TELKOMNIKA, Vol.16, No.4, August 2018, pp. 1449~1456
ISSN: 1693-6930, accredited First Grade by Kemenristekdikti, Decree No: 21/E/KPT/2018
DOI: 10.12928/TELKOMNIKA.v16i4.10491

Evaluation of Research Standards at Ministry of Research, Technology and Higher Education with I-MR Map Control Analysis

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Abstract

In order to accommodate research activities at all universities in Indonesia, the Directorate Genereal of Strengthening for Research and Development, Ministry of Research, Technology, and Higher Education (Kemenristekdikti) of the Republic of Indonesia established research quality standard. The standard includes the minimum targets that must be achieved by each University at the period of conducting the research activity. However, until now there has been no measurement to find out whether the existing standard was good enough or needs to be evaluated. Therefore, this study was conducted to measure the standards. The method used was the analysis of I-MR (Individual and Moving Range) control chart to see the performance of the standard. The results show that existing research schemes have encouraged the improvement of international publications, but have not yet maximized the production of other outputs such as textbooks, accredited national publications, intellectual property rights, and ptototypes. The result of the research was expected to be used as material for evaluation and improvement of policy to improve the quality of research standard in Kemenristekdikti.

Keywords*: Quality of research standard, individual moving range; improvement of policy*

1. Introduction

Higher Education is obliged to organize education, research, and community service [1]. Research in Higher Education is directed to develop science and technology, as well as improve the welfare of society and nation competitiveness. The results of research should have benefits for science and technology enrichment and learning; the improvement of the quality of higher education and the progress of the nation's civilization; increasing the independence, progress, and competitiveness of the nation; fulfillment of strategic needs of national development; and community change into a knowledge-based society [2]. In order to guarantee the quality of higher education, national standards of higher education are stipulated. One of such standards is the national standard of research. The national standard of research is used to measure the quality of research activities. The standard is also used as a minimum performance measure for research activities undertaken by Universities in Indonesia. In other words, there is a regulation of minimum results to be achieved for each research activity.

Many aspects of the standard of research results that must be applied to all research activities in Indonesia, especially in Higher Education. To find out whether the implementation of the standard is good or not, the evaluation needs to be conducted. Evaluation activities are done by studying directly about what is actually happening at the practical level. Evaluation of research activity is conducted by using criteria specified in Ministry Regulation of Research, Technology, and Higher Education (Permenristekdikti) 44/2015 on National Standard of Higher Education [3], which consists of 7 (seven) criteria that is result standard, content standard, process standard, assessment standard, researcher standard, facilities and infrastructure standard, management standards, and standard of funding and research financing.

According to Permenristekdikti 44/2015, the standard of research results is a minimum criteria about the quality of research results. The results of research at universities are directed in order to develop science and technology, as well as improve the welfare of society and the

Received April 8, 2018; Revised May 21, 2018; Accepted June 6, 2018

competitiveness of the nation. The results of the research shall be all outputs generated through activities that fulfill the rules and scientific method systematically according to academic autonomy and academic culture. While the standard of research content is a minimum criteria about the depth and breadth of research material. The depth and breadth of the research material includes material on basic research and applied research. Standard research process is a minimum criteria of research activities consisting of planning, implementation, and reporting. The standard of assessment of the research is a minimum criterion of assessment of the process and research results.

The researcher standard is the minimum criterion of the researcher's ability to carry out the research. Researchers must have the ability mastery level research methodology in accordance with the field of science, research objects, as well as the level of complexity and level of depth of research. The standard of research facilities and infrastructure is a minimum criterion of facilities and infrastructure needed to support the needs of content and research process in order to meet the research results. The research management standard is the minimum criteria of planning, implementation, controlling, monitoring and evaluation, and reporting of research activities. Funding standards and research financing are the minimum source criteria and funding mechanisms and research financing. Colleges are required to provide internal research funding. Aside from the internal research budget of universities, research funding can be sourced from the government, cooperation with other institutions inside and outside the country, or funds from the community.

