education (HE) in the Kingdom of Saudi Arabia (KSA) are also discussed in Chapter 2.

The proposed Holistic Framework for Monitoring Quality in Higher Education Institutions using Business Intelligence Dashboards in the Kingdom of Saudi Arabia (HF-HEQ-BI) was validated as discussed in detail in Chapter 5 and Chapter 6. An HF-HEQ-BI Framework Utilisation Tool is presented in this chapter to demonstrate how the HF-HEQ-BI Framework can be used for the purpose of developing dashboards for monitoring quality in HE in KSA. A prototype dashboard, developed based on the Utilisation Tool, is presented in the chapter to provide an illustration of the way in which the HF-HEQ-BI Framework can be applied in practice. The chapter also considers related issues such as Human-Computer Interaction (HCI) which are required to ensure that the data is presented in the dashboard in ways which meet the needs of users.

7.2 Human-Computer Interaction (HCI)

Nielsen (1993) suggested that Human-Computer Interaction (HCI) refers to the usability of the information system. Therefore, several authors suggested that understanding the relationship between the users and the information systems interfaces is important in order to design systems that are ‘user friendly’ (Jooste et al., 2014; Magdalena et al., 2019; Dyczkowski et al., 2014; Nielsen, 1993).

Data visualisations provided by Business Intelligence (BI) dashboards require human intervention to obtain the benefit of these visualisations (Magdalena et al., 2019; Jooste et al., 2014). This intervention depends on the type of information and the level of details required to be displayed and visualisations which might need drill down for more insight. In addition, users can also decide on the colour coding required to present the data easily without the need to refer back to legends in order to understand the information presented in the visualisations. With regard to usability in BI, users need to interact with an application in a way that ensures that their decision-making is not hindered because of the complexity of the interface (Jooste et al., 2014).

For the purpose of developing BI dashboards, Oppl and Stary (2005) suggested that Human-Centred Design (HCD) is useful for developing diagrammatic representation schemes illustrating requirements such as usability. The HCD facilitates the involvement of end users with little or no modelling experience in the design process (Oppl & Stary, 2005). The involvement of end users during the design is helpful in enhancing the usability of the information system (Gatsou et al., 2013). The HCD process illustrated in Figure 7.1 shows the four main activities of the process: (1) specifying the context of use, (2) specifying the requirements, (3) creating design solutions, and (4) evaluating these designs. This approach is also suggested by the ISO 13407 standard (International Organisation for Standardisation, 1999).

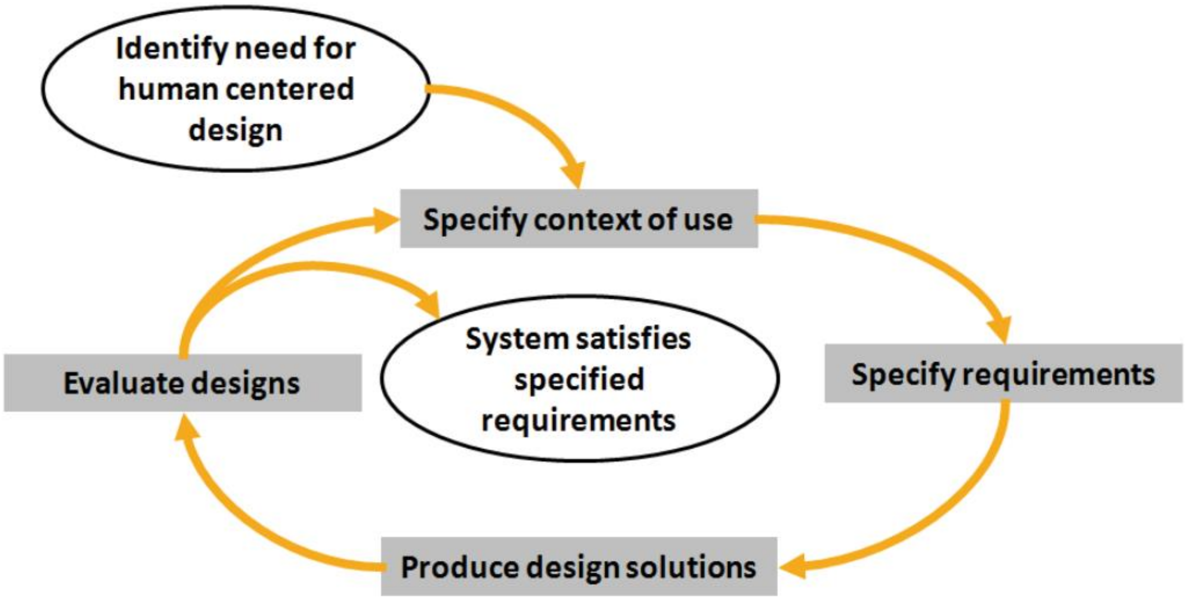


Figure 7.1: Human-Centred Design Process (Elias, 2014, p.8)

The HCD process illustrated in Figure 7.1 can be used for the development of BI systems in HE. Figure 7.2 illustrates the four main activities of the HCI design for developing BI systems based on the proposed HF-HEQ-BI framework in HE. The process activities are as follows:

1. **Specifying the context of use:** throughout this activity, the HEI must determine the QA aspects which need to be monitored throughout the dashboard. In this research, the HF-HEQ-BI framework will guide HEIs in determining the areas that will be monitored in order to assure quality. The HF-HEQ-BI utilisation tool presented in Section 7.3 of this chapter will allow the users to specify the QA context of the dashboard.

2. **Specifying the requirements:** the BI system requirements will be identified by the HEI. During this stage, the HEI will decide which BI architecture they may wish to adopt, data sources, KPIs, etc. Different BI architectures in HE were discussed in detail in Section 2.10 in Chapter 2.
3. **Produce the design solutions:** the BI dashboard development will depend upon the information obtained through the requirements specified in 2.
4. **Evaluate the designs:** during the evaluation process, the BI system will be assessed in order to decide whether the system meets the requirements. BI Scorecards may be used for the purpose of the evaluation process (Dyczkowski et al., 2014).

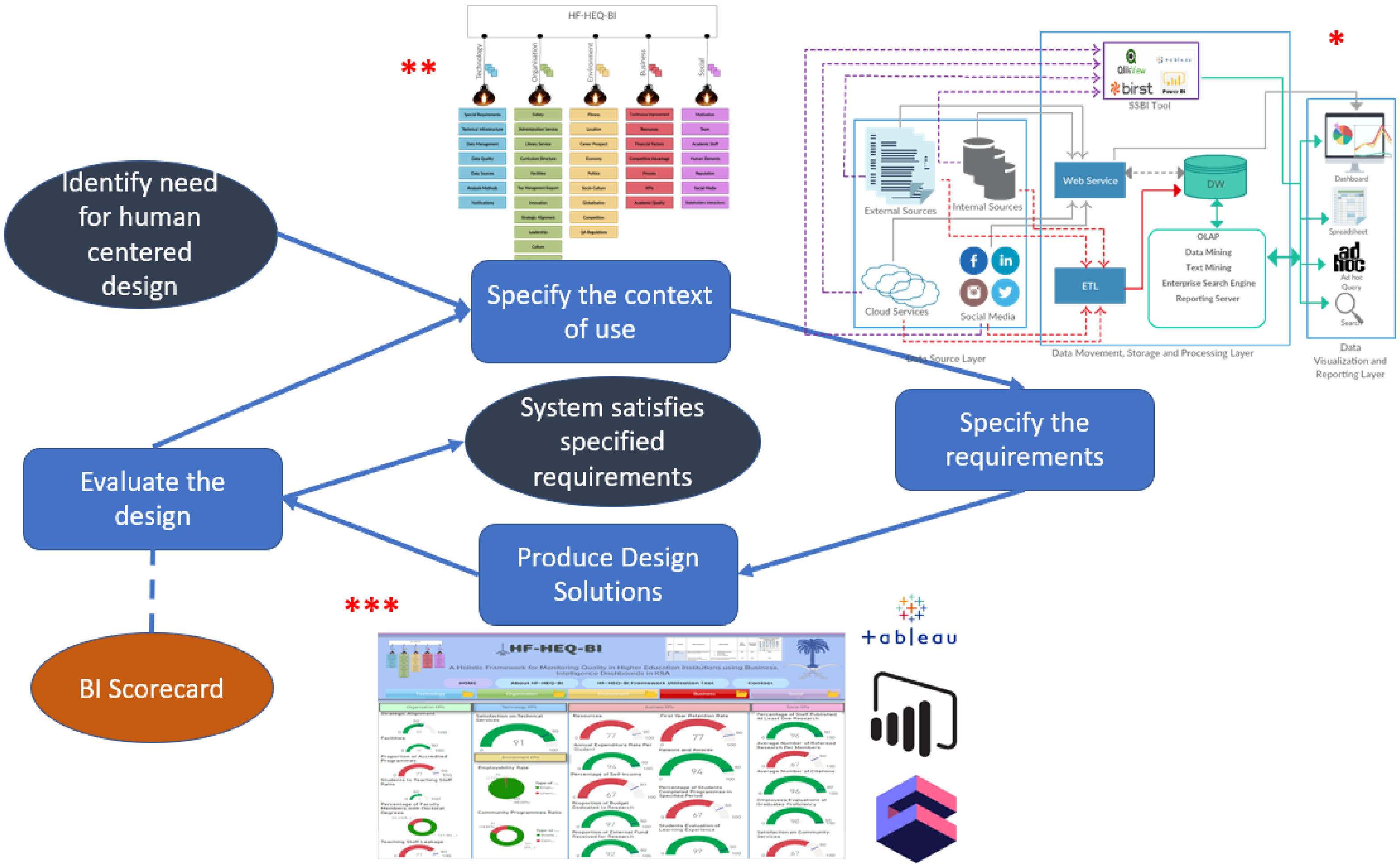


Figure 7.2: Human Centred Design Process for BI systems in Higher Education

*(The thumbnail diagrams enclosed in Figure 7.2 are shown in detail as follows * Figure 2.10, ** Figure 6.7, and *** Figure 7.6)*

In the context of HEIs in KSA, QA monitoring is currently conducted through annual audits using checklists designed in spreadsheets format. The process of monitoring compliance with NCAAA standards and the 23 mandatory KPIs is undertaken through obtaining analytics from different sources (including manual surveys and portal-based surveys). The results are summarised to indicate the degree of compliance and to monitor deviations. The developed BI dashboard for monitoring QA in HEIs will replace manual audits conducted to assure quality. The HEIs will be able to interactively monitor QA performance through the BI dashboard and determine areas for action where the performance is not satisfactory. When using manual audits conducted on an annual basis, the HEIs are not able to determine unsatisfactory performance until the next audit, which is done in the next academic year. Dashboards developed based on the HF-HEQ-BI framework will be linked to the HEI's Information System, meaning that the data displayed in the dashboard will be updated automatically, allowing for continuous monitoring. The use of BI dashboards in monitoring QA in HEIs in the KSA conforms with the trend of utilising BI dashboards for monitoring in several governmental agencies as outlined in Section 2.9.5 in Chapter 2.

The NCAAA accreditation process has been discussed in detail in Section 2.4 in Chapter 2. The dashboard built using the HF-HEQ-BI Framework will be able to show the NCAAA mandatory KPIs and help decision-makers to track compliance with the 8 NCAAA standards for QA. The next section discusses the development phases of a prototype dashboard for monitoring QA in HEIs in KSA using the HF-HEQ-BI Framework. This prototype dashboard has been developed to illustrate the way in which the HF-HEQ-BI framework can be applied to support Quality Assurance in HEIs in the context of KSA.

7.3 Framework Utilisation Tool

The HF-HEQ-BI framework identifies factors that should be considered while designing dashboards for monitoring quality in HEIs in KSA. The framework is intended for use by Top Management and QA Deanships in KSA HEIs as illustrated in Figure 7.3 together with the development process (Input-Process-Output). The framework provides a comprehensive and a holistic view of QA factors. The dashboard is based on the HF-HEQ-BI framework developed and validated in this research and supports dashboard functionality such as drilling-down capability to enable middle managerial levels of the institutions to use these dashboards. In addition, the dashboard presents the 23 NCAAA KPIs as well as Social Media Analytics and institutional specific KPIs.

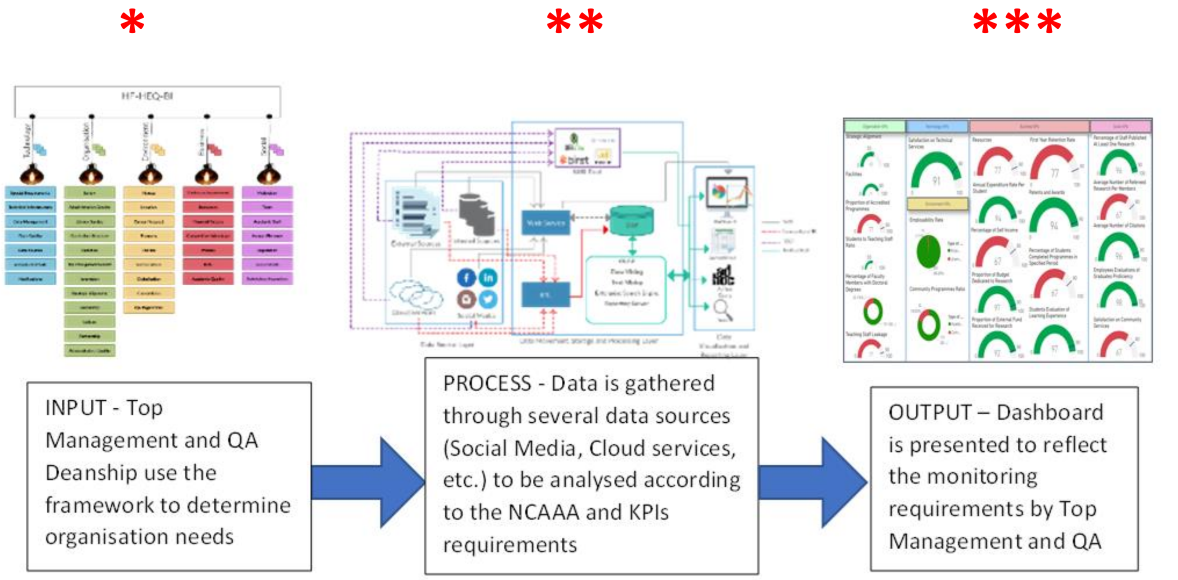


Figure 7.3: Dashboard Development Process through HF-HEQ-BI Framework

*(The thumbnail diagrams enclosed in Figure 7.3 are shown in detail as follows * Figure 6.7, ** Figure 2.10, and *** Figure 7.6)*

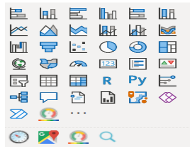
For the purpose of utilising the factors presented in the HF-HEQ-BI, Framework a Utilisation Tool has been developed. The framework utilisation tool aims to assist decision-makers in determining what data is required as a pre-requisite for QA system. The Framework Utilisation Tool shows the factors that HEIs should consider while developing BI dashboards for monitoring QA performance. An explanation of the factors is provided in the Framework Utilisation Tool. The NCAAA KPI related to the factors are presented in the tool to guide the developers when designing these mandatory requirements. In addition, the tool provides a column (‘*Visualisation Required’*) where the user can determine the required visualisation to be used for presenting the performance. The visualisations presented in the Framework Utilisation Tool have been selected from Microsoft Power BI. They are provided as guidance to show that the user may select the required visualisation to display the factor measurement. The user may wish to select different visualisations or different BI Architectures or SSBI tool, and this is supported as the Framework Utilisation Tool is easy to customise. The HF-HEQ-BI framework has taken into consideration that HEIs may adopt additional institutional specific KPIs. Therefore, the HF-HEQ-BI Framework Utilisation Tool shows how these additional KPIs may be added, and illustrates visualisations selected for each additional KPI. The Framework Utilisation Tool has been colour coded to represent the five pillars of the HF-HEQ-BI Framework. For readability and conciseness, Table 7.1 shows only the Technology pillar and the other 4 pillars Organisation, Environment, Business and Social are presented in Appendix E.

For the purpose of using the HF-HEQ-BI Framework Utilisation Tool, the following steps should be followed:

1. The user should answer all questions in the measurement column
2. The information column provides a description of the measurement and links the measurement to the mandatory NCAAA KPIs.
3. KPIs – NCAAA column shows the KPI associated with the measurement (if any)
4. Standards – NCAAA column shows the NCAAA standards associated with the metric (if any)
5. Visualisations Required column shows the visualisation that the user may select to represent the data. Visualisations from 'Visualisations Pane' in Microsoft Power BI have been provided here for guidance.

The HF-HEQ-BI Framework Utilisation Tool is designed to show how the HF-HEQ-BI factors can be utilised for the purpose of building a BI dashboard for monitoring QA in HEIs. The tool can be extended to include additional KPIs as shown in the Business Pillar (See Appendix E under KPIs Factors in Business Pillar). The HEI may decide that some factors are not applicable to their individual case, or that there are additional requirements that they may wish to add under specific factors. Therefore, each HEI can modify the tool to suit their requirements and needs. In addition, the type of visualisation and the level of details that each HEI management may be different. Therefore, each HEI may decide which visualisations are required and the level of details they wish to present in the dashboard. Consequently, the tool allows for customisation and can be 'tailored to the size of the institution'.

Table 7.1: HF-HEQ-BI Framework Utilisation Tool (Technology Pillar of HF-HEQ-BI)

Pillar	Factor	Measurement	Information Determination and Appropriate Tasks	KPIs - NCAAA	Standard - NCAAA	Visualisations Required – Illustrated in MS Power BI 
Technology	Special Requirements	What is the suitable architecture for our organisation?	Identify the scope, data volumes and expected use of the system	N/A	N/A	N/A
			Identify the requirements for the BI dashboard system	N/A	N/A	N/A
		What are the requirements of the selected architecture?	Determine the required BI architecture (DW, or SoBI, or SSBI)	N/A	N/A	N/A
			Determine the requirements and tools for the selected architecture	N/A	N/A	N/A
			Calculate compliance with the requirements specified	N/A	N/A	Gauge 
	Technical Infrastructure	Does our organisation have the required IT infrastructure?	Determine areas which need to be improved in our IT infrastructure environment	N/A	N/A	N/A
		Calculate the satisfaction of beneficiaries with technical services	Calculate average satisfaction rate on five-point scale in annual survey on suitability	KPI-I-15	6	Gauge 
			Calculate average satisfaction rate on five-point scale in annual survey on safety and confidentiality	KPI-I-15	6	Gauge 
			Calculate average satisfaction rate on five-point scale in annual survey on availability and ease of access	KPI-I-15	6	Gauge 

			Calculate average satisfaction rate on five-point scale in annual survey on maintenance and support services	KPI-I-15	6	Gauge
	Data Management	Does our organisation have a data integrity policy?	If a data integrity policy does not exist or requires updating, develop an appropriate data integrity policy	N/A	N/A	N/A
			Determine the data collection, storage, mining, and archiving tools that will be used in the system.	N/A	N/A	N/A
		Where is data going to be stored?	Calculate the compliance with the data integrity policy.	N/A	N/A	Gauge
	Data Quality	What are the standards for assessing quality of data?	Determine the audits required for assuring that data satisfies the desired level of quality before integrating it into the system	N/A	N/A	N/A
			Calculate compliance with the Data Quality standards	N/A	N/A	Gauge
	Data Sources	What are the sources that will be used for the purpose of gathering data for presentation?	Identify data sources that the system will be connected to (Cloud Services, Databases, Spreadsheets, Manual Data Entry, etc.)	N/A	N/A	N/A
			Display connection health to each data source	N/A	N/A	Gauge
	Analysis Methods	What are the analytical methods required for presenting the data?	For each KPI, determine the required information to be presented and the visualisation type required	N/A	N/A	N/A
			Calculate the degree of compliance with the specified analysis methods.	N/A	N/A	Gauge
	Notifications	What are the types of details required in the notifications report?	Determine the levels of performance that require management attention per each KPI	N/A	N/A	N/A

7.4 Dashboard Development Phases

The development of BI dashboards is discussed in Section 7.2 and illustrated in Figure 7.2 for convenience. The development of the dashboard includes identifying the requirements, production of the design solution, and evaluation of the designed dashboard. In this section, the dashboard development phases will be outlined in more detail. Figure 7.4 illustrates how users can apply the HF-HEQ-BI Framework for the purpose of developing the dashboard for monitoring quality in HE. Figure 7.4 shows that the Self-Service Business Intelligence (SSBI) tool obtains the inputs from users responsible for gathering data related to measuring QA performance. The developed dashboards will allow Top Management to monitor QA activities and determine areas that require attention. The end users of the dashboard should be able to have limited access to the data that are related to their specific role in the organisation. For example, if a Head of Department is using the dashboard, only data related to that specific department will be displayed in the dashboard.

During the development process, a Community of Practice (COP) approach was used to solicit constructive comments about the dashboard design from experts with experience in QA and management roles in QA in KSA. The prototype dashboard was presented to a panel of experts and senior academics who served as senior managers in QA in KSA and UK for the purpose of obtaining their opinions regarding the presentation of the dashboard, and several comments have been suggested regarding the presentation of the dashboard (outlined in Appendix F).

The initial prototype dashboard presented only the design solution produced by Microsoft Power BI. The level of detail presented in the dashboard was limited. Only 23 NCAAA KPIs were presented in the dashboard under the five pillars of the HF-HEQ-BI Framework. Following comments received, the dashboard was further improved to add details related to the QA KPIs in order to allow monitoring of all QA factors through the dashboard. It was decided to represent the dashboard through a web portal to support the development of a navigation bar on the top of the page. The purpose of adding the top pane is to provide additional information about the project and how the HF-HEQ-BI Framework can be used for the purpose of developing QA monitoring dashboard. The navigation bar allows users to navigate through the dashboard and use the functionalities of the dashboard (drilling-down, drilling-through, filtering, etc.) and return back to the home screen to assist in navigation.

The use of a web portal for publishing the dashboard allows the management to provide user permissions and roles. Top Management of the HEI would have full access to view all details on the dashboard. Colleges Deans would normally have access to details related to their college only.

Accordingly, the dashboard went through several iterations in response to the COP comments. These iterations are outlined in (Appendix F). A summary of comments made by senior managers involved in QA from the COP team is outlined in Appendix F.

