

## Redesign of Laboratory Facilities Layout Quality Control at PT. Industri Kimia

Putri Dwi Octaviani<sup>1</sup>, Yanty Maryanty<sup>1\*</sup>

<sup>1</sup>D-IV Teknologi Kimia Industri, Teknik Kimia, State Polytechnic Of Malang

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#### \*e-mail corresponding author :

[yanty.maryanty@polinema.ac.id](mailto:yanty.maryanty@polinema.ac.id)

### ABSTRAK

PT. Industri kimia adalah perusahaan yang memproduksi hidrogen peroksida sejak tahun 1992. Salah satu yang berperan penting pada pabrik kimia ini adalah Laboratorium Quality Control yang berfungsi melakukan analisa bahan baku serta hasil produk hydrogen peroksida sebelum didistribusikan ke konsumen agar terjamin kualitas produknya. Berdasarkan Standard sistem manajemen mutu laboratorium, SNI ISO/IEC 17025:2008, menyatakan bahwa untuk memfasilitasi kebenaran unjuk kerja pengujian, maka laboratorium harus memantau, mengendalikan dan merekam suhu serta kelembaban di ruangan pengujian karena akan berdampak pada validitas mutu data yang dihasilkan. Namun, Pengadaan fasilitas alat uji di laboratorium QC PT. Industri Kimia tidak didukung dengan perencanaan tata letak fasilitas yang baik, sehingga diperlukan penataan ulang tata letak meliputi fungsi peralatan dan bahan-bahan, serta pengkondisian sistem utilitas dan listrik. Parameter perancangan ulang tata letak laboratorium yang digunakan adalah pengukuran luas lantai, analisa ARC (Activity Relationship Chart) dan analisa ARD (Activity Relationship Diagram). Hasil penelitian berupa perhitungan nilai total closeness rating pada diagram hubungan kedekatan aktivitas, nilai yang terbesar yaitu ruang sample sebesar 6200 dan nilai terendah adalah ruang computer sebesar 200. Dari perhitungan tersebut kemudian dibuat template tata letak fasilitas laboratorium pengujian berdasarkan urutan nilai total closeness rating terbesar hingga nilai paling kecil, sehingga akan didapatkan relayout laboratorium yang sesuai standard SNI ISO/IEC 17025:2008 dan dapat menciptakan lingkungan kerja yang efektif dan efisien.

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### ABSTRACT

*PT. The chemical industry is a company that has been producing hydrogen peroxide since 1992. One of the essential roles of this chemical factory is the Quality Control Laboratory, which functions to analyze raw materials and hydrogen peroxide products before distributing them to consumers to ensure product quality. Based on the standard of laboratory quality management system, SNI ISO/IEC 17025:2008 states that in order to facilitate the correctness of test performance, the laboratory must monitor, control and record the temperature and humidity in the testing room because it will have an impact on the validity of the quality of the data produced—however, Procurement of test equipment facilities in the QC laboratory of PT. The chemical industry is not supported by good facility layout planning, so it is necessary to rearrange the layout, including the function of equipment and materials and the conditioning of utility and electricity systems. The laboratory layout redesign parameters used are floor area measurement, ARC (Activity Relationship Chart) analysis, and ARD (Activity Relationship Diagram) analysis. The study results are in the form of calculating the total closeness rating value on the activity proximity relationship diagram, the largest value is the sample space of 6200, and the lowest value is the computer room of 200. From these calculations, a layout template for testing laboratory facilities is created based on the order of the highest total closeness rating value to the smallest value so that a laboratory layout will be obtained according to the SNI ISO/IEC 17025:2008 standard and can create an effective and efficient work environment.*

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## 1. INTRODUCTION

PT. The Chemical Industry is a factory that has been producing hydrogen peroxide since 1992. This factory is one of the oldest factories that has been operating for approximately 30 years. The H<sub>2</sub>O<sub>2</sub> plant initially had a capacity of 18,000 tons per year. However, because one unit is no longer operating, its capacity is only 9,000 tonnes per year. Apart from being a supplier of raw materials for paper making at PT. chemical tjiwi. This factory has met many needs at home and abroad. Factory PT. The Chemical Industry is located in the Village of Kramat Temenggung, East Java includes company offices, production buildings (A and B), raw material warehouses, finish good warehouses, waste processing buildings, control rooms, QC laboratories, IC laboratories. The QC (Quality Control) laboratory is located on the 2nd floor above the control room which has a total area of 6 mx 6 m.