In this study, it is used quality control analysis that is using I-MR (Individual Moving Range) control chart. The analysis is very common to know the quality of a process. Rahardja examines the development of the I-MR control chart. He compared the combination of I-MR and Individual Chart. The results show that I-MR can be used to measure quality control [4]. Khaliq also discussed the comparison of I-MR and Tukey control charts. The study was conducted using data simulation. The results also show that I-MR can be used as an instrument for quality measurement [5]. Dumicic and Zmuk use the I-MR control chart to examine the quality of stock trading in Croatia. The results show similarities with both previous studies [6]. The similarity of those three studies is the using the I-MR control chart. Therefore, the selection of the I-MR control chart as a quality control analysis tool is fairly reasonable. The results of this study is expected to be one of the considerations to evaluate and as an input of the improvement of Kemenristekdikti policy, especially related to the quality of research activities.

2. Method

Evaluation of research activities conducted using seven criteria in Permenristekdikti 44/2015 mentioned above. It is assumed that all of the seven criteria are already reflected in the research scheme managed in the Information Systems of Research and Community Service (*Simlitabmas*). The analysis of research activities is based on research data obtained from Simlitabmas data of 2017. I-MR is used as a method to analyze the data.

Simlitabmas is an application instrument for research management in the Directorate General of Strengthening for Research and Development to facilitate the implementation of research and community service for Universities and also some Research Institutes in Indonesia. The process of registration research, screening and assessment of proposals by reviewers, monitoring of research implementation, and research reporting are administered through the system. In the year of 2017 there were 15.124 research proposals are funded through Simlitabmas.

2.1. SPC (Statistical Process Control) for the Research

To analyze the ability of a process, keep in mind how a process is running. There is a statistical method that can be used to determine whether a process is controlled or not. The method is statistical process control (SPC) or better known as the control chart. Six sigma qualities in the research activity are measured according to predetermined standards. Some steps that must be taken to determine the appropriate control chart are as in [7].

Based on Figure 1, the researcher will be able to determine the method to analyze the research performance data. Since the dat used in the study is scale, with each group being a single observation, the method used is the I-MR or X-MR charts (Individual measure and moving range). The indicator of the success of research activities in the Ministry of Research,

Technology, and Higher Education can be seen whether there are observations that come out of control limits or not.

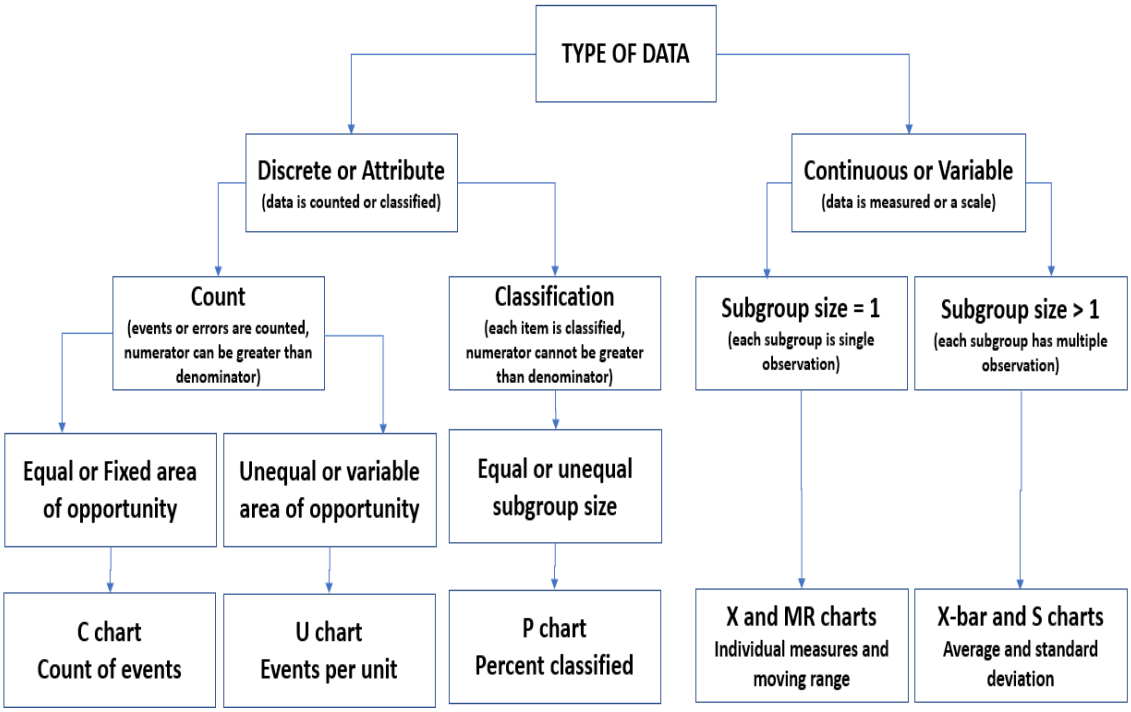

Figure 1. Selection of control charts by data type [8]