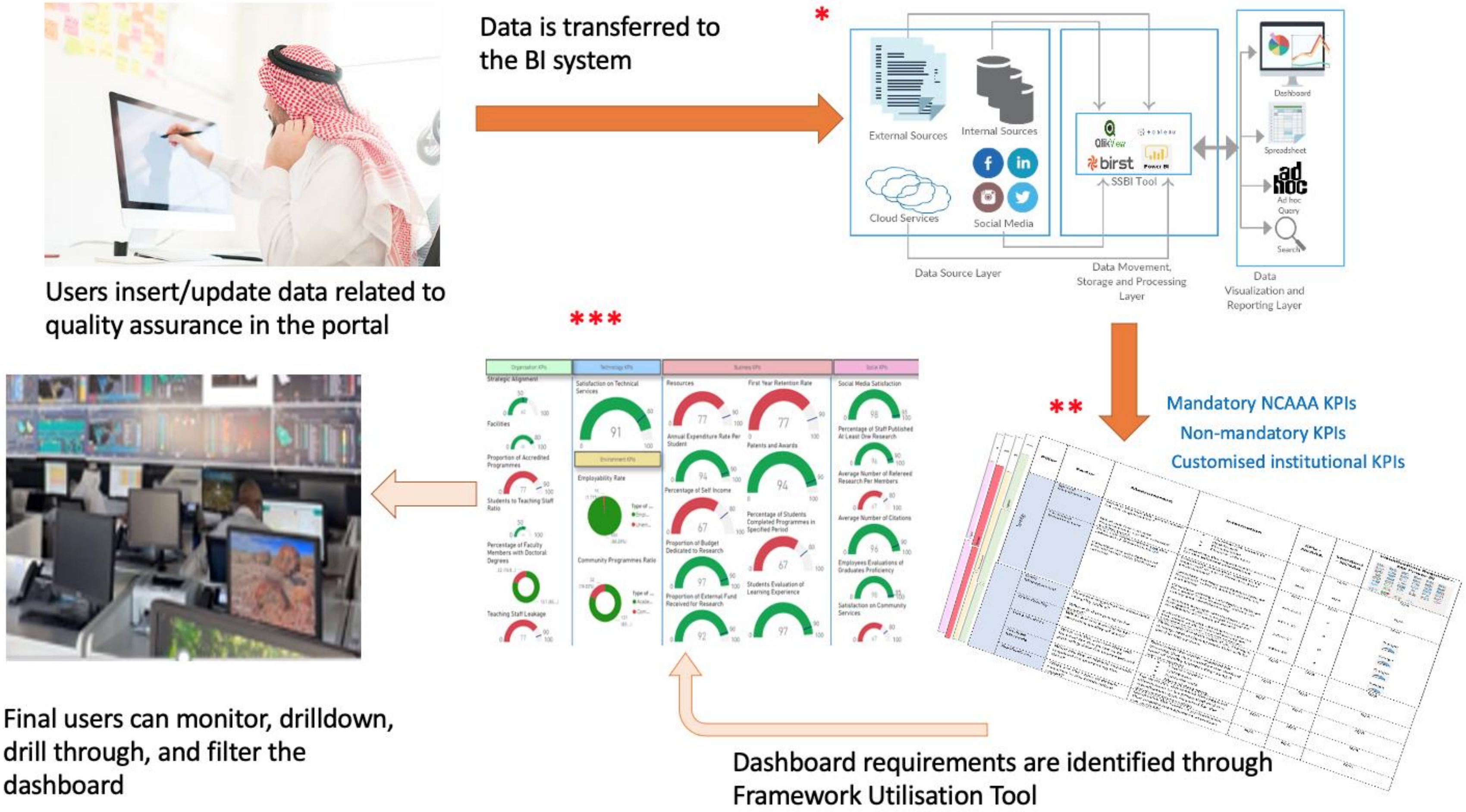


Figure 7.4: Dashboard Development Process

*(The thumbnail diagrams enclosed in Figure 7.4 are shown in detail as follows * Figure 2.9, ** Table 7.1, and *** Figure 7.6)*

7.4.1 Identifying Dashboard Context

The HF-HEQ-BI framework is used for the purpose of determining the context of use of the dashboard. The developed dashboard will be used for the purpose of monitoring quality in HEIs. Additionally, the dashboard designed using the HF-HEQ-BI takes into consideration the mandatory requirements of the National Centre for Academic Accreditation and Assessment (NCAAA) as well as provides Social Media Analytics. The prototype dashboard presented here is illustrated with twitter-based analytics, but this can be extended to include other forms of Social Media Analytics. Sentiment Analysis of the text-based interactions (comments) and other Social Media Analytics will appear in the dashboard to allow Top Management to monitor them. Some HEIs may add further KPIs which can sometimes be as many as 100 to monitor strategic plan alignment or financial metrics. For example, King Saud University adopted a total of 56 KPIs for measuring QA performance (King Saud University, 2012). Qassim University adopted 50 KPIs for strategic management performance monitoring (Qassim University, 2020). Majmaah University adopted 21 KPIs to monitor strategic performance in addition to the NCAAA mandatory KPIs (Majmaah University, 2016). These KPIs may be presented in the dashboard in the Business pillar to provide improved visualisation of institutional performance such as successful application rate and diversity of students.

7.4.2 Identifying Dashboard Requirements

The HF-HEQ-BI Framework Utilisation Tool outlined in Section 7.3 has been used for the purpose of determining the requirements and visualisations desired for designing the dashboard. A prototype dashboard has been developed using a Self-Service Business Intelligence tool (SSBI). The justification for choosing an SSBI architecture to implement the dashboard is that SSBI allows more flexibility and saves time (Maryska & Doucek, 2017). SSBI tools allow dashboards to be developed without the need to heavily invest in developing Data Warehouses (DW). It was not practical to design a DW for this project due to time and data constraints. The prototype dashboard presented throughout this chapter is designed for the purpose of illustration and evaluating the HF-HEQ-BI Framework. The most popular SSBI tools are Microsoft Power BI, Tableau, QlikView, and Birst (Maryska & Doucek, 2017; Paulussen, 2019). Microsoft Power BI was selected for this project, and this is discussed further in Section 7.4.3.

7.4.3 Production of Design Solution

For the purpose of developing the prototype dashboard, Microsoft Power BI and Tableau (SSBI tools) and Cube.js (SoBI tool) were reviewed and tested. Tableau was found to provide several services such as the ability to install it on Macintosh Operating System (MacOS) as well as Windows. Tableau provides a trial for all of its functionalities for one year to all students studying in academic institutions. One of the drawbacks of Tableau is that it does not support the Arabic Language in its interface. Node.js is Service Oriented Business Intelligence which requires web hosting services in order to be able to use its functionalities. In addition, Node.js requires web programming skills to be able to portray the visualisations to fit the web pages. Microsoft Power BI Desktop was selected for the purpose of developing the prototype dashboard as it is intuitive to design and free to Microsoft users (Noonpakdee et al., 2018). Microsoft Power BI Desktop has been used in several studies for developing dashboards. Noonpakdee et al. (2018) used Power BI to develop a dashboard template for Small and Medium-Sized Enterprises (SMEs), and Sluijter and Otten (2017) used Power BI for developing personalised student dashboards.

The visualisation requirements have been identified through using the HF-HEQ-BI Framework Utilisation tool, and a prototype dashboard has been used for the development process. The main page of the dashboard outlined in Figure 7.5 shows a PHP webpage represents the home page of the system. The top pane of the home page provides users with information about the dashboard and the HF-HEQ-BI Framework and also includes a navigation bar to navigate to different pages.

Figure 7.5: Home Page

The developed prototype dashboard has been divided into several screens to allow decision-makers to monitor QA performance and compliance with NCAAA and QA standards by the HEI. Figure 7.6 illustrates the first page of the prototype dashboard. The dashboard presented in Figure 7.6 displays the 23 mandatory KPIs and measures the degree of compliance with the respective KPIs in the HEI. Users are able to drilldown to investigate performance related to a specific college or department. Decision-makers in the HEI will be able to monitor compliance with the 23 KPIs and identify the areas where special attention is required to be able to achieve/maintain the national NCAAA accreditation.

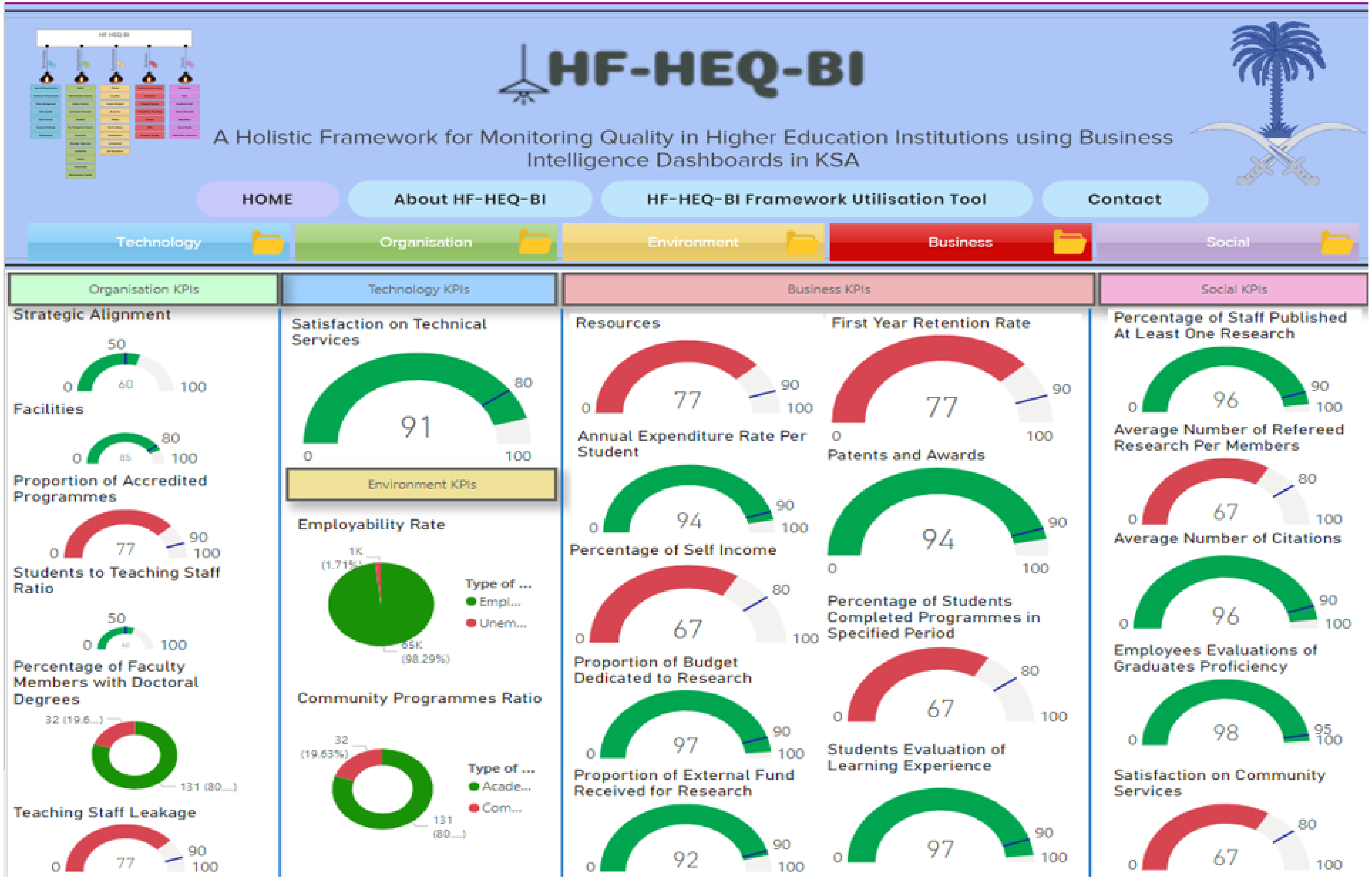


Figure 7.6: Quality Assurance Dashboard (NCAAA KPIs)

In Figure 7.7, the prototype dashboard shows the Institutional Specific KPIs, which are related to the factors measuring the compliance with QA standards that have not been covered by the NCAAA standards. As QA monitoring encompasses monitoring activities related aspects such as ‘Locations covered by the institution’ and ‘Health and Safety requirements’ etc., decision-makers will be able to monitor the compliance with such factors through this screen. This information, which has been identified throughout the process of developing the HF-HEQ-BI Framework, has been found to be essential for building QA system in HEIs.

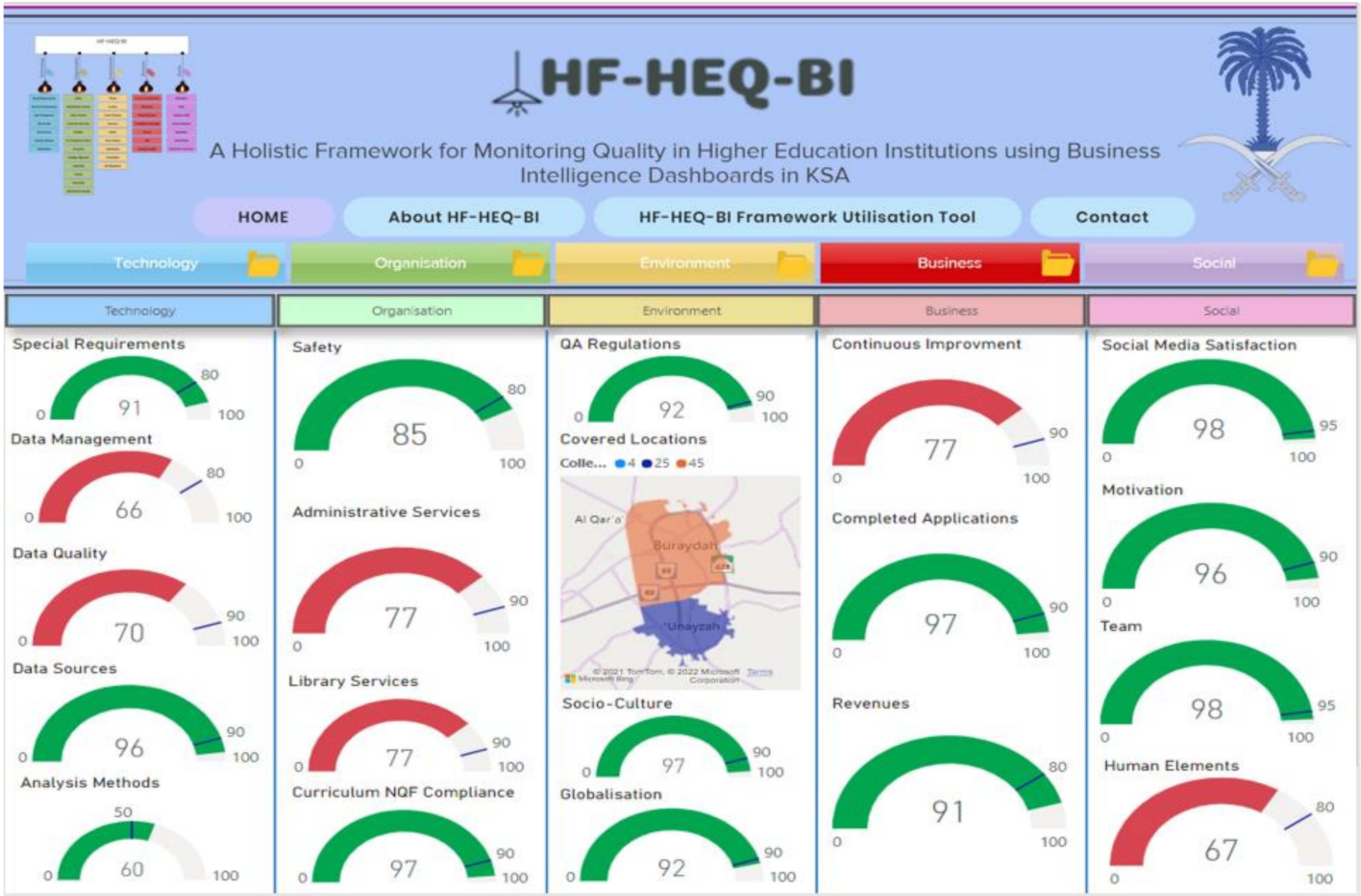


Figure 7.7: Quality Assurance Dashboard (Institutional Specific KPIs)

The prototype dashboard shows Social Media Analytics including Sentiment Analysis of Tweets coming from Twitter Platform. KSA was one of the first countries in the Arab World to use Twitter as a social media channel (OKAZ, 2020). According to UNIRANK, 17 Saudi Arabian universities appeared in the Top 200 Universities on Twitter based on Followers Count in 2021 (UNIRANK, 2021). In some private HEIs in KSA, the senior management monitor Twitter feeds on a regular basis for adverse publicity as some institutions may get several hundred daily tweets. Therefore, Social Media Analytics has been presented in the prototype dashboard as illustrated in Figure 7.8.

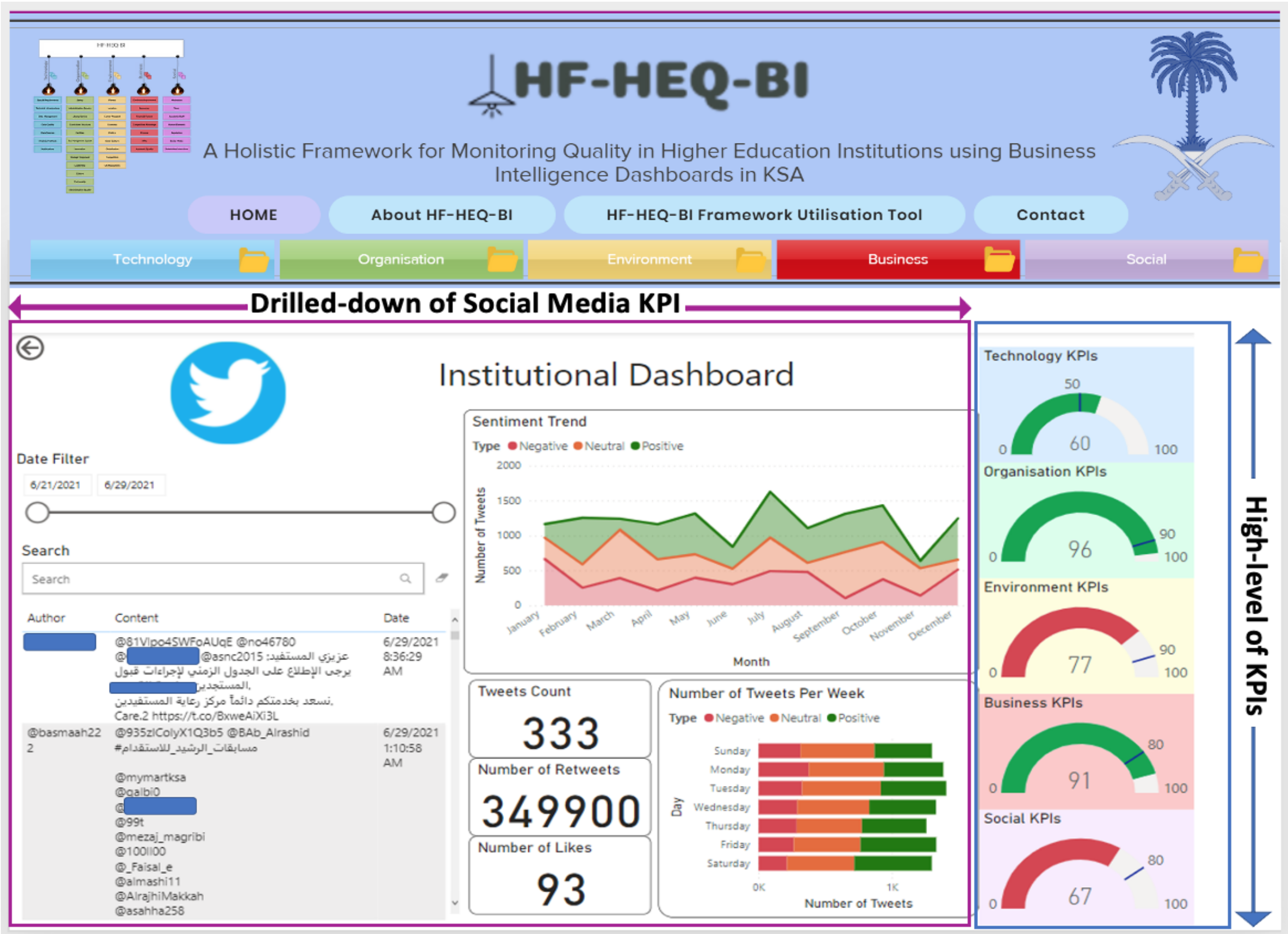


Figure 7.8: Quality Assurance Dashboard (Social Media Analytics)

For the purpose of obtaining data related to Tweets coming from Twitter, the Twitter Application Programming Interface (API) was integrated into the dashboard. The API allows the user to find Tweets for specific periods of time and export Sentiment Analysis data into Spreadsheets to allow the SSBI tool to represent the data. Some SSBI tools allow the users to connect to other third-party Sentiment Analysis provider such as Hootsuite and Brand24.

The HEI may be required to monitor additional KPIs to keep track of their institutional performance. These additional KPIs such as successful application rates, students per class, and revenue streams generated by the programmes may be monitored through the dashboard as illustrated in Figure 7.9.

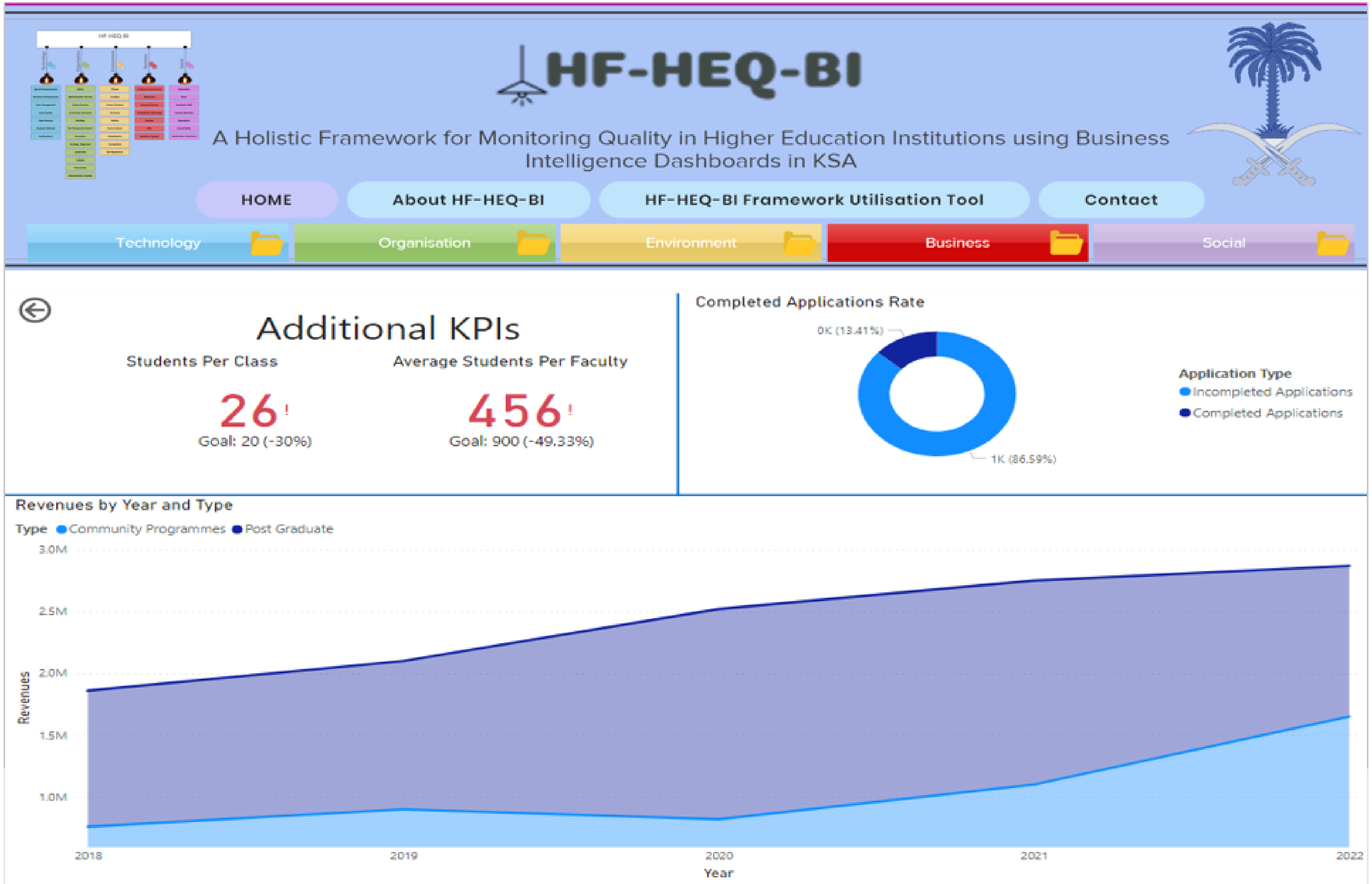


Figure 7.9: Quality Assurance Dashboard (Additional KPIs)

7.4.4 Design Evaluation

The prototype dashboard was developed through the use of the HF-HEQ-BI Framework Utilisation Tool. Howson (2008) presented a BI Scorecard approach to evaluate BI systems which is based on the Scorecards Framework. Dyczkowski et al. (2014) used BI Scorecards in an evaluation process of a developed dashboard. Dashboards capabilities may be evaluated using the BI Scorecards including evaluating the design, presentation, alerting, analysis, KPIs, interactivity, delivery, and architecture (Noonpakdee et al., 2018). The process of evaluation of the prototype dashboard is discussed in detail in Chapter 8.

7.5 Discussion of Quality Monitoring Dashboard Features

The prototype dashboard presented in Section 7.4 was developed through the use of the HF-HEQ-BI Framework Utilisation Tool. The prototype dashboard presents the 23 mandatory NCAAA KPIs as well as other KPIs related to the QA factors identified by the HF-HEQ-BI Framework. The development of the prototype dashboard went through several iterations of improvement until reaching the shape presented in Section 7.4. Figure 7.10 outlines the development screen from Microsoft Power BI.

