

PAPER NAME

**International consensus on data and information quality-IJPQM.pdf**

AUTHOR

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WORD COUNT

**7037 Words**

CHARACTER COUNT

**39450 Characters**

PAGE COUNT

**17 Pages**

FILE SIZE

**252.1KB**

SUBMISSION DATE

**Nov 4, 2022 4:21 PM GMT+8**

REPORT DATE

**Nov 4, 2022 4:21 PM GMT+8**

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## **International consensus on data and information quality for better quality decision-making in higher education institutions**

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**Abstract:** The main objective of this study is to develop a structured and comprehensive framework and strategy for obtaining high quality data and information in Indonesian higher education (HE) institutions. This study employs three research methods. A three-round international Delphi study was used in the first year of the study (reported in this paper). A national survey and a case study will be conducted in the second and third years. The integrated framework and strategy for forming a better HE system will consist of the triangulation of the findings of these three methods. The most significant findings of the Delphi study were the key data and information quality (DIQ) dimensions related to HE; the DIQ together with the factors impacting the problems in HE from technological, organisational, and personal approaches; and a strategic way to identify and correct DIQ problems to develop better decision-making to improve the competitive advantage of the national education system.

**Keywords:** data quality; information quality; real-time; decision-making; higher education; data and information quality; DIQ.

**Reference** to this paper should be made as follows: Syafar, F., Husain, H. and Sabara, E. (2022) 'International consensus on data and information quality for better quality decision-making in higher education institutions', *Int. J. Productivity and Quality Management*, Vol. 37, No. 2, pp.143–159.

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## 1 Introduction

Currently, quality is considered a critical concern for education worldwide, particularly at the higher education (HE) level. As HE systems grow and expand the potential for a decrease in quality arises. The various indications of an emerging 'quality emergency' in HE institutions include high dropout rates at the early stages of education programs, an increasing rate of university graduate unemployment, and a general perception of declining academic standards.

HE organisations undoubtedly make great efforts to gather and utilise data and information. Data, information, and knowledge provide a foundation for making good, appropriate decisions. Data and information have become an increasingly important source of support for educational activities; therefore, HE institutions always seek to produce and collect more supporting data. However, having more data does not mean that the information is better or that better decision-making is guaranteed. According to Gao and Koronios (2014), more than 70% of the data produced by many institutions are never used. Otto (2015) concludes that most institutions have much data but cannot use it well and that the necessary data are not available.

The need for accurate data/information is increasing. However, academic information systems (ISs) are still unable to produce reliable, complete, and timely data and information. Various problems may be encountered as early as the implementation of an educational information system, including HE providers lacking a common purpose. The application of academic ISs has not been carried out efficiently, resulting in redundant data and the unnecessary duplication of activities. The quality of the data collected is poor, irrelevant data are collected, and the reporting of data is not timely. In addition, the feedback system is not optimal, and the utilisation of data and information for advocacy, program planning, monitoring, and management at the faculty, department, and study program levels is still minimal, resulting in the inefficient use of resources.

The research and literature on the quality of HE data and information in Indonesia are so limited as to be nearly non-existent. Therefore, this paper is the first attempt to address the lack of research by exploring the current data and information quality (DIQ) dimensions and the problems relevant to HE practices in Indonesia. This study is carried out using a holistic approach covering aspects of technological, organisational, and personal (TOP) perspectives.

The research questions focus on the following:

- RQ1 What are the current applications of the DIQ dimensions in HE institutions?
- RQ2 What are the current DIQ problems in HE?
- RQ3 What factors influence the quality of data and information?
- RQ4 How can the quality of data and information be improved through the development of an integrated framework?

The main objectives of the research are:

- 1 to identify the state of the art of the DIQ problems related to the better management of HE, along with the factors that influenced the main problems; and
- 2 to develop an integrated framework for identifying and correcting DIQ issues through various approaches and strategies

Eleven highly experienced academics and nine professionals who are prominent members of the HE DIQ community contributed to the research. This international Delphi study was conducted from April to September 2019.

This paper is structured as follows. Section 2 describes the theoretical foundation. Section 3 presents the research methodology. The findings and discussion are presented in Sections 4 and 5, and the paper ends with a conclusion.

