Abstract.
This study aims to measure and analyze the results of the learning process at the P faculty who graduated in 2017/2018 with a quantitative approach through Statistical Process Control. The number of samples was sixty graduates that were randomly selected (customary for cases like this). The results of research measurements show that the average value of productivity is 16.66, the range is 1.20, the standard deviation is 0.71, Defects per Million Opportunity (DPMO) is 17,240, and sigma level is 3.61. The average value control chart, DPMO, and sigma level indicate an uncontrolled state that is characterized by the presence of sample set points that come out of the upper and lower control limits, as well as the individual values that make up the sample set.

Keywords: control, measurement, learning process, productivity.

INTRODUCTION.
Education is an essential thing and inseparable from the life of a human being. Education becomes the primary means to produce quality human beings needed by every nation. The education in Indonesia is set under the constitution No. 20 of 2003 Article 13 paragraph 1, which states that the education pathway consists of formal, non-formal, and informal education. Formal education consists of three levels or stages, namely Basic Education, Secondary Education, and Higher Education.

The university as a level of education in Indonesia, also known as the organizer of Three Duties of Higher Education, has a role as a place to prepare quality resources through the learning process involving such elements as lecturers, students, officers, parents, government, infrastructures et cetera.

The number of institutions of higher education in Indonesia based on higher education statistics has increased from 2015 to 2017, followed by an increase in the number of new students registered in Indonesia from the year 2015-2017. The number of higher education institutions in Indonesia in 2015-2016 increased thirty institutions more, worth 0.93% growth. In 2016-2017 there was an addition of seventeen institutions or a 0.52% increase. As for the number of new students, the academic year of 2015-2016 saw a decrease of 21,240 students or down worth 1.46%. The declining numbers of new students took place in several types of education levels, such as high schools, colleges, and polytechnics. In contrast, the year 2016-2017 saw an increase of 34,731 students or up to 2.42% that took place at universities, institutes, and academies.

One of the provinces in Indonesia that have participated in increasing the number of institutions providing higher education and new students is South Sulawesi. The 2015-2016 academic year added two higher education institutions or 0.93% value. However, it was not
accompanied by the increase of new students. In 2016 the number of new students decreased by 6,843 students or 8.36%. Then in 2017, both institutions of higher education providers and new students alike will increase. For institutions of higher education, increased by 47 institutions or 21.56%, and new students increased by 9,874 people or 13.16%.

The increase in the number of institutions providing higher education and new students should certainly be a motivation for each of these institutions to improve the quality and performance of their education. So that parents and students can get more from the sacrifice of payment they make.

One aspect of performance measurement of organizational output is no exception for universities is productivity; simply put productivity is the ratio between output and input. Several studies related to higher education productivity have been carried out such as Hayati and Lolytasari (2017) which measures the productivity of UIN Syarif Hidayatullah Jakarta lecturers in terms of the number of lecturer publications, the level of collaboration and collaboration index in Scopus indexed journals while Walid, Sugiman, and Wiyanti (2018) measure the level of productivity of the performance of lecturers and education personnel at Semarang State University (UNNES) uses several factors such as knowledge, expertise, abilities, attitudes, and behavior. Different components of productivity measurement are also found in research conducted by Moradi-Motlagh, Jubb, and Houghton (2016) by analyzing the productivity of universities in Australia using total expenditure from universities as input for further comparison with the number of students and publications owned by the university.

Some of the previous studies described above showed that no one has conducted the productivity measurements from the old side of the student study in education and then measured using the Statistical Process Control approach. Therefore, this productivity research will be conducted on a study program at one of the universities in South Sulawesi, namely Hasanuddin University with 25 accreditation courses A, nine received B courses and six C accreditation study programs as well as one of the programs that have not been accredited (Kompas Pedia, 2016).

LITERATURE REVIEW

This study deals with several theoretical concepts such as conditional use management or business processes, especially productivity measurement, quality control, and process control.

Operations Management

Operations management can be defined as a series of activities that produce value in the form of products, both goods and services, by converting inputs into outputs (Heizer and Render, 2015).

