DOI: https://doi.org/10.33479/sakti.v4i1.90

Jurnal Sains dan Aplikasi Keilmuan Teknik Industri (SAKTI)
Journal of Industrial Engineering: Application and Study
Volume 04 No. 01 - June 2024
Journal homepage: www.sakti.machung.ac.id
ISSN: 2829-8519 (print) – ISSN: 2829-8748 (online)

Determination of Physical Enviroment Factor Levels to Improve Productivity in the Filleting Process (Case study: PT Bumi Menara Internusa Surabaya)

Johan Chenwidy[1,a)], Yuswono Hadi[1,b)], Sunday Noya[1,b)]

[1]*Industrial Engineering Study Program, Faculty of Technology and Design, Universitas Ma Chung*
Jalan Villa Puncak Tidar N-01, Malang, Indonesia, 65151

Author Emails
[a)] *412010007@student.machung.ac.id**
[b)] *Yuswono.hadi@machung.ac.id*
[c)] *Sunday.alexander@machung.ac.id*

Received 21 May 2024 / Revised 20 June 2024 / Accepted 27 June 2024 / Published 30 June 2024

Abstract. PT Bumi Menara Internusa Surabaya is a producer of processed frozen seafood products, which uses a lot of human resources in its production. The use of human resources in the production process is closely related to productivity which will ultimately affect work efficiency and effectiveness. PT Bumi Menara Internusa itself has many products from various types of fish, one of which is salmon. The production process for frozen salmon products has several processing stages, one of which is the filleting process. The filleting process is a process where the fish flesh is separated from the fish backbone. To determine employee productivity in the production of frozen salmon products, employee output will be recorded every hour. Based on observations, records held by the company and interviews that have been conducted, it was found that employees in the fillet section were often unable to achieve the daily output targets that had been planned and calculated by the department concerned. Therefore, study was carried out using the Taguchi method to increase the productivity of salmon fillet employees. The results of the study carried out were an increase in productivity value of 3.556.

Keywords: Physical work environment; Productivity; Salmon fillet; Taguchi

1. Introduction

Work productivity is something that describes the results or outcomes of a person's activities by considering the resources/capital (time, land, money, etc.) to produce these outcomes. Productivity is a comprehensive measurement of the quantity and quality of goods or services produced by workers or machines and raw materials or resources as inputs (Nugroho, 2021). The work environment itself is divided into two, namely the non-physical work environment and the physical work environment (temperature, noise, light, and so on). The physical work environment means all the conditions that exist around the workplace, which will affect employees either directly or indirectly (Sedarmayanti, 2011). Increasing productivity is one way to increase profits (Sijoatmodjo & Hadi, 2021), increasing productivity is also a solution when the price of raw materials/inputs has increased (Hadi et al., 2018).

Citation format: Chenwidy, J., Hadi, Y., & Noya, S. (2024). Determination of Physical Enviroment Factor Levels to Improve Productivity in the Filleting Process (Case Study: PT Bumi Menara Internusa). *Jurnal Sains dan Aplikasi Keilmuan Teknik Industri (SAKTI)*, *4*(1), 55-68. https://doi.org/10.33479/sakti.v4i1.90

PT Bumi Menara Internusa Surabaya is one of the producers of frozen seafood products, which in its production uses a lot of human resources. The use of human resources in the production process is closely related to productivity which will ultimately affect the efficiency and effectiveness of work. PT Bumi Menara Internusa itself has many products from various types of fish, one of which is salmon. The production process of frozen salmon products has several processing stages, one of which is the filleting process. The filleting process is a process where the fish meat will be separated from the fish backbone. To determine employee productivity in the production of frozen salmon products, employee output records will be made every hour. Based on observations, records owned by the company and interviews that have been conducted, it is often found that employees in the fillet section cannot achieve the daily output targets that have been planned and calculated by the section concerned.