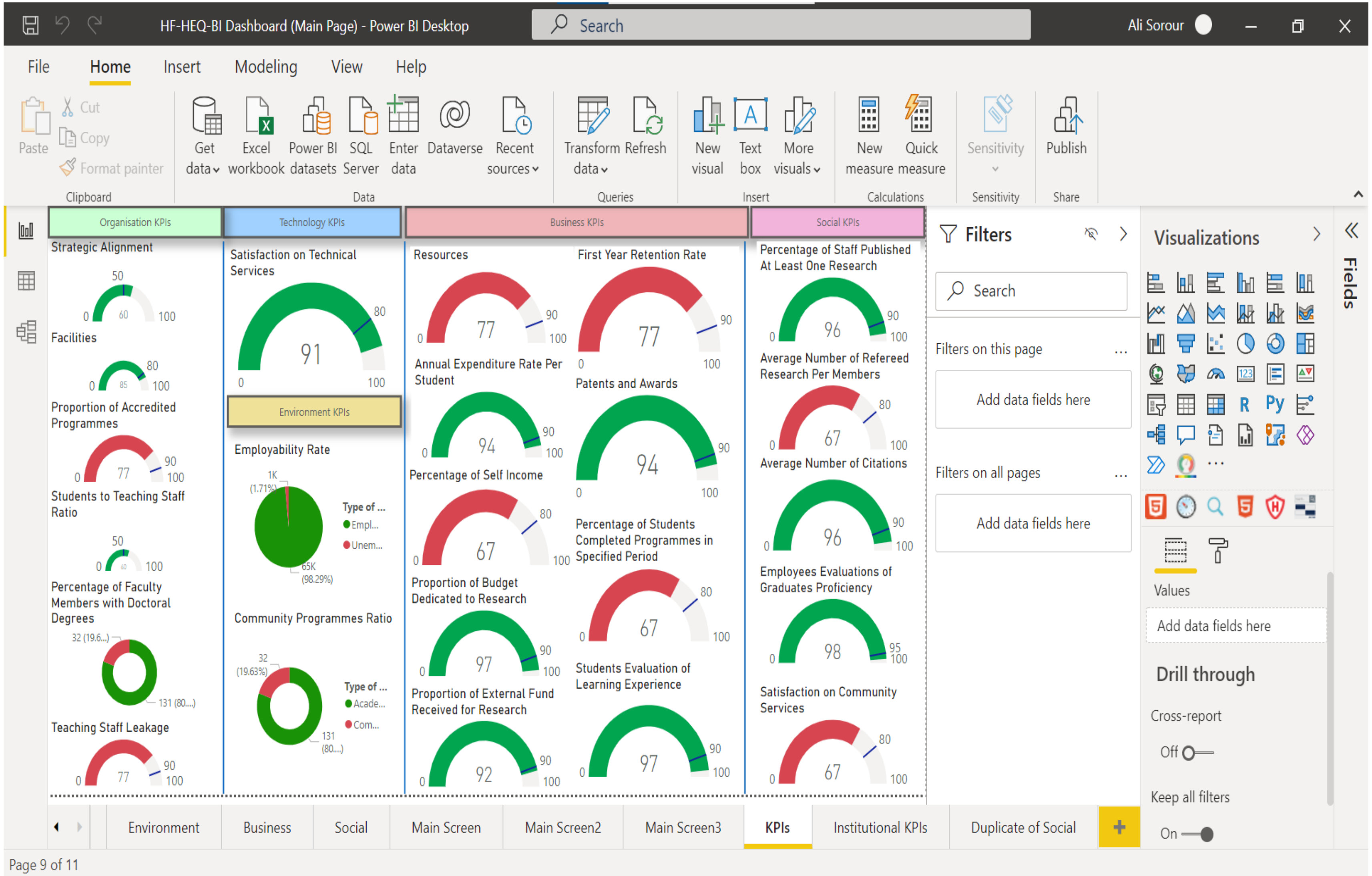


Figure 7.10: Microsoft Power BI Development Screen

The prototype dashboard allows the addition of other performance metrics KPIs and also supports monitoring of social media streams. Figure 7.11 presents a visualisation of the dashboard outputs from the Framework Utilisation Tool (FUT).

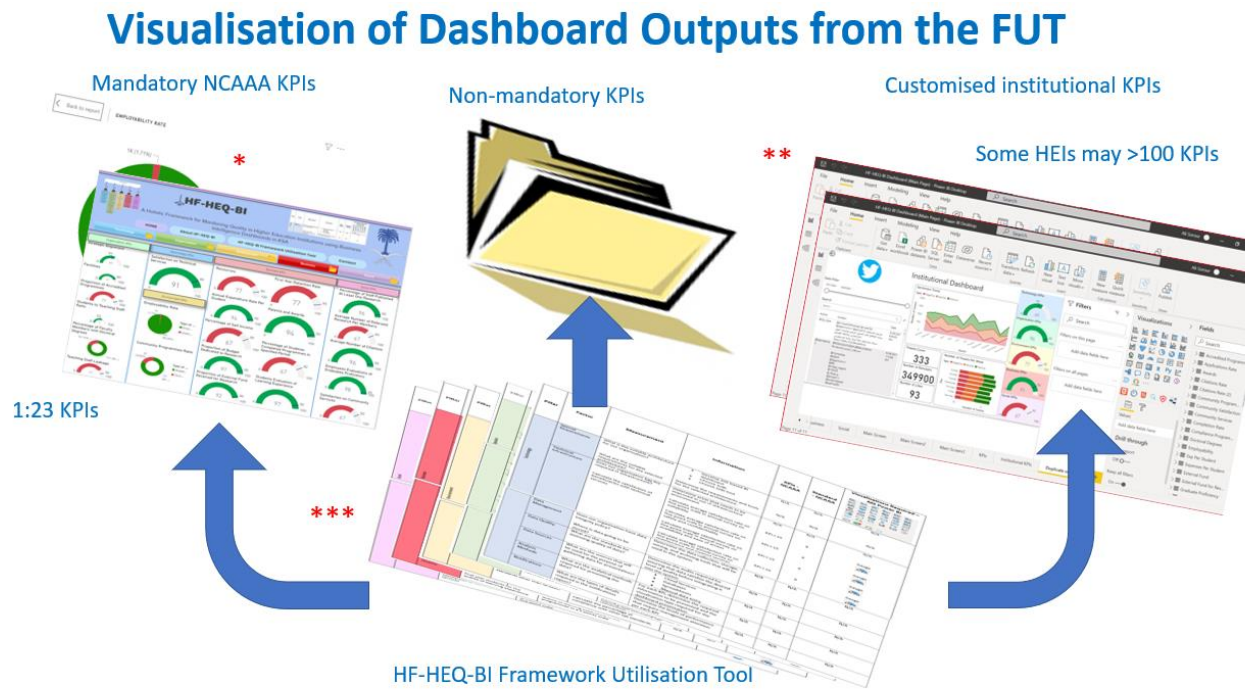


Figure 7.11: Visualisation of Dashboard Outputs from the Framework Utilisation Tool (FUT)

*(The thumbnail diagrams enclosed in Figure 7.11 are shown in detail as follows * Figure 7.6, ** Figure 7.10, and *** Table 7.1 Framework Utilisation Tool (Appendix E))*

As illustrated in Figure 7.11, the main screen of the dashboard presents the 23 mandatory NCAAA KPIs. The user can navigate to access the supporting documentation for QA activities such as QA manuals or Safety and Procedures compliance audits logs. The dashboard allows customisation of the required visualisations as well as monitoring as many KPIs as the institution's Top Management desire. The end user of the dashboard will be allowed to monitor QA performance through the dashboard screen. The users will be able to drill-down to data in the dashboard to monitor a specific College or Department as presented in Figure 7.12.

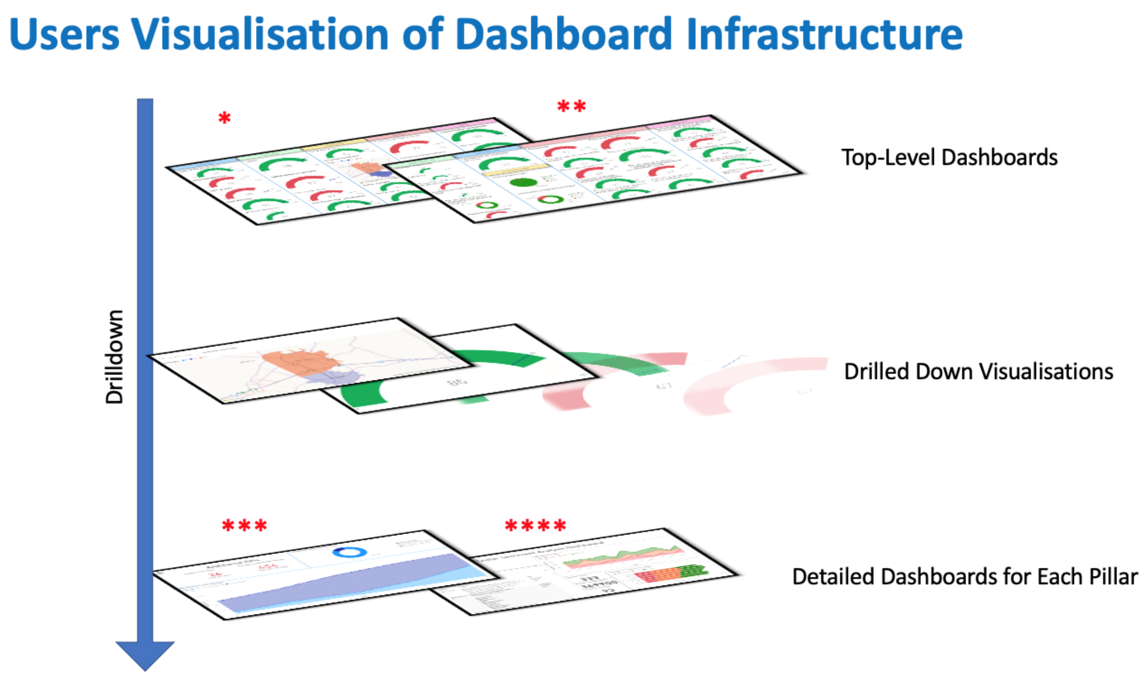


Figure 7.12: Users Visualisation of Dashboard Infrastructure

*(The thumbnail diagrams enclosed in Figure 7.12 are shown in detail as follows * Figure 7.7, ** Figure 7.6, and *** Figure 7.9, **** Figure 7.8)*

Figure 7.13 illustrates the Filter abilities of the dashboard based on Keywords and time. As seen in (1) in Figure 7.13, the Sentiment Analysis dashboard shows Twitter analytics for a specified period of time. The user can find the number of Tweets, Retweets, and Likes on the Dashboard. The users can filter the results to show tweets that are related to specific period of time using the slide bar filter as shown in (2) in Figure 7.13. As a result, the number of Tweets, Retweets, and Likes is changed to reflect the new period specified using the slide bar. In addition, the user can be able to filter the results to show tweets that contains specific keywords as shown in (3) in Figure 7.13. The dashboard reflects the changes showing Tweets, Retweets, and Likes that contain these Keywords. The prototype dashboard has been developed to illustrate the way in which the HF-HEQ-BI framework can be used to support the development of a quality assurance dashboard. Institutions developing dashboards based on the framework will be able to customise the data and build in more sophisticated sentiment analysis.

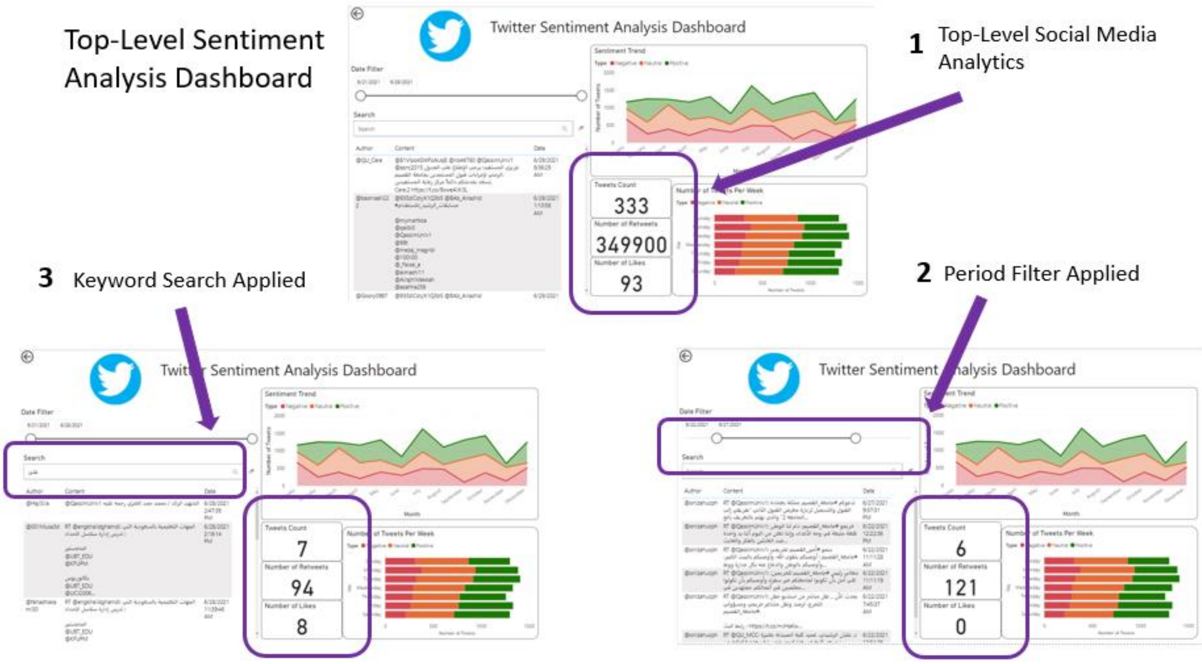


Figure 7.13: Filtering results in the dashboard

7.6 Conclusion

This chapter shows how the HF-HEQ-BI Framework can be applied in the development of a BI dashboard for monitoring quality in HEIs and presents a prototype dashboard developed from the framework. The process of developing the BI dashboard was discussed to show how the HF-HEQ-BI Framework Utilisation Tool may be used for determining the requirements that are required to be presented in the dashboard. The HF-HEQ-BI Framework Utilisation Tool assists in determining the required visualisation for each KPI to be displayed in the dashboard. The Framework Utilisation Tool is customisable and can be adapted by users to reflect the requirements of individual HEIs.

A prototype dashboard has been developed to illustrate the application of the framework and also for the purpose of evaluating the HF-HEQ-BI Framework. The developed dashboard shows a monitoring display of the 23 NCAAA mandatory KPIs, Institutional Specific KPIs, Additional KPIs, and Social Media Analytics. The Social Media Analytics presented in the dashboard included Sentiment Analysis of data drawn from Twitter feed through an integration of Twitter Application Programming Interface (API). Additionally, the prototype dashboard presents allows the users of the dashboard to represent additional KPIs related to performance monitoring in the institutions.

The developed prototype dashboard will be evaluated through the use of BI Scorecards Framework. The process of evaluation will be discussed in detail in Chapter 8.

Chapter 8 : Evaluation of the Prototype Dashboard for Monitoring Quality in Higher Education Institutions

8.1 Introduction

In Chapter 7, the HF-HEQ-BI Framework was used to develop a Business Intelligence Dashboard for monitoring Quality in HEIs in KSA. This chapter discusses the evaluation process for the designed prototype dashboard. The evaluation process includes the assessment of the dashboard developed through the Holistic Framework for Monitoring Quality in Higher Education Institutions using Business Intelligence Dashboards (HF-HEQ-BI) by a panel of experts with experience in Quality Assurance in Higher Education Institutions. The prototype dashboard presented in Chapter 7 has been developed through the use of HF-HEQ-BI Framework Utilisation Tool. This chapter assesses whether the HF-HEQ-BI framework can assist in producing a dashboard that captures quality assurance requirements. An evaluation tool was developed for the purpose of the evaluation process using a BI Scorecard tool and Technology Acceptance Model (TAM) usability criteria. A case study was used for the purpose of evaluation of the prototype dashboard. The chapter outlines the case study results of the evaluation process.

8.2 Aim of Evaluation

The aim of the evaluation process is to assess the approach of using the HF-HEQ-BI framework to support the development of a prototype dashboard to monitor QA. In addition, the evaluation process aimed also to assess the designed prototype dashboard. Usability evaluations of newly released Information Technology (IT) solutions are essential for the purpose of assuring that the IT system is easy to use, efficient, effective, and achieves the required objectives (Hwang & Salvendy, 2010). To support the evaluation of the dashboard described in this chapter, a panel of experts in Quality Assurance (QA) in Higher Education (HE) in KSA were involved in the demonstration and their feedback on the prototype dashboard was obtained. The selection criteria for the panel of experts were as follows:

1. The expert must have 10+ years in Quality Assurance in Higher Education
2. The expert must be working/have worked in a Higher Education Institution in the Kingdom of Saudi Arabia
3. The expert is aware of the QA and accreditation process and requirements of Higher Education Institutions in the Kingdom of Saudi Arabia

It was suggested by Nielsen (2000) that the number of usability problems found through usability tests by incorporating ‘n’ users in the test can be expressed by the following function:

$$N = (1 - (1 - L)^n) \qquad \text{Equation 8.1}$$

Where N: total number of usability problems found in the design (expressed as percentage of usability problems found through testing); L: proportion of usability problems found by single user testing.

Nielsen (2000) suggested that the typical value of L is 31% based on their results in previous studies. Depicting 31% in Equation 8.1 will lead to the curve outlined in Figure 8.1.

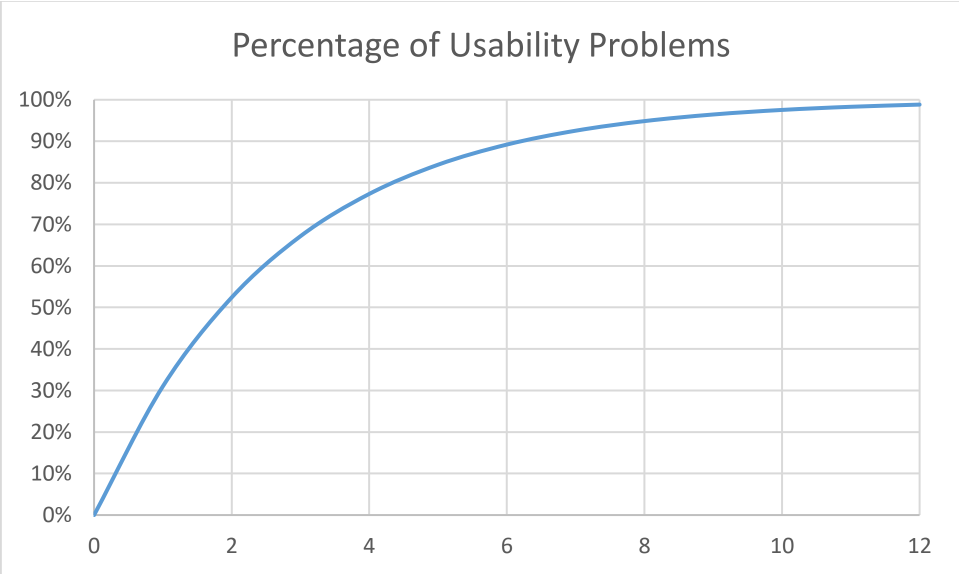


Figure 8.1: Probability of Usability Problems

As illustrated in Figure 8.1, single user testing may lead to identification of 31% of usability problems, 5 users testing may address up to 84% of usability problems. Sánchez Prieto et al. (2016) suggested a use of six evaluators for using TAM model in evaluating educational development technologies. Li and Helenius (2007) suggested that six evaluators are usually sufficient to address most usability problems. Therefore, for the purpose of this research project, the Sánchez Prieto et al. and Li and Helenius approach is followed and eight academics who met the selection criteria were identified.

8.3 Business Intelligence Systems Evaluation

Business Intelligence systems are often evaluated using Business Intelligence Evaluation Frameworks owned by consulting companies such as Gartner and Dresner Advisory Services (Dyczkowski et al., 2014).

Howson (2008) has proposed the BI Scorecard for the purpose of providing a tool for evaluating BI systems through assessing the BI system against several criteria. Dyczkowski et al. (2014) presented a comparison of selected frameworks for evaluating BI systems. The BI Scorecard is based on Norton and Kaplan Balanced Scorecards (BSC) Framework (Dyczkowski et al., 2014; Kaplan & Norton, 1992). Dyczkowski et al. (2014, p.1149) defined BI Scorecards as a '*tool to support the evaluation process based on multi-level pre-defined breakdown structure of the evaluation criteria and scoring technique*'. The BI Scorecard addresses 9 categories for evaluating the features of dashboards. The evaluation categories of BI Scorecard for dashboard evaluation are as follows: (1) Dashboard Layout, (2) Dashboard Design, (3) Presentation, (4) Alerting, (5) Analysis, (6) KPI/ Metrics, (7) Dashboard Interactivity, (8) Delivery, and (9) Architecture (Howson, 2008, 2005; Dyczkowski et al., 2014).

Balanced Scorecards (BSC) are used by High Income Countries (HICs) for the purpose of performance measurement (Rabbani et al., 2011). BSC uses multi perspective measurements for the purpose of performance evaluation (Reid, 2011; Rabbani et al., 2011). In addition, it can be customised to meet the specific needs for performance evaluation (Reid, 2011). Malagueno et al. (2018) indicated that BSC is the most widely used management practice for performance monitoring.

Bach et al. (2016) suggest that the Technology Acceptance Model (TAM) can be utilised for the purpose of evaluating BI systems. Chen (2012b) used TAM to investigate the users' acceptance of Educational Intelligence (EI) systems which are based on BI. Poropat (2014) adopted TAM for evaluating users' motivation for using BI systems. Bach et al. (2016) proposed a model for BI acceptance factors in USA companies based on the TAM model. Abormegah and Tarik (2020) adopted TAM for evaluating BI tools in terms of usability characteristics through interviewing professionals from different industries. The evaluation of BI dashboards includes examining the user interface for the purpose of determining the acceptance of the BI dashboard and the willingness of users to use it. Therefore, the TAM model will be utilised for the purpose of developing the evaluation criteria for the purpose of this research project.

BI Scorecards are the standard evaluation tool for BI systems (Dyczkowski et al., 2014; Noonpakdee et al., 2018). The literature showed that research on BI systems evaluation tools is limited and that most authors use the BI Scorecard approach. Therefore, BI Scorecards and TAM Usability criteria were used to adopt the evaluation tool in this research project. The evaluation tool used in this research was adapted to take into consideration evaluation of elements that are not included in the BI Scorecard such as Sentiment Analysis. Table 8.1 outlines evaluation criteria for the BI Scorecard approach (based on Howson, 2008) and TAM Usability criteria. Table 8.1 shows that most of the TAM Usability criteria can be mapped to BI Scorecard Criteria. Each evaluation criteria mapped to TAM Usability has been assigned the same colour code as shown in Table 8.1.

Table 8.1: Comparison of Selected Business Intelligence Evaluation Frameworks

Evaluation Tool/ Criteria	**BI Scorecard** (Howson, 2008)	**Definition on BI Scorecard**	**TAM Usability**
Evaluation Criteria	Dashboard Layout	Multiple objects are presented on the display, the ability to resize objects, and multiple data sources are presented on the dashboard	Easy to Use
	Dashboard Design	Use of consistent formatting, provides web-based design environment, and ease of design	Easy to Learn
	Presentation	Use of conditional formatting and presenting multiple visualisations	Usefulness
	Alerting	Present visual display of exceptions, email notifications, and Really Simple Syndication (RSS) feed	
	Analysis	Refers to whether the dashboard provides time-based analysis, ranking, asymmetrical reporting, and what-if analysis	
	KPI/Metrics	The dashboard allows users to enter targeted KPIs and provides multiple targets per metric and shows a user-defined KPIs	Comprehensiveness
	Dashboard Interactivity	Refers to whether the dashboard allows user to drill-down, drill-through, apply filters to data, sort, and organisation of data in the dashboard, use of sliders for navigation, and overall usability of the dashboard	Adaptability
	Delivery	The dashboard can be exported to several file formats (such as Excel, PDF, PowerPoint, etc.)	
	Architecture	Refers to the BI architecture used for the development of the dashboard	
		Refers to whether the user would use the proposed BI system if they are in a position to do so.	Intention to Use

The evaluation criteria selected for the purpose of this study are outlined in Table 8.2. The evaluation criteria outlined in Table 8.2 were incorporated into a Microsoft Excel sheet to allow participants to evaluate the dashboard as discussed in Section 8.4. The reason for excluding 'Delivery' (which is related to exporting files), from the selected evaluation criteria is because the delivery method is not the primary objective of the prototype dashboard. In addition, 'Architecture' has been excluded since, as discussed in Section 7.4 in Chapter 7, it was decided to develop the prototype dashboard using Self-Service Business Intelligence (SSBI) tool, therefore, it is not relevant to evaluate the BI architecture.