Operations management is one area of management from the part of the organization that has the responsibility to produce goods and or services, the creation of products or services includes the transformation or conversion of inputs into outputs using one or more processes (Stevenson W.J. and Chuong S.C., 2014)

The operation function is not only related to inputs, processes, outputs but also relates to value-added, which is the core of this function itself. value-added is the difference between input costs and the value or price of output, or it can also be said as the number of benefits obtained by customers when purchasing output produced by a particular organization. For more details, here is an illustration of the relationship between involved in the operation function (Stevenson W.J. and Chuong S.C., 2014):
Operations management is not only discussed in the scope of manufacturing organizations but also in-service organizations. In service organizations, customers are the focal point of all policies and actions of a service organization. The role of operations in the triangle is the primary role. The activities carried out form the service system (procedures, equipment, and facilities) and play a role in regulating the work of the service workforce, which generally governs the majority of employees in large-scale service organizations (Jacobs and Richard B. Chase, 2015).

Productivity

In the broadest sense, Jacobs and Richard B. Chase (2015) explain that productivity is the ratio between the output produced and the input used by an organization in manufacturing its products and generally used to find out how well a country, industry or business unit. Productivity can also be seen from the relationship between the results and the time needed to complete a production process. The shorter the time needed to achieve the desired results, it can be said that the system is more productive (Wibowo, 2012) so that it can be said that if it is contextualized at the university, productivity can be seen from the side of the student's study period. According to the Chancellor's Rule of Hasanuddin University, the duration of the Bachelor Program study is scheduled for eight semesters and can be taken in at least six semesters and fourteen semesters in perpetuity.

There are three measures of productivity, namely partial productivity (based on one input), productivity of many factors (more than one input) and total productivity (all inputs) and all of these measures can be adjusted according to the purpose of the measure being carried out (Stevenson W.J. and Chuong S.C. 2014).

\[
\text{Ukuran sebagian} = \frac{\text{Output}}{\text{Input}} = \frac{\text{Output}}{\text{Tenaga Kerja}} = \frac{\text{Output}}{\text{Mesin}} = \frac{\text{Output}}{\text{Modal}} = \frac{\text{Output}}{\text{Energi}}
\]

\[
\text{Ukuran banyak faktor} = \frac{\text{Output}}{\text{Output}} = \frac{\text{Output}}{\text{Tenaga Kerja+Mesin}} = \frac{\text{Output}}{\text{Tenaga Kerja+Modal+Energi}}
\]

\[
\text{Ukuran total} = \frac{\text{Output}}{\text{Output}} = \frac{\text{Output}}{\text{Barang atau jasa yang dihasilkan}} = \frac{\text{Output}}{\text{Seluruh Input yang digunakan}}
\]

\[H_1: \text{The average value of the productivity of the P study program alumni study period has not yet reached the ideal number}\]

Quality Management

The concept of quality has traditionally only focused on inspection activities, the process of separating good products from bad ones and then reworking the defective products. different
from the traditional concept, this inspection activity is considered as a futile activity in the modern quality system because the inspection activities do not contribute to quality improvement, inspections are carried out only to prevent the passage of defective products into the hands of customers (Gaspersz, 2001).

Furthermore, the modern perspective assumes that modern quality must be customer-oriented, has a commitment from top management in the process of continuous quality improvement, there is an understanding of each person on the specific responsibilities for quality and availability activities which are oriented towards damage prevention (Gaspersz, 2001).

Quality management becomes an effort to improve the performance of an organization continuously at every level of the process, the functional area of an organization by using all available resources, both human resources or the capital they have (Gaspersz, 2001).

The concept of quality management can also be applied to the field of education; this concept is known as Total Quality Management in Education (TQME). The application of TQM in tertiary institutions is expected to reduce the level of gap that exists between tertiary education graduates in Indonesia and business and industry needs, providing an overview of the old and new paradigms (Gaspersz 2011).