Based on this description, the studyer wants to conduct a study with the title "Determination of Physical Environment Factor Levels to Increase Productivity in the Filleting Process at PT Bumi Menara Internusa" to determine the effect of physical environment factors on the work productivity of filleting employees of PT Bumi Menara Internusa Surabaya and the optimal physical environment tuning design. This study will use 3 physical environmental factors and each of these factors has 3 levels, the 3 factors are the type / genre of songs, light intensity, and sound intensity (production room noise combined with song sounds). After selecting the factors, the following levels are also determined for the song type factor: dangdut, pop, and jazz, then for the light intensity factor: 100-250 lux, 500-800 lux, and 850-1050 lux, then for the sound intensity factor: 75-80 dB, 80-85 dB, and 85-90 dB. The selection of factors and levels above is based on several previous studies and government regulations, namely study conducted by (Setiyanto, 2011), (Puspitaratna & Dwiyanti, 2013), (Khomariah et al., 2016), (Yusuf, 2013), (Andriyanti, 2007), Peraturan Menteri Ketenagakerjaan No. 5 Tahun 2018, Keputusan Menteri Negara Lingkungan Hidup No. 48 tahun 1996, (Padmanaba, 2006), and (Yusuf ,2013).

The experimental design method that studyers will use in this study is the taguchi method, the use of this method is because the taguchi method is a more efficient method than the full factorial method which suits the needs of studyers who need efficient study methods due to relatively short study time. The efficiency of the taguchi method can be seen from the number of trial combinations that are less than the full factorial method so that it can save study time.

This study aims to determine the physical work environment factors that affect the productivity of the filleting section of the production of frozen salmon products at PT Bumi Menara Internusa Surabaya. This study also aims to find the best setting level of each of these influential factors, then further this study also wants to analyse the results of implementing the optimal setting level of these influential factors on the productivity of the filleting section.

2. Methods

2.1 Experimental Design

Experimental Design is a systematic effort in designing a design through the action of conditioning several factors (Montgomery, 1997). According to Iriawan & Astuti (2006), experimental design aims to determine input variables (factors) that can influence the response, determine factors that make the response approach or reach the desired value, and determine input variables that cause small variations in the response.

2.2 Taguchi Method

The Taguchi method is divided into three main stages that cover all experimental approaches. The three stages are planning, implementation and analysis (Pranogyo, 2020). Then the three stages can be described in more detail into problem formulation, determination of experimental objectives, determination of independent variables, identification of factors, separation of control factors and disturbance factors, determination of the number of levels and level values of factors, calculation of degrees of freedom, selection of orthogonal arrays, forging columns for factors in

the interaction into orthogonal arrays, conducting experiments, analysis stage, and confirmation experiments.

The study method describes the activities carried out during the study at PT Bumi Menara Internusa Surabaya. Figure 1 is a flowchart of this study:

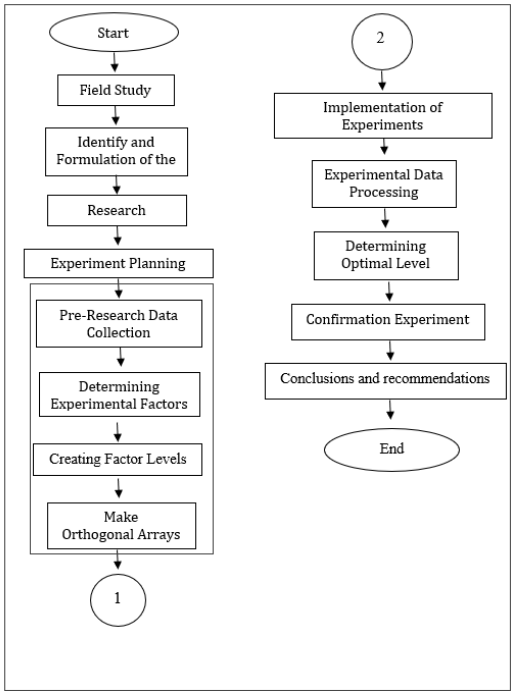

Figure 1 Study Flowchart

3. Results and Discussion

3.1 Experiment Implementation

The experimental implementation stage is carried out in accordance with the planning that has been made. In accordance with the previous stages of the experiment to be carried out is as many as 9 experiments and will be replicated twice. The combination of experiments to be carried out will be made with the help of Minitab software version 19. The combination of nine physical work environment experiments at PT Bumi Menara Internusa Surabaya can be seen in Table 1.