Table 8.2: Selected Evaluation Criteria for Evaluating Business Intelligence Dashboard

Evaluation Criteria	Definition	Reference Source
KPI/Metrics (Indices)	Refers to the inclusion of KPIs that measure essential activities within the organisation	(Howson, 2005, 2008; Fuchs, 2010)
Sentiment Analysis	Refers to whether the dashboard supports Sentiment Analysis for analysing data from Social Media	(Qiu et al., 2015, 2016; Kamisli Ozturk et al., 2017; Howson, 2008, 2005)
Easy to Learn	Refers to whether the dashboard is easy to understand and easy to use when searching for specific information	(Magdalena et al., 2019; Nielsen, 1993; Abormegah & Tarik, 2020; Poropat, 2014; Eltahir et al., 2019)
Easy to Use	Refers to whether the dashboard is easy to navigate in order to reach information quickly	(Magdalena et al., 2019; Nielsen, 1993; Igbaria et al., 1997; Abormegah & Tarik, 2020; Poropat, 2014) The interviews with experts, documented in Chapter 3, indicated that there is a need for the dashboards to be easy to use
Usefulness	Refers to whether the proposed system will improve the performance within the organisation	(Howson, 2008, 2005; Nielsen, 1993; Igbaria et al., 1997; Abormegah & Tarik, 2020; Poropat, 2014; Eltahir et al., 2019)
Comprehensiveness	The dashboard provides comprehensive (provides all information business needs) overview of business data	(Fuchs, 2010; Nielsen, 1993)
Adaptability	Refers to the degree to which the dashboard can be adapted to meet the specific needs of users	(Jooste et al., 2013; Howson, 2008, 2005; Nielsen, 1993)
Intention to use	Refers to whether the dashboard is likely to be used in HEIs	(Nielsen, 1993; Abormegah & Tarik, 2020; Poropat, 2014; Eltahir et al., 2019)

8.4 Evaluation Template Tool

This section discusses the evaluation tool that was used for the purpose of evaluating the prototype dashboard that has been developed using the HF-HEQ-BI Framework. Table 8.3 outlines the evaluation tool that the participants used for the purpose of dashboard evaluation. The evaluation tool uses the evaluation criteria outlined in Table 8.2. The evaluation tool is based on Balanced Scorecards (BSC) in terms of adopting multicriteria for evaluation that are non-financial metrics (Kaplan & Norton, 1992) and the BI Scorecard (Howson, 2005). The tool uses a 5-point Likert Scale to allow the evaluator to select the appropriate response for each evaluation criteria (Magdalena et al., 2019; Noonpakdee et al., 2018; Calitz et al., 2012).

Table 8.3: Dashboard Evaluation Tool

Evaluation Criteria	**1**	**2**	**3**	**4**	**5**
The dashboard provides analytics that cover NCAAA **KPIs** and Institutional **KPIs**	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
The dashboard supports **sentiment analysis** for Social Media data	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
The dashboard is **easy to learn**	Very difficult to learn	Difficult to learn	Not easy nor difficult to learn	Easy to learn	Very easy to learn
The dashboard is **easy to use**	Very difficult to use	Difficult to use	Not easy nor difficult to use	Easy to use	Very easy to use
The dashboard will be **useful** for monitoring NCAAA compliance	Not useful at all	Not useful but could be considered for use	Useful but would require modification	Useful	Very useful
The dashboard provides **comprehensive** coverage of QA requirements	Not comprehensive at all	Not sufficiently comprehensive	Fairly comprehensive	Comprehensive	Very comprehensive
The dashboard is **adaptable** to meet the specific requirements of users	Not adaptable at all	Not sufficiently adaptable	Fairly adaptable	Adaptable	Very adaptable
Intend to use	Very Unlikely	Unlikely	Neither Unlikely nor Likely	Likely	Very likely

8.5 Case Study

The process of evaluation of the HF-HEQ-BI Framework is conducted through the application of a case study. Case studies are a widely used approach; Calitz et al. (2012) used a case study in the evaluation of BI dashboards for Enterprise Resource Planning (ERP) system using usability evaluations. In addition, Sakys et al. (2013) used a case study approach for the application of their proposed framework on one university case study. The reason for using case study for the purpose of evaluating the prototype dashboard is that the outcomes of the case study can be generalised to many other cases (Yeoh & Koronios, 2010).

The case study used for the evaluation of the prototype dashboard in this research project was modelled on a large HEI in KSA. The prototype dashboard was designed at institutional level and was based on the researcher's own experience supported by cooperation from the institution. This allowed the research to present the participants with a realistic case study scenario which would be familiar and relevant to them to carry out tasks in terms of evaluating the usability of the HF-HEQ-BI Framework. The institution has been anonymised for the purpose of confidentiality and all data presented in the prototype dashboard is a simulation. The design process of the prototype dashboard was discussed in detail in Section 7.4 in Chapter 7. During the case study, the participants were given a standard demonstration and presentation of the prototype dashboard. The HF-HEQ-BI Framework Utilisation Tool was explained to the participants, and they confirmed that they understood how the tool can be used for the purpose of developing the dashboard. The participants understood the factors outlined in the HF-HEQ-BI framework and how they are related to the design of BI system for monitoring quality in HE. Three of participants involved in the demonstration were face-to-face while the other 5 participants were by video conference.

All participants showed understanding of the process of developing the dashboard based on the HF-HEQ-BI framework and how the HF-HEQ-BI is utilised for this purpose through the Framework Utilisation Tool.

The NCAAA QA system in the KSA was explained to all participants and as all participants were working in KSA HEIs currently or previously, they were aware of the NCAAA requirements. Additionally, they were aware of the strategic management process that HEIs in KSA follow for the purpose of assuring quality and the adoption of additional institutional specific KPIs. The institutional QA manual and QA requirements for an anonymised KSA HEI were discussed in the demonstration with the participants in order to give them an understanding of the QA requirements of the case study and how the institution is assuring quality through the application of surveys and spreadsheets for measuring compliance. Participants were given the opportunity to navigate the dashboard and use the evaluation tool to evaluate the prototype dashboard. Participants who took part by Zoom were given control of the dashboard so they could use the dashboard interactively.

All the participants compared the visualisations provided in the prototype dashboard and the NCAAA KPIs. Additionally, the institutional specific KPIs were reviewed and compared to the visualised KPIs in the prototype dashboard together with an investigation of the Social Media analytics.

Figure 8.2 shows the types of HEIs where participants were working in i.e., Private, Public and/or Public/Private. Out of 8 experts who participated in the evaluation process, 4 worked in Public HEI, 3 have worked in both Public and Private HEIs, and 1 of them only worked in Private HEI. Table 8.4 summarises the participants' experience in HE and the type of institutions where they have been working. All the participants details were anonymised, and they have been assigned participant number as shown in Table 8.4. As seen in Table 8.4, the average years of experience in HEIs for participants was 17 years in KSA HEIs and 5.6 years in HEIs outside KSA.

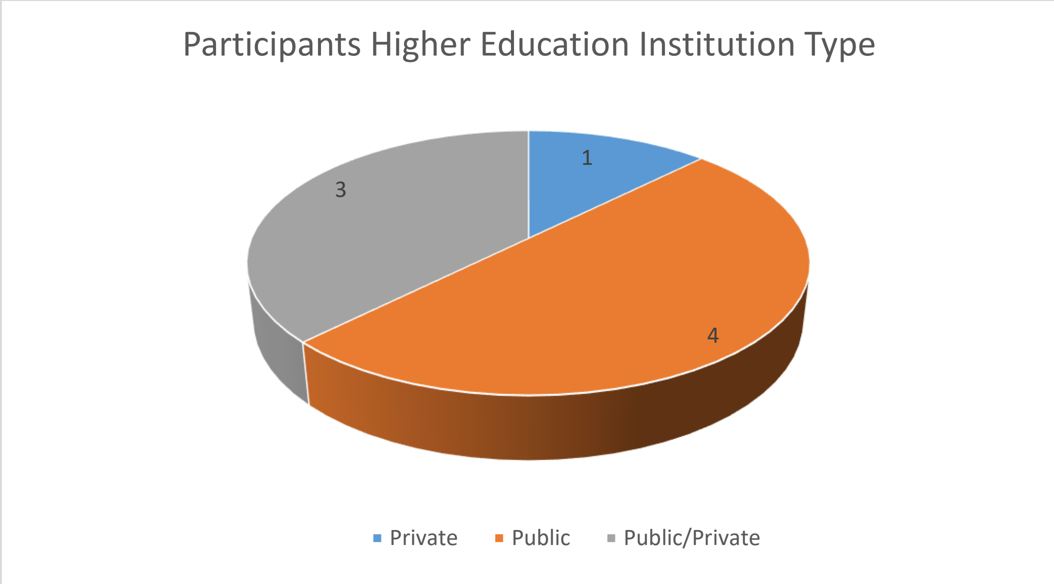


Figure 8.2: Higher Education Institution Type of Participants

Table 8.4: Case Study Participants Details

Participant	HEI Experience	Countries of Experience	Academic Level	Managerial Level	HEI Type
P1	32 Years in KSA 9 Years outside KSA	KSA Sweden Algeria Egypt	Professor	Head of Department	Public/ Private
P2	14 Years in KSA	KSA	Associate Professor	College Dean	Public/ Private
P3	11 Years in KSA	KSA	Assistant Professor	Head of Department	Public
P4	25 Years in KSA	KSA	Professor	Vice Chancellor Consultant	Public/ Private
P5	13 Years in KSA 15 Years outside KSA	KSA Egypt	Professor	Programme Director	Public/ Private
P6	17 Years in KSA 7 Years outside KSA	KSA UAE	Lecturer	Unit Head	Public
P7	13 Years in KSA	KSA	Assistant Professor	Unit Head	Private
P8	9 Years in KSA 14 Years outside KSA	KSA Egypt	Professor	Head of Department	Public

8.6 Analysis and Results

This section discusses the case study results based on participants' evaluation of the prototype dashboard. Table 8.5 outlines the average, maximum, and minimum scores based on participants selection.

Table 8.5: Participants Evaluation of the Prototype Dashboard

Evaluation Criteria	Average Response	Minimum Score	Maximum Score
Analysis	4.50	3	5
Social Media	4.63	4	5
Easy to Learn	4.50	3	5
Easy to Use	4.63	4	5
Usefulness	4.38	3	5
Comprehensiveness	4.38	3	5
Adaptability	4.13	3	5
Intention to Use	4.75	4	5

Figure 8.3 illustrates the ranges of responses discussed in Table 8.5 and the average score for each evaluation criteria based on participant selection. Figure 8.3 shows that 'Analysis', 'Easy to Learn', 'Usefulness', 'Comprehensiveness', and 'Adaptability' criteria received an evaluation score ranging between 3 and 5 with an average score rates of 4.50, 4.50, 4.38, 4.38, and 4.13 respectively. The remaining evaluation criteria 'Social Media', 'Easy to Use', and 'Intention to Use' was evaluated with a score ranging between 4 and 5 and an average score of 4.63, 4.63, and 4.75 respectively.

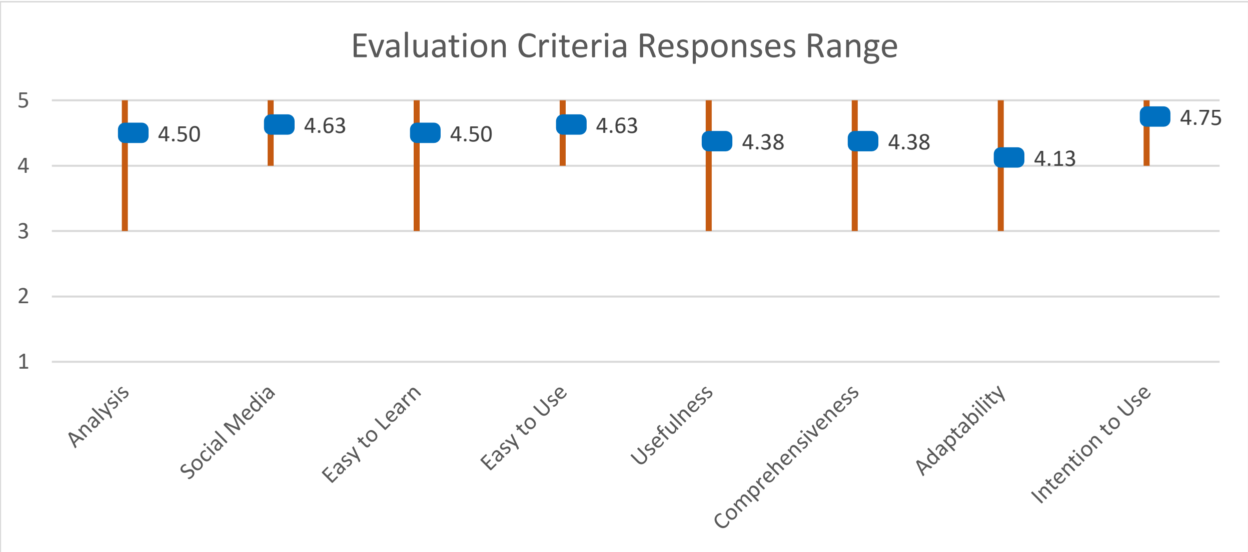


Figure 8.3: Participants Response Range for Evaluation Criteria

Figure 8.4 illustrates the overall evaluation of the prototype dashboard depicted in a radar diagram. Figure 8.4 shows that all average scores were between 4 and 5. Therefore, none of the evaluation criteria have an average score of less than 4 out of 5 points. For the purpose of determining whether there are statistically significant differences in mean scores between responses obtained from participants, t-test was conducted. Responses have been tested to determine whether differences exist based on the participants' (1) country of experience, (2) HEI type, and (3) managerial level.

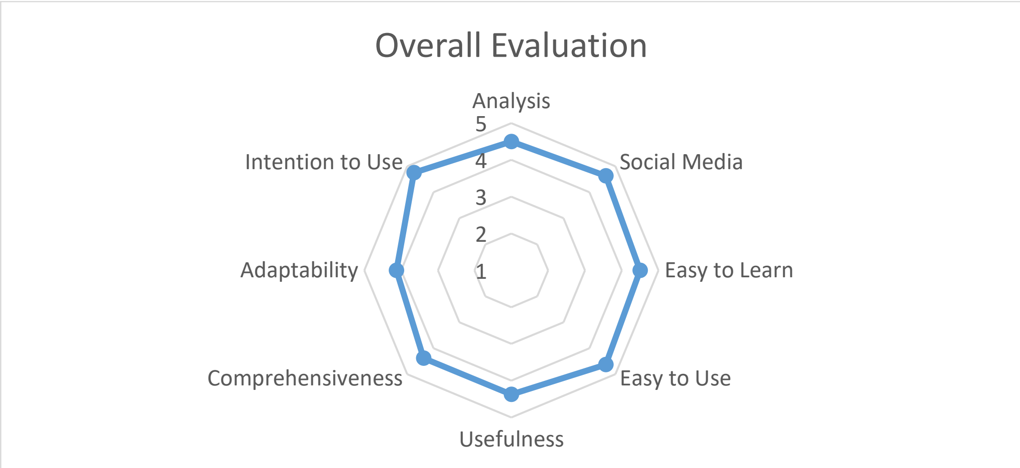


Figure 8.4: Radar Diagram of Dashboard Evaluation Criteria

Figure 8.5 shows a radar diagram illustrating the evaluation score averages for each evaluation criteria. The radar diagram shows two lines. The blue depicts the averages for participants who have worked in KSA HEIs only while the orange depicts the averages for participants who have worked in KSA and other countries. It can be shown on Figure 8.5 that averages for each evaluation criteria are ranging between 4 and 5.

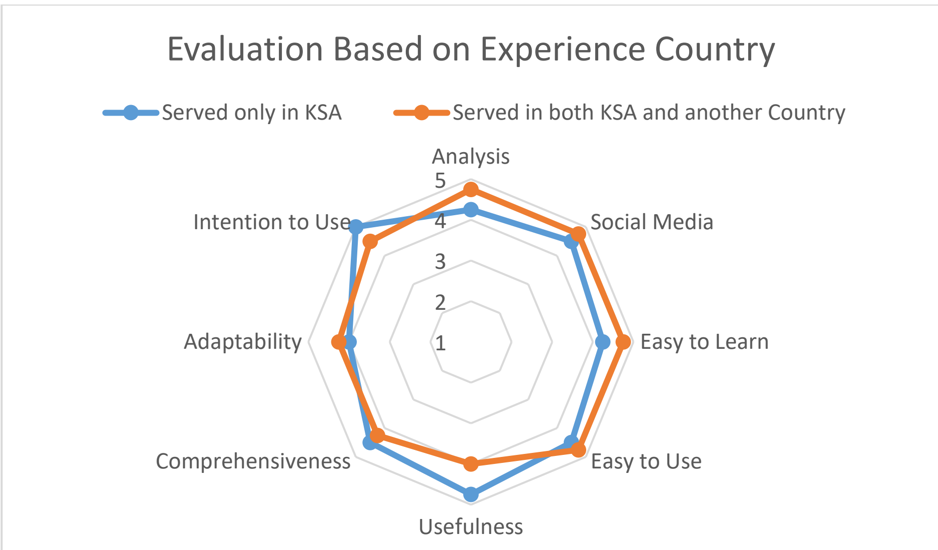


Figure 8.5: Dashboard Evaluation Based on Country of Experience

Table 8.6 shows the average scores for each evaluation criterion based on the countries where participants worked in HEIs. Average scores for dashboard evaluation criteria from participants who have their work experience in KSA only was ranging from 4.00 to 5.00. Average scores for dashboard evaluation criteria from participants who have worked in KSA HEIs and in other countries was ranging from 4.00 and 4.75. Statistical analysis through t-test indicated that there were no statistically significant differences between the average responses obtained from participants who worked in KSA only and participants who had worked in both KSA and other countries. All values obtained from t-test were not statistically significant at 95% confidence level as shown in Table 8.6.

Table 8.6: Average Evaluation Scores Based on Country of Experience

Evaluation Criteria	**Mean ± SD**		**t-Value**	**P-Value ≤ 0.05**
	Experience in KSA only	Experience in KSA and outside KSA		
Analysis	4.25 ± 0.96	4.75 ± 0.50	-0.926	0.390
Social Media	4.50 ± 0.58	4.75 ± 0.50	-0.655	0.537
Easy to Learn	4.25 ± 0.96	4.75 ± 0.50	-0.926	0.390
Easy to Use	4.50 ± 0.58	4.75 ± 0.50	-0.655	0.537
Usefulness	4.75 ± 0.50	4.00 ± 0.82	1.567	0.168
Comprehensiveness	4.50 ± 1.00	4.25 ± 0.50	0.447	0.670
Adaptability	4.00 ± 0.82	4.25 ± 0.50	-0.522	0.620
Intend to Use	5.00 ± 0.00	4.50 ± 0.58	1.732	0.134

Figure 8.6 illustrates the evaluation score averages based on the type of HEI where the participants were working. The blue line depicts average score for participants who were working only in Public HEIs while orange shows the averages for participants who had worked in both Public and Private HEIs. Figure 8.6 indicates that the evaluation score averages for all evaluation criteria were ranging from 4.00 to 4.75.

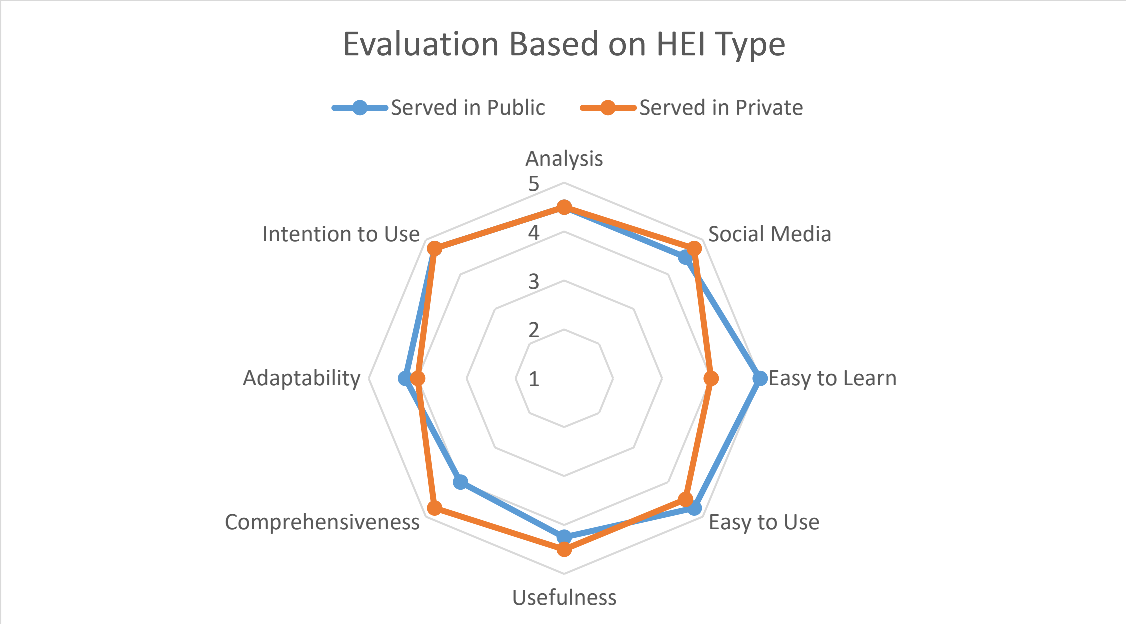


Figure 8.6: Dashboard Evaluation Based on Higher Education Institution Type

Table 8.7 outlines the average score received for each evaluation criteria based on the type of institution where the participant was working. Participants who had worked in Public HEIs evaluated the dashboard based on the evaluation criteria and gave an average score ranging between 4.00 and 5.00. Participants have worked in both Public and Private HEIs scores were ranging from 4.00 to 4.75. The results obtained from t-test indicate that 'Analysis', 'Social Media', 'Easy to Use', 'Usefulness', 'Comprehensiveness', 'Adaptability', and 'Intention to Use' evaluation criteria averages were not significantly different between responses obtained from participants working in Public institutions and participants who had worked in Public and Private institutions. However, 'Easy to Learn' criteria were statistically significant different as the average score was (5.00) for participants who had worked only in Public institutions in comparison to an average of (4.00) for participants who worked in both Public and Private institutions.

Table 8.7: Average Evaluation Scores Based on Higher Education Institution Type

Evaluation Criteria	**Mean ± SD**		**t-Value**	**P-Value ≤ 0.05**
	Public/Private	Public		
Analysis	4.50 ± 0.58	4.50 ± 1.00	0.000	1.000
Social Media	4.75 ± 0.50	4.50 ± 0.58	0.655	0.537
*Easy to Learn**	4.00 ± 0.82	5.00 ± 0.00	-2.449	0.050
Easy to Use	4.50 ± 0.58	4.75 ± 0.50	-0.655	0.537
Usefulness	4.50 ± 0.58	4.25 ± 0.96	0.447	0.670
Comprehensiveness	4.75 ± 0.50	4.00 ± 0.82	1.567	0.168
Adaptability	4.00 ± 0.82	4.25 ± 0.50	-0.522	0.620
Intend to Use	4.75 ± 0.50	4.75 ± 0.50	0.000	1.000

Figure 8.7 illustrates the average scores of evaluations of the prototype dashboard. The blue line shows the averages for participants who have worked in a top managerial position. The orange line shows the average scores for participants who have worked in lower managerial position in HEI. For the purpose of this research project, all participants with work experience as or above a Head of Department were considered top management level as they usually participate in long-term managerial activities such as strategic planning and are attending college councils. Figure 8.7 shows that all evaluation criteria averages were between 4 and 5.