2.2. Individual Control Map and Moving Range (I-MR)

Individuals and moving range (I-MR) control chart is used if the number of sub-groups is 1 (one). Map control is widely used in the field of industry or business to control the existing process. This time I-MR will be applied to evaluate the quality of research activities undertaken by the Directorate General of Research and Development, Ministry of Research, Technology, and Higher Education, Republic of Indonesia. The I-MR control chart is a combination of control chart I (Individual) containing the observation score, and the MR (Moving Range) control chart contains the data distribution. The illustration of the control chart is as shown in Figure 2. Figure 2 shows the quality of a process measured over a period of time. There are three main components in the I-MR control chart, namely:

a. Upper Control Limit (UCL) or Upper Control Limit is the maximum data distribution allowed,
b. The middle line (Average) denotes the middle value of the observation, and
c. Lower Control Limit (LCL) or Lower Control Limit is the minimum allowed data distribution.

Moving Range value in individual control chart is the distance between one observation with other observation, that is:

$$R = \mathrm{X}_{\max} - \mathrm{X}_{\min} \quad (1)$$

$$\bar{R} = \frac{\sum_{i=2}^{n} R_i}{n-1} \quad (2)$$

where: $\mathrm{X}_{\max}$=Maximum value between the i data; i=2,3,4, ..., n
$\mathrm{X}_{\min}$=Minimum value between the i data; i=2,3,4, ..., n
$\bar{R}$=Average range
n=the number of observations

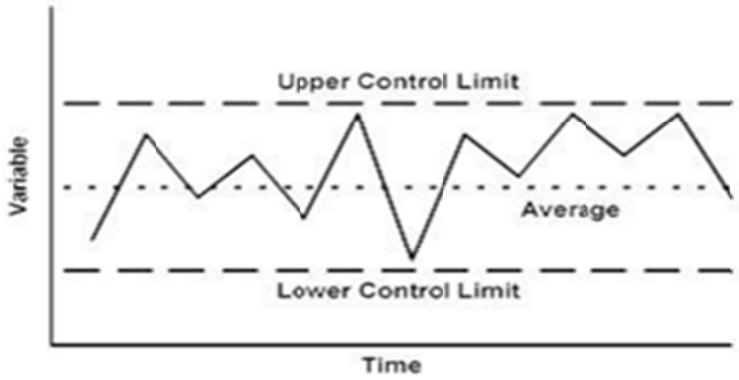

Figure 2. I-MR chart [9]

The parameters for the Moving Range control map are estimated by the following formula:

$$\text{UCL MR} = D_4 * \bar{R} \quad (3)$$

$$\text{middle line} = \bar{R}$$

$$\text{LCL MR} = D_3 * \bar{R} \quad (4)$$

where: D_3 and D_4 are obtained from the table. Many conditions require the use of sample sizes equal to one, such as checking the quality of each research unit. In that case, individual control charts will be very useful. The formula for constructing individual control charts is as follows:

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n} \quad (5)$$

where: x=frequency of number of studies per scheme
$\bar{x}$=average frequency of number of studies per scheme
The individual moving range control chart parameters are as follows:

$$\text{UCL} = \bar{\text{x}} + 3\sigma = \bar{\text{x}} + 3\frac{\bar{\text{R}}}{\text{d}_2} \quad (6)$$

$$\text{middle line} = \bar{\text{x}}$$

$$\text{LCL} = \bar{\text{x}} - 3\sigma = \bar{\text{x}} - \frac{\bar{\text{R}}}{\text{d}_2} \quad (7)$$