Table 1 Experiment Combinations $L_9(3^4)$

Eksperiment	Factors		
	Light Intensity	Sound Intensity	Type of Music
1	1	1	1
2	1	2	2
3	1	3	3
4	2	1	2
5	2	2	3
6	3	1	3
7	3	2	3
8	3	2	1
9	3	3	2

With a description of the level of each factor, namely for the light intensity factor level 1 is 100-250 Lux, level 2 is 500-800 lux, level 3 is 850-1050 lux, then for the sound intensity factor level 1 is 75-80 dB, level 2 is 80-85 dB, 85-90 dB, and for the music type factor level 1 is dangdut, level 2 is pop, and level 3 is jazz.

Experiments were run according to table 1 above. For example, when running the first experiment, the first level of each factor will be used which is 100-250 lux light, 75-80 dB sound intensity, and dangdut music. The implementation of the experiment will begin with setting the lighting, music and sound intensity at the station that has been provided. Then the employees for fillets will alternately go to the station to carry out salmon fillet activities, data collection of fillet output will be taken per hour and will be repeated twice, the implementation of the experiment will be carried out at 09.00-12.00 and continued again at 13.00-14.00.

Because the study situation was carried out directly when the production process in the factory was running, so that it had to pay attention so that the production process was not disrupted during the experiment, the implementation of the experiment (as described in the previous paragraph) was not ideal. Where the ideal experimental process is the collection of data on the output of fillet division employees in each combination should be carried out by all fillet division employees simultaneously instead of alternately as was done in this experiment.

3.2 Experiment Result Data

After the experiment implementation stage is carried out, a record of the fillet results of each employee in each experimental combination will be obtained, which will then be used to calculate the average output of the fillet division employees or in this study will be equated with the productivity (output / input) of the fillet division. The productivity of the salmon fillet division can be seen in Table 2.

Table 2 Productivity Data of Fillet Division

Combination	Fillet Division Productivity	
	R1	R2
1	93.333	94.667
2	87.000	84.000
3	90.667	91.333
4	86.000	84.000
5	84.000	86.667
6	100.000	100.667
7	81.667	83.333
8	95.333	90.667
9	92.000	94.00

3.3 Data Processing of Experiment Results

3.3.1 Calculation of Means and Signal to Noise Rasio (SNR)

At this stage, the average value and signal to noise ratio of the fillet output of each experimental combination will be calculated. The mean and SNR calculation data for each experiment can be seen in Table 3.

Table 3 Calculation Results of Mean and SNR

Combination	Fillet Division Productivity		SNR	Mean
	R1	R2		
1	93.333	94.667	39.4619	94.000
2	87.000	84.000	38.6353	85.500
3	90.667	91.333	39.1807	91.000
4	86.000	84.000	38.5866	85.000
5	84.000	86.667	38.6192	85.333
6	100.000	100.667	40.0288	100.333
7	81.667	83.333	38.3277	82.500
8	95.333	90.667	39.3615	93.000

Combination	Fillet Division Productivity		SNR	Mean
	R1	R2		
9	92.000	94.000	39.3682	93.000

3.3.2 ANOVA Calculation for Mean Values

At this stage, the ANOVA calculation will be carried out for the average value. This calculation will use formulas 2.2 to 2.16. This ANOVA calculation is done using the Minitab version 19 application. The results of the ANOVA calculation for the average value can be seen in Table 4.

