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KMS MR FRAMEWORK SOLUTION TO OVERCOME INFORMATION OVERLOAD: A CASE STUDY

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Abstract. *Information Overload in the digital era occurs in various systems as well as in the Knowledge Management System (KMS). In the context of Information Overload, an additional load of information does not always increase benefits to users. In the previous study, a KMS MR framework was designed to address Information Overload. Following that, this research follows through earlier research by experimenting with a case study. The case study involved students working on quizzes that were allowed to open the Internet, open books, and KMS applications with a 30-minute time limit. In this baseline, the research question ushers on the impact of the implementation of the KMS MR framework in the case study and whether to improve the information quality perceived by students. The research method is based on experimental, questionnaires and statistics for processing data and decision making. In addition, this study intends to evince the reliability of the KMS MR framework in overcoming the Information Overload issue. At the end of the study, the results indicated the gap of 1.50 points as the differences in the value of information quality between the two groups of KMS MR and KMS. Per this outcome, the KMS MR framework is capable of improving the information quality and shifting the culmination point of Information Overload.*
Keywords: Knowledge Management System (KMS), Information Overload (IO), MapReduce, KMS MR, Case study

1. **Introduction.** Recently, various studies related to the Information Overload (IO) continue to evolve [1-3] due to the technology, socio-cultural, and current digitalization [4-6]. The discussion related to this topic provides a lot of opportunities since IO science was introduced by Jacoby et al. in 1974 [7]. The IO represents a condition where users receive information that greatly exceeds their capacity to process it [1,8]. In this case, adding information no longer provides superior information for users after reaching a certain point. Figure 1 [1,9] visualizes the condition graphically as an inverted U curve.

Figure 1 illustrates an IO in general where the addition of information load (horizontal axis) will have a positive impact on the information advantage (vertical axis). At a closer look, the addition of information no longer has a positive impact and even decreases [1,10]. In this respect, the Information Overload is visualized by the shaded area that emphasizes the saturation of information. On the vertical axis, the information advantage represents the benefits received from information usages, such as decision accuracy [1], productivity [9], performance [11], and decision effectiveness [12].

Arguably, IO condition occurs in myriad systems, including Knowledge Management System (KMS) [13] and numerous fields, such as government, office, education, military,

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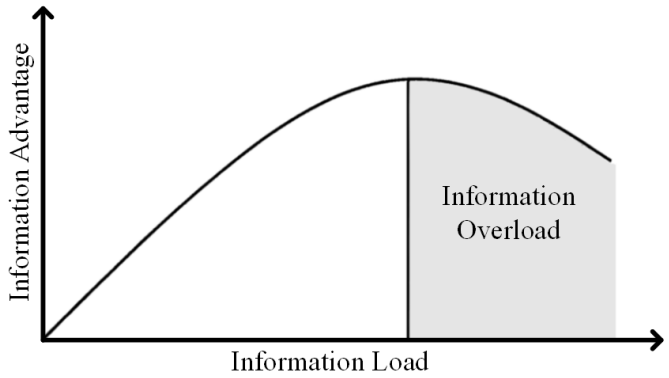

FIGURE 1. Information Overload curve (Source: Eppler and Mengis [1])

health, public organizations, and arts [14]. Therefore, it requires a general method to cope with this context. In the previous study, a KMS MR framework has been produced to overcome IO problems. The research question for this study is how to prove the KMS MR framework that is capable of solving the IO problem in a case study.

The significance of this study emphasizes on proving that the KMS MR framework can solve IO problems in a case study. In this case, a solution of IO problem refers to the shift of the peak point on the curve (Figure 1) to acquire a better (or equal) information advantage (vertical axis) with less amount of load information (horizontal axis). Based on several considerations, the selected case study in this study is the education area. The reasons are 1) data availability, 2) challenging cases, and 3) enabling experiment scenarios. Details of the experimental plot will be explained in the subsequent part.

In a previous work, researchers Grudzień and Hamrol from Poland conducted a study of measuring the information quality in the Quality Management System [15]. In this study, it was found that there was a relationship between information attributes and process characters. In addition, the researchers also used information quality measurements using vector formula from the function of seven attributes [15].

2. **Methodology.** The research method is a procedure for how research is conducted [16]. This study applied a combination of experimental and quantitative methods to answering the research questions. The experimental method is performed by trying out the KMS MR framework in a case study to prove whether it can solve the Information Overload problem. With this viewpoint, the data were collected from the respondents by questionnaires. Finally, the researcher processed the data with statistics to conclude.