Six Sigma is a method for comparing organizational performance with specifications expected by customers (such as students and parents in the education system), trying to match the quality required by them. This is done by measuring the results, calculating how much variation in the size of the results to improve further or improve the quality of the parts that create unwanted changes or not following customer expectations, can also be referred to as defects (LeMahieu, Nordstrum and Cudney, 2017) explains that the three measurements in the six sigma method are:

1. **Defect Per Million Opportunity (DPMO)**: shows the failure per million occasions with an ideal value of 3.4 DPMO and is interpreted that in a single product unit there is an average chance of failure of a CTQ (Critical-to-quality) characteristic of only 3.4 failures Per one million occasions (DPMO)

2. **Sigma Level**: interpret a world quality product with an ideal value of 6 sigma

3. **Process Capability Index**: the ability of the process to produce products according to specifications set by the company where these specifications also reflect the expectations of customers. If the calculation of \( C_{pm} \geq 2.0 \), it can be said that the process is very capable of meeting the specifications of the quality target set by the customer with a failure rate close to zero (zero defects). If the value of \( C_{pm} \) and \( C_{pmm} \) is between 1.0 to 1.99, the process is between not quite capable, so it needs to be improved while if \( C_{pm} <1.00 \), then the process status is considered to be very unable to reach the quality target at the failure rate.

**H2**: Defect Value Per Million Opportunity (DPMO) productivity of alumni of study program \( P \) has not yet reached the ideal number

**H3**: The sigma value of the productivity level of the \( P \) study program alumni study period has not yet reached the ideal number.

**Process Control.**

Process control can be seen on the map the distribution of average values, DPMO values, and also sigma level values. The control chart is usually used to monitor the process continuously all the time so that the process remains statistically stable (Gaspersz, 2012), which has several components, namely:

1. **Central line or Central Line (CL)**
2. **Control limit (control limits)** consisting of UCL (Upper Control Limit) or upper specification limit and LCL (Lower Control Limit) or lower specification limit. These two limits will help us to determine whether the process is under control or not. if the
distribution value on the control map does not cross the UCL and LCL values line, it can be said that the process is controlled, but if there is a distribution value that crosses the UCL and LCL lines, the process is not controlled.

**H₄:** The average value of productivity, the DPMO value, and the sigma level of the study period alumni of the P study program have not described a controlled learning process.

**Conceptual Model.**

To measure the performance of outputs based on the productivity of the learning process involves three components, namely input, process, and output. If it is contextualized in the learning process specifically that takes place at a tertiary institution, the input component is the party that directly influences the process component. The input component is represented by students, lecturers, knowledge or information shared and supported by campus facilities and infrastructure.

The process component is the learning process itself which is experienced by every student the learning process in tertiary education primarily undergraduate programs can usually be taken for eight semesters even though nationally it is recognized that it can be made for six semesters and a maximum of fourteen semesters. The learning process involves four to eight courses in each semester and each course has sixteen sessions or the equivalent of sixteen processes.

The output that will be obtained from the learning process is S1 alumni who have passed all the minimum course requirements valued at 144 SKS which are taken with different durations between each student.

Simply put, the description of this research can be seen in the conceptual framework below:

![Conceptual Model](image)

**RESEARCH METHOD**

**Location and Research Design**

This research was conducted at Hasanuddin University located in South Sulawesi Province, Makassar City starting in February to April 2020. This research location was chosen because Hasanuddin University is one of the favorite campuses and has a very good reputation especially in Eastern Indonesia.

**Population or Samples**

The population of this study were all graduates of the Hasanuddin University S1 program in the 2017/2018 period with a population of around 4000 graduates from sixty study programs while the sampling technique was cluster random sampling by selecting one of the study programs with A accreditation with twenty sample sets in the study program complies with the DPMO and Sigma Level calculation requirements.
Data Collection Method
In this paper, the method of data collection that the author uses is documentation by photocopying the book of graduates of Hasanuddin University in the 2017/2018 period.

Data Analysis Method.
The data collected in this study will be processed using a productivity formula, that is output divided by input. In addition, this study also uses the Six Sigma methodology which consists of five sequential process series called "DMAIC" processes, namely Define, Measure, Analyze, Improve, and Control but in this study focuses on the Measure phase and will enter the Analyze shutter a little. This method is used to determine the DPMO value and sigma level of learning process productivity in related study programs at Hasanuddin University. The following explanation.