Table 4 ANOVA Resluts for Mean Values

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Light Intensity	2	0.969	0.969	0.4846	0.32	0.760
Sound Intensity	2	105.228	105.228	52.6142	34.37	0.028
Type of Music	2	155.784	155.784	77.8920	50.88	0.019
Residual Error	2	3.062	3.062	1.5309		
Total	8	265.043				

In interpreting the results of ANOVA calculations, hypothesis testing will be carried out. The F table value is determined through the F table based on the free degree of treatment, namely 6 as F1 and the free degree of error, namely 2 as F2. The F table values for free degrees 6 and 2 (F1=6 and F2=2) at the 5% and 1% levels are 19.33 and 99.33, respectively. If you want to use the formula in Microsoft Excel, the formula used is FINV(α;df1:df2).

After obtaining the value of the F table, the next step is to compare this value with the results of F count. This comparison is done by hypothesis testing on each factor used in the experiment. The following hypothesis test is used for decision making in this study.

1. Light Intensity
   H0 : There is no effect of light intensity on the productivity of fillet employees
   H1 : Light intensity affects the productivity of fillet employees
   α : 0.05 or 5%
   CR : F count > F table 5% or F count > F table 1%
   F count : 0,32
   F table : 19.33 (5% level) and 99.33 (1% level)
   Decision : Accept H0, because F count < F table 5% or 0.32 < 19.33
   Conclusion: F count < f table at the 5% level, then H0 is accepted, meaning that light intensity has no effect on the productivity of fillet section employees.
2. Sound Intensity
   H0 : There is no effect of sound intensity on the productivity of fillet employees
   H1 : Sound intensity affects the productivity of fillet employees
   α : 0.05 or 5%
   CR : F count > F table 5% or F count > F table 1%
   F count : 34,37
   F table : 19.33 (5% level) and 99.33 (1% level)
   Decision : Reject H0, because F count > F table 5% or 34.37 > 19.33
   Conclusion: F count > F table at 5% level, then H0 is rejected, meaning that sound intensity has an influence on the productivity of fillet section employees and the difference between treatments is real.
3. Type of Music
   H0 : There is no effect of music type on fillet employee productivity
   H1 : Music type affects the productivity of fillet employees
   α : 0.05 or 5%
   CR : F count > F table 5% or F count > F table 1%
   F count : 50,88
   F table : 19.33 (5% level) and 99.33 (1% level)

Decision : Reject H0, because F count>F table 5% or 50.88>19.33
Conclusion: F count > F table at 5% level, then H0 is rejected, meaning that the type of music has an influence on the productivity of fillet section employees and the difference between treatments is real.

It can be seen from the results of the hypothesis test above, it can be concluded that the factors of sound intensity and music type have a significant influence on the productivity that can be produced by fillet employees and the differences between the effects of treatments are real. This is based on the calculated F value of the two factors which is greater than the F table at the 5% level. The results of the Main Effect Plot for the average value can be seen in Figure 2.