QC laboratory is a room or building equipped with equipment to carry out scientific experiments and research. The laboratory is also a place to obtain analytical data from field observations. With the existence of a laboratory, it is hoped that the facts from the observations can be demonstrated scientifically. The laboratory is also a cultural entity that has a certain power, secrecy and a special symbol for outsiders [1]. According to the laboratory quality management system standard, SNI ISO/IEC 17025:2008, that in order to facilitate the correctness of the test results, the testing laboratory must be able to monitor, control, record the temperature and humidity in the testing room because it will have an impact on the quality validity results [2]. One of the efforts to simplify the work of employees and control the temperature and humidity of the testing room is by managing the layout of the laboratory room facilities. Placement of facilities in a laboratory is expected to prevent work accidents in the laboratory. Apart from being safe, placement of facilities should be effective and efficient. Facts show that around 20% - 50% of the costs are allocated for facility layout and transportation [3]. The QC laboratory located at PT. The Chemical Industry functions as a final checking process that is carried out to ensure the quality and quality of the products produced are still in accordance with the initial qualifications. Based on the activities carried out, the rooms in the QC laboratory can be grouped into office rooms and testing rooms. The office space consists of Supervisor's Room, Laboratory Coordinator Room, Field Coordinator Room Meanwhile, the testing room includes instrumentation analysis room. In the instrumentation analysis, there are instrumentation equipment in the form of a pH meter room, a polarography room, a spectrophotometry room, and a gas chromatography room, a Mohr balance and a refractometer. For sample analysis there is a sample equipment room and a raw material room. The layout design of the QC (Quality Control) laboratory adopts the factory layout design method. There are several techniques commonly used in layout design, including conventional techniques. Spectrophotometry Room, and Gas Chromatography Room, Mohr Balance and Refraktometer. For sample analysis there is a sample equipment room and a raw material room. The layout design of the QC (Quality Control) laboratory adopts the factory layout design method. There are several techniques commonly used in layout design, including conventional techniques. Spectrophotometry Room, and Gas

Chromathography Room, Mohr Balance and Refraktometer. For sample analysis there is a sample equipment room and a raw material room. The layout design of the QC (Quality Control) laboratory adopts the factory layout design method. There are several techniques commonly used in layout design, including conventional techniques.

In previous research, the author Fitri Lu'ailik has written a journal about redesigning the layout of the Quality Control laboratory at PT. Indofood CBP Sukses Prosperous. Layout design for QC laboratory facilities based on SNI ISO/IEC 17025:2008 laboratory quality requirements. Based on the problems regarding the analysis of the initial layout of the testing laboratory, measurements were made to calculate the required laboratory floor area, then an analysis of the proximity of the facilities was carried out by making an ARC diagram (Activity Relationship Chart) and carrying out the preparation of an ARD (Activity Relationship Diagram). The final step is to create a testing laboratory facility layout template. The layout of the QC laboratory is prepared based on the dimensions and area available and adapted to the requirements of the SNI/IEC 17025:2008 laboratory quality management system [4]. The difference in writing this journal is research on laboratory layout design in the chemical industry while the research above does layout design in the food industry so that there are aspects that must be considered such as furniture materials used, lighting and utility flow as raw materials in the analysis. Because the chemical industry is related to chemical compounds that are corrosive and dangerous. Several previous studies examined the design of facility layouts such as research by Kolo et al. (2021) designed the layout of a eucalyptus manufacturing facility in North Central Timor. The method used is ARC and also ARD. The results show a more efficient eucalyptus oil refining process with a planned layout [5]. Research by Iskandar and Fahin (2017) designed the layout of truck production facilities in the Commercial Vehicle building using ARC and ARD with rectilinear measurements and material handling costs. The results of calculating distances and costs by measuring rectilinear distances and material handling costs in the initial layout are 591 m<sup>2</sup> and Rp. 360,598, the first proposal is 565m<sup>2</sup> and Rp. 344,734, the second proposal is 584 m<sup>2</sup> and Rp. 356,327, so the choice is the first proposal as a proposal the most efficient. [6]

Procurement of test equipment facilities in the QC laboratory at PT. The chemical industry is not supported by good facility layout designs and inadequate equipment to support OSH. Test equipment facilities are placed without regard to the relationship between testing, employee involvement, and information flow. Test equipment facilities that have the same function using the same material are placed far apart as well as test equipment facilities to test the same product are placed far apart. thus causing employees to have to walk a longer distance to reach the test equipment facility. Facility layout problems are one of the factors that play an important role in increasing productivity [7]. Based on the problems above, it is necessary to redesign the layout of laboratory facilities in the QC laboratory of PT. Chemical Industry. to facilitate employees in carrying out their duties and create an effective and efficient work environment. It is hoped that the layout that will be made is in accordance with the SNI ISO/IEC 17025:2008 standard and is in accordance with the relationship between test equipment facilities. The QC laboratory

development/renovation plan will be built on the 1st floor close to the hydrogen peroxide production building and the finish good warehouse. This renovation is for The QC laboratory development/renovation plan will be built on the 1st floor close to the hydrogen peroxide production building and the finish good warehouse. This renovation is for The QC laboratory development/renovation plan will be built on the 1st floor close to the hydrogen peroxide production building and the finish good warehouse. This renovation is forensure that the stages of the testing process can run effectively and efficiently through the layout and design relayout of the QC laboratory that will be made.