This succeeding study continues the previous research that emphasizes on the Information Overload area. Through that research, authors produced a KMS framework with the MapReduce algorithm approach called the KMS MR framework. In the previous study, the KMS MR framework was complete and prepared to be implemented in a case study. Therefore, this experimental study served as the implementation of former research. The case study in this research is conducted in the education platform at Bina Nusantara University, Jakarta, Indonesia. The sample of data is taken in the even semester 2017/2018 academic period with the subject being COMP6100-Software Engineering. The number of the classes involved ten classes and five lecturers in regular classes with one additional lecturer in a big class. Each lecturer teaches at two regular classes, except the big class lecturer. The number of students from these classes is 237 students. Each lecturer teaches on the 3rd shift (11:20-13:00) and 4th shift (13:20-15:00). The total number of students for the 3rd shift is 126 students, while the total number of students for the 4th shift is 111 students. The group of student at the 3rd shift worked on a quiz with KMS assistance while the other at the 4th shift worked on a quiz with the assistance of KMS

TABLE 1. Experimental data: lecturer, shift, number of students and their distribution

No.	Lecturer	Shift	Number of Students	Shift 3 (KMS)	Shift 4 (KMS MR)
1	L1	3. 11:20-13:00	24	24	
2	L1	4. 13:20-15:00	12		12
3	L2	3. 11:20-13:00	24	24	
4	L2	4. 13:20-15:00	26		26
5	L3	3. 11:20-13:00	27	27	
6	L3	4. 13:20-15:00	24		24
7	L4	3. 11:20-13:00	26	26	
8	L4	4. 13:20-15:00	23		23
9	L5	3. 11:20-13:00	25	25	
10	L5	4. 13:20-15:00	26		26
Total			**237**	**126**	**111**

MR. Furthermore, these groups are called KMS and KMS MR. Data of lecturers, shift, number of students and their distribution can be seen in Table 1.

In this point of entry, each group completed a quiz with the characteristics of an open book, Internet, and access to KMS application. The duration of the quiz lasted for 30 minutes with the same type of questions, i.e., multiple choice (two questions), essay (two questions) and one case. In this token, students were distributed questionnaires to receive feedback after working on the quiz. Measurement of Information Quality (IQ) in this case uses five parameters, i.e., P1: Number of documents accessed, P2: Number of supporting documents, P3: KMS accelerated problem-solving, P4: KMS benefited for problem-solving, and P5: Students' score. The questionnaire functions to obtain IQ scores from P1 to P4, while P5 refers to the quiz score [17-20].

Before testing, these both groups tested their normality of data based on the Liliefors method. The parameters used in this measurement are the students' GPA scores. The purpose of measuring the normality is to ensure that these two groups are equivalent. The result of this test signifies that both groups are normally distributed (H0 is accepted). On that basis, the homogeneity test was performed on both data. The result of the test concludes that both the KMS and KMS MR groups data are homogeneous. Based on the testing of normality and homogeneity, the data is valid for further experiment. Taking the cues from this, the next steps of this experiment are initialization, conduct the quiz, data collection, data processing, and create a conclusion.

3. **Experimental Result.** It is important to ensure the respondents' experimental data is valid before the initialization process. First, socialization was conducted to all lecturers who involved in this experiment. Each lecturer prepared resources and questions for the quiz. This primary resources (37 documents) are marked with hashtag #SE1ione as the KMS resources. The quiz maker (L6) discussed with other lecturers to make two sets of the quiz with the same level of difficulty.

Subsequently, the Map and Reduce processed initial resources and the quiz (as moderating resources) to produce new resources (21 documents). In the process, these resources are marked with hashtag #SE2iwed as the KMS MR resources. In this point of entry, all resources were inserted into the KMS application with each hashtag so that the students performed the quiz. In this setting, each group of students worked on each open book quiz, Internet access, and KMS application access with their respective hashtag (#SE1ione for group KMS and #SE2iwed for group KMS MR). The hashtags are created randomly. Figure 2 depicted the detail of the implementation of this framework.