## 2 Theoretical foundation

### 2.1 Data quality

Initially, data quality (DQ) was interpreted only through the perspective or dimension of accuracy, but then many studies observed that DQ consists of several additional dimensions. The four dimensions of DQ that are most often mentioned in studies as being required for datasets are accuracy (accurate), completeness (complete), timeliness (on time) and consistency (consistent) (Batini et al., 2004; Bouzeghoub and Peralta, 2004; Liu and Chi, 2002; Naumann et al., 2004). A dataset might be able to fulfil three of the four dimensions but not all of them. Fulfilling or improving one dimension can interfere with the other dimensions. For example, while improving or satisfying the dimension of timeliness, the accuracy dimension may be sacrificed (Neely, 2002); in the alternative, both dimensions can be achieved at additional costs (Ballou and Pazer, 1995). Moreover, organisations sometimes have different standard requirements or DQ dimension priorities (Heinrich et al., 2018).

Good quality data may be suitable for one particular institution (Giannoccaro et al., 1999; Syfar et al., 2014a, 2014b) but may not be considered relevant to other institutions (Ballou and Pazer, 1995; Heinrich et al., 2018). Furthermore, the dimensions of DQ may be deemed appropriate for a particular decision but not for other decisions. That is why the definition of DQ proposed by Wang and Strong (1996), which states that ‘quality data is data that is suitable for use by data users’ was adopted in this study. Ogunnaike et al. (2018) conclude that DQ provides quality to examinations, assignments, student group discussions and knowledge resources in universities.

Maintaining DQ is often a problem because only good quality data can be referenced for effective decision-making. According to Buana and Wirawati (2018), examples of the many factors that can hinder the quality of data in institutions, companies, and industries in Indonesia include inadequate management structures to ensure the completeness, timeliness, and accuracy of data; insufficient rules, training, and procedural guidelines for those involved in data collection; and inconsistencies between services related to data collection.

## 2.2 *Information quality*

The quality of information is an essential factor in total quality management (Flores and Sun, 2018; Larry, 2009), particularly in supporting decision-making in HE institutions. Information quality (IQ) refers to the quality of the content of e-learning ISs (Pinho et al., 2018). Information quality practices enable the rapid development and increased availability of accurate, relevant, valid and up-to-date learning information (Deja, 2019). As an outcome, IQ practices in HE affect user (staff, student, and management) satisfaction (Kadoić et al., 2017).

Researchers have used ‘DQ’ and ‘information quality’ synonymously, mostly when addressing quality issues. This paper uses ‘data’ interchangeably with ‘information’ but predominantly uses ‘DIQ’.

## 2.3 *Information technology in HE*

As organisations that have a strategic role in educating the people of the nation, HE institutions in Indonesia should each have a long-term development plan that describes the direction of its development. Based on a report from the Secretary of the Directorate General of HE, almost all state universities in Indonesia already have a long-term development plan. Nevertheless, in reality, the implementers of educational institution development never refer to the long-term development plans that they have prepared. According to Lytras et al. (2018), the learning process in HE institutions requires the adoption of information technologies (ITs), particularly those that integrate information, including through the utilisation of DIQ, across academic purposes.

The need for IT adoption described above can only be fulfilled if HE institutions use high quality data as raw material for the preparation and processing of quality, effective, and efficient information (Prinsloo, 2020). Good quality information is needed to satisfy reporting needs (Prinsloo, 2020) and for executive information to be trusted as a reference for decision-making (Pinho et al., 2018; Prinsloo, 2020) by an institution’s leadership (such as the chancellor, dean, or head of a school or the chair of a study program).

There are various types of technical specifications and operational and administrative systems for managing HE assets, and they not only manage the operation of equipment but also provide maintenance support throughout the assets’ life cycle, especially for physical assets (Syafar et al., 2017, 2015). The use of IT in HE asset management could improve the quality of asset management data and information and lead to increased output (Syafar et al., 2015) and decision-making quality (Lytras et al., 2018).

## 2.4 TOP approach

The TOP model allows analysts to see the context of a problem from the technical, organisational and personal (TOP) perspectives (Linstone, 1999).