where: d_2=Constant values obtained from the table

3. Results and Discussions

Quality measurements with I-MR control charts are based on the quantity of research schemes funded by Directorate General of Strengthening for Research and Development, Kemenristekdikti. There are 11 (eleven) research schemes provided in the information system of research management and community service (Simlitabmas), namely Foreign Cooperation Research (FCR), Competency Based Research (CBR), National Strategic Research (NSR), National Strategic Excellence Research (NSER), Beginner Research (BR), Inter-University Cooperation Research (PIUCR), Post-graduate Research Team (PGRT), Doctoral Dissertation Research (DDR), Post-Doctoral Research (PDR), Primary Research of Higher Education (PRHE), and Excellent Applied Research for Higher Education (EARHE) [10]. Each research scheme has a minimum standard of achievement that must be met. Descriptive statistics for the FCR research scheme are listed in Figure 3.

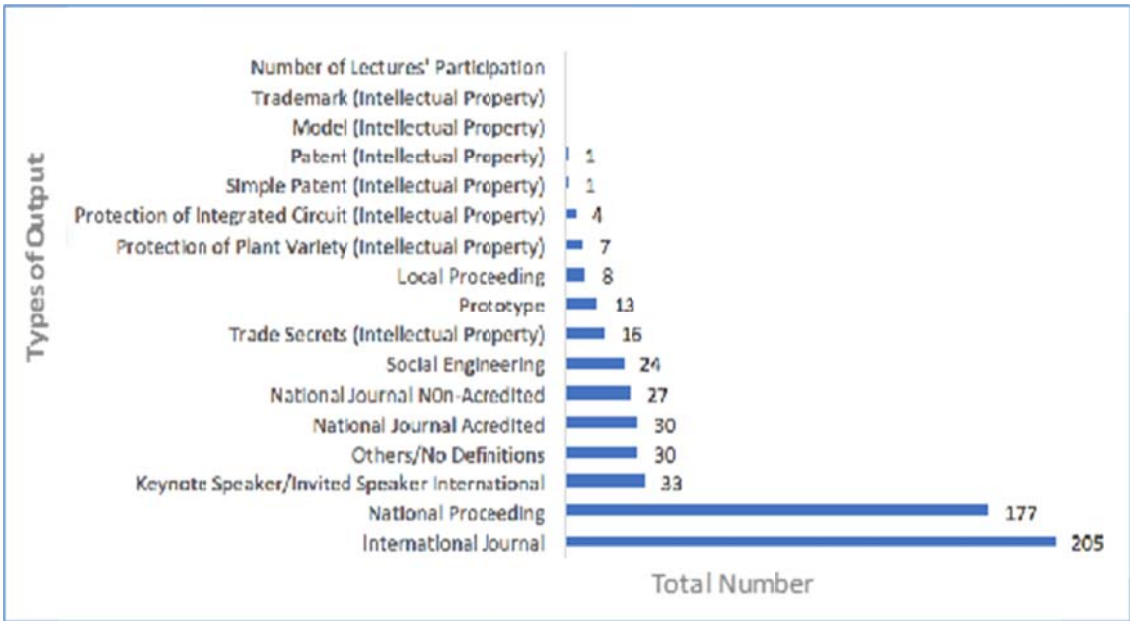

Figure 3. Descriptive statistics research scheme FCR

The output that must be achieved in this research scheme is publication in international journals. So it can be said that this research scheme already has good quality. The I-MR control chart will then be developed for the research scheme [11]. Based on Figure 4 it shows that there are some results that exceed the Upper Control Limit (UCL).