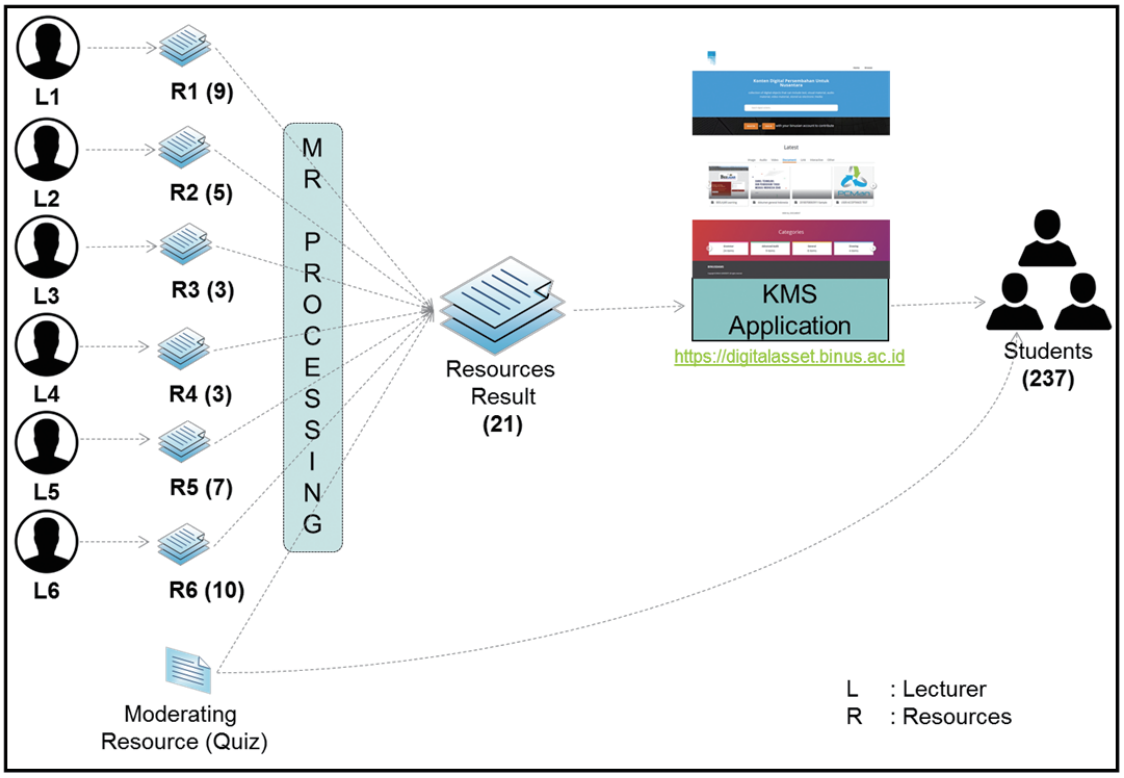

FIGURE 2. KMS MR framework implementation in case study

All resources of KMS and KMS MR are grouped into three groups, i.e., MM = Main Material, TB = Text Book, and EM = Enrichment Material. Main Material (MM) Group consists of presentation slide materials as the teaching aid for lecturers in the classroom. Text Book (TB) Group represents a soft copy of the textbook in the course of COMP6100-Software Engineering. The textbooks used entitled "A Practitioners Approach 8th edition Pressman" and "Software Engineering 9th edition Sommerville". The last group (EM) encompasses additional material from lecturers. Each resource group has its functions and roles during lectures and in this quiz case.

At the beginning of the MapReduce Process, thirty-seven primary resources retrieved the score of the Knowledge Area (KA) for each document. Knowledge Area is a collection of main topics at this course. In total, nine knowledge areas are coded as KA1 to KA9. In the process, all KA are collected and grouped in the Map process. In the next process, all mapped resources become the input in the Reduce process to obtain the KA distribution for each document. In this respect, the lecturers decided resources to select as KMS MR resources based on the results and the quiz document. The number of selected documents is twenty-one new sources. Figure 3 illustrates the MapReduce process.

After students completed the quiz in thirty minutes, the students were asked for feedback by filling out the questionnaire. The data collected from the questionnaire was processed and analyzed with a quantitative statistical approach to obtain the average value of each parameter. The questionnaire is used as a measurement tool to measure the parameters P1 to P4, whereas the value of P5 is obtained from the students' score. The values P1 to P5 are used to measure Information Quality with the summation of the average formula for all parameters.