## 2. RESEARCH AND METHOD

Redesigning the layout of the QC laboratory at PT. Industri Kimia is carried out by conducting field studies, namely direct observation of the layout of facilities in a QC (Quality Control) laboratory. Identification is carried out to determine the current condition of the Quality Control laboratory. Followed by the calculation of the area required for the layout design of the Quality Control laboratory facility. The next stage is to create an ARC (Activity Relationship Chart), namely. If there are two machines/facilities that have a strong relationship then these machines/facilities need to be placed close together and vice versa [8].

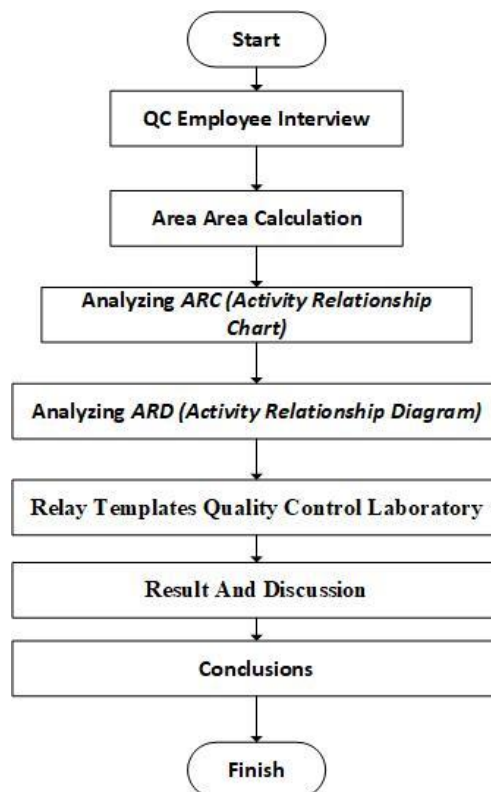


Figure 1. Flowchart of Research Methods

### 2.1. Area Area Calculation

Identification of area calculations is carried out to determine the current conditions in the Quality Control laboratory of PT. Industri Kimia. Followed by the calculation of the area required for the layout design plan for Quality Control laboratory facilities. The calculation

is done by measuring the equipment in the Quality Control laboratory using a measuring instrument.

**2.2. Analysis ARC (Activity Relationship Chart)**

Determine the relationship between test machines/facilities by discussing and interviewing test operators. The relationship between facilities is often interpreted as an affinity requirement [9]. Procedure for determining ARC Analysis :

1. Identify and record all work facilities that will be arranged in a layout and write a sequential list on the map.
2. Conduct interviews (interviews) or surveys to employees of PT. Industri Kimia especially those working in QC laboratories.
3. Analyzing the relationship criteria between test equipment facilities that will be positioned based on the degree of relationship. Next, give the value of the relationship for each activity relationship between test equipment facilities.

After that, discussing the results of the assessment of the relationship between the activities that have been mapped with the reality in the QC laboratory at PT. Industri Kimia, then conducts an evaluation or change that is more appropriate based on the quality management system standard SNI ISO/IEC 17025:2008. The following is a reference standard in mapping the closeness and interrelationships between facilities based on tables [10].

Table 1. Degrees of Closeness  
Source: Wignjosoebroto, 1996

Mark	Proximity
A	Absolute need to be brought closer
E	It's important to be close
I	It's important to be close
O	Enough/ordinary
u	Not important
X	Not wanted close by

Table 2. Reasons for Proximity  
Source: Wignjosoebroto, 1996

Reason Code	Reason Description
1	Simultaneous use of notes
2	Using the same workforce
3	Using the same space area
4	The degree of frequent personnel contact
5	Degree of contact of frequently performed work papers
6	Workflow sequence
7	Carry out the same work activities
8	Using the same tools/work materials

After getting the ARC analysis, then determine the Corelap algorithm to calculate the test equipment facilities that are most often used in the layout or which have the most links with other test equipment facilities. Then the results of the calculation of the closeness of the test equipment facility with other tool facilities are sorted from the highest result to the lowest result [11]. The result with the highest number is placed first in the layout matrix. Next, an activity is selected that must be close to it and placed as close as possible. CORELAP algorithm steps as follows:

1. Calculate the Total Closeness Rating (TCR) for each test equipment facility.
2. Choose one of the test equipment facilities with the maximum TCR, then place it first.
3. If there are the same TCR, select the one with the larger area first, then if the area is the same, then select the one with the smallest number of test equipment.
4. The second allocated test equipment facility, select a test equipment facility that has a relationship A with the selected test equipment facility.
  - a. If there is, then choose the one with the largest TCR.
  - b. If the TCR is the same, then choose any.
5. Repeat the second process, until all facilities are selected. If there are no facilities that have an A or E relationship with the selected facilities (all), then continue with I or O, and U or X relationships.

The following is the calculation of the total closeness rating (TCR) with the determination of the value of each symbol written as follows:

*CV Values*

$$\begin{array}{ll}
 V(A) = 10000 & V(O) = 10 \\
 V(E) = 1000 & V(U) = 1 \\
 V(I) = 100 & V(X) = -1000
 \end{array}$$

### 2.3 Analysis ARD (Activity Relationship Diagram)

ARD analysis serves to map and compile a bar diagram showing the proximity of facilities to facilitate the drawing of the final design. ARD is prepared based on the results from ARC . which is a diagram of the relationship between test lay facilities based on the priority level of proximity, so it is expected that the cost of designing the QC layout reaches a minimum handling. The basis for ARD analysis is the result of the TCR value. So those that occupy the first priority on the TCR must be located closer together then followed by the next priority. When compiling the ARD, the possibility of error is very large because we use the assumption that all test equipment facilities are close to each other. What is meant by error here is a situation where the test equipment facilities receive priority one and cannot occupy their positions to be close to each other without any boundaries from other test equipment facilities.

### 2.4 Relay Templates Quality Control Laboratory

The results of the layout with the highest layout score are then analyzed in terms of space available with space requirements, the flow of the testing process, and the



completeness of the facilities and see if the layout has been completed meet the land use pattern requirements set by the government, until it is finally made template using Microsoft Visio 2007.[12]

### 3. RESULTS AND DISCUSSION

#### 3.1 Floor Area Measurement

In the first discussion stage to make a proposal for designing a QC (Quality Control) laboratory layout, namely calculating the area needed for each room based on the dimensions and area of the laboratory area available, namely  $\pm 6 \text{ m}^2 \times 6 \text{ m}^2$ . The following is the result of calculating the floor area requirement for the QC laboratory area.

**Table 3. Floor Area of QC Laboratory (Source: PT. Industri Kimia)**

No	Work Station Name	Tool's name	Tool		Operator		Total Area
			Dimensions p.s	l	Dimensions p.s	l	
1	Polarography	Polarography Equipment computer desk	0.8	0.45	0.5	0.4	0.56
2	Gas Chromatography	Computer desk GC Equipment	1,1	0.51	0.7	0.4	0.841
3	PH meter	Place of Analysis Equipment pH Meter tools	0.45	0.5	0.5	0.4	0.425
4	Spectrophotometer	Computer Desk Spectrophotometer Equipment	0.45	0.6	0.7	0.4	0.55
5	Sample Room	Analysis Room Sample Cabinet	1,6	0.32	1,1	0.45	1.007
6	Computer room	Operator's Computer Desk	1,1	0.5	0.5	0.4	0.75
7	Employee Room	Employee Desk 3	1.25	0.72	0.5	0.4	1,1
8	K3 Room	PPE Equipment Sink	1,1	0.8	0.5	0.4	1.08
9	Data Room	File Cabinets Labels, Seals	1,4	0.65	1	0.65	1.56

Of all the required testing facilities, then the level of relationship with other facilities is analyzed by observing and discussing with the test analysts. From the results of observations and discussions, an ARC (Activity Relationship Chart) was created.

#### 3.2 ARC (Activity Relationship Chart)

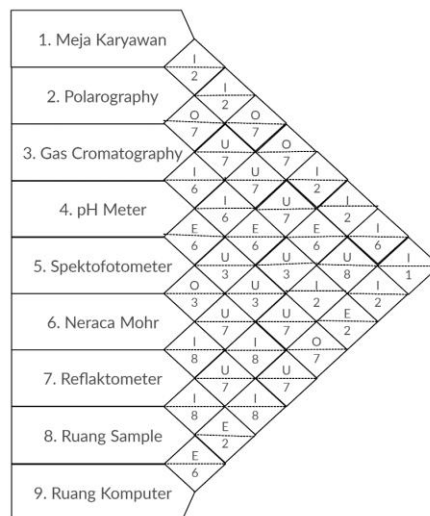


Figure 2. Analysis Results of ARC (Activity Relationship Chart)