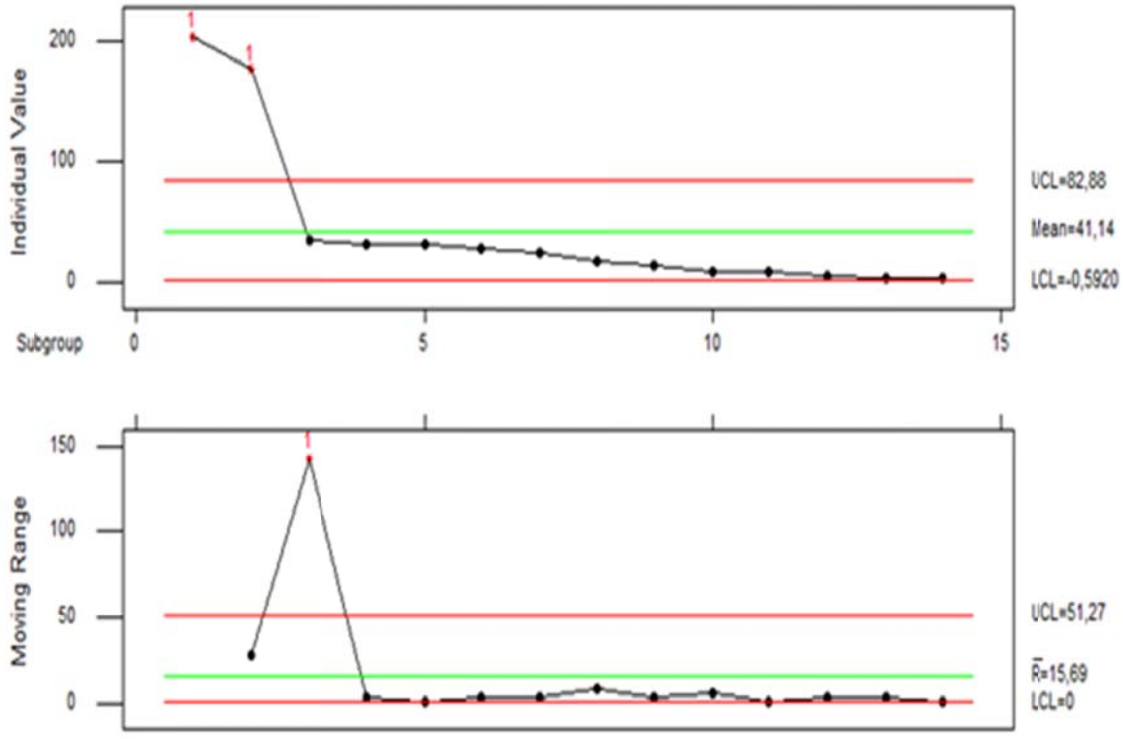

Figure 4. Map of I-MR control for FCR

That's because the research scheme requires the researchers have to publish in international journals. So the number of recipients of research schemes that publish the results of his research in international journals quite a lot. The I-MR control chart for each research scheme is shown in Figure 5.