- The technical (T) side perceives HE institutions as hierarchical or as systems of interrelationships between students, staff, lecturers, and systems, such as data, information, knowledge, science technology, and wisdom.
- The organisational (O) side perceives the world through a different filter, namely, from the perspectives of HE institutions that affect or are affected by the particular problem, and considers an institutions' daily routines in terms of the total quality education, for example, the management view, the dependence on academicians (university lecturer), and institutional IT context awareness.
- The personal (P) side bring attention to individuals' apprehensions, for example, educational level, learning experience, academic achievement, and training.

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## 3 Research method

### 3.1 Research design

The research design consists of three stages: an international Delphi study (reported in this paper) and then a national survey and a national deep case study (which will be undertaken in the second and third years of the study, respectively).

### 3.2 Delphi method

The Delphi method was applied to identify DIQ problems encountered in HE institutions and the factors that may influence those problems. The Delphi technique was employed to more accurately build a consensus from the perceptions of the panel experts.

This method was employed for at least four reasons. The 'DIQ in HE' topic is relatively new, the topic is complicated, only a few studies on the topic exist in the literature, and few empirical data on the topic are available. For these reasons, the Delphi study was useful for presenting a DIQ problem to the HE panels of experts. The Delphi study was conducted for three rounds (Linnstone, 1999; Syafar et al., 2013).

### 3.3 Nomination of expert

Thirty-eight experts who had strong academic backgrounds, research experience, and professional experience in the area of DIQ relevant to the HE sector were invited to participate in the Delphi survey. Of these, 21 were willing to participate in this research. The included 12 university lecturers (academia) and nine professionals from ten different countries. The experts' profiles are illustrated in Tables 1 and 2.

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**Table 1** Panel members by current role

<i>Background</i>	<i>Participants</i>	
	<i>Frequency</i>	<i>Percentage (%)</i>
Academia	12	57
Professional	9	43
Total	21	100

**Table 2** Panel members by country

<i>Country of origin</i>	<i>Participants</i>	
	<i>Frequency</i>	<i>Percentage (%)</i>
Australia	3	14
Canada	2	9.5
England	2	9.5
France	2	9.5
Germany	2	9.5
Greece	1	5
Japan	3	14
Singapore	1	5
United Arab Emirates	1	5
US	4	19
Total	21	100

### 3.4 Three-round Delphi design

**1** *The first round* (generating ideas/issues) was about identifying an initial assortment of DIQ problems through open-ended questions. The respondents were asked about four basic topics corresponding to the four research questions (RG). Explicitly, RQ1 asked the experts (respondents) to list DIQ dimensions relevant to the HE industry. To answer RQ2, the experts were asked to list DIQ problems in HE institutions within the technological (T), organisational (O), and personal (P) categories. In RQ3, the experts were asked to list factors that may influence the DIQ problems identified in response to RQ2. Then, in RQ4, they were asked how to recognise and correct the identified DIQ problems to achieve better HE management. In this round, one of the 21 experts did not send answers after three reminders.

*The second round* (eliciting agreement) was the justification of the categorised lists of DIQ dimensions, problems and factors. The experts were asked to verify whether the responses in the first round had been properly interpreted and sited in the appropriate TOP category or group in the lists. In addition, they were also requested to remove, add or regroup the item(s) into other group or categories wherever appropriate. The level of agreement was set at 70% to 100% agreement or disagreement. **2**

*The third round* (obtaining consensus) was about ranking the most relevant DIQ dimensions and DIQ problems together with their **2** *ors*. The DIQ problems/factors were ranked by importance. Ranking order consensus for the relevant groups and **1** categories was reached in this final round.

### 3.5 Data analysis

The responses from the expert groups were summarised at the end of each round and then repeated in the next round to obtain additional answers. Through the process of convergence with the content analysis approach, general trends and similarities were identified. Finally, a consensus was reached at the end of the third round.

### 3.6 Development of the DIQ framework

The results of the international Delphi study will be triangulated with the results of the nationwide survey and the national case study (the next stages) to obtain a complete set of DIQ problems and influencing factors. Using of multiple methods to develop a comprehensive understanding of phenomena can provide a strong of information from different sources. Therefore, triangulation is used here in an effort to ensure the accuracy of the DIQ issues identified from a variety of different perspectives by reducing the latency of the variances that may occur during the data collection and analyses. The factors and subsets of factors that occur within the majority of the respondents' responses (after triangulating the three methods) can be identified as key (main) DIQ factors. According to Syafar and Husain (2017) and Syafar and Gao (2013), the purpose of the triangulation process is to control the empirical validity of research.