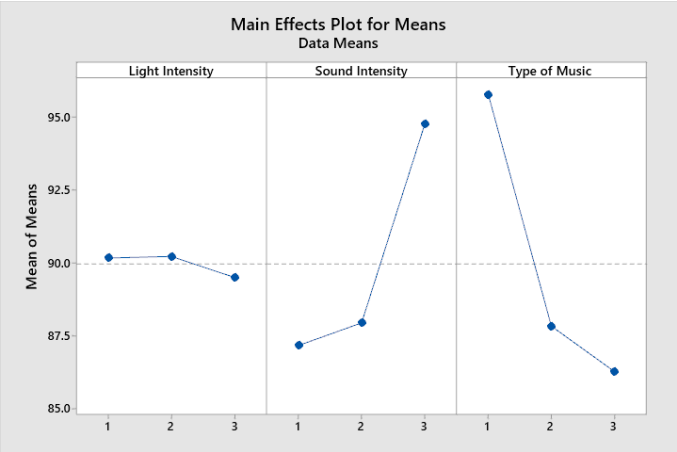

Figure 2 Main Effect Plot of Means Values

Based on Figure 4, it can be seen that when the sound intensity is at level 3, it produces the highest productivity value which can reach 94.7778 tails. In the music type factor, the productivity value of the fillet division is at level 1, which is 95.7778 tails. So it can be determined that the optimal level for influential factors based on the average experimental results is level 3 sound intensity factor (85-90 dB) and level 1 music type factor (dangdut).

3.3.3 ANOVA Calculation for SNR Value

Signal To Noise Ratio is a value of how well a process maintains consistency or accuracy with respect to relevant factors. The SNR calculation is performed to select the largest factor level to optimise the quality characteristics of the experiment. The SNR calculation formula depends on the characteristics of the desired results, where in this study using the larger is better characteristic. The way to interpret the SNR value is always the same in all characteristics, namely the greater the SNR value, the better. The steps taken are the same as the ANOVA calculation of the average value. ANOVA calculation of SNR aims to identify the effect of the level of the factor on the variability of productivity of fillet division employees. ANOVA calculations were performed using the Minitab version 19 application. The results of ANOVA calculations for SNR values can be seen in Table 5.

Table 5 Anova Results for SNR Values

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Light Intensity	2	0.00910	0.00910	0.004550	0.25	0.802
Sound Intensity	2	0.97236	0.97236	0.486181	26.46	0.036
Type of Music	2	1.41710	1.41710	0.708549	38.56	0.025
Residual Error	2	0.03675	0.03675	0.018374		
Total	8	2.43531				

In interpreting the results of ANOVA calculations, hypothesis testing will be carried out. The F table value is determined through the F table using the treatment free degree of 6 as F1 and the error free degree of 2 as F2. The F table values for free degrees 6 and 2 (F1 = 6 and F2 = 2) at

the 5% and 1% levels are 19.33 and 99.33, respectively. If you want to use the formula in Microsoft Excel, then the formula entered is FINV (α;df1;df2).

After obtaining the value of the F table, the next step is to compare this value with the results of F count. This comparison is done by making a hypothesis test on each factor used in the experiment. The following hypothesis test is used in making decisions in this study.

1. Light Intensity
   H0 : There is no effect of light intensity on the productivity of fillet employees
   H1 : Light intensity affects the productivity of fillet employees
   α : 0.05 or 5%
   CR : F count > F table 5% or F count > F table 1%
   F count : 0,25
   F table : 19.33 (5% level) and 99.33 (1% level)
   Decision : Accept H0, because F count < F table 5% or 0.25 < 19.33
   Conclusion: F count < F table at 5% level, then H0 is accepted, meaning that light intensity has no influence on the variability of productivity of fillet section employees.
2. Sound Intensity
   H0 : There is no effect of sound intensity on the productivity of fillet employees
   H1 : Sound intensity affects the productivity of fillet employees
   α : 0.05 or 5%
   CR : F count > F table 5% or F count > F table 1%
   F count : 26,46
   F table : 19.33 (5% level) and 99.33 (1% level)
   Decision : Reject H0, because F count > F table 5% or 26.46 > 19.33
   Conclusion: F count > F table at 5% level, then H0 is rejected, meaning that sound intensity has an influence on the variability of productivity of fillet section employees and the difference between treatments is significant.
3. Type of Music
   H0 : There is no effect of music type on fillet employee productivity
   H1 : Type of music affects the productivity of fillet employees
   α : 0.05 or 5%
   CR : F count > F table 5% or F count > F table 1%
   F count : 38,56
   F table : 19.33 (5% level) and 99.33 (1% level)
   Decision : Reject H0, because F count > F table 5% or 38.56 > 19.33.
   Conclusion: F count > F table at 5% level, then H0 is rejected, meaning that the type of music has an influence on the variability of employee productivity in the fillet section among the real treatments.