The results of the average score measurement for the five parameters between the KMS group and the KMS MR group showed that the average value of the KMS MR group is greater than the KMS. The first parameter (P1) of the KMS group scores 2.96, while the KMS MR group equals 3.47. The second parameter (P2) of KMS group scores 2.27, while the KMS MR group is 2.51. The third parameter (P3) of the KMS group points 3.67,

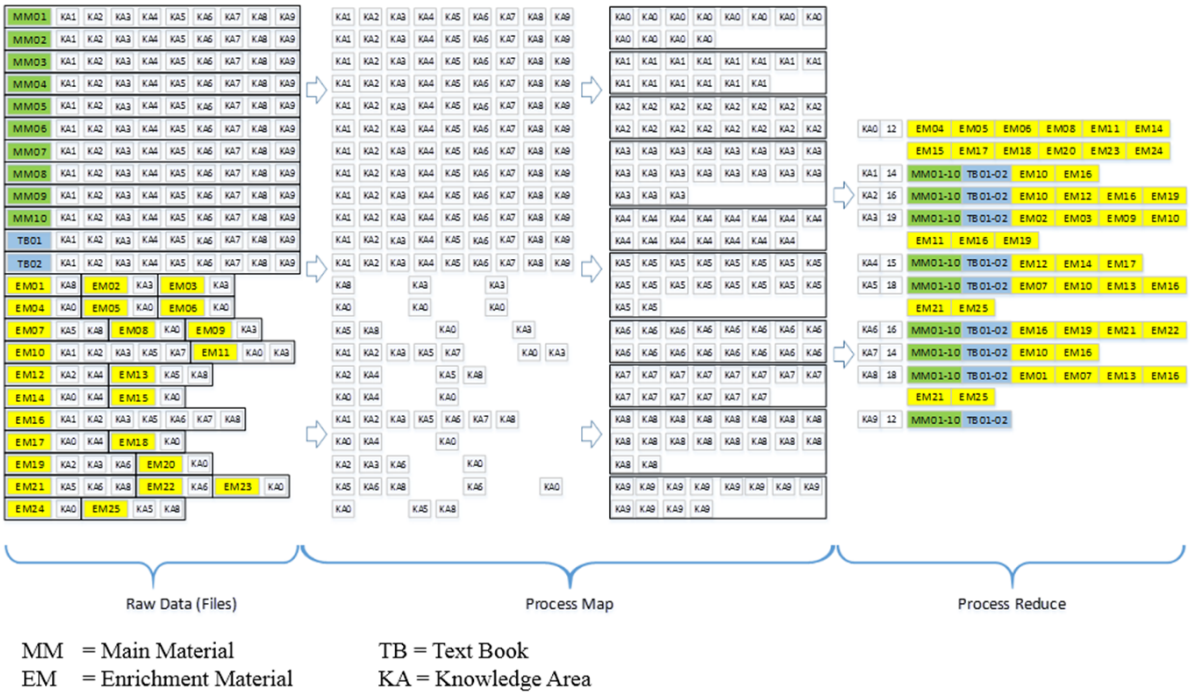

FIGURE 3. MapReduce process on KMS resources becomeing KMS MR resources

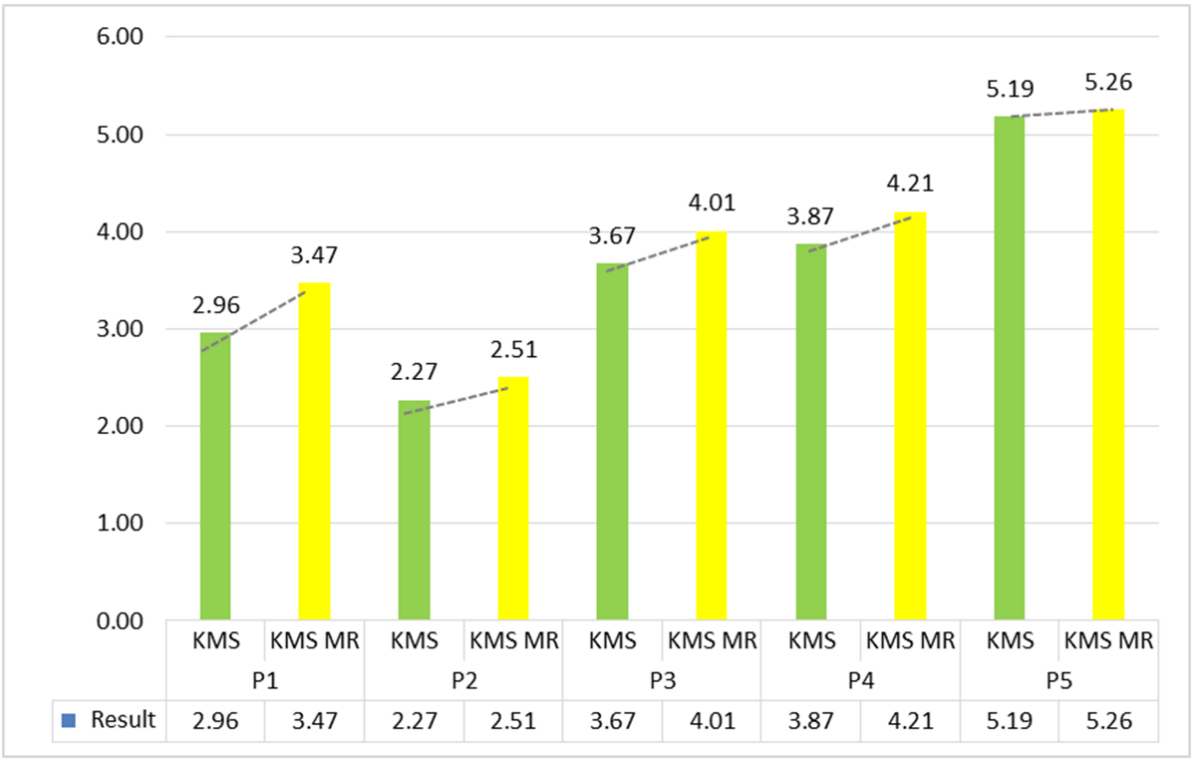

FIGURE 4. Measurement result of 5 parameters between KMS and KMS MR

while the KMS MR group equals 4.01. The fourth parameter (P4) of the KMS group indicates 3.87, while the KMS MR group is 4.21. The fifth parameter (P5) of KMS group scores 5.19, while the KMS MR group equals 5.26. Figure 4 described the graph of the measurement results.

In this sense, the IQ score of each KMS and KMS MR group is calculated by the average summation formula of each parameter. IQ calculations are obtained from the cumulative