## 4 Findings and discussion

### 4.1 The top six DIQ dimensions relevant to HE

In the final round, 20 expert panel members rated the importance of the 16 DIQ dimensions. The highest levels of consensus were documented as follows. Due to space limitations, the six highest-ranked dimensions are listed in Table 3 and discussed below.

**Table 3** Data/Information quality relevant to HE

<i>Rank</i>	<i>DIQ HE dimension</i>
1	Accessibility
2	Accuracy
3	Timeliness
4	Credibility
5	Coherency
6	Understandability

- 1 Accessibility reflects how readily available data and information concerning learning and academic context is to HE institution stakeholders or how easily and quickly it can be provided upon demand.
- 2 Accuracy is the degree to which data and information properly, reliably and consistently estimates or defines the number or features of HE purposes they are intended to measure.



- 3 Timeliness reflects the length of time between HE data becoming available and being sufficiently updated and the events or phenomena that led to that data and information.
- 4 Credibility is the extent to which data and information are regarded as true and credible for the HE context.
- 5 Coherence reflects the degree to which data are logically connected and consistent.
- 6 Understandability reflects the ease with which students, staff and other users might recognise and properly use and analyse data.

#### 4.2 *The top five DIQ problems and influencing factors*

During the second round, 43 TOP DIQ problems were identified, and 64 influencing factors were found to be critical for the development of better HE. Twenty panel members in the final iteration of the Delphi study ranked this set. Due to space limitations, the five highest-ranked factors for each TOP perspective are listed in Tables 2, 3, and 4 and discussed below.

##### 4.2.1 *Technological*

Table 4 presents technological DIQ problems and influencing factors and is followed by a detailed explanation of the issues identified.

**Table 4** DIQ technological problems and influencing factors

<i>DIQ technological problems</i>	<i>Factors</i>
1 System integration	System integration Interoperability
2 Configurability-deployment	Speed at which devices/tools are ready
3 Database synchronisation	Database synchronisation
4 System adoption, implementation, and documentation	Adoption of IT systems System implementation Use multiple versions of software Standardisation of system documentation
5 DIQ verification	System standardisation

##### 1 System integration

Data and information are disseminated across different schools (faculties), departments, and study programs. The system mechanism has to be capable of supporting discussion, negotiation, and decision-making to integrate academic ISs with different software systems. DQ software in HE institutions is designed to improve the accessibility, accuracy, timeliness, credibility, understandability, and coherency of the HE institutions' data. If the ISs are not integrated, effort and resources might be wasted in manually inputting repeated data. It may also prove difficult to make timely data access interoperable across different systems. In general, the DQ tools most often used in HE institutions are data matching, data preparation, data cleansing, data profiling, data deduplication, data enrichment and

data standardisation for data-driven decision-making (DDDM) software. Data-driven decision-making implements big data and information practices in the HE industry.

## 2 Configurability-ease of deployment

The amount of time it takes to activate an IT device is an essential factor. A quick boot-up time enables IT crews in HE institutions to productively and effectively use dead times. Most of the staff and even the students in universities are non-programming users. As such, software must be simple and easy to use with a minimum of complicated configurations and unnecessary features.

Academic ISs must be easy to adapt and designed to be configurable. The goal should be that HE institutions can make changes and add new capabilities to their academic ISs in far less time than it takes today and without having to engage external consultants. The data entry/capture capability of the systems must be flexible. IT crews, as operators/administrators, must be able to quickly add good quality data and information.

## 3 Database synchronisation

HE ISs typically have distributed heterogeneous systems monitoring datasets at multiple sites, as HE institutions have multiple campuses, schools and departments. One of the important actions in DQ administration is to synchronise multiple database settings. Most of the panel members noted the poor quality of the digital educational asset database synchronisation within the HE industry.

Database synchronisation provides suitable frameworks for classifying data and information into proper taxonomies. The purpose of database synchronisation is to provide universities with integrated DIQ frameworks in which data are managed (collected, edited, revised, saved, and distributed), information is conveyed, and decisions are made. Using fractional, old-fashioned databases often causes data to be managed inappropriately.