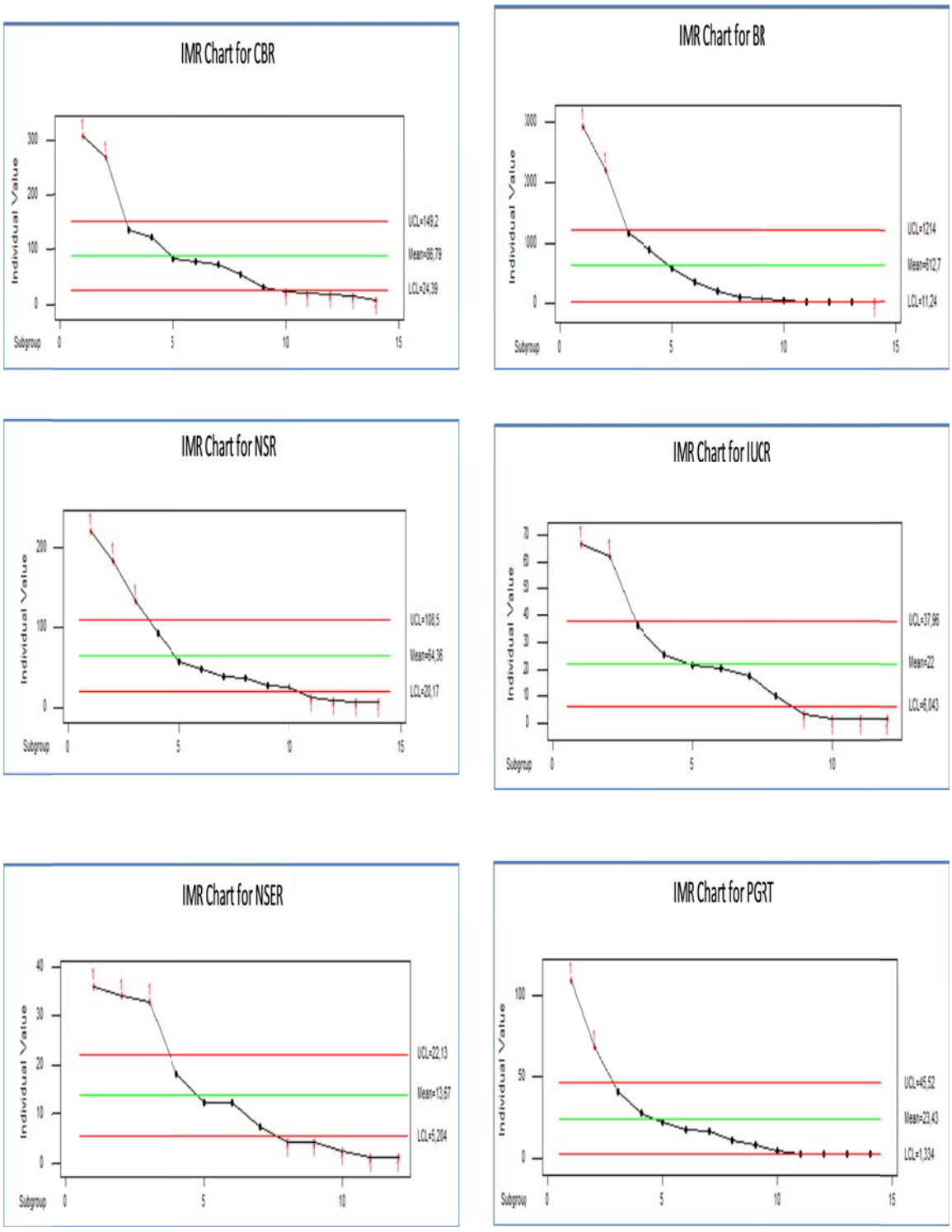

Figure 5. I-MR Control Chart for CBR, NSR, NSER, BR, IUCR, PGRT

I-MR Control Chart for DDR, PDR, PRHE, EARHE as shown in Figure 6. Now, attention will be focused on observations that go beyond the Lower Control Limit (LCL). There are several research schemes that have such observations that are scheme CBR, NSR, NSER, IUCR, PRHE, and EARHE. The observations state the number of unpublished research results in international journals, but they are expressing in other forms. Based on this, it can be seen that there is a big difference between the published results in the form of international journals and which are expressed in other forms. It can have a positive effect, as well as a negative effect.

The negative effect is, if the results of the study should be published in international journals, it will make researchers reluctant to publish the results of his research in other forms, such as textbooks, teaching-books, accredited national journals, prototypes, intellectual property rights, and others. With reluctance to express the results of research in other forms, because of the encouragement of international publications is so strong it will create teaching support instruments, such as textbooks, teaching-books, as well as national publications, and prototypes will be reduced.