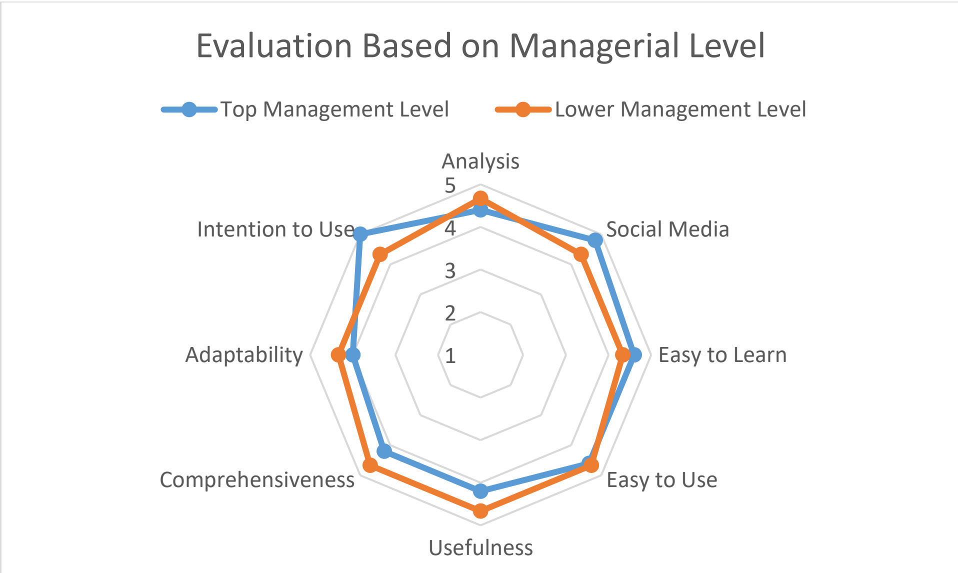


Figure 8.7: Dashboard Evaluation Based on Managerial Level of Participant

Table 8.8 shows the average evaluation scores for the dashboard evaluation criteria based on the managerial level of participants. Top Management Level participants average evaluation of the dashboard was ranging between 4.00 and 5.00. Lower Management Level participants average evaluation score was ranging between 4.33 and 4.67. The results of t-test indicated that the differences in average responses obtained from participants working in lower managerial level and participants working in higher managerial levels were not significantly different for all evaluation criteria except '*Intend to Use*'. As shown in Table 8.8, *'Intend to Use'* average response evaluation was higher for participants who were working in Higher Managerial Positions (5.00) compared to participants worked in Lower Managerial Positions (4.33).

Table 8.8: Average Evaluation Scores Based on Managerial Level of Participant

Evaluation Criteria	**Mean ± SD**		**t-Value**	**P-Value ≤ 0.05**
	Lower Managerial Position	Higher Managerial Position		
Analysis	4.67 ± 0.57	4.40 ± 0.89	0.455	0.665
Social Media	4.33 ± 0.57	4.80 ± 0.45	-1.292	0.244
Easy to Learn	4.33 ± 1.15	4.60 ± 0.55	-0.455	0.665
Easy to Use	4.67 ± 0.58	4.60 ± 0.55	0.164	0.875
Usefulness	4.67 ± 0.58	4.20 ± 0.83	0.841	0.433
Comprehensiveness	4.67 ± 0.58	4.20 ± 0.83	0.841	0.433
Adaptability	4.33 ± 0.58	4.00 ± 0.71	0.685	0.519
*Intend to Use**	4.33 ± 0.58	5.00 ± 0.00	-2.739	0.034

8.7 Discussion

The evaluation of the prototype dashboard which has been developed through using the HF-HEQ-BI Framework indicated that the prototype dashboard provides the required '*Analysis*' of QA data, supports '*Sentiment Analysis*' of Social Media data, *'Easy to Learn'*, *'Easy to Use', 'Useful'* if used for monitoring QA in HEI, '*Comprehensive'* to cover the NCAAA requirements and institutional KPIs, and '*Adaptable*'. In addition, participants indicated that they '*Intend to Use*' such a dashboard for monitoring quality in their HEIs if they were in the position to authorise it in their institution.

All dashboard evaluation criteria averages were ranging between 4.13 and 4.75 which indicates that the prototype dashboard that has been built using the HF-HEQ-BI Framework is able to capture the elements required for monitoring QA in HEIs in KSA. This, in turn, indicates that the HF-HEQ-BI Framework meets its objectives of identifying the factors that are required to monitor QA in HEIs using Business Intelligence Dashboards. The NCAAA KPIs, institutional KPIs, and sentiment analysis of Social Media data are all included in the dashboard developed through the utilisation of the HF-HEQ-BI Framework.

For the purpose of determining whether there were statistically significant differences between groups of participants, t-test was conducted as outlined in Section 8.6. The results of the t-test indicate that there were no significant differences in the average evaluation scores between participants that can be attributed to countries where the participants were working (UAE, Egypt, Sweden and Algeria). The results of t-test indicated that there are statistically significant differences between average evaluation scores of participants for 'Easy to Learn' criteria that can be attributed to the HEI type where the participants were working as the average score was higher for participants who had worked in Public institutions only in comparison to average score of participants who had worked in both Public and Private HEIs. In addition, 'Intend to Use' criteria averages were statistically different between participants based on their managerial position. Participants who worked in higher managerial position (Head of Department or above) were more likely to use the dashboard as the average score was (5.00) in comparison to participants who worked in lower managerial positions (below Head of Department) as the average score was (4.33). This might indicate that academics working in higher managerial positions are more interested in the type of reports provided by the BI dashboard in comparison to those who are working in lower managerial positions. However, all other evaluation criteria differences were not significant based on the HEI type or managerial position. Therefore, it can be concluded that 'Analysis', 'Social Media', 'Ease of Learn', 'Ease of Use', 'Usefulness', 'Comprehensiveness', and 'Adaptability' of the BI dashboard are not affected by the managerial position of the academic using the BI dashboard. In addition, 'Analysis', 'Social Media', 'Ease of Use', 'Usefulness', 'Comprehensiveness', 'Adaptability', and 'Intention to Use' of the BI dashboard are not affected by the type of HEI where the user of BI dashboard works. This suggests that the underlying framework has captured the required elements for QA in HEIs in KSA.

Participants who have work experience in Public HEIs only found the use of dashboards more 'Easy to Learn'. This result may indicate that the use of BI dashboards in public agencies in the KSA may have an impact on the learnability as the participants can interact with several dashboards published in public agencies such as Ministry of Education. In addition, participants who worked in lower managerial positions and also had teaching responsibilities were expected to be less interested in using the dashboards in comparison to participants working in higher managerial levels.

Two participants suggested the need for training of QA staff in HEIs to be able to use the functionalities of the dashboard. Additionally, all participants were satisfied with the presentation of the NCAAA KPIs in one screen suggesting that it provides a view of QA performance in the HEI. Social Media analytics provided by the dashboards were found useful for providing analytics related to public opinions expressed by stakeholders in Social Media.

The results of the case study indicated that all dashboard evaluation criteria received an average score ranging between 4 and 5. Which indicates that the prototype dashboard is usable based on the evaluation criteria and achieves the required purpose. Therefore, the second research question *'Can* *a Holistic Framework for Monitoring Quality in Higher Education in the KSA using Business Intelligence Dashboards assist in Monitoring Quality in HEIs?'* has been addressed.

8.8 Conclusion

The prototype dashboard developed in Chapter 7 using the HF-HEQ-BI Framework has been evaluated through this chapter. The chapter outlines the evaluation process. A dashboard evaluation tool has been designed based on the BI Scorecard and TAM usability criteria. The prototype dashboard has been evaluated through a case study. Eight participants were invited to evaluate the prototype dashboard based on the evaluation criteria selected using a realistic case study scenario which would be familiar to them to carry out tasks in terms of evaluating the usefulness of the BI dashboard. All the participants have considerable experience in HEI in KSA and the average years of experience of the participants was 17 years in the KSA and around 5 years outside KSA.

For the purpose of analysis of the evaluation results, a t-test has been used to study the differences in scores given by participants for evaluation. The results of t-test indicated that there were no significant differences among participants' average score except for 'Easy to Learn' criteria and 'Intend to use' criteria as discussed in Section 8.7.

The results of the evaluation of the prototype dashboard indicated that the prototype dashboard achieves the required purpose of its development. The prototype dashboard was designed to present all QA requirements in HEI context. All average scores of evaluation criteria were ranging between 4.13 and 4.75 out of 5.00. The evaluation process demonstrated the underpinning HF-HEQ-BI Framework supported the development of the prototype dashboard and the participants indicated that they would adopt this approach if they were in a position to authorise it in their institution. The next chapter presents an overview of the research project and outlines suggestions for future work.

Chapter 9 : Conclusions and Future Work

9.1 Introduction

In this chapter, a summary of the research project is presented. The phases of this research project are addressed and assessed against the aim and the research objectives outlined in Chapter 1. The chapter highlights the research project's contributions to knowledge. Additionally, research limitations are discussed, and the generalisation of the research findings is outlined in the chapter. The chapter concludes by suggesting areas for future work.

9.2 Research Summary

This research was conducted for the purpose of developing a novel Holistic Framework for Monitoring Quality in Higher Education Institutions in the Kingdom of Saudi Arabia using Business Intelligence Dashboards (HF-HEQ-BI). The main objectives of this thesis were to (1) find how a holistic framework may assist in identifying the factors that affect the design of BI dashboards for monitoring quality in HEIs in KSA, and (2) find how the holistic framework can assist in monitoring quality in HEIs. In order to answer these questions, an extensive literature review of research databases such as PubMed, IEEE Explore, and ACM Digital Library indicated that existing frameworks for monitoring quality in Higher Education do not cover the essential components for building a Business Intelligence system for QA in KSA. Current frameworks identified from a literature review were analysed through a Gap Analysis. The Gap Analysis indicated that the current frameworks do not cover the KSA National Centre for Academic Accreditation and Evaluation (NCAAA) requirements. The NCAAA 2018 standards require that all HEIs operating in the KSA need to monitor and report on 23 KPIs on an annual basis for the purpose of complying with 8 QA standards. Additionally, it was noted through the literature review that current QA surveys that measure students' satisfaction are not reflecting the usage of Social Media for QA purposes. Therefore, the HF-HEQ-BI framework has been developed to address these issues. The development of HF-HEQ-BI framework includes an extensive review of the literature for the purpose of identifying the factors that affect the design of BI and QA systems in HE and 45 QA factors were identified. These QA monitoring factors have been integrated into five main pillars (Technology, Organisation, Environment, Business, and Social). The HF-HEQ-BI has been validated through qualitative and quantitative analysis to provide triangulation. Qualitative analysis from the interviews resulted in a slightly modified version of the HF-HEQ-BI framework in which some factors were merged, and some were deleted which resulted in a slight reduction in the number of factors. Quantitative analysis results confirmed the factors that affect the design of BI systems for QA purposes. The quantitative analysis also indicated that there were no significant differences in the results obtained from practitioners in Public or Private HEIs in 30 of the factors identified and used in the framework. However, there were 12 factors that were found to be given more attention by participants working in Public HEIs compared with responses from participants working in Private HEIs. For example, ‘QA Regulations’, ‘Continuous Improvement’, and ‘Financial Factors’ were among the factors that were given more attention from participants working in Public HEIs in comparison to participants working in Private HEIs. These differences may be attributed to the different levels of awareness of quality regulations in the KSA among Public and Private HEIs. As the HF-HEQ-BI was developed and validated, the first research question was addressed.

The HF-HEQ-BI framework has then been used to develop a prototype BI dashboard for monitoring QA in HEIs to evaluate the framework. A Framework Utilisation Tool was developed to assist in determining the visualisation requirements for BI dashboards. The evaluation of the prototype dashboard showed that the HF-HEQ-BI framework can assist in developing a BI dashboard that captures QA performance according to the NCAAA 2018 requirements. In addition, the developed dashboard provides Social Media Analytics of sentiments expressed on Social Media channels. The HF-HEQ-BI framework takes into consideration that HEIs may also wish to adopt additional institutional specific KPIs in order to monitor strategic alignment. Therefore, the evaluation of the prototype dashboard indicated that the HF-HEQ-BI framework can assist in capturing the factors that are visualised in the dashboard and the second research question was addressed.

The following section provides a summary of the outcomes of this thesis as follows:

Chapter 1: Introduction

This chapter outlined the motivation for research and the contribution to knowledge. The research aim, objectives, and research questions were addressed in this chapter. The research philosophy, methodology, strategies, and design were discussed, together with the research choices that were made for this research project. Ethical considerations were discussed. In addition, research validation, evaluation, and triangulation were outlined. Finally, a research outline of the thesis was given to conclude the chapter.

Chapter 2: Critical Review of Quality Assurance in Higher Education and its Applications to Business Intelligence

This chapter outlines the QA system of HEIs in the context of the KSA. The NCAAA standards and KPIs were addressed together with the process of QA and accreditation in HEIs in the KSA. A comparison between the NCAAA standards and several international QA standards was conducted. The comparison revealed no significant differences between NCAAA standards and international standards.

The second part of this chapter discussed the role of Information and Communication Technologies (ICT) in QA management as well as the use of Business Intelligence (BI) in the HE context. A definition of BI was provided in this chapter. Additionally, several business intelligence architectures were discussed in order to review different options for the implementation of BI solutions in organisations of different sizes.

Chapter 3: Review of Current Frameworks for Monitoring Quality Assurance in Higher Education Institutions

In this chapter, an extensive literature review was conducted to examine existing QA frameworks. Staffordshire University Library was 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 was also used in the search process. The literature review identified 52 studies. Among these studies, it was found that only 18 studies discussed frameworks and models for monitoring performance in HE and all these 18 frameworks and models were reviewed. Five frameworks which provided visualised outputs of performance were then selected from the 18 frameworks to be analysed using a Gap Analysis technique as outlined in this chapter. The results from the Gap Analysis indicated that none of the current frameworks covers the QA requirements in the KSA. In addition, only one framework was found to take into consideration the role of Social Media for monitoring service quality in HEIs. It was concluded from this chapter that the development of a holistic framework for monitoring quality in HEIs in KSA is required.

Chapter 4: Development of a Holistic Framework for Monitoring Quality Assurance in Higher Education Using Business Intelligence (HF-HEQ-BI)

This chapter discussed the development process of a Holistic Framework for monitoring Higher Education Quality using Business Intelligence Dashboards (HF-HEQ-BI) in the context of the Kingdom of Saudi Arabia (KSA). The chapter outlined several theoretical frameworks and provided the justification for selecting three well documented frameworks, namely Technology-Organisation-Environment (TOE), Human, Organisation and Technology-fit (HOT-fit) together with the Information Systems Strategy Triangle (ISST) to support HF-HEQ-BI dashboard for monitoring QA in the KSA HEI context. Diffusion of Innovation theory (DOI), Unified Theory of Acceptance and Use of Technology (UTAUT), and Technology, Organisation, Social (TOS) model were also reviewed to support the change from ‘Human’ perspective to ‘Social’ perspective in the framework.

For the purpose of identifying the factors that needs to be considered for monitoring quality in HEIs, an extensive literature review was undertaken to determine the factors influencing the pillars which have been used in the development of the first version of the holistic HF-HEQ-BI framework. The chapter concludes with a mapping of the HF-HEQ-BI to NCAAA 2018 standards and KPIs in the context of KSA.

Chapter 5: Qualitative Analysis of Factors Affecting Monitoring Quality in Higher Education Institutions

In this chapter, a qualitative validation of the HF-HEQ-BI framework was conducted. A panel of experts were interviewed for the purpose of the validation process. The experts selected for the purpose of this study have considerable experience in Quality in HE and 60% of the participants were working, or have previously worked, in HEIs in KSA. Data gathered from interviews were analysed using NVivo12. The qualitative analysis conducted in the chapter resulted in a modification of the HF-HEQ-BI framework developed from literature review. Among the HF-HEQ-BI framework factors, 3 were deleted, 1 was merged into another factor, and 1 new factor was introduced giving a total of 42 factors.

Chapter 6: Quantitative Analysis of Factors Affecting Monitoring Quality in Higher Education Institutions

This chapter outlined a quantitative survey of practitioners working in QA in Higher Education. Faculty members in KSA Higher Education institutions were surveyed using a questionnaire and asked to express their opinion regarding the framework and the factors affecting the design of BI dashboards. Sample size was calculated after identifying the population. Several statistical tests were conducted on data gathered from the survey. Cronbach's Alpha was calculated to measure the internal consistency of the questionnaire. All pillars received > 0.8 coefficient α value. Confirmatory Factor Analysis (CFA) indicated that all factors were significant as their factor loadings were > 0.3. t-test was conducted to test whether significant differences exist among the responses obtained from participants which may be attributed to the type of HEI where they work. The results of the quantitative analysis are presented in this chapter and indicate that the practitioners who were surveyed support the framework derived from the qualitative analysis. Consequently, it is concluded that no further modification is required to the framework. The final version of the HF-HEQ-BI framework is outlined in this chapter.

Chapter 7: Dashboard Development for Monitoring Quality in HEIs in the Kingdom of Saudi Arabia

This chapter outlined the process of development of a prototype dashboard through the utilisation of HF-HEQ-BI framework. The prototype dashboard was developed for the purpose of evaluating the HF-HEQ-BI framework. HF-HEQ-BI Framework Utilisation Tool was developed to show how to use the factors for the purpose of capturing the visualisation requirements for monitoring the mandatory 23 NCAAA KPIs, the institutional specific KPIs, and Social Media analytics for QA in HEIs. A prototype dashboard was developed, and its functionalities were discussed in this chapter.

Chapter 8: Evaluation of the Prototype Dashboard for Monitoring Quality in Higher Education Institutions

This chapter discussed the evaluation of the prototype dashboard that was developed through the use of a HF-HEQ-BI framework. An anonymised case study was used to support the evaluation. The evaluation of the prototype dashboard showed that the dashboard developed through the use of a HF-HEQ-BI framework is able to capture all the NCAAA requirements, institutional KPIs, and Social Media analytics. For the purpose of determining whether significant difference exists among evaluation scores that can be attributed to the type of HEI, academic level, or managerial level of participant, t-test was conducted. The results of t-test indicated that there were no significant differences in evaluation scores averages except for 'Easy to learn' and 'Intend to Use' criteria as discussed in this chapter.

Chapter 9: Conclusions and Future Work

This chapter outlines the research overview, conclusions, research limitations and future work as discussed in the next sections.

9.3 Fulfilment of Research Aims and Objectives

As discussed in Section 1.3 in Chapter 1, the main aim of this research project is to *'Develop a Holistic Framework for Monitoring Quality in Higher Education Institutions Using Business Intelligence Dashboards in the Kingdom of Saudi Arabia'*. The findings of this research project have contributed to five conference papers and made a contribution to a book chapter. Table 9.1 lists the research objectives, how the objectives were achieved together with the chapters where this is described and indicates whether the results have been published.

Table 9.1: Research Objectives Fulfilment

Research Objective	Chapter	Research Methods	Publication
1. Conduct a literature review on Higher Education quality and Business Intelligence in Higher Education	2	Literature review of academic databases such as PubMed, Scopus, IEEE Explore, etc. and Staffordshire Digital Library.	Sorour, A., Atkins, A. S., and Stanier, C., (2019) 'The Role of Business Intelligence and Analytics in Higher Education Quality: A proposed Architecture', *International Conference on Advances in the Emerging Computing Technologies (ACET),* Islamic University (February 10-12). Madinah: IEEE, pp 24-40 DOI:10.1109/AECT47998.2020.9194157 Corpus ID:221718159
2. Identify frameworks for monitoring quality in Higher Education Institutions discussed in current literature	3		Sorour, A., Atkins, A. S., and Stanier, C., (2020) 'Comparative Frameworks for Monitoring Quality Assurance in Higher Education Institutions using Business Intelligence', *International Conference on Computing and Information Technology,* Tabuk University (September) pp.20-24. DOI: 10.1109/ICCIT-144147971.2020.9213808
3. Identify factors that affect the design of Business Intelligence systems for monitoring quality in Higher Education Institutions	4		Sorour, A., Atkins, A. S., Stanier, C., Alharbi, F. and Campion R. C., (2020) 'Integrated Dashboards with Social Media Analysis Capabilities for Monitoring Quality in Higher Education Institutions', *12th International Conference on Education and New Learning Technologies*, pp.2862-2870. DOI: 10.21125/edulearn.2020.0861
4. Develop a Holistic Framework that covers the factors that affect the design of Business Intelligence systems for monitoring quality in Higher Education	4		
5. Validate the Holistic Framework using interviews with a panel of experts	5	Convergent Interviews of experts in QA in HEIs and use of NVivo12 in thematic analysis and text mining of responses	Sorour, A., Atkins, A. S., Stanier, C., Alharbi, F. and Campion R. C., (2021) 'Quality Monitoring with Business Intelligence Dashboards in Higher Educational Institutions using NVivo Approach to Support Qualitative Analysis', *14th annual International Conference of Education, Research and Innovation*, pp. 897-904. DOI: 10.21125/iceri.2021.0280
6. Validate the Holistic Framework through surveys	6	Survey of practitioners of QA in HEIs and use of SPSS V.27 in conducting statistical analysis	
7. Use the Holistic Framework to design a prototype dashboard to show how the framework factors can be utilised	7	Use of a Self-Service Business Intelligence (SSBI) tool to develop the BI dashboard	Sorour, A., Atkins, A. S., Stanier, C., Alharbi, F. and Campion R. C., (2022) 'The Development of Business Intelligence Dashboard for Monitoring Quality in Higher Education Institutions in Saudi Arabia Including Sentiment Analysis from Social Media', *16th International Technology, Education and Development Conference*, pp. 1391-1399. DOI: 10.21125/inted.2022.0413
8. Evaluate the prototype dashboard through a case study	8	Use of an anonymised case study to evaluate the prototype dashboard developed by using HF-HEQ-BI framework.	
9. Critically review the research process and identify future research work	9	Summarise the research finding and documenting results and suggested future work	

9.4 Research Limitations and Challenges

This research project aimed to develop a Holistic Framework for Monitoring Quality in Higher Education Institutions in the Kingdom of Saudi Arabia using Business Intelligence Dashboards. All research objectives were met. However, this research acknowledges some limitations which are discussed as follows:

- The HF-HEQ-BI framework is developed to cover the specific requirements of QA in HEIs in the KSA context. The applicability of the framework in other countries in the Middle East and North Africa (MENA) is outside the scope of this study.
- As described in Chapter 3, the literature review found that there was very limited literature which discussed QA monitoring in HEIs in KSA. To address this limitation., the literature review was expanded to include all studies that discussed QA monitoring in HEIs worldwide.
- For the purpose of conducting statistical analysis, a Confidence Interval (CI) of 10% was used through this project as discussed in Chapter 6. Ideally, 5% Confidence Interval is preferred for achieving higher accuracy, but use of this confidence interval would increase the required sample size from 96 to 382 which is difficult to achieve based on similar research studies such as Alharbi et al. (2016) and Oreski (2011). However, 10% CI is acceptable in most social science studies as discussed in Chapter 6 (Xi et al., 2021; Storck et al., 2016; Oreski, 2011). The literature indicates that a sample size of more than 100 valid responses is adequate for reaching conclusions (Ping et al., 2018; Hair et al., 1995; Williams et al., 2012). The number of responses obtained from the questionnaire survey was 188. Of these responses, 124 were considered valid completed responses (66% of responses), which decreases the Confidence Interval to 8.79 rather than 10. In order to overcome this limitation, the validation of HF-HEQ-BI framework was not limited to quantitative analysis. The validation process achieved triangulation as outlined in Section 1.7 in Chapter 1, Chapter 4, 5 and 6 using an extensive literature review, qualitative analysis, and quantitative analysis.
- During the research study, COVID-19 pandemic started in late 2019. As an effect of COVID-19, most countries had gone through lockdowns to manage the spread of the disease. Therefore, the interviews with QA experts were conducted online as discussed in Chapter 5 to overcome the restrictions on face-to-face interviews.