## 4 System adoption, implementation, and documentation

In adopting primary DIQ software systems, HE institutions have faced both external and internal pressures. External government-mandated decisions, together with IT-driven internal decisions from the top down, do not provide an opportunity for a particular university to determine which system it needs. IS project managers have been concerned that system fitness might have an impact on DIQ.

## 5 DIQ verification

According to 16 of the 20 panel members, it was difficult to develop a standard data format for identifying their central asset inventories. The IT crew members from different departments or study programs did not use the same terms in describing academic and administrative problems. Each school, department, and study program office represented in the study used different names to refer to the same thing, including physical and digital assets. Consequently, this might be an issue that causes DQ problems in HE institutions.

#### 4.2.2 Organisational

Table 5 presents organisational DIQ problems and influencing factors and is followed by a detailed explanation of the problems identified.

**Table 5** DIQ organisational problems and influencing factors

<i>DIQ organisational problems</i>		<i>Factors</i>
1	Clear data/information vision (DIQ strategy – HE institution leader)	Academic process flow Operational merit Quality assurance
2	IT governance	Data transparency
3	Manual data acquisition	Manual data collection and entry Data capture process
4	Data access and coordination access across schools, departments, study programs	Coordination of data/information
5	Data integration	Data integration

#### 1 Clear DIQ data vision from HE leadership

HE institutions must comprehend the business process flow of DIQ and its operational and implementation factors. Defining the critical points and potential problems of DIQ within the process flow enables HE institutions' IT staff to quickly determine which technology approaches should be adopted to improve or solve the DIQ issues.

A clear DIQ vision from HE management is required to create a data-informed academic institution and to streamline analytics. Universities need to treat their data and information as being as necessary as their financial and engineering assets to be able to make more informed decisions properly and quickly and to take advantage of great future opportunities.

#### 2 IT (data) governance

Without having a clear understanding of why data need to be collected and the use of such data, how can data collectors decide which is the right data to collect? The experts believed that a clear understanding of DIQ requirements might help produce the correct data and have a positive impact on the quality of HE institutions.

One of the panel members argued with the other panel members in round two of the Delphi study and then agreed with them in the final round:

“If you look across the departments on your campus, chances are you will find a myriad of systems and processes that use data. And because those systems are often closed within an individual school or department, it is difficult to get a clear picture of all the data that exist on your campus. As an example, think about all the data you collect on a student. There is demographic information captured in your student information system. There are academic data that indicate if students are attending class and how they are performing academically. There might be even more data captured in your learning

management system. And what about the data that indicates whether or not a student is engaged in campus life? All of these data points together can paint a picture of how likely – or not – a student is to succeed at your institution. But when these data exist across systems and departments, gaining a clear picture of the information available is a challenge.”

The IT governance literature suggests that IT governance and DIQ are interlinked and can support each other. DIQ is a core element of IT governance. The application of IT governance principles provides support to assuring DIQ, and DIQ is the core aspect of achieving the goals defined in IT governance approaches. Without accurate and timely delivered data, reporting and monitoring efforts are of little value. Because poor-quality data and insufficient information can easily cripple the IT function as a whole, an appropriate level of DIQ is a prerequisite for achieving the goals of IT governance. The risk of not investing in DIQ, therefore, is substantial and can, in an extreme case, result in comprising an enterprise’s entire approach to IT governance. HE management or IT crews can develop data-sharing agreements to define how departments can share data. Data governance also provides a way for users to identify problems with data and route them to the appropriate person for resolution.

### 3 Data integration

The need to integrate and access disparate information sources in consistent, trusted, and reusable ways has become critical as today’s HE institutions extend their boundaries globally. According to the majority of the Delphi study panellists, integrating and accessing HE data and information can be difficult because the data often come from external providers/vendors and are only passed on to some schools/departments in a paper-based report format. Without integrating the data into asset management systems, the usefulness of such data is limited.

In HE institutions, there are so many sources of data and information in both physical and non-physical forms (digital and finance) that the institutions must deal with a bewildering diversity of data sources. Having disparate sources of data is perceived to be an issue that might cause data access problems.