1. Calculation of the average value, range, standard deviation, DPMO and sigma level. The value of DPMO (Deffects Per Million Opportunities) can be done on Ms. Excel with the following formula (Gaspersz 2012):

\[
1000000-(NORMDIST((USL-XBAR)/S)*1000000+NORMDIST((LSL-XBAR)/S)*1000000)
\]

As with DPMO values, sigma level values can also be calculated using Ms. Excel with the following formula:

\[
NORMSINV [(1000000 – DPMO)/1000000] + 1,5
\]

2. Determination of upper control limit value and lower control value for control chart of average productivity value
3. Making the DPMO value spread control map
4. Making control maps of sigma level scattered values
5. Calculation of Process Capability Index (C_p dan C_pmk).

RESULTS
Descriptive Statistics
Based on the results of the analysis of the data collected, it can be seen the average value of productivity, DPMO and sigma level of the productivity of the P study program alumni graduated in 2017/2018. These values can be seen in the following table:
Table 1: Average Value of Productivity, DPMO and Sigma Level of Productivity Period of Study Program Alumni of P Study Program Graduated in Period 2017/2018

<table>
<thead>
<tr>
<th>No.</th>
<th>X1</th>
<th>X2</th>
<th>X3</th>
<th>Total</th>
<th>Average (XBAR)</th>
<th>Range</th>
<th>S</th>
<th>DPMO</th>
<th>SIGMA LEVEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>18.00</td>
<td>18.00</td>
<td>18.00</td>
<td>54.00</td>
<td>18.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>18.00</td>
<td>18.00</td>
<td>18.00</td>
<td>54.00</td>
<td>18.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>18.00</td>
<td>18.00</td>
<td>18.00</td>
<td>54.00</td>
<td>18.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>18.00</td>
<td>18.00</td>
<td>18.00</td>
<td>54.00</td>
<td>18.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>16.00</td>
<td>16.00</td>
<td>16.00</td>
<td>48.00</td>
<td>16.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td>16.00</td>
<td>16.00</td>
<td>16.00</td>
<td>48.00</td>
<td>16.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>16.00</td>
<td>16.00</td>
<td>16.00</td>
<td>48.00</td>
<td>16.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>6</td>
</tr>
<tr>
<td>8</td>
<td>16.00</td>
<td>16.00</td>
<td>16.00</td>
<td>48.00</td>
<td>16.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>6</td>
</tr>
<tr>
<td>9</td>
<td>16.00</td>
<td>16.00</td>
<td>16.00</td>
<td>48.00</td>
<td>16.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>6</td>
</tr>
<tr>
<td>10</td>
<td>16.00</td>
<td>16.00</td>
<td>16.00</td>
<td>48.00</td>
<td>16.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>6</td>
</tr>
<tr>
<td>11</td>
<td>16.00</td>
<td>13.09</td>
<td>16.00</td>
<td>45.09</td>
<td>15.03</td>
<td>2.91</td>
<td>1.72</td>
<td>2880</td>
<td>4.26</td>
</tr>
<tr>
<td>12</td>
<td>13.09</td>
<td>16.00</td>
<td>11.08</td>
<td>40.17</td>
<td>13.39</td>
<td>4.92</td>
<td>2.91</td>
<td>143053</td>
<td>2.57</td>
</tr>
<tr>
<td>13</td>
<td>13.09</td>
<td>16.00</td>
<td>18.00</td>
<td>47.09</td>
<td>15.70</td>
<td>4.91</td>
<td>2.90</td>
<td>33103</td>
<td>3.34</td>
</tr>
<tr>
<td>14</td>
<td>18.00</td>
<td>18.00</td>
<td>10.29</td>
<td>46.29</td>
<td>15.43</td>
<td>7.71</td>
<td>4.56</td>
<td>159498</td>
<td>2.50</td>
</tr>
<tr>
<td>15</td>
<td>18.00</td>
<td>18.00</td>
<td>18.00</td>
<td>54.00</td>
<td>18.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0</td>
<td>6.00</td>
</tr>
<tr>
<td>16</td>
<td>18.00</td>
<td>18.00</td>
<td>18.00</td>
<td>54.00</td>
<td>18.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0</td>
<td>6.00</td>
</tr>
<tr>
<td>17</td>
<td>18.00</td>
<td>14.40</td>
<td>14.40</td>
<td>46.80</td>
<td>15.60</td>
<td>3.60</td>
<td>2.13</td>
<td>6263</td>
<td>4.00</td>
</tr>
<tr>
<td>18</td>
<td>18.00</td>
<td>18.00</td>
<td>18.00</td>
<td>54.00</td>
<td>18.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>6.00</td>
</tr>
<tr>
<td>19</td>
<td>18.00</td>
<td>18.00</td>
<td>18.00</td>
<td>54.00</td>
<td>18.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>6.00</td>
</tr>
<tr>
<td>20</td>
<td>18.00</td>
<td>18.00</td>
<td>18.00</td>
<td>54.00</td>
<td>18.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>6.00</td>
</tr>
</tbody>
</table>