9.5 Research Contributions

This research project provides a novel contribution to knowledge with the following outputs which are outlined as follows:

- The main contribution to knowledge provided by this research is the development of the Holistic Framework for monitoring Quality in Higher Education Institutions using Business Intelligence Dashboards in KSA (HF-HEQ-BI). The output of this work is the HF-HEQ-BI framework which is outlined in Figure 6.7 in Section 6.8 which identifies the QA factors and corresponding pillars that need to be considered for the purpose of developing Business Intelligence dashboards for monitoring quality in HE in KSA which covers:
    a) Monitoring compliance with the 8 NCAAA 2018 quality assurance standards and the 23 KPIs which have been mapped in Table 4.2 and Table 4.3 in Chapter 4 in Section 4.5.
    b) A prototype dashboard has been developed through the use of HF-HEQ-BI framework to show the monitoring of the 8 NCAAA QA standards and the 23 KPIs
    c) The prototype dashboard shows the monitoring of the institutional specific KPI which the HEI may adapt to monitor strategic alignment (some HEIs may have up to 100 institutional specific KPIs)
    d) The Kingdom of Saudi Arabia is one of the top users of Social Media and are among the top users of Twitter. The prototype dashboard integrates an Application Programming Interface (API) from a social media platform (Twitter) to obtain real time social media analytics to allow monitoring of public opinions. The top management of HEIs in the KSA are concerned and influenced from the opinions expressed on social media. The dashboard allows sentiment analysis of data obtained from Twitter and the functionality to provide drill-down facility to provide proactive management of the sentiments
- A Framework Utilisation Tool was developed in order to capture the requirements for monitoring QA in HEIs in terms of visualisation to develop BI dashboards. The Framework Utilisation Tool was aligned to the NCAAA 23 KPIs as outlined in Table 7.1 in Section 7.3 and detailed in Appendix E pp. 274-284.
- One of the outputs provided by this research project was a BI dashboards evaluation tool based on BI Scorecards and Technology Acceptance Model (TAM) usability criteria. The evaluation tool can assist HEIs in evaluating the usability of BI dashboards in HEIs. The results of the evaluation of the prototype dashboard by practitioners suggested there was a strong intention to use a BI dashboard for monitoring compliance with the mandatory 8 NCAAA standards, the 23 NCAAA KPIs, the additional institutional specific KPIs, and Social Media analytics.

9.6 Generalisation of Research Results

This research project developed a Holistic Framework for Monitoring Quality in Higher Education Institutions using Business Intelligence Dashboards in KSA. As discussed in Section 2.4 in Chapter 2, there is considerable similarity between HEI QA standards in the KSA and several international QA standards including QAA in UK and AQIP in the USA. During the course of this research project at the Early Stage Review panel at the University, it was advised that the research should be scoped and should focus only on the development of a holistic framework in Higher Education in the context of KSA. However, in order to ensure that research findings could be generalised, the development of the HF-HEQ-BI framework included the identification of QA factors that affect the design of BI dashboards in HE in an international context, based on an extensive literature review. The literature review was not limited to studies in the KSA context only but included all studies found in the literature that discussed QA monitoring worldwide.

A panel of experts was interviewed for the purpose of validating the framework as outlined in Chapter 5. The experts selected all have experience of QA in KSA HEIs and in addition, the majority of the experts have experience of QA in HEIs in other countries including UK, USA, Australia, India, and Egypt. The use of experts with experience of QA in HEIs in countries other than KSA helps to support generalisation of the HF-HEQ-BI framework. In the evaluation of the prototype dashboard, a case study approach was used as discussed in Chapter 8. Experts involved in the evaluation process of the dashboard have QA experience in both in KSA HEIs and also HEIs in Egypt, UAE, Sweden, and Algeria. The research could be extended to other contexts in future work for the following reasons:

1. There were similarities between QA standards in the KSA and several international QA standards
2. The holistic framework was developed through a literature review of worldwide studies and was not limited to KSA studies only.
3. The validation of the holistic framework involved interviewing experts who had experience of QA in other countries indicating there are some similarities in the systems.
4. The framework allows factors to be amended by addition/deletion for generalisation as depicted in Figure 6.7.
5. The Framework Utilisation Tool, which shows how the framework can be utilised for the purpose of building a BI dashboard, shows that the framework is flexible and identifies the requirements of visualisations based on the specific needs of the HEI.
6. The evaluation of the prototype dashboard from experts having QA experience from HEIs in several countries.

It is also proposed that the HF-HEQ-HI framework approach could be adapted for use in other environments, as discussed in 9.7, future work.

9.7 Future Work

Based on the outcomes of this research project, the following areas have been identified for future work.

Programme Accreditation Monitoring

As discussed in Section 2.4.1.1 in Chapter 2, there are two types of academic accreditation in HEIs in KSA. Future work may include customisation of the HF-HEQ-BI framework to allow the monitoring of compliance with programme accreditation requirements.

Programme accreditation requirements present a challenge for HEIs in KSA because some of them are large in their size as discussed in Section 1.2.1 in Chapter 1. Some HEIs can have more than 100k students. Public HEIs in KSA are operating in several locations through satellite campuses, QA of courses taught in different locations is more challenging and HEIs are required to assure the same level of quality on these courses. Additionally, unified examinations may be administered at the same time but in different locations, which imposes additional difficulties for QA.

Application of HF-HEQ-BI Framework in Middle East and North Africa (MENA)

The HF-HEQ-BI allows customisation to meet the specific needs of the HEIs through the addition/deletion of the factors as shown in Figure 6.7 in Chapter 6. This customisation of the framework allows the capture of different requirements for visualisation of HE quality. As discussed in Section 2.4.1 in Chapter 2, there is considerable similarity between the NCAAA QA standards and several international QA standards. Additionally, participants in the interviews for validating the HF-HEQ-BI framework had QA experience from several countries such as UK, Egypt, USA, Australia, and India. QA in HE is a well-established field in countries such as USA and Australia but is only started to develop in Middle East and North Africa (MENA) countries. Therefore, future work may include evaluation of the HF-HEQ-BI framework for capturing the requirements of QA standards in other Middle East countries in the MENA region.

Applications of HF-HEQ-BI Framework in Other Contexts

As the HF-HEQ-BI framework allows customisation of QA factors to support monitoring through dashboards, the approach used can be adapted to monitor QA in contexts other than HE. For example, in the KSA, there are 292 licensed Certified Public Accountants (CPA) firms (Saudi Organization for Certified Public Accountants (SOCPA), 2022). All of these CPA firms are required to comply with Professional Performance Quality Control Program (Saudi Organization for Certified Public Accountants (SOCPA), 2021). This programme includes several aspects that CPA firms are required to monitor and report on the compliance with the programme. For example, all CPA firms must maintain the balance between types of engagements based on the number of working hours. In addition, they must control the number of staff based on their qualifications and maintain the minimum level of KSA citizens qualified staff. Future work may include applying the HF-HEQ-BI approach to study the factors used for monitoring quality in CPA firms in the KSA.

Additionally, the Capital Markets Authority (CMA) in the KSA requires all listed companies in the Tadawul All Share Index (TASI) capital market to comply with Essential Cybersecurity Control (ECC) guidelines. The ECC was established by the National Cybersecurity Authority (Saudi Arabian National Cybersecurity Authority, 2018). The CMA established KPIs that all listed companies are required to comply with and report on their compliance on annual basis. Currently, listed companies have difficulties in monitoring compliance with these requirements. Listed companies can incur costs related to professional services provided by third parties to assist them in determining the degree of compliance. Future work could include studying the factors required to monitor compliance with the ECC guidelines according to the CMA KPIs, using the HF-HEQ-BI approach.

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Appendix A: NCAAA Benchmarking Example

The NCAAA requires all HEIs to undergo the Self-Evaluation process. During this process, a set of KPIs are benchmarked against the targeted result expected from the institution (NCAAA, 2018; Education and Training Evaluation Commission (ETEC), 2019). For example, some HEIs set a programme KPI to target a specific number of graduates annually, the HEI monitor the actions done to achieve this target by measuring graduates annually. Figures A.1 and A.2 shows an example of benchmarking process that NCAAA required HEI to undergo for the purpose of measuring their quality of services through the self-study report (Education and Training Evaluation Commission (ETEC), 2019, p.9,10).

2. program Self-study

2.1 Self-Study Process

A brief description of procedures followed and administrative arrangements for the self-study, including the structure of self-study committees. ***Attach*** *a report on self-study process (including membership and terms of reference for committees, sub-committees, working teams, and process for the preparation of each standard).*

2.2 Key Performance Indicators (KPIs) and Benchmarking

2.2.1 Methodology of Identifying Program Internal and External Benchmarking

Including benchmarking partners and selection criteria/reasons.

2.2.2 Summary of KPIs and Benchmarks

A list of KPIs that are used in the SSRP (including NCAAA required KPIs)

KPI No.	KPI	KPI Results				
		Actual Benchmark	Target Benchmark	Internal Benchmark	External Benchmark	New Target Benchmark

Important Note

- Provide description and analysis for each KPI under the related standard
- **Attach** a complete analysis report of the Program KPIs (including trends and comparisons based on gender and branches/locations)

Figure A.1: NCAAA Benchmarking Example (Education and Training Evaluation Commission (ETEC), 2019, p.9)

3. Evaluation in Relation to Quality Standards

Standard 1. Mission and Goals **(Overall Rating: ……)**

A. A brief realistic and objective presentation of the present status of the Program Mission and Goals

B. Report on Standard:

1. Evaluation of Program Goals

Goals	Performance Indicators	Target Benchmarks	Actual Benchmarks
Comments:			

2. Provide an analytical and critical report about the evaluation results of the standard based on required data, evidence and KPIs.

C. Overall Evaluation for Quality of the Standard:
Strengths:

Areas for Improvement:

Priorities for Improvement:

Figure A.2: NCAAA Benchmarking Example (Education and Training Evaluation Commission (ETEC), 2019, p.10)

Appendix B: Ethical Approval

STAFFORDSHIRE UNIVERSITY

Computing and Digital Technologies

ETHICAL APPROVAL FEEDBACK

Researcher name:	Ali Sorour Ali Sorour
Title of Study:	Holistic Framework for Monitoring Quality in Higher Education using Business Intelligence Dashboards
Status of approval:	Approved

Thank you for addressing the committee's comments. Your research proposal has now been approved by the Ethics Panel and you may commence the implementation phase of your study. You should note that any divergence from the approved procedures and research method will invalidate any insurance and liability cover from the University. You should, therefore, notify the Panel of any significant divergence from this approved proposal.

You should arrange to meet with your supervisor for support during the process of completing your study and writing your dissertation.

When your study is complete, please send the ethics committee an end of study report. A template can be found on the ethics BlackBoard site.

Signed: **Date: 18.03.20**

E. Benf

Professor Elhadj Benkhelifa

Chair of the Computing and Digital Technologies Ethics Panel

Appendix C: Interview Response Sample

Research Title
Holistic Framework for Monitoring Quality in Higher Education Using Business Intelligence Dashboards

Researcher Contact Information	
Name	Ali Sorour MSc MBA
Phone	+966544150133
E-mail	S033335e@student.staffs.ac.uk

Description

This study is being undertaken as part of the PhD/MPhil research study for Developing Holistic Framework for Monitoring Quality in Higher Education Using Business Intelligence Dashboards.

The purpose of this research is to develop a holistic framework that addresses the main factors that should be considered while deploying system for monitoring Quality activities in higher education institutions. The framework is aimed to be a reference for designing monitoring systems as it should cover the areas that higher education institutions are required to implement for quality assurance through the imposed quality assurance standards in the Kingdom of Saudi Arabia.

Please note that:

- DO NOT participate in this interview if you are vulnerable to coercion or undue influence or under 18 years of age.
- All answers will be treated anonymously, and names of participants are not required.
- You can stop at any time during the interview.
- You are not required to answer all questions in this interview.
- While your cooperation in answering every question will help us understand important questions with regards to monitoring quality in higher education, you are not obligated to answer every question.

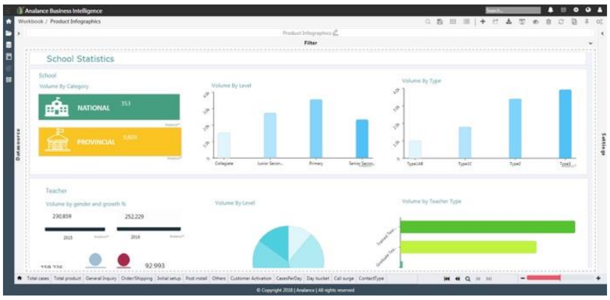
- Your participation in this project is voluntary.
- If you agree to participate, you can withdraw from participation at any time without any consequences.
- There are no direct benefits to you for participating in this research.
- There are no risks associated with participation.
- By your starting this interview, you consent to participate in this study.

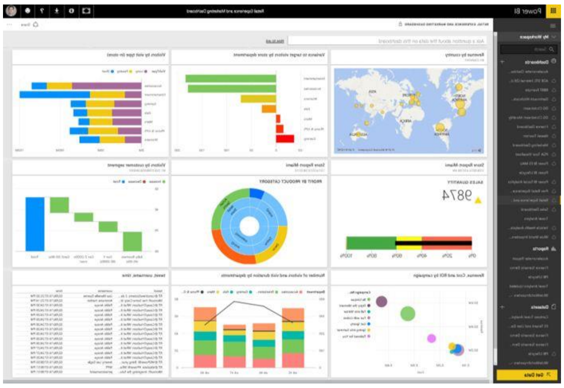
Interviewee Code	Interview Date	Interview Time	Duration
P4	24/04/2020	11:00	30 minutes

Interviewee Information

Academic Level (Present Level)	☐ **Professor**
Managerial Position (Identify All Applicable)	☐ **Quality Assurance Unit Head**
Previous QA Experience	HE related experience …12. Years Non-HE related Experience …6… Years
HEI Type (Identify All Applicable)	Public University …30. Years (previous) Private University …3. Years (previous)

Dashboard Example





BI related Questions

1. In your opinion, what are the most important barriers to implementing QA in the HEIs?

   I think that the main barriers for implementing quality assurance systems is in the human element. Workers in HE need qualifying to be able to understand QA systems and the role of each worker in achieving quality and maintain it continuously. Upon realising this, they must understand the responsibilities they assigned in QA when they are assigned their educational work load, which might require more financial resources to support these activities.

   There are also few decision makers who still require doing some procedures manually and electronically, especially these which requires personal signature of faculty members

2. In your opinion, what are the challenging issues in monitoring QA in the HEIs?

   The main challenge is change resistance from human element as they don't understand how QA is important, which requires training workers in HE and qualify them for cooperative work for achieving quality and maintain it. It's important also to describe what is meant by dashboards and what is the role it plays for assuring quality.

3. Do you consider that BI dashboards will help in improving the monitoring of QA in HEI?

a. Do you consider that using dashboards will provide a better view of QA activities? Could you please explain and elaborate?
   Yes, and it needs to be clear to users

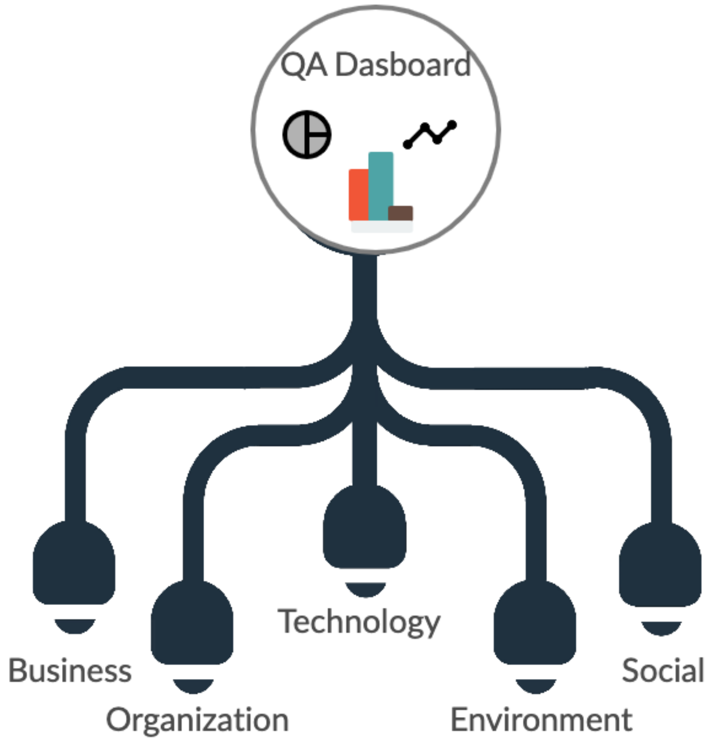
b. Do you consider that using dashboards will enhance the monitoring issue? Could you please explain and elaborate?
   Yes as it gives immediate view of QA activities

c. Do you consider that the outputs provided by dashboards will be easier to understand than traditional data presentation techniques for monitoring Quality?
   Yes I think so

d. Do you consider that using dashboards can assist in the accreditation process?
   Yes of course

e. Do you consider that using dashboards can assist in the benchmarking process?
   Yes, assuming that dashboard users will understand what dashboard provide for them in terms of continuously updated QA information.

4. With reference to the diagram, do you consider that the main pillars and the sub-factors are appropriate for developing BI system for monitoring QA performance in HEI? Would you add/move/delete one or more of these factors?



Pillar	Factors
Technology	Technical requirements Data quality I think that technical requirements is enough for describing these detailed requirements
Organisation	Administration service Facilities Strategic alignment Leadership Culture Top management support I think only highlighted are enough, and I believe that you mean top management but not management as management is wide term
Environment	Competition QA Standards

	QA standards in Saudi Arabia include assuring deploying NQF, so there is no need for duplication
Business	Financial factors KPIs Academic Quality
Social	Motivation Team Academic Staff Relationship Quality

Conclusion

1. Have you got any other comments you wish to make?
   I think there are some factors needs to be combined together, look for financial factors and costs, I think they are related to one thing. And also in Technology pillar we can say Technical requirements to describe most of these factors

   Highlight only the factors that I will tell you, I think they are enough for each pillar.

2. Do you have any other questions?
   No, thank you and good luck on your studies

Thank you for participation.

Appendix D.1: Questionnaire

The survey was administered through Qualtrics. It was provided to participants in both the English and Arabic languages. The participants were able to toggle between languages during the survey. The survey was mobile friendly and was shown on mobile devices properly. Screenshots of the survey as it appeared to participants in English language in web browser is shown in this Appendix.

STAFFORDSHIRE UNIVERSITY

English

This study is being undertaken as part of the PhD/MPhil research study for Developing Holistic Framework for Monitoring Quality in Higher Education Using Business Intelligence Dashboards.

The purpose of this research is to develop a holistic framework that addresses the main factors that should be considered while deploying system for monitoring Quality activities in higher education institutions. The framework is aimed to be a reference for designing monitoring systems as it should cover the areas that higher education institutions are required to implement for quality assurance through the imposed quality assurance standards in the Kingdom of Saudi Arabia.

Please note that:

- DO NOT participate in this questionnaire if you are vulnerable to coercion or undue influence or under 18 years of age.
- All answers will be treated anonymously, and names of participants are not required.
- You can stop at any time during the questionnaire.
- You are not required to answer all questions in this questionnaire.
- While your cooperation in answering every question will help us understand important questions with regards to monitoring quality in higher education, you are not obligated to answer every question.
- Your participation in this project is voluntary.
- If you agree to participate, you can withdraw from participation at any time without any consequences.
- There are no direct benefits to you for participating in this research.
- There are no risks associated with participation.
- By your return of the completed questionnaire, you consent to participate in this study.
- This questionnaire is available in two languages (Arabic and English).

This questionnaire requires about 10-15 minutes to complete.

→

English

IN THIS SECTION, PLEASE INDICATE THE ANSWER THAT BEST DESCRIBES YOUR POSITION IN HIGHER EDUCATION INSTITUTION

Academic Level (Present Level)

- ○ Professor
- ○ Associate Professor
- ○ Assistant Professor
- ○ Lecturer
- ○ Teaching Assistant

Managerial Position (Identify All Applicable)

- ☐ Dean of Quality Assurance Deanship
- ☐ Vice Dean of Quality Assurance Deanship
- ☐ College Dean
- ☐ College Vice Dean for Quality Assurance
- ☐ Quality Assurance Unit Head
- ☐ Department Head
- ☐ Other (specify) ....

Please identify all the types of institution where you **currently** work and specify number of years at institution?

- ☐ Public University .... years
- ☐ Private University .... years
- ☐ Vocational College .... years
- ☐ Private Colleges .... years

Please identify all the types of institution where you **previously** worked and specify number of years at institution?

- ☐ Public University ……. years
- ☐ Private University ……. years
- ☐ Vocational College ……. years
- ☐ Private Colleges ……. years

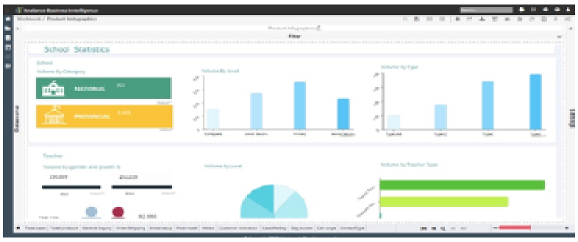
Current HEI Size (current full-time position)

- ○ < 1000 students
- ○ > 1000 and < 5000 students
- ○ > 5000 and < 10000 students
- ○ > 10000 and < 25000 students
- ○ > 25000 students

→

English

With regard to Business Intelligence Dashboards as seen in the Figures below, please indicate your degree of agreement on each of the following statements where 1 indicates that you strongly disagree with the statement while 5 indicates that you strongly agree with the statement.