Furthermore, after the ARC diagram has been identified, determine the Corelap algorithm. The following is the calculation of the total closeness rating (TCR) with the determination of the value of each symbol as follows:

CV Values :

$$V(A) = 10000 \quad V(E) = 1000 \quad V(I) = 100 \quad V(O) = 10 \quad V(U) = 1 \quad V(X) = -10000$$

Table 4. TCR Calculation Table

TOOL	TOOL									SUMMARY					TCR	ORDER	
	1	2	3	4	5	6	7	8	9	A	E	I	O	u			X
1	-	I	I	O	O	I	I	I	I	-	-	6	2	-	-	620	8
2	I	-	E	U	U	U	U	E	U	-	2	1	-	5	-	2100	5
3	I	E	-	O	I	I	I	E	U	-	2	4	1	1	-	2410	2
4	O	U	O	-	U	U	U	E	U	-	1	-	2	5	-	1020	7
5	O	U	I	U	-	I	I	E	U	-	1	3	1	3	-	1310	6
6	I	U	I	U	I	-	E	E	U	-	2	3	-	3	-	2300	3
7	I	U	I	U	I	E	-	E	U	-	2	3	-	3	-	2300	4
8	I	E	E	E	E	E	E	-	I	-	6	2	-	-	-	6200	1
9	I	U	U	U	U	U	U	I	-	-	-	2	-	6	-	200	9

So that the CORELAP algorithm is obtained as follows:

2	1	9
3	8	5
7	6	4

### 3.3 Activity Relationship Diagram (ARD)

Activity Relationship Diagram (ARD) is a combination of the degree of relationship between activity and material flow. The initial ARD is prepared based on the existing initial layout. In the proposed layout, it can be seen that the location of the proximity of the sample room with instrument equipment is interrelated, and finally the employee desk and computer room are supporting equipment. So we get the Flow Relationship Diagram as follows:

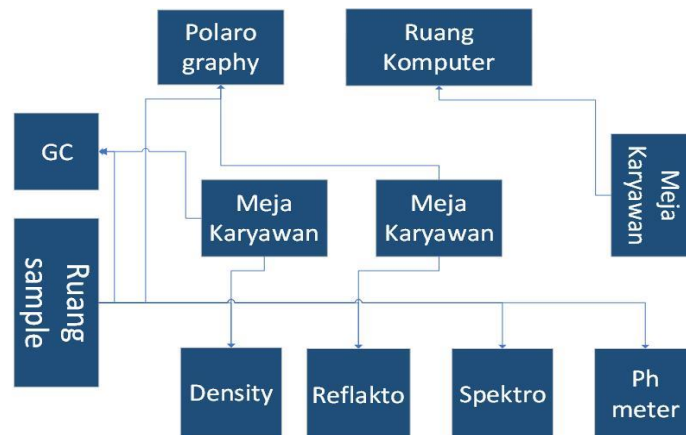


Figure 3. Activity Relationship Diagrams



### 3.4 Final Design



Figure 4. Final Design of Quality Control Laboratory

### 3.5 Discussion

In previous studies the results of redesigning the layout of quality control laboratories in the food industry, while in this study the focus was on the chemical industry. This study discusses redesigning the layout of rooms such as office rooms, weighing rooms, inoculation rooms, preparation rooms, sanitation rooms, distillation rooms, and media manufacturing rooms. So it requires the right distance between rooms according to SNI

Whereas in this study only redesigned the layout between test equipment facilities in a quality control laboratory room such as polarography, gas chromatography, spectrophotometer, Mohr balance, pH meter, sample room and computer room so that it does not require accurate distances between facilities, it's just that it pays close attention materials and equipment used such as analysis tables, utility systems, lighting systems, electricity requirements and storage of chemicals. This study was also designed based on the SNI ISO/IEC 17025: 2008 standard. This study also discussed the design of employee desks based on ergonomic proximity which aims to increase employee productivity.

The design of the workplace can affect the safety and health of workers. Working conditions that do not pay attention to comfort, satisfaction, occupational safety and health will certainly greatly affect the productivity of human work. The human body has a range of motion. Movements carried out within the range of motion will improve human blood circulation and be more flexible so that humans become more comfortable when moving and their productivity increases. In designing a workplace, human range of motion must be considered to help reduce fatigue and muscle disorders [13].