### 11 4 Data access and coordination

Collaboration for decision-making is one component of HE culture, particularly in educational process environments. Collaborative decisions are subject to common data and information. Nevertheless, access to data and information is, in some cases, restricted to those who use it repeatedly. It is therefore critical to share data and information to improve the quality of decisions. However, numerous HE institutions fail to ensure cooperation and collaboration as a top priority. The collaboration problem in the HE context is that there are data and information silos that effectively hide data from various users within universities. Departmental data and information that users need to exchange in educational process often reside in other schools, departments or study programs and are consequently unreachable.

Several Delphi panel members noted the following:

“Coordinating data across departments can be difficult because the data come from different sources, both internally and externally. Weak synchronization of data and information within departments/study programs was a serious issue that might impact HE DIQ problems. Besides, there were gaps between various stakeholder groups/departments, which made data access and data coordination very difficult in the university. Unable to have a single clear view of the data, stakeholders were not able to use the data in the HE information system.”

5 Paper-based data collection

Paper-based data assortment is still used in HE institutions due in part to its portability and independence from technology. Laboratory job sheets and standard operating procedures are common examples of tools for collecting and distributing paper-based data. The experts observed that manual paper-based data collection might increase the likelihood of human error and cause DQ problems. The findings of the Delphi study indicated possible reasons why manual paper-based data collection might cause DQ problems. For example, IT staff may record fewer data on paper to reduce their data input responsibilities when they arrive at work.

Despite standard forms for recording academic data being used in many HE institutions, the lack of enforcement in using those forms to record data was perceived to trigger DIQ problems. The details of the data to be recorded are left to individual technicians to determine. This might increase the likelihood of creating inconsistent, incomplete data.

4.2.3 Personal

Table 6 presents personal DIQ problems and influencing factors, and is followed by a detailed explanation of the identified problems.

**Table 6** DIQ people problems and influencing factors

<i>DIQ people problems</i>	<i>Factors</i>
1 Craft skill and training	Education and specific training
2 Teamwork	Awareness of the mutual advantages of working as a team and as an individual
3 Data stewardship	Data stewardship
4 Disconnect among data stakeholders	Awareness of the importance of data production The knowledge gap between data collector and data entry staff (in study programs, departments, and schools).
5 Performance evaluation and motivation	Self-motivation for data/information collection

1 Craft skill and training

Most importantly, the DIQ skills and knowledge of IT crews in HE institutions are critical to ensuring that the dimensions of DIQ relevant to HE processes are adequately performed. Unskilled IT staff will not be able to manage and control IT systems, and even perfect systems are unable to support effective collaborative decision-making. Quality training must be continuous to meet changes in DIQ

tool/software technology in the environment in which HE institutions operate (central and remote campuses).

The training structure should include a collaborative work mechanism and, most importantly, IT people. Quality training can be considered part of a cycle of HE improvement.

## 2 Teamwork and communication

Data collection requires that everyone in a university work as a team. The collaboration must apply within and between schools, departments, and study programs. Frequently, IT people in different divisions within a campus lack communication ability to work as a squad team rather than only within their specific part. Moreover, communication is also a problem among IT staff, such as analysts, designers, and developers.

One of the Delphi study panellists said the following:

“IT designers often criticize the incomplete or inaccurate data in students’ records and are unable to gain support from the administrative staff. This poor teamwork and communication have the possibility of causing DIQ problems.”

## 3 Data stewardship

Placing DIQ personnel in charge of the management of DIQ issues would improve decision-making regarding DIQ in HE institutions. The IT manager on the panel was concerned that the lack of a data steward had resulted in nobody caring about data in one particular institution. One of the Delphi study panellists noted the following:

“Nobody cares about data. Well, even with data cleansing, they [system people] were not sure who should do it.”

Similarly, another panellist commented as follows:

“Sometimes, data users in the campus perceived that having a DIQ manager would make a positive transformation in data quality. It was believed that the lack of a data quality manager’s oversight to accomplish DIQ-related problems might impact DIQ.”