Please choose the appropriate selection (Technology Context)

	I Don't know	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Monitoring Quality using Business Intelligence Dashboards requires significant investment in IT infrastructure.	○	○	○	○	○	○
Monitoring Quality using Business Intelligence Dashboards requires specialist software packages and requirements.	○	○	○	○	○	○
The volume of data needed to monitor Quality in Higher Education has grown so much that traditional data management approaches are not sufficient.	○	○	○	○	○	○
The data used to monitor Quality in Higher Education now includes data from social media and other non-traditional sources.	○	○	○	○	○	○
High quality data is essential for Monitoring Quality using Business Intelligence Dashboards.	○	○	○	○	○	○
Monitoring Quality using Business Intelligence Dashboards requires special analytical methods and techniques	○	○	○	○	○	○

	I Don't know	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Notifications provided by Business Intelligence Dashboards can assist in monitoring quality in Higher Education	○	○	○	○	○	○

Please choose the appropriate selection (Organisation Context)

	I Don't know	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Monitoring Quality using Business Intelligence Dashboards can assist the Higher Education Institutions in monitoring alignment to the Institution's strategic plan.	○	○	○	○	○	○
Monitoring Quality using Business Intelligence Dashboards can assist the Higher Education Institutions in monitoring performance of administrative services.	○	○	○	○	○	○
Business Intelligence Dashboards for monitoring Quality in Higher Education will succeed if supported by Top Management in my organization.	○	○	○	○	○	○
Implementing the use of dashboards to monitor Quality in my organization will require cultural change.	○	○	○	○	○	○
Monitoring Quality using Business Intelligence Dashboards can assist in monitoring compliance with Health and Safety requirements	○	○	○	○	○	○
Monitoring Quality using Business Intelligence Dashboards can assist in monitoring the quality of administration processes.	○	○	○	○	○	○
Monitoring Quality using Business Intelligence Dashboards can assist in monitoring the quality of Library services	○	○	○	○	○	○
Monitoring Quality using Business Intelligence Dashboards can assist in curriculum development and structure	○	○	○	○	○	○
Monitoring Quality using Business Intelligence Dashboards can assist in monitoring institutional facilities and services	○	○	○	○	○	○
Monitoring Quality using Business Intelligence Dashboards can support Higher Education Innovation	○	○	○	○	○	○

	I Don't know	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Effective Leadership at all levels is essential for the success of Quality Monitoring using Business Intelligence Dashboards	○	○	○	○	○	○
Monitoring Quality using Business Intelligence Dashboards can assist in monitoring partnerships' progress	○	○	○	○	○	○

Please choose the appropriate selection (Environment Context)

	I Don't Know	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Monitoring Quality using Business Intelligence Dashboards can assist in monitoring socio-cultural forces (such as student demand and diversity)	○	○	○	○	○	○
Monitoring Quality using Business Intelligence Dashboards can assist in monitoring Economic Forces (such as fund per student and student costs)	○	○	○	○	○	○
Monitoring Quality using Business Intelligence Dashboards can assist in monitoring Government requirements (such as government control over curriculum)	○	○	○	○	○	○
Monitoring Quality using Business Intelligence Dashboards can help in monitoring adherence to Quality Assurance regulations (Such as NCAAA or AACSB or NQF).	○	○	○	○	○	○
Monitoring Quality using Business Intelligence Dashboards can assist in determining programmes fitness (fulfilling its purpose)	○	○	○	○	○	○
Monitoring Quality using Business Intelligence Dashboards can assist in monitoring Institutional location accessibility	○	○	○	○	○	○
Monitoring Quality using Business Intelligence Dashboards can assist in enhance students career prospects (such as students professional career advisership and availability of exchange programmes	○	○	○	○	○	○
Monitoring Quality using Business Intelligence Dashboards can assist in responding to globalisation issues	○	○	○	○	○	○

	I Don't Know	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Monitoring Quality using Business Intelligence Dashboards can assist in attaining competitive edge	○	○	○	○	○	○

Please choose the appropriate selection (Business Context)

	I Don't know	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Business Intelligence dashboards can assist in monitoring Key Performance Indicators (KPIs) determined for quality assurance purposes.	○	○	○	○	○	○
Monitoring Quality using Business Intelligence dashboards will provide instant feedback for continuous improvement.	○	○	○	○	○	○
Monitoring Quality using Business Intelligence Dashboards can provide better monitoring of academic quality (such as teaching and learning)	○	○	○	○	○	○
Monitoring Quality using Business Intelligence Dashboards can provide improved monitoring of Higher Education Institutional Resources	○	○	○	○	○	○
Monitoring Quality using Business Intelligence Dashboards can provide improved monitoring of organizational financial performance.	○	○	○	○	○	○
Monitoring Quality using Business Intelligence Dashboards can achieve competitive advantage for Higher Education Institutions	○	○	○	○	○	○
Monitoring Quality using Business Intelligence Dashboards can provide improved monitoring of the business process (including business centres)	○	○	○	○	○	○

Please choose the appropriate selection (Social Context)

	I Don't know	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Opinions expressed by Stakeholders' on Social Media are important for measuring Quality in Higher Education.	○	○	○	○	○	○
Monitoring Quality using Business Intelligence Dashboards may require manual data entry by organization staff.	○	○	○	○	○	○

	I Don't know	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Monitoring Quality using Business Intelligence Dashboards can provide improved monitoring for stakeholders' relationships (such as Community Services and Parents Meetings outcomes).	○	○	○	○	○	○
My organization currently has the expertise required for Monitoring Quality using Business Intelligence Dashboards.	○	○	○	○	○	○
Academic Staff in my organisation are willing to use Quality monitoring Dashboards	○	○	○	○	○	○
Monitoring Quality using Business Intelligence Dashboards can have an impact on motivation of organisation staff	○	○	○	○	○	○
Monitoring Quality using Business Intelligence Dashboards can provide feedback on institutional reputation	○	○	○	○	○	○

→

Appendix D.2: Ethical Approval

Ethical approval was obtained from Staffordshire Ethics panel as of 18.03.2020. Amendments on the questionnaire were inserted based on the outcome of the analysis conducted in Chapter 5. Therefore, an ethical approval on these amendments were obtained on 03.02.2021.

STAFFORDSHIRE UNIVERSITY

School of Digital, Technologies and Arts

ETHICAL APPROVAL FEEDBACK

Researcher name:	**Ali Sorour Ali Sorour**
Title of Study:	SU_20_094_Holistic Framework for Monitoring Quality in Higher Education using Business Intelligence Dashboards
Award Pathway:	**PhD**
Status of approval:	**Amendment approved**

Thank you for your correspondence requesting approval of a minor amendment to your approved ethics application SU_19_086, as outlined in your application dated 22.1.21.

Your amended application is approved. We wish you well with your research.

Action now needed:

Your amendment has now been approved by the Ethics Panel.

You should note that any divergence from the approved procedures and research method will invalidate any insurance and liability cover from the University. You should, therefore, notify the Panel in writing of any significant divergence from this approved proposal.

You should arrange to meet with your supervisor for support during the process of completing your study and writing your dissertation.

When your study is complete, please send the ethics committee an end of study report. A template can be found on the ethics BlackBoard site

Signed: **Date: 3rd February 2021**

E. Benkhelifa

Prof Elhadj Benkhelifa

Chair of the Digital Technologies Ethics Panel

Appendix D.3: General Authority Inquiry

Inquiry about request

Request Number

IR00384019001

Mobile Number

966503171912

Apply

Name:

Ali Sorour

Employer:

Staffordshire University

Job title:

باحث

Mobile number:

966503171912

E-mail:

s033335e@student.staffs.ac.uk (mailto:s033335e@student.staffs.ac.uk)

Request Details:

ارغب في احصائيات اعداد اعضاء هيئة التدريس بالجامعات السعودية الاكاديميين بدون الموظفين الاداريين لغرض البحث العلمي

Request Status:

مقفل

Decision:

نسعد دومًا بتواصلكم، ونشكر لكم إتاحة الفرصة لدعمكم، وبناءً على طلبكم المُتضمن اعداد اعضاء هيئة Ali Sorour /عميلنا العزيز الأستاذ
التدريس بالجامعات السعودية الاكاديميين بدون الموظفين الاداريين تجدون في مرفقات هذا البريد.التعليم العالي الحكومي والاهلي
لعام 2019م ولمزيد من المعلومات والبيانات يمكنكم زيارة الموقع الرسمي والاطلاع على أحدث النشرات والتقارير والإصدارات الإحصائية
المتخصصة www.stats.gov.sa 920020081 لمزيد من الاستفسارات يمكنكم التواصل معنا من خلال الرقم الموحد

Attachments:

التعليم العالي الحكومي حسب الجهة2019م.xlsx
(https://www.stats.gov.sa/sites/default/files/%D8%A7%D9%84%D8%AA%D8%B9%D9%84%D9%8A%D9%85%20%D8%

التعليم العالي الأهلي حسب الجهة 2019م.xlsx
(https://www.stats.gov.sa/sites/default/files/%D8%A7%D9%84%D8%AA%D8%B9%D9%84%D9%8A%D9%85%20%D8%

Request Number:

IR00384019001

Appendix D.4: Upper Percentage Points of the t Distribution

Table D.1 shows the Upper Percentage Points of the *t* Distribution. It is used to determine the value of Z while calculating sample size. The desired confidence level of most of studies in 95% which means that the researcher is 95% confident that the results of the sample are representative to the population. The confidence interval of 10% means that the sample can predict ±10% of the real population measure.

Table D.1: Upper Percentage Points of the t Distribution (Sekaran & Bougie, 2016)

	Q=0.4	**0.25**	**0.1**	**0.05**	**0.025**	**0.01**	**0.005**	**0.001**
V	**2Q=0.8**	**0.5**	**0.2**	**0.1**	**0.05**	**0.02**	**0.01**	**0.002**
1	0.325	1.000	3.078	6.314	12.706	31.821	63.657	318.31
2	0.289	0.816	1.886	2.920	4.303	6.965	9.925	22.326
3	0.277	0.765	1.638	2.353	3.182	4.541	5.841	10.213
4	0.271	0.741	1.533	2.132	2.776	3.747	4.604	7.173
5	0.267	0.727	1.476	2.015	2.571	3.365	4.032	5.893
6	0.265	0.718	1.440	1.943	2.447	3.143	3.707	5.208
7	0.263	0.711	1.415	1.895	2.365	2.998	3.499	4.785
8	0.262	0.706	1.397	1.860	2.306	2.896	3.355	4.501
9	0.261	0.703	1.383	1.833	2.262	2.821	3.250	4.297
10	0.260	0.700	1.372	1.812	2.228	2.764	3.169	4.144
11	0.260	0.697	1.363	1.796	2.201	2.718	3.106	4.025
12	0.259	0.695	1.356	1.782	2.179	2.681	3.055	3.930
13	0.259	0.694	1.350	1.771	2.160	2.650	3.012	3.852
14	0.258	0.692	1.345	1.761	2.145	2.624	2.977	3.787
15	0.258	0.691	1.341	1.753	2.131	2.602	2.947	3.733
16	0.258	0.690	1.337	1.746	2.120	2.583	2.921	3.686
I7	0.257	0.689	1.333	1.740	2.110	2.567	2.898	3.646
18	0.257	0.688	1.330	1.734	2.101	2.552	2.878	3.610
19	0.257	0.688	1.328	1.729	2.093	2.539	2.861	3.579
20	0.257	0.687	1.325	1.725	2.086	2.528	2.845	3.552
21	0.257	0.686	1.323	1.721	2.080	2.518	2.831	3.527
22	0.256	0.686	1.321	1.717	2.074	2.508	2.819	3.505
23	0.256	0.685	1.319	1.714	2.069	2.500	2.807	3.485
24	0.256	0.685	1.318	1.711	2.064	2.492	2.797	3.467
25	0.256	0.684	1.316	1.708	2.060	2.485	2.787	3.450
26	0.256	0.684	1.315	1.706	2.056	2.479	2.779	3.435
27	0.256	0.684	1.314	1.703	2.052	2.473	2.771	3.421
28	0.256	0.683	1.313	1.701	2.048	2.467	2.763	3.408
29	0.256	0.683	1.311	1.699	2.045	2.462	2.756	3.396
30	0.256	0.683	1.310	1.697	2.042	2.457	2.750	3.385
40	0.255	0.681	1.303	1.684	2.021	2.423	2.704	3.307
60	0.254	0.679	1.296	1.671	2.000	2.390	2.660	3.232
120	0.254	0.677	1.289	1.658	1.980	2.358	2.617	3.160
∞	0.253	0.674	1.282	1.645	1.960	2.326	2.576	3.090

As the desired level of confidence is 95%, it means that there is 5% risk of reaching wrong conclusion. Therefore, the significance level chosen in Table D.1 will be 0.05 for two tailed test. In Table D.1, V represents the degrees of freedom. Degrees of freedom for a relatively large samples (above 30) is usually chosen to be infinite (Thomas, 2020). Therefore, the Z value from Table A6.1 will be 1.96.

Krejcie and Morgan (1970) developed tables that can be used for determining sample size for a known population. As the number of HE faculty staff in KSA are known through the inquiry as in Appendix D.3, sample size can be obtained from Krejcie and Morgan tables. These tables were based on sample size calculation formula (Krejcie & Morgan, 1970):

$$n = \frac{x^2 NP(1-P)}{c^2(N-1)+x^2P(1-P)} \qquad \text{Equation D.1}$$

Where:

n: Sample size, N: Population size, P is the proportion assumed to be 0.50, c: confidence interval, x^2: Chi-Square value at 1 degree of freedom for the confidence level desired.

Table D.2 shows the values of Chi-Square. At 1 degree of freedom, Chi-Square value is 3.84 for 95% confidence level. Therefore, the sample size will be:

$$n = \frac{(3.84)(84189)(0.50)(0.50)}{(0.10)^2(84188)+(3.84)(0.50)(0.50)} = 95.89 \approx 96 \qquad \text{Equation D.2}$$

Table D.2: Chi-Square Distribution Values (Besar et al., 2021)

d.f	**0.995**	**0.99**	**0.975**	**0.95**	**0.9**	**0.1**	**0.05**	**0.025**	**0.01**
1	0.00	0.00	0.00	0.00	0.02	2.71	3.84	5.02	6.63
2	0.01	0.02	0.05	0.10	0.21	4.61	5.99	7.38	9.21
3	0.07	0.11	0.22	0.35	0.58	6.25	7.81	9.35	11.34
4	0.21	0.30	0.48	0.71	1.06	7.78	9.49	11.14	13.28
5	0.41	0.55	0.83	1.15	1.61	9.24	11.07	12.83	15.09
6	0.68	0.87	1.24	1.64	2.20	10.64	12.59	14.45	16.81
7	0.99	1.24	1.69	2.17	2.83	12.02	14.07	16.01	18.48
8	1.34	1.65	2.18	2.73	3.49	13.36	15.51	17.53	20.09
9	1.73	2.09	2.70	3.33	4.17	14.68	16.92	19.02	21.67
10	2.16	2.56	3.25	3.94	4.87	15.99	18.31	20.48	23.21

Appendix D.5: IBM SPSS and AMOS Outputs

D.5.1 Cronbach's Alpha

D.5.1.1 Technology Pillar

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.849	.854	7

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Technical Infrastructure	25.64	14.083	.511	.449	.843
Special Requirement	25.52	14.102	.642	.517	.826
Data Management	25.57	13.555	.620	.407	.827
Data Source	25.65	13.483	.519	.303	.845
Data Quality	25.52	12.981	.769	.639	.805
Analysis Methods	25.68	13.399	.625	.527	.826
Notifications	25.59	13.533	.618	.465	.827

D.5.1.2 Organisation Pillar

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.919	.920	12

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Strategic Alignment	43.32	80.372	.578	.576	.916
Administrative Services	43.30	78.765	.672	.644	.913
Top Management Support	43.27	80.486	.539	.478	.917
Culture	43.30	79.032	.549	.496	.917
Safety	43.65	74.058	.655	.530	.913
Administrative Quality	43.43	72.572	.866	.778	.903
Library Services	43.60	75.461	.663	.540	.913
Curriculum Structure	43.62	73.037	.756	.674	.908
Facilities	43.65	73.867	.706	.635	.911
Innovation	43.65	74.058	.725	.623	.910
Leadership	43.52	76.519	.614	.569	.915
Partnership	43.55	75.964	.699	.614	.911

D.5.1.3 Environment Pillar

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.939	.940	9

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Socio-Culture	30.53	75.124	.755	.646	.933
Economy	30.67	72.915	.730	.680	.935
Politics	30.77	72.540	.731	.689	.935
QA Regulations	30.43	75.193	.778	.638	.932
Fitness	30.63	76.981	.660	.610	.938
Location	30.82	73.658	.754	.667	.933
Career Prospects	30.70	71.993	.838	.777	.928
Globalisation	30.65	70.248	.825	.738	.929
Competition	30.54	69.978	.863	.776	.927

D.5.1.4 Business Pillar

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.949	.949	7

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
KPIs	24.47	32.448	.840	.759	.940
Continuous Improvment	24.42	33.049	.857	.775	.939
Academic Quality	24.37	32.878	.850	.754	.939
Resources	24.40	32.367	.883	.820	.936
Financial Factors	24.43	32.712	.855	.780	.939
Competitive Advantage	24.59	33.976	.774	.635	.945
Process	24.50	34.395	.734	.563	.949

D.5.1.5 Social Pillar

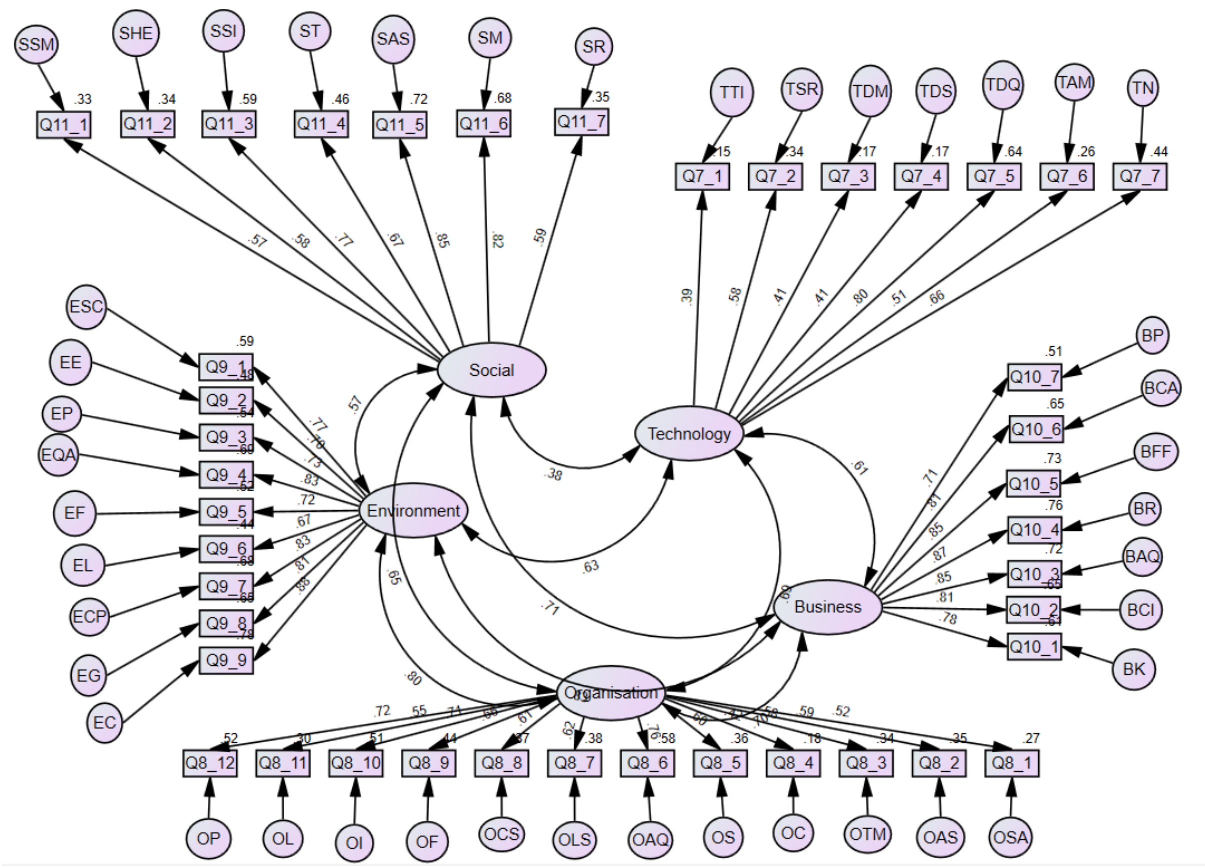
Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.911	.910	7

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Social Media	23.35	37.809	.618	.408	.909
Human Elements	23.23	36.618	.632	.509	.908
Stakeholders Interactions	23.30	35.891	.712	.606	.900
Team	23.40	34.282	.773	.650	.893
Academic Staff	23.48	33.212	.815	.713	.888
Motivation	23.54	33.870	.800	.750	.890
Reputation	23.50	33.672	.763	.687	.894

D.5.2 Confirmatory Factor Analysis (CFA) Results



Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	P	Label
Q7_1	<---	Technology	1.000				
Q7_2	<---	Technology	1.287	.355	3.622	***	par_1
Q7_3	<---	Technology	.993	.321	3.091	.002	par_2
Q7_4	<---	Technology	.945	.305	3.095	.002	par_3
Q7_5	<---	Technology	1.555	.391	3.976	***	par_4
Q7_6	<---	Technology	1.248	.364	3.426	***	par_5
Q7_7	<---	Technology	1.355	.358	3.787	***	par_6
Q8_1	<---	Organisation	1.000				
Q8_2	<---	Organisation	1.000	.204	4.904	***	par_7

			Estimate	S.E.	C.R.	P	Label
Q8_3	<---	Organisation	.921	.188	4.887	***	par_8
Q8_4	<---	Organisation	.852	.218	3.905	***	par_9
Q8_5	<---	Organisation	1.435	.290	4.953	***	par_10
Q8_6	<---	Organisation	1.631	.289	5.649	***	par_11
Q8_7	<---	Organisation	1.441	.285	5.057	***	par_12
Q8_8	<---	Organisation	1.507	.301	4.998	***	par_13
Q8_9	<---	Organisation	1.563	.297	5.259	***	par_14
Q8_10	<---	Organisation	1.645	.301	5.473	***	par_15
Q8_11	<---	Organisation	1.260	.268	4.710	***	par_16
Q8_12	<---	Organisation	1.508	.273	5.519	***	par_17
Q9_2	<---	Environment	1.016	.126	8.079	***	par_18
Q9_3	<---	Environment	1.032	.120	8.607	***	par_19
Q9_4	<---	Environment	1.057	.106	9.937	***	par_20
Q9_5	<---	Environment	.891	.105	8.455	***	par_21
Q9_6	<---	Environment	.971	.126	7.693	***	par_22
Q9_7	<---	Environment	1.096	.110	9.927	***	par_23
Q9_8	<---	Environment	1.233	.128	9.661	***	par_24
Q9_9	<---	Environment	1.303	.122	10.727	***	par_25
Q11_1	<---	Social	1.000				
Q11_2	<---	Social	1.252	.238	5.263	***	par_26
Q11_3	<---	Social	1.603	.254	6.311	***	par_27
Q11_4	<---	Social	1.474	.253	5.824	***	par_28
Q11_5	<---	Social	1.885	.282	6.682	***	par_29
Q11_6	<---	Social	1.687	.257	6.575	***	par_30
Q11_7	<---	Social	1.477	.278	5.312	***	par_31
Q9_1	<---	Environment	1.000				
Q10_2	<---	Business	.994	.100	9.915	***	par_32
Q10_3	<---	Business	1.003	.095	10.592	***	par_33

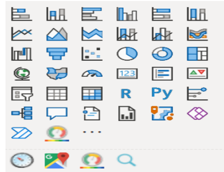
			Estimate	S.E.	C.R.	P	Label
Q10_5	<---	Business	1.013	.095	10.678	***	par_34
Q10_4	<---	Business	1.051	.096	10.982	***	par_35
Q10_1	<---	Business	1.000				
Q10_7	<---	Business	.941	.111	8.493	***	par_36
Q10_6	<---	Business	.906	.091	9.910	***	par_37

Standardized Regression Weights: (Group number 1 - Default model)

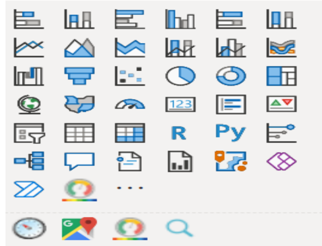
			Estimate
Q7_1	<---	Technology	.387
Q7_2	<---	Technology	.580
Q7_3	<---	Technology	.412
Q7_4	<---	Technology	.413
Q7_5	<---	Technology	.803
Q7_6	<---	Technology	.507
Q7_7	<---	Technology	.660
Q8_1	<---	Organisation	.517
Q8_2	<---	Organisation	.588
Q8_3	<---	Organisation	.585
Q8_4	<---	Organisation	.423
Q8_5	<---	Organisation	.598
Q8_6	<---	Organisation	.759
Q8_7	<---	Organisation	.619
Q8_8	<---	Organisation	.607
Q8_9	<---	Organisation	.662
Q8_10	<---	Organisation	.713
Q8_11	<---	Organisation	.552

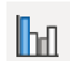
			Estimate
Q8_12	<---	Organisation	.724
Q9_2	<---	Environment	.696
Q9_3	<---	Environment	.735
Q9_4	<---	Environment	.828
Q9_5	<---	Environment	.724
Q9_6	<---	Environment	.667
Q9_7	<---	Environment	.827
Q9_8	<---	Environment	.809
Q9_9	<---	Environment	.880
Q11_1	<---	Social	.573
Q11_2	<---	Social	.584
Q11_3	<---	Social	.766
Q11_4	<---	Social	.675
Q11_5	<---	Social	.848
Q11_6	<---	Social	.823
Q11_7	<---	Social	.591
Q9_1	<---	Environment	.765
Q10_2	<---	Business	.806
Q10_3	<---	Business	.847
Q10_5	<---	Business	.852
Q10_4	<---	Business	.870
Q10_1	<---	Business	.784
Q10_7	<---	Business	.712
Q10_6	<---	Business	.805