Laying out employee desks, reasons for selecting work desks: When working, some types of work must be done in a standing position (standing workstation), but there are

some jobs that are more comfortable to do in a sitting position (sitting workstation). One of the factors that affect the comfort of workers both for work carried out in a standing position or a sitting position is the work table. The height of the work table surface must be in accordance with the user. If the height of the work surface is too high, the shoulders and upper arms will be lifted into an uncomfortable position which can cause muscle fatigue and pain. Meanwhile, if the height of the work surface is too low, the neck and head will bend so that it can cause the spine and muscles to strain. The height of the table used for work is influenced by the type of work. For work carried out in a sitting position, in addition to the height of the table, it is also necessary to pay attention to the height of the work chair. The height of the work chair is usually adjusted to the height of the work table. The calculation of the ideal work chair with the height of the work table is usually done by subtracting the work table height obtained by sitting elbow height. for work done in a sitting position (sitting workstation), especially for industry, the recommended table height is: The calculation of the ideal work chair with the height of the work table is usually done by subtracting the work table height obtained by sitting elbow height. for work done in a sitting position (sitting workstation), especially for industry, the recommended table height is: The calculation of the ideal work chair with the height of the work table is usually done by subtracting the work table height obtained by sitting elbow height [14]. for work done in a sitting position (sitting workstation), especially for industry, the recommended table height is:

- 5 cm above the elbow height, namely with a table height of 66.4 cm with a chair height of 44.8 cm,
- 10 cm above elbow height with a table height of 71.4 cm with a chair height of 49.8 cm
- 15 cm above elbow height with a table height of 76.4 cm with a chair height of 54.8 cm.

Comparison of the current Laboratory Design and the latest Laboratory Design

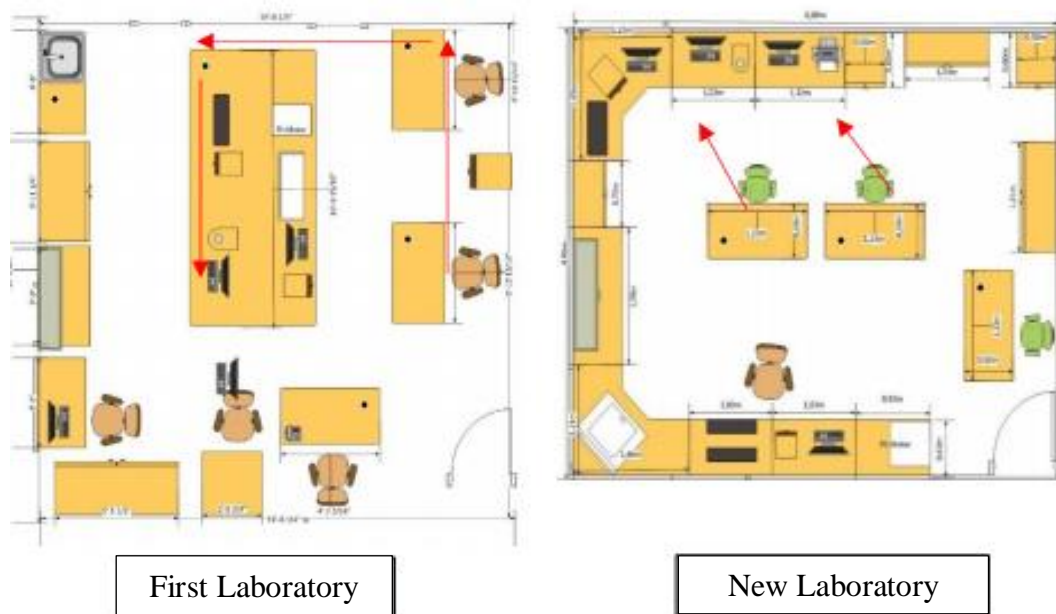


Fig. 5. Comparison of QC Laboratory Design

The difference between the original laboratory and the newest laboratory is that the employees' desks are quite far apart from the test equipment used by employees for analysis (polarography and gas chromatography). This resulted in the test operator having to walk a longer distance to reach the test equipment facilities. Placement of Cabinets  
Placement of cabinets around the computer room aims to facilitate the grouping of documents used for document filing. According to SNI ISO/IEC 17025: 2008 standard [15]. placing cupboards around the computer room is highly recommended to minimize scattered or lost documents, as well as to make it easier for employees to access these documents considering that documents are very important in running a laboratory. Placement of Polarographic Equipment beside Gas Chromatography Equipment because it uses the same workforce and has the degree of frequent contact between personnel. According to the standard SNI ISO/IEC 17025:2008 No 5.5.3 Equipment must be operated by authorized personnel [16]. Located near the sample room because to make it easier for personnel/employees in making samples, it will also maximize the workflow process/work sequence to make it more effective and efficient.