$$\mathrm{IQ}_{\mathrm{KMS\ MR}} = \sum_{i=1}^{5} \left(\frac{1}{k} \sum_{j=1}^{k} \left((\overline{x}_{\mathrm{KMS\ MR}})_i \right)_j \right)_i$$

$$\mathrm{IQ}_{\mathrm{KMS}} = \sum_{i=1}^{5} \left(\frac{1}{k} \sum_{j=1}^{k} \left((\overline{x}_{\mathrm{KMS}})_i \right)_j \right)_i$$

$$\delta\mathrm{IQ} = \mathrm{IQ}_{\mathrm{KMS\ MR}} - \mathrm{IQ}_{\mathrm{KMS}}$$

Lable:
IQ = Information Quality
δIQ = Delta (difference) IQ
$\overline{x}_{\mathrm{KMS}}$ = Mean Parameter KMS
$\overline{x}_{\mathrm{KMS\ MR}}$ = Mean Parameter KMS MR
i = index of parameter
j = index of class
k = number of classes

FIGURE 5. IQ mathematic and delta IQ formula (Source: authors' work)

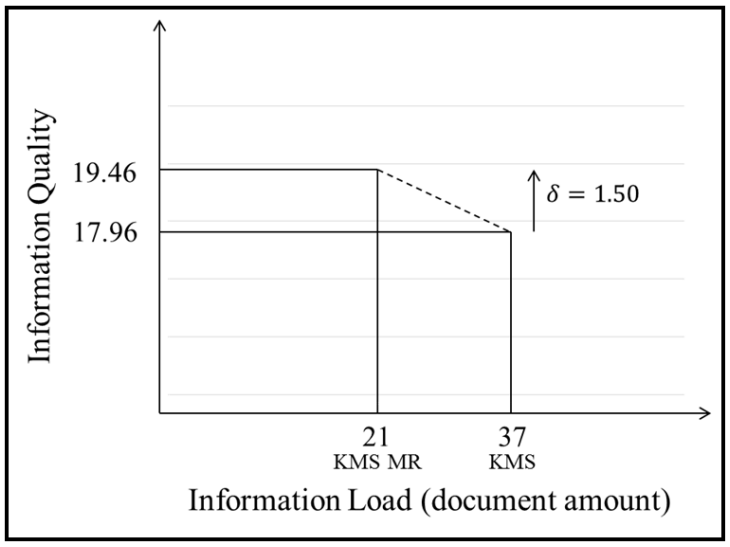

FIGURE 6. Delta IQ result on the KMS MR framework experiment

of all classes and parameters. It highlights that delta IQ is the reduction of IQ KMS MR and IQ KMS. Figure 5 exhibits the formulations mathematically.