As can be seen from the results of the hypothesis testing above, it can be concluded that the factors of sound intensity and music type have a significant influence on the variability of fillet productivity and the differences between the treatment effects are significant. This is based on the calculated F value of the two factors which is greater than the F table at the 5% level. The Main Effect Plot results for the average value can be seen in Figure 3.

The SNR value has a function to show how well the desired signal compares to unwanted noise in a system or process. The higher the SNR value, the better the quality or performance of the system. Based on Figure 5, the largest factor level value for each factor will be selected. The factor level that has the best SNR value is the sound intensity factor level 3 and the music type factor level 1.

3.4 Determination of Optimal Level Setting

After performing ANOVA calculations on the average value and SNR, the optimal level setting can be determined to increase the productivity of the fillet section. Determination of the optimal

level setting is done using Minitab version 19. The results of the optimal level setting can be seen in Tables 6 and 7.

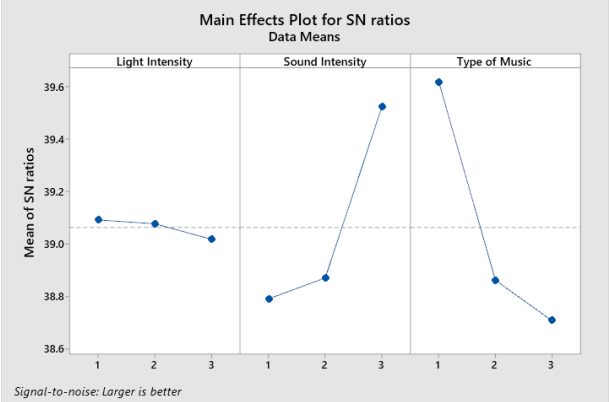

Figure 3 Main Effect Plot of SNR Values

Table 6 Optimal Setting Level

Faktor	Level	Setting Level
Intensitas Cahaya	2	500-800
Intensitas Suara	3	85-90 dB
Jenis Musik	1	Dangdut

Table 7 SNR and *Mean* Value of Optimal level Setting

S/N *Ratio*	Mean	StDev	Ln(StDev)
40.0948	100.852	0.680918	-0.598501

3.5 Calculation of Confidence Interval for Optimal Condition

1. Calculation of the confidence interval for the optimal condition of the average value. In this section there are two calculations, namely the calculation of $\mu_{prediction}$ and CI_{mean}. Here are the two calculations to get the confidence interval for the average optimal condition:
   - Calculation of $\mu_{prediction}$ or estimate of optimal conditions

     $\mu_{prediction} = \bar{y} + (\overline{A_2} - \bar{y}) + (\overline{B_3} - \bar{y}) + (\overline{C_1} - \bar{y})$ (1)

     $\mu_{prediction} = \overline{A_2} + \overline{B_3} + \overline{C_1} - 2\bar{y}$

     $\mu_{prediction} = 90{,}2222 + 94{,}7778 + 95{,}7778 - 2x89{,}963$

     $\mu_{prediction} = 100{,}852$
   - Calculation of CI_{mean}

     Before calculating CI_{mean}, it is necessary to calculate the value of n_{eff}. he following is the calculation of the value using the formula:

     $n_{eff} = \frac{Total\ Number\ Experiment}{1+Number\ of\ DF\ in\ the\ average\ estimate}$ (2)