Placement of the Sample Room Placed close to the sink because to make it easier if a work accident occurs to be rinsed immediately using running water in accordance with the provisions of the MSDS for each compound. Where the MSDS contains if the chemical gets on the skin, rinse it immediately with running water for 5-10 minutes, if the chemical gets in your eyes rinse carefully with running water, so that the placement of the sample room near the sink is very concerned about K3, namely security and safety work in the laboratory. According to the standard SNI ISO/IEC 17025:2008 No 5.5.6 The laboratory must have procedures for safe handling, transportation, storage, use and planned maintenance of measuring equipment to ensure proper functioning and to prevent contamination or degradation of the tool.[17]

This sample room is also placed in an area that is close to all analytical equipment in the quality control laboratory because it is a work flow sequence and uses the same raw materials and tools for all analyzes in the quality control laboratory. On the side of the sample room is a sample cabinet which aims to group samples that have been sent to consumers, this is to be aware if there are complaints from consumers regarding production quality. So that an analysis will be carried out by laboratory employees so that it is in accordance with the standard SNI ISO/IEC 17025:2008 No 4.9 Concerning Control of inappropriate testing and/or calibration work [18]: Placement of the sink, the sink is placed in front of the left corner of the QC laboratory, this is because in front of the QC laboratory, to be precise across the room, there is a waste treatment building so that the waste stream in the sink can be directly channeled into the waste disposal pond, the sink is placed near the analysis room because after carrying out the analysis chemicals can be disposed of directly into the sink so as not to cause contamination with other equipment and maintain work safety in the QC laboratory.

The placement of the equipment for the Mohr balance and the refractometer is placed on the same table because the two equipment use the same analytical materials, that is, so as not to waste the materials used, the Mohr balance and the refractometer are analyzed by

the same workforce so that the use of the same table makes it easier the task of the employee in using the equipment, the Refractometer is placed near the window because the Refractometer works using the principle of light refraction when passing through a solution. Refractometers use this principle to determine the amount of solute in a solution by passing light through it. According to the standard SNI ISO/IEC 17025:2008 No 5.3 : Laboratory facilities for testing and/or calibration, including (but not limited to) energy sources, lighting conditions and environment. [19]

Selection of goods used in the chemical laboratory, among others, in connection with the procurement of equipment and chemicals, the laboratory must plan the purchase of equipment and chemicals complete with their specifications. In planning the purchase, the laboratory should prioritize the selection of methods according to the applicable quality standards. Chemicals and equipment and their software, whether used for sampling and/or testing environmental quality parameters, must be capable of producing the required accuracy and must comply with specifications relevant to testing based on applicable environmental laws and regulations. In preparing the technical specifications, the equipment and chemicals to be purchased must be adjusted to the testing requirements and the referenced regulatory quality standard values. Written specifications must be complete and clear, including information on the limit of detection for the equipment and the purity (grade) for the desired chemical. The selected tool specification must have a tool detection limit between 1/5 to 1/10 under the referenced quality standard. Specifically for planning and technical procurement of equipment and chemicals, it must include information on the supplier's obligations to carry out after-sales guarantees, for example: availability of spare parts, technicians, minimum one year equipment warranty, installation of main and supporting equipment, room upgrades and so on. Written specifications must be complete and clear, including information on the limit of detection for the equipment and the purity (grade) for the desired chemical. The selected tool specification must have a tool detection limit between 1/5 to 1/10 under the referenced quality standard. Specifically for planning and technical procurement of equipment and chemicals, it must include information on the supplier's obligations to carry out after-sales guarantees, for example: availability of spare parts, technicians, minimum one year equipment warranty, installation of main and supporting equipment, room upgrades and so on. [20]

Some of the main furniture in the laboratory room are analysis tables, analysis chairs, employee tables and tool and material cabinets. This type of chemical analysis table size is usually done standing, so the analysis table for chemical experiments is around 75-80cm. table materials also need to be adjusted to each sub-field of study. For chemical activities,

it should be made of materials that are resistant to corrosive chemicals, for example phenolic resin. In chemical experiments, employees do a lot of activities so this type of armchair is not suitable for use in the laboratory. The type of chair material also needs to be considered and adjusted to the sub-field of study. Generally the seat height is about 30-40cm shorter than the table height.

Material and tool cabinets have a standard height, around 180-195 cm with a depth ranging from 30-40cm. Cabinets should be locked, especially cabinets that contain hazardous materials or tools that are expensive.[21]



Figure 6. Analysis Table Specifications

Table specifications for analysis of polarographic equipment, GC, computer room, spectrophotometer, refractometer, Mohr balance, and pH meter.