Based on the formula, the calculation of $\mathrm{IQ}_{\mathrm{KMS}}$, $\mathrm{IQ}_{\mathrm{KMS\ MR}}$ and delta IQ is as follows:

$$\mathrm{IQ}_{\mathrm{KMS}} = \sum_{i=1}^{5} \left(\frac{1}{k} \sum_{j=1}^{k} \left((\overline{x}_{\mathrm{KMS}})_i \right)_j \right)_i = 2.96 + 2.27 + 3.67 + 3.87 + 5.19 = 17.96$$

The $\mathrm{IQ}_{\mathrm{KMS}}$ score is the sum of mean for each parameter, i.e., $\overline{x}_{\mathrm{PKMS1}} + \overline{x}_{\mathrm{PKMS2}} + \overline{x}_{\mathrm{PKMS3}} + \overline{x}_{\mathrm{PKMS4}} + \overline{x}_{\mathrm{PKMS5}}$. Each parameter value is the summation of: $2.96 + 2.27 + 3.67 + 3.87 + 5.19$. The total of $\mathrm{IQ}_{\mathrm{KMS}}$ score is 17.96 point.

$$\mathrm{IQ}_{\mathrm{KMS\ MR}} = \sum_{i=1}^{5} \left(\frac{1}{k} \sum_{j=1}^{k} \left((\overline{x}_{\mathrm{KMS\ MR}})_i \right)_j \right)_i = 3.47 + 2.51 + 4.01 + 4.21 + 5.26 = 19.46$$

The $\mathrm{IQ}_{\mathrm{KMS\ MR}}$ score is the sum of the mean for each parameter, i.e., $\overline{x}_{\mathrm{PKMS\ MR1}} + \overline{x}_{\mathrm{PKMS\ MR2}} + \overline{x}_{\mathrm{PKMS\ MR3}} + \overline{x}_{\mathrm{PKMS\ MR4}} + \overline{x}_{\mathrm{PKMS\ MR5}}$. Each parameter value is the summation of: $3.47 + 2.51 + 4.01 + 4.21 + 5.26$. The total of $\mathrm{IQ}_{\mathrm{KMS\ MR}}$ score is 19.46 point.

$$\delta\mathrm{IQ} = \mathrm{IQ}_{\mathrm{KMS\ MR}} - \mathrm{IQ}_{\mathrm{KMS}} = 19.46 - 17.96 = 1.50$$

It confirmed that delta IQ value is the result of the difference between $\mathrm{IQ}_{\mathrm{KMS\ MR}}$ and $\mathrm{IQ}_{\mathrm{KMS}}$ with a score of $19.46 - 17.96$. The delta of IQ scores 1.50 point. Figure 6 represents the delta IQ result.

4. **Conclusions.** In consonance with the preliminary research, this study produces the implementable KMS MR framework in a case study. From this angle, the KMS MR framework is a framework to support the Knowledge Management Systems (KMS) process based on the MapReduce algorithm approach to overcome Information Overload (IO) problems. In this framework, there is a process of preparing resources for a specific purpose. This framework also features a KMS application model consisting of the presentation layer, function layer, and database & repository layers.

In this corridor, the KMS MR framework experiments in a case study of the education area at Bina Nusantara University, Jakarta, Indonesia. The result reflects that the framework obtained better Information Quality (IQ) score than regular KMS. The KMS group obtained a 17.96 IQ point, and the KMS MR group scored a 19.46 IQ point. The difference between these frameworks underscored that KMS MR provides a better information quality with 1.50 point.

To support the study, the testimonials from students as the respondents in the quiz experiment with the KMS MR application are as follows:

"With this KMS MR, students are easier to learn and also very helpful in the quiz because this KMS MR could present the right information according to the needs of students during the quiz."

Mr. Calvin Fernando, student.

"By using this KMS MR, I feel that my quiz score is better."

Ms. Agnes Pricilia, student.

In general, all students who receive assistance from this KMS MR perceive positive benefits in doing the quiz. In this direction, the KMS MR framework can be experimented in another field of studies and other case studies to complement this research and for further work enhancement.

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