     $n_{eff} = \frac{9\ x\ 2}{1+DF_A+DF_B+DF_C}$

     $n_{eff} = \frac{9\ x\ 2}{1+2+2+2} = 2{,}571$

     After getting the n_{eff} value, it is necessary to calculate the CI_{mean} value as follows:

     $$CI_{mean} = \pm\sqrt{F_{(\alpha,v1,v2)}x\ MS_e x \frac{1}{n_{eff}}} \quad (3)$$

     $$CI_{mean} = \pm\sqrt{F_{(0{,}05,1,2)}x\ 1{,}5309x \frac{1}{2{,}571}}$$

     $$CI_{mean} = \pm\sqrt{18{,}51x\ 1{,}5309x0{,}3889}$$

CI_{mean} = ±$\sqrt{11,02}$

CI_{mean} = ± 3,319

Based on the calculation results of $\mu_{prediction}$ and CI_{mean}, the optimal average value confidence interval is obtained as follows:

$$\mu_{prediction} - CI_{mean} \leq \mu_{prediction} \leq \mu_{prediction} - CI_{mean}$$

$$100,852 - 3,319 \leq \mu_{prediction} \leq 100,852 + 3,319$$

$$97,533 \leq \mu_{prediction} \leq 104,171$$

2. Calculation of the confidence interval for the optimal condition of the SNR value. In this section there are two calculations, namely the calculation of SNRprediksi and CISNR. Here are the two calculations to get the confidence interval for the average optimal condition:
   - Calculation of $SNR_{predictoni}$ or estimated optimal conditions
     $SNR_{prediction} = \overline{SNR} + (\overline{A_2} - \overline{SNR}) + (\overline{B_3} - \overline{SNR}) + (\overline{C_1} - \overline{SNR})$ (4)
     $SNR_{prediction} = \overline{A_2} + \overline{B_3} + \overline{C_1} - 2\,\overline{SNR}$
     $SNR_{prediction}$ = 39,0926 + 39,5259 + 39,6174 – 2x39,063
     $SNR_{prediction}$ = 40,1099
   - Calculation of n_{eff}
     Before calculating CI_{SNR}, it is necessary to calculate the value of n_{eff}. The following is the calculation of the n_{eff} value using formula 2:
     $n_{eff} = \frac{Total\ Number\ Experiment}{1+Number\ of\ DF\ in\ the\ average\ estimate}$
     $n_{eff} = \frac{9}{1+DF_A+DF_B+DF_C}$
     $n_{eff} = \frac{9}{1+2+2+2} = 1,286$

After obtaining the neff value, it is necessary to calculate the CI_{SNR} value as follows:

$$CI_{SNR} = \pm\sqrt{F_{(\alpha,v1,v2)}x\ MS_e x \frac{1}{n_{eff}}} \quad (5)$$

$$CI_{SNR} = \pm\sqrt{F_{(0,05,1,2)}x\ 0,018374x \frac{1}{1,286}}$$

$$CI_{SNR} = \pm\sqrt{18,51x\ 0,18374x0,7776}$$

$$CI_{SNR} = \pm\sqrt{2,607}$$

$$CI_{SNR} = \pm\ 1,6146$$

Based on the calculation results of $SNR_{prediksi}$ and CI_{SNR}, the optimal average value confidence interval is obtained as follows:

$$SNR_{prediction} - CI_{SNR} \leq SNR_{prediction} \leq SNR_{prediction} - CI_{SNR}$$

$$40,1099 - 1,6146 \leq SNR_{prediction} \leq 40,1099 + 1,6146$$

$$38,4953 \leq SNR_{prediction} \leq 41,7245$$

3.6 Confirmation Experiment

The data from the confirmation experiment can be seen in Table 8.