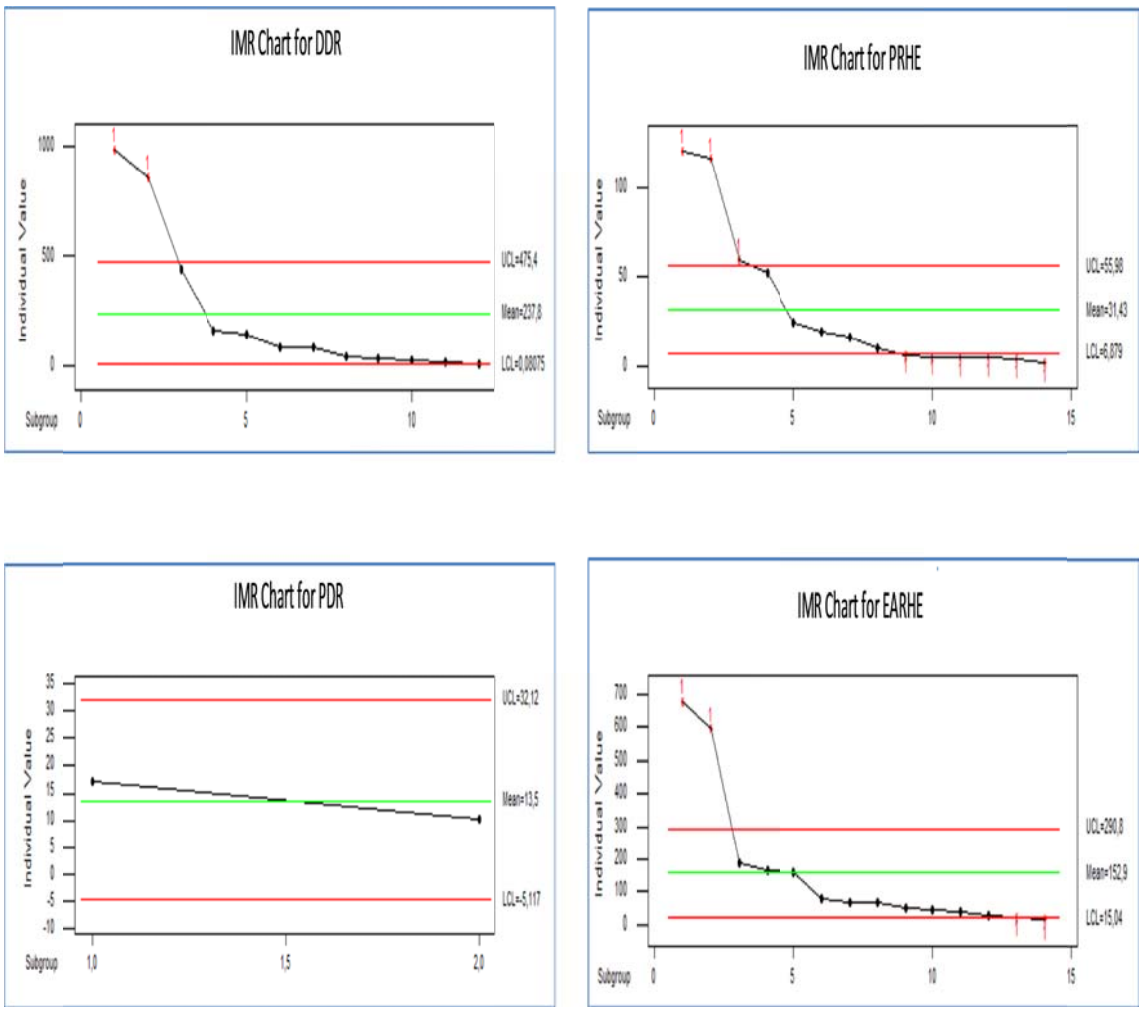

Figure 6. I-MR Control Chart for DDR, PDR, PRHE, EARHE

It is therefore necessary to find an alternative solution which is capable of encouraging the balance of international publications and the expression of research results in other forms. Other alternatives that need to be developed and balanced are alternative outputs on DDR, PDR, PRHE, and EARHE schemes. In order to encourage the output of accredited national journals, prototipes, and intellectual property rights, so these schemes can be added with the

previously mentioned output. This will indirectly assist the development of accredited national journals, prototipes, and intellectual property rights. Of course, the percentage of publications in international journals remains prioritized, but without excluding other output standards. With the changes and additional outputs of the scheme, it is hoped that in the future the balance of international publication forms and accredited national publications can be achieved.

4. Conclusion

Based on the results of the analysis, there are positive and negative things. The positive thing is that with the provision of criteria in the current research scheme encouraging the number of publications in international journals is very high. Yet another form of output is very low. The situation is unbalanced and lacks the optimum capability of the researcher. If the situation is continuesly like this, the researchers will be lazy to write a book and publish his work in accredited national journals as well as other forms of output, so accredited national journals and other output will not be able to grow and compete with the output of international journals. Thus improvement of research scheme, mainly output for DDR, PDR, PRHE, and EARHE schemes needs to be done, in order to encourage the optimality of the researcher's ability to produce research output. As part of the achievements of the Ministry of Research, Technology, and Higher Education are international publications, intellectual property rights, as well as prototypes, so that the additional output for this scheme with the previously mentioned output will have a positive effect on achieving the target.

Acknowledgements

We are grateful to the all related institutions, especially Ministry of Research, Technology, and Higher Education, Republic Indonesia (*Kemenristekdikti*) for funding supports and providing data. We also thanks to Muhammad Hasan Sidiq Kurniawan, Muhammad Muhajir,Wahyu Listyawan, Zaky Musyarof, Anggara Setyabawana Putra from the Department of Statistics, Faculty of Mathematics and Natural Sciences, Islamic University of Indonesia for coding and data processing support.

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