Appendix E: HF-HEQ-BI Framework Utilisation Tool

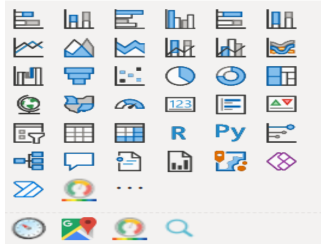
Pillar	Factor	Measurement	Information Determination and Appropriate Tasks	KPIs - NCAAA	Standard - NCAAA	Visualisations Required – Illustrated in MS Power BI 
Technology	Special Requirements	What is the suitable architecture for our organisation?	Identify the scope, data volumes and expected use of the system	N/A	N/A	N/A
			Identify the requirements for the BI dashboard system	N/A	N/A	N/A
		What are the requirements of the selected architecture?	Determine the required BI architecture (DW, or SoBI, or SSBI)	N/A	N/A	N/A
			Determine the requirements and tools for the selected architecture	N/A	N/A	N/A
			Calculate compliance with the requirements specified	N/A	N/A	Gauge 
	Technical Infrastructure	Does our organisation have the required IT infrastructure?	Determine areas which need to be improved in our IT infrastructure environment	N/A	N/A	N/A
			Calculate average satisfaction rate on five-point scale in annual survey on suitability	KPI-I-15	6	Gauge 
		Calculate the satisfaction of beneficiaries with technical services	Calculate average satisfaction rate on five-point scale in annual survey on safety and confidentiality	KPI-I-15	6	Gauge 
			Calculate average satisfaction rate on five-point scale in annual survey on availability and ease of access	KPI-I-15	6	Gauge 

			Calculate average satisfaction rate on five-point scale in annual survey on maintenance and support services	KPI-I-15	6	Gauge 
	Data Management	Does our organisation have a data integrity policy? Where is data going to be stored?	If a data integrity policy does not exist or requires updating, develop an appropriate data integrity policy Determine the data collection, storage, mining, and archiving tools that will be used in the system. Calculate the compliance with the data integrity policy.	N/A N/A N/A	N/A N/A N/A	N/A N/A Gauge 
	Data Quality	What are the standards for assessing quality of data?	Determine the audits required for assuring that data satisfies the desired level of quality before integrating it into the system Calculate compliance with the Data Quality standards	N/A N/A	N/A N/A	N/A Gauge 
	Data Sources	What are the sources that will be used for the purpose of gathering data for presentation?	Identify data sources that the system will be connected to (Cloud Services, Databases, Spreadsheets, Manual Data Entry, etc.) Display connection health to each data source	N/A N/A	N/A N/A	N/A Gauge 
	Analysis Methods	What are the analytical methods required for presenting the data?	For each KPI, determine the required information to be presented and the visualisation type required Calculate the degree of compliance with the specified analysis methods.	N/A N/A	N/A N/A	N/A Gauge 
	Notifications	What are the types of details required in the notifications report?	Determine the levels of performance that require management attention per each KPI	N/A	N/A	N/A

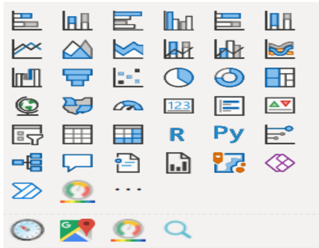
Pillar	Factor	Measurement	Information Determination and Appropriate Tasks	KPIs - NCAAA	Standard - NCAAA	Visualisations Required – MS Power BI 
Organisation	Safety	Does my organisation have a safety and health policies and procedures manual?	Determine if there is manual exist Does it need update?	N/A	N/A	N/A
			Calculate the degree of compliance with safety and health policies and procedure (percentage of compliance) for the institution	N/A	N/A	Gauge 
			Calculate the degree of compliance with safety and health policies and procedure (percentage of compliance) for the colleges	N/A	N/A	Gauge 
			Calculate the degree of compliance with safety and health policies and procedure (percentage of compliance) for the facilities	N/A	N/A	Gauge 
	Administrative Services	Determine satisfaction level on administrative services provided.	Calculate satisfaction rate on administrative services provided by administrative units in the institution.	N/A	N/A	Gauge 
	Library Service	Does my organisation have library policy?	Determine whether the policy exists or needs to be updated.	N/A	N/A	N/A
		What are the academic databases the institution is subscribed to?	Display the number of active subscriptions in databases.	N/A	N/A	KPI 
		Determine the level of satisfaction on library services.	Display the results of satisfaction on library services survey.	N/A	N/A	Gauge 

	Curriculum Structure	Does my organisation have a curriculum development policy? Are all programmes designed according to the NQF requirements?	Determine whether the policy exist or needs update. Calculate the percentage of programmes complies with NQF requirements and curriculum development policy.	N/A N/A	N/A N/A	N/A Gauge 
	Facilities	Students' satisfaction with offered facilities	Calculate average satisfaction rate of services offered by different facilities in the institution (restaurants, transport, sport facilities, etc.) in a five-point scale	KPI-I-10	4	Column Chart 
	Top Management Support	Does Top Management support QA activities in my organisation?	Calculate average responses from staff and students on the level of support of Top Management (through survey)	N/A	N/A	KPI 
	Innovation	Does my organisation support innovative activities? Does my organisation have policy for rewards for innovative ideas?	Calculate innovation rate (revenues from innovative ideas / total revenue) Determine whether there is a policy for supporting innovation.	N/A N/A	N/A N/A	KPI  N/A
	Strategic Alignment	The HEI must develop their strategic plan including on (Institution, College, Department levels) - Defining Mission statement - Defining Vision - Define Strategic Objectives	Calculate the percentage of achieved indicators of the Institutional Strategic Plan objectives	KPI-I-01	1	Gauge 
	Leadership	Does my organisation identify qualities for effective leaders?	Display an evaluation of Top Management based on staff surveys on leader qualities	N/A	N/A	Gauge 
	Culture	Does my organisation identify Service Level Agreement (SLA) for each department? Does my organisation have objectives for culture transformation monitoring?	Determine whether SLA is identified for all departments and activities in the organisation Display the performance of employees' surveys on organisational culture (use organisation culture assessment tool such as Emprising Tool)	N/A N/A	N/A N/A	N/A Gauge 
	Partnership	Does my organisation have partnership policies?	Calculate the degree of compliance in partnership agreements to the policy.	N/A	N/A	KPI 

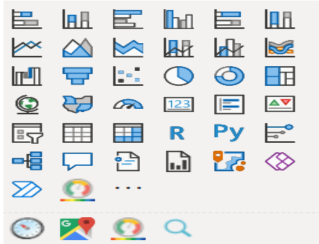
		Does my organisation have partnership agreements?	Display the number of agreements and the compliance with achieving the desired number of partnerships in the strategic plan	N/A	N/A	KPI
	Administrative Quality	Determine the number of accredited programmes to the total programmes provided in the HEI	Display the proportion of Accredited Programmes	KPI-I-02	2	Donut Chart
		Calculate Ratio of students to teaching staff	Calculate total number of students to total number of full-time equivalent teaching staff at institution level	KPI-I-11	5	Donut Chart
			Calculate total number of students to total number of full-time equivalent teaching staff for each programme	KPI-I-11	5	Donut Chart
		Proportion of faculty members with doctoral qualifications	Calculate percentage of faculty members with verified doctoral qualifications to total number of teaching staff at institution level	KPI-I-12	5	Donut Chart
			Calculate percentage of faculty members with verified doctoral qualifications to total number of teaching staff at each branch	KPI-I-12	5	Donut Chart
		Calculate turnover percentage	Calculate percentage of teaching staff leaving institution to total number of teaching staff (excluding age retirement)	KPI-I-13	5	Donut Chart

Pillar	Factor	Measurement	Information Determination and Appropriate Tasks	KPIs - NCAAA	Standard - NCAAA	Visualisations Required – MS Power BI 
Environment	Fitness	Do all programmes satisfy the sustainable development plan?	Calculate the percentage of programmes aligned with sustainable development plan	N/A	N/A	Donut Chart 
	Location	Does my organisation operate in several locations?	Display on a map the location of campuses	N/A	N/A	Map 
		What are the implications of current/new locations where campuses operate?	Display Competitors Campuses.	N/A	N/A	Map 
	Career Prospects	Percentage of graduates from undergraduate programmes who are employed or attended postgraduate programme within one year of graduation	Calculate graduates' employability percentage	KPI-I-05	3	Donut Chart 
	Economy	Rate of community programs and initiatives	Calculate the average rate of community programmes provided by each academic programme to the total number of academic programmes	KPI-I-23	8	Donut Chart 
	Politics	Does our organisation comply with political and governmental requirements?	Calculate the level of compliance with governmental requirements.	N/A	N/A	Gauge 
	Socio-Culture	Does our organisation have policies for managing cultural differences and diversity?	Calculate the degree of compliance with cultural differences and diversity policies.	N/A	N/A	Gauge 
		Does our organisation have an anti-discrimination policy?	Calculate the degree of compliance with anti-discrimination policy.	N/A	N/A	Gauge

	Globalisation	Is our organisation aware of globalisation challenges? Does our organisation have plans to respond to globalisation challenges?	Determine the degree of awareness to globalisation challenges. Calculate the degree of compliance with the globalisation plan.	N/A N/A	N/A N/A	Gauge Gauge
	Competition	What are the main competitors in the region where the HEI operate? What is the impact of the existence of competitors? How does competition affect our strategic plan?	Determine whether competitors have been identified. Identify and display the data that can be used to determine the impact of competition. Alter strategic plan to reflect competition issues. Determine competition response plan Display the compliance with the competition response plan	N/A N/A N/A N/A N/A	N/A N/A N/A N/A N/A	N/A Gauge N/A N/A Gauge
	QA Regulations	Is our organisation required to comply with specific QA standards other than NCAAA?	Calculate the percentage of compliance with NCAAA QA standards. Calculate the percentage of compliance with other QA standards.	N/A N/A	N/A N/A	Gauge Gauge

Pillar	Factor	Measurement	Information Determination and Appropriate Tasks	KPIs - NCAAA	Standard - NCAAA	Visualisations Required – MS Power BI 
Business	Continuous Improvement	Does our organisation have an improvement programme?	Calculate the percentage of compliance with improvement programme at the institutional level.	N/A	N/A	KPI 
			Calculate the percentage of compliance with improvement programme at the colleges level.	N/A	N/A	Gauge 
			Calculate the percentage of compliance with improvement programme at facilities level.	N/A	N/A	Gauge 
	Resources	Determine the average beneficiaries’ satisfaction rate on learning resources using five points scale	Calculate satisfaction with the adequacy and diversity of resources (Journals, databases, etc.)	KPI-I-07	3	Gauge 
			Calculate the satisfaction rate with support services provided for these resources	KPI-I-07	3	Gauge 
	Financial Factors	Determine the average expenditure rate per students	Calculate annual expenditure rate per student (other than accommodation and students’ allowances) to the total number of students	KPI-I-09	4	KPI 
		Determine the percentage of self-income of the institution	Calculate the Percentage of self-income of the institution to the total income of the institution	KPI-I-14	6	KPI 

		Determine the proportion of budget dedicated to research	Calculate the proportion of budget dedicated to research to total budget of the institution	KPI-I-20	7	KPI
		Determine the proportion of external funding to research	Calculate the proportion of external fund received for research to the total budget of research	KPI-I-21	7	KPI
	Competitive Advantage	Determine the percentage of first year students who continue the next year to the total number of first year students in the same year	Calculate First year students' retention rate	KPI-I-04	3	Column Chart
		Determine the number of patents and innovations	Calculate number of patents and innovations	KPI-I-19	7	KPI
		Determine the number of awards of excellence	Calculate the number of awards of excellence obtained by staff annually	KPI-I-19	7	KPI
	Process	Determine the completion rate of programmes	Calculate the percentage of students completed the programmes within the specified period of each programme to the total number of students	KPI-I-06	3	Column Chart
	KPIs	Are there any additional KPIs in the strategic plan that needs to be monitored other than mandatory NCAAA KPIs?	Calculate the actual performance against expected performance of additional KPIs identified in the strategic plan (e.g., students' performance in national tests, debt ratio, financial stress ratios, etc.).	N/A	N/A	KPI
	Academic Quality	Determine the average rating of final year students for the quality of learning experience	Calculate the students' evaluation of quality of learning experience in the programmes in a 5 points scale	KPI-I-03	3	Donut Chart

Pillar	Factor	Measurement	Information Determination and Appropriate Tasks	KPIs - NCAAA	Standard - NCAAA	Visualisations Required – MS Power BI 
Social	Motivation	Does my organisation have a compensation and reward programme?	Calculate the degree of compliance with the programme at the institutional level	N/A	N/A	Gauge 
			Calculate the degree of compliance with the programme at colleges level	N/A	N/A	Gauge 
			Calculate the degree of compliance with the programme at facilities level	N/A	N/A	Gauge 
	Team	Does my organisation support teamwork?	Determine whether activities done in departments and councils support teamwork (use staff surveys).	N/A	N/A	KPI 
	Academic Staff	Percentage of publications of faculty members	Calculate the percentage of full-time faculty members published at least one research during the year to total faculty members in the institution	KPI-I-16	7	KPI 
		Calculate rate of published research per faculty member	Calculate the average number of refereed and/or published research per each member	KPI-I-17	7	KPI 
		Calculate citation rate in refereed journals per faculty members	Calculate the average number of citations in refereed journals per full-time equivalent faculty members in the institution	KPI-I-18	7	KPI 
	Human Elements	Does my organisation have an HR management policy?	Calculate compliance with the HR policy and development plan.	N/A	N/A	Gauge 

		Does my organisation consider individual needs in workplace?	Determine whether individual needs are being met by the organisation through staff survey.	N/A	N/A	Gauge
	Reputation	Determine type of awards and rankings that will be considered for institutional reputation	Display the actual ranking of the institution against the institutional objective of ranking.	N/A	N/A	KPI
	Social Media	Determine what are the social media channels that need to be monitored for gathering public opinions of service quality	Determine the analytics that will be presented in the dashboard - The number of interactions - Number of shares of pages - Social media marketing analytics - Sentiment analysis of text on comments	N/A	N/A	Gauge
		Does my organisation have social media policy?	Calculate the degree of compliance with the social media policy at institutional level	N/A	N/A	Gauge
			Calculate the degree of compliance with the social media policy at the colleges level	N/A	N/A	Gauge
			Calculate the degree of compliance with the social media policy at departments level	N/A	N/A	Gauge
	Stakeholders Interaction	Employers' evaluation of the proficiency of graduates on a five-point scale in annual survey	Calculate employers' evaluation of graduates' proficiency	KPI-I-08	3	Gauge
		Satisfaction of community services	Calculate the average satisfaction rate of community services annually on five-point scale	KPI-I-22	8	Gauge

Appendix F: Dashboard Refinement

The developed dashboard has been developed through Microsoft Power BI. The HF-HEQ-BI Framework Utilisation Tool was used in determining the visualisations that will be presented in the dashboard screens.

The prototype dashboard was refined through several iterations using a Community of Practice (COP). COP are considered useful for socialisation as they allow researchers to obtain valuable knowledge related to their field of expertise (Almuayqil et al., 2017). The prototype dashboard has also been presented to senior managers in the KSA involved in QA monitoring in HE for their comments.

The first version of the prototype dashboard is outlined in Figure F.1. and the dashboard has been revised through several iterations and some are outlined as follows:

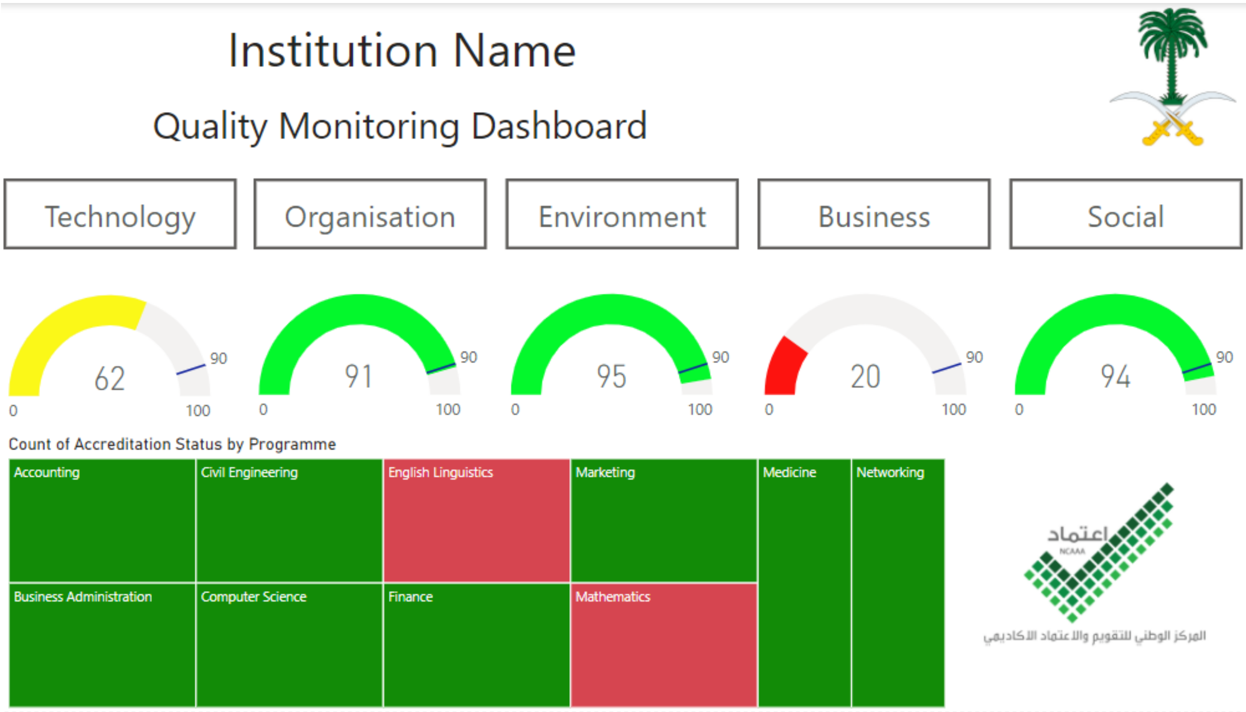


Figure F.1: Prototype Dashboard (First Version)

The first version of the dashboard shows High Level of the compliance as outlined in Figure F.1. The dashboard has been improved to show the compliance with the NCAAA 23 KPIs in the main page as presented in Figure F.2.

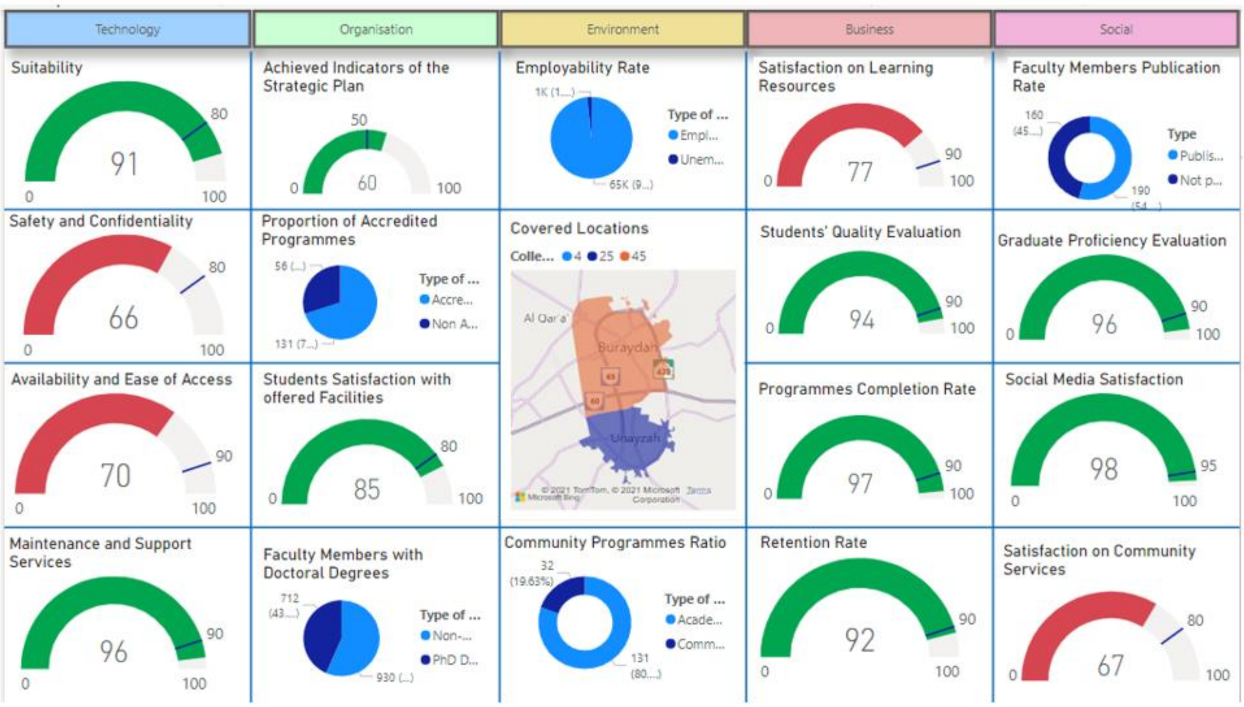


Figure F.2: Prototype Dashboard (Second Version)

The senior managers and supervision advisers of the COP have considerable experience in QA in HEI in KSA and overseas. The feedback on the prototype dashboard and a summary of the comments from the COP are outlined a as follows:

1. The dashboard should be flexible to allow addition of KPIs as the institution may develop their own performance measurement KPIs.
2. The developed dashboard should be easy to understand
3. The dashboard should allow users to use different visualisations
4. The dashboard should support smartphones as Top Management tend to use their smartphones in monitoring performance and checking emails.
5. The dashboard may focus on some important metrics such as the number of students continuing their studies in the institution
6. The dashboard should allow comparisons of data through years
7. The dashboard should present Social Media feed

The dashboard has been improved to show colour coding of performance in order to allow users to distinguish low levels of performance where red colour indicate that the institution fails to achieve the targeted value of the KPI while green colour indicate satisfactory performance as illustrated in Figure F.3. Additionally, only 23 NCAAA standards were presented in the home screen of the dashboard. The additional institutional specific standards were presented in additional pages of the dashboard.

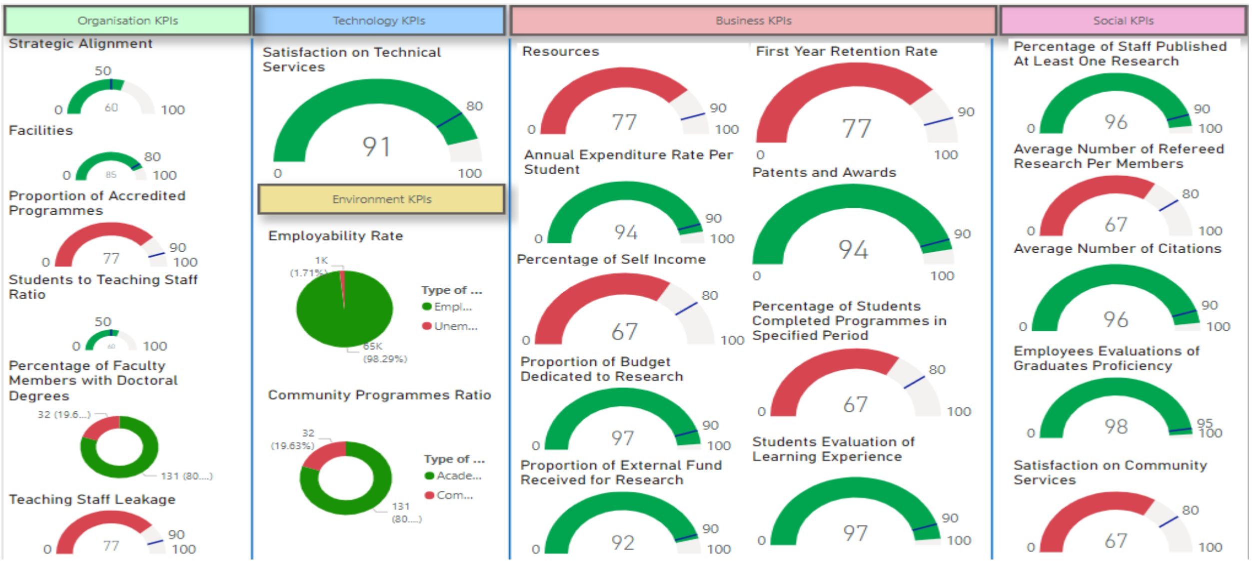


Figure F.3: Prototype Dashboard (Third Version)

To provide a more commercial appearance it was decided to allow navigation throughout the different pages of the dashboard. The top pane was developed through the use of a PHP editor, the dashboard has been embedded into the webpage in order to provide a portal for monitoring QA in HEI as presented in Section 7.4 in Chapter 7. The web portal allows the users to navigate different screens of the dashboard to be able to assure that the institutional performance is in compliance with the QA requirements.