Table 8 Productivity Results of Fillet Division in the Confirmation Experiment

Day	Hours	Output	Input (Number of Workers)	Productivity Value
1	3	296	3	98.66667
1	4	300	3	100
1	5	296	3	98.66667
2	4	292	3	97.33333
2	5	306	3	102
2	7	290	3	96.66667
3	3	300	3	100
3	7	306	3	102

After getting the data from the confirmation experiment results, the average value (mean) and SNR will be calculated with the lager the better classification. The following is the calculation of the average value and SNR of the work environment of the confirmation experiment results:

1. Average score calculation (*mean*)

$$\mu = \frac{1}{n}\sum_{i=1}^{n} yi \quad (6)$$

$$\mu = \frac{1}{8}(98{,}667 + 100 + 98{,}667 + 97{,}333 + 102 + 96{,}667 + 100 + 102)$$

$$\mu = \frac{1}{8}(795{,}333) = 99{,}41667$$

2. SNR value with larger is better classification using the formula using formula 2.19

$$SNR = -10\log\left(\frac{1}{n}\sum_{t=0}^{n}\frac{1}{Y_i^2}\right) \quad (7)$$

$$SNR = -10\log(\frac{1}{8}(\frac{1}{98{,}667^2} + \frac{1}{100^2} + \frac{1}{98{,}667^2} + \frac{1}{97{,}333^2} + \frac{1}{102^2} + \frac{1}{96{,}667^2} + \frac{1}{100^2} + \frac{1}{102^2}))$$

$$SNR = -10\log(\frac{1}{8}(0{,}00010272+0{,}0001+0{,}00010272+0{,}00010555+0{,}00009611+0{,}000107+0{,}0001+0{,}00009611)$$

$$SNR = -10\log(\frac{1}{8}(0{,}00071391)$$

$$SNR = -10\log(0{,}00008923875)$$

$$SNR = 40{,}494$$

Furthermore, a confidence interval calculation will be carried out to determine whether the experimental design fulfils the existing requirements. The calculation of the confidence interval will be carried out on the average value and SNR. The following is the calculation of the confidence interval for the average value and SNR.

1. Calculation of the confidence interval for the mean value using formula 3:

$$CI_{mean} = \pm\sqrt{F_{(\alpha,v1,v2)}x\ MS_e x\left|\frac{1}{n_{eff}} + \frac{1}{r}\right|}$$

$$CI_{mean} = \pm\sqrt{F_{(0{,}05,1,2)}x\ 1{,}5309x\left|\frac{1}{2{,}571} + \frac{1}{8}\right|}$$

$$CI_{mean} = \pm\sqrt{18{,}51x\ 1{,}5309x0{,}05139}$$

$$CI_{mean} = \pm\sqrt{14{,}5638}$$

$$CI_{mean} = \pm\ 3{,}816$$

Based on the calculation of the mean (μ) dan CI_{mean}, the confidence interval of the confirmation experiment for the mean value is:

$$\mu_{confirmation} - CI_{mean} \le \mu_{confirmation} \le \mu_{confirmation} - CI_{mean}$$

$$99{,}41667 - 3{,}816 \le \mu_{confirmation} \le 99{,}41667 + 3{,}816$$

$$95{,}6 \le \mu_{confirmation} \le 102{,}8$$

2. Calculation of confidence interval for SNR value using formula 4

$$CI_{SNR} = \pm\sqrt{F_{(\alpha,v1,v2)} x\ MS_e x \left|\frac{1}{n_{eff}} + \frac{1}{r}\right|}$$

$$CI_{SNR} = \pm\sqrt{F_{(0,05,1,2)} x\ 0{,}018374 x \left|\frac{1}{1{,}286} + \frac{1}{5}\right|}$$

$$CI_{SNR} = \pm\sqrt{18{,}51 x\ 0{,}18374 x 0{,}9776}$$

$$CI_{SNR} = \pm\sqrt{3{,}3248}$$

$$CI_{SNR} = \pm\ 1{,}8234$$

Based on the calculation results of $SNR_{prediksi}$ and CI_{SNR}, the optimal average value confidence interval is obtained as follows:

$$SNR_{confirmation} - CI_{SNR} \leq SNR_{confirmation} \leq SNR_{confirmation} - CI_{SNR}$$

$$40{,}494 - 1{,}8234 \leq SNR_{confirmation} \leq 40{,}494 + 1{,}