Rata-rata Proses | 16.66 | 1.20 | 0.71 | 17.240 | 3.61 |

Source: Data processed using Ms. Excel

Table 1 shows that the average value of the productivity of the P study program alumni study period is 16.66, the DPMO value is 17,240 and the sigma level value is 3.61, then the visualization of control charts of the three measures (average value, DPMO value and sigma level value) which can be seen in the following image:

Figure 3. Controlling the Average Value of Learning Process Productivity Study Program P.
DISCUSSION

1. The Average Value of Productivity Period of Study Program Alumni P
   Based on the calculation results in table A1, the average value of the productivity of the alumni study period in the P study program shows a figure of 16.66, which means the productivity value of the learning process in the study program has not reached the ideal number of 18.00. This figure is not achieved because there are still variations in the average value of productivity as many as seven levels of variation ranging from 13.39 - 18.00 spread over twenty sample sets.

2. Defect Per Million Opportunity (DPMO) Value for the Study Program Alumni Study Period P
   The DPMO value in the P study program in table A1 shows the number 17,240 which means that the DPMO value has not reached the ideal figure of 3.4 DPMO. This DPMO value was not achieved because there were still five variations on twenty sets of samples ranging from zero to 2,880.

3. Value of Sigma Level Productivity Period of Study Program Alumni P
   The sigma level value in the P study program in table A1 shows the number 3.61, which means the sigma level value has not reached the ideal number which is 6 sigma. as well as the DPMO value, the sigma level value is not achieved because there are still five variations on twenty sets of samples ranging from 2.5 to 6 sigma.

4. Controlling Average Value, DPMO Value and Sigma Level Productivity Level of Alumni Study Program P
Controlling the average value of the productivity of the study period can be seen in Figure 3. The picture shows that there is a sample point that comes out of the control limit value (upper and lower limit), that is at sample point number 12. In addition, if we look at individual data in the sample set, there are five data that are outside the control limit, namely individual data on sample set number 12, 13, 14. The sample point that comes out of the control limit value indicates that the control of the learning process is still not controlled, especially with the scattered values on the control chart that is still fluctuating.

For controlling DPMO values, the productivity of the study period can be seen in Figure A4. The figure shows the spread of DPMO values that are still fluctuating so that it can be said that the control of the learning process is still not controlled.

Similar to the DPMO value, controlling the sigma level value in Figure A5 also shows the spread of sigma level values that are still fluctuating so that the control of the learning process is still not controlled.

**CONCLUSION**

Based on the results of the research and discussion above, it can be concluded that both the average value, DPMO and sigma level of productivity of the period of study of students are still not reaching the ideal value. The control chart for the average value, DPMO and sigma level also does not show a controlled condition because it is still fluctuating. This condition also shows that the learning process in the P study program does not yet reflect the condition of world quality products so that various improvement efforts are needed for this.

**REFERENCE**