## 4 Disconnect among data stakeholders

The Delphi findings also suggested that while HE institutions have concerns about the quality of their education and academic data, there is a disconnect between high-level data owners and operational-level data producers and custodians. The majority of HE institutions still employ a reactive approach to DIQ management and do not treat DIQ problems with high priority. They have no plans to implement any DIQ management solutions. This research finding indicated that improving system capability, together with data coordination across schools, departments, and study programs, strongly influences DIQ.

## 5 Performance evaluation and motivation

Data collection can have an important impact on DIQ. The right attitude towards data collection can make a great difference in the outcome of data collection. The right data collection mindset requires motivation. Some of the Delphi panel members mentioned the following:

“It was believed that including the DIQ requirements as part of the job descriptions might help IT staff in HE institutions establish the right attitude towards data collection.”

### *4.3 Identifying and correcting DIQ problems*

In response to the question, ‘How can you identify and correct the DIQ problems you have identified?’, the experts answered as follows.

#### *4.3.1 Identify the most common issues regarding data and information*

Data are centralised, and inefficient processes of manual data input are time consuming and error prone. The specific job description for data management is not well defined, and there is a deficiency of communication between schools, departments and study programs. These problems contribute to inaccurate data and an inability to accurately control data and quality information.

#### *4.3.2 Know that HE institution have similar DIQ issues*

HE data and information are characteristically identified as incomplete, out-of-date and siloed. There is a lack of possession of and accountability for data and information at the study program level. Consequently, there is operational inefficiency, including a failure to recognise and improve the student experience and an inability to detect at-risk students and offer appropriate support.

#### *4.3.3 Identify the root problems*

Strategic DIQ policies initiate collaboration among data creators and end-users to determine the root causes of DIQ problems. These problems can be corrected if the data are created by IT staff rather than assigned to IT staff to fix the corrupt data.

#### *4.3.4 Improve the quality of new data*

HE institutions should focus on improving the quality of new data instead of working to clean up existing bad data. DIQ problems should not be abandoned to IT authorisers. Data should be the responsibility of the data creator, who benefits the most from having access to good DIQ.

#### *4.3.5 Aggregate all the data and information into an integrated HE IS*

This can be done by integrating and validating data sources using a sophisticated matching algorithm technique to eliminate duplicate records. Finally, all data and information can be accessed through a simple, direct line or retrieved from the cloud whenever needed.

## 5 Future research

The remaining two stages (the national survey and the national case study) will be conducted within the next two years. This study is expected to provide a comprehensive understanding of the framework and methodology of DIQ. As a result, HE institutions will be able to obtain valid and reliable data and information through the formulation of data management policies and procedures, clarity of ownership, adequate data cleansing and excellent planning approaches.

## 6 Conclusions

Adhering to the values of good DIQ allows for real-time decision-making, controls risk and resource allocation strategies and increases the popularity of HE institutions. DIQ are the obligation of all IT staff entering, extracting, or analysing data – from the bottom level (study program) to the university’s knowledge management ISs. All IT staff relies on universities’ DIQ rules and should be aware that the data they input, use and manage contribute to legal proceedings, financial controls, performance indicators, and university reputation. Quality data and information underpin the development of data-driven decision-making. When collected data are not accessible, accurate, up-to-date, credible, coherent and relevant to HE institution perspectives, they will not be appropriate references in the decision-making process.

In data-driven decision-making, data and relevant supporting information are used to make decisions related to academic and non-academic planning and process and implementation strategies at the school, department, study program, classroom, and individual student levels within universities. It is critical to understand the value of DQ tools since they are fundamental in evaluating DIQ programs. DIQ tools support various configurations that might predict outcomes in student achievement and identify university lecturers and/or programs that need improvement.

By improving the DIQ framework in the HE industry, it is possible to improve learning settings in real-time and offer accurate data and information to improve student success, both during university education and after graduation. Improving the quality of all DIQ dimensions results in a much higher quality guarantee and create good HE management at all levels (schools/faculties, departments, and study programs).

## Acknowledgements

The authors would like to thank all panels Delphi Study for their great contribution to this research. This research was fully supported by Kementerian Riset, Teknologi dan Pendidikan Tinggi (RISTEKDIKTI) Republik Indonesia (grant number 146/N36.9/PL/2019). The grant support of RISTEKDIKTI of the years 2019 to 2021 is gratefully acknowledged.



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