- a. The table top is made of chemically resistant phenolic resin which can withstand chemicals that corrode easily
- b. There is a Double electric socket closecap system as a power source for analysis equipment that uses a computer, the type of socket must be closed because to avoid being exposed to spilled chemicals
- c. Below it can be given a data cabinet to store analysis records so that it is easy to find and safe or not easily lost which is made of Galvanized steel structure with a special beveled robust door handle, at the bottom of the cabinet there are wheels to make it easier to move the cabinet into the laboratory
- d. Measuring pxlxt = 3.37m x 1.43m x 0.75





Figure 7. Sample Table Specifications

Sample table and sink specifications:

- a. The standard thickness of the analysis table top is 13 mm, 16 mm and 19 mm
- b. Equipped with a hanging cupboard for samples at the top which is resistant to reagents
- c. Equipped with a cupboard at the bottom of the analysis table to store samples made of HPL, EX, DUROPAL GERMANY with a thickness of 18mm. with a polypropylene type cupboard
- d. On the side of the table is equipped with a solid wooden structure measuring 30 x 60 mm with an epoxy point finish material

The instrument room must be equipped with devices to control temperature and humidity and it is advisable to use a dehumidifier. For laboratory room doors, it is recommended to use double doors to minimize dust contamination. In the AAS/ICP/Hg-Analyzer room, if the operation of the tool requires gas, piping must be installed, to drain gas from outside the room and to remove dirty air around the burner on the AAS/ICP tool using a blower and ducting. The maximum distance between the ducting and the furnace is 0.5 meters or according to the tool installation instructions, which is regulated in the Regulation of the Minister of Environment number 06 of 2009 Appendix I.[22]

The laboratory must provide a lighting system for the testing process so as to facilitate the correctness of performance. In this case, the lighting can be natural from sunlight or from lamps. For analysis equipment such as refractometers and spectrodotometers that utilize sunlight, it is recommended to use glass windows with an area of about 1/3 (one-third) of the floor area of the room and if using window coverings, use flammable materials is not permitted. Laboratory management must ensure that the energy source is sufficient for its operational activities, the laboratory is also advised to have a generator and UPS (Uninterruptible Power Supply) for energy backup in the event of a power outage. The minimum electricity requirement is around 20 kilowatts and if the laboratory



has used AAS and/or GC equipment, the minimum electricity requirement will be 40 kilowatts.[23]

## **4. CONCLUSION**

### **4.1. Conclusion**

The results of redesigning the layout of the quality control testing laboratory require the transfer of several facilities, including:

1. The office space consisting of supervisor desks and staff desks is placed in one room adjacent to the polarography and gas chromatography testing equipment facilities so that they are within the reach of the test equipment operators. In accordance with the contents of sub-chapter 5.3 of SNI ISO/IEC 17025:2008.
2. The computer room is placed near the file cabinet to facilitate grouping of used documents and for archiving documents. In accordance with the contents of sub-chapter 4.3 of SNI ISO/IEC 17025:2008. About document control
3. Polarographic Equipment is located adjacent to Gas Chromatography Equipment because it uses the same workforce and has a high degree of frequent personnel contact. In accordance with the contents of sub-chapter No 5.5.3 of SNI ISO/IEC 17025:2008 concerning Equipment must be operated by authorized personnel.
4. Sample Room Placed close to the sink due to make it easier in the event of a work accident. In accordance with the contents of sub-chapter No. 5.5.6 SNI ISO/IEC 17025:2008 concerning Laboratories must have procedures for safe handling
5. The sample room is placed in an area that is close to all analytical equipment in the quality control laboratory because it is a sequence of work flows. In accordance with the contents of sub-chapter No. 4.9 SNI ISO/IEC 17025:2008 concerning Control of inappropriate testing and/or calibration work
6. The Mohr balance equipment and the refractometer are placed on the same table because the two equipment use the same analytical materials. Placed near a window because the Refractometer works using the principle of light refraction when passing through a solution. In accordance with the contents of sub-chapter No. 5.3 SNI ISO/IEC 17025:2008 concerning Laboratory facilities for testing and/or calibration, including (but not limited to) sources of energy, lighting conditions and environment, must be such that they are capable of facilitating the correctness of the performance of the tests and/or calibrations
7. Spectrophotometer equipment is placed next to the Ph meter because it is done by the same workforce. This equipment is not placed in the IC lab because it is instrument equipment. In accordance with the contents of sub-chapter No. 5.5 According to the standard SNI ISO/IEC 17025:2008 regarding equipment

### **4.2. Suggestions**

In designing the laboratory layout, it is hoped that there will be guidance or theory regarding the design of a good and correct laboratory layout to add to our literature and knowledge in solving problems in the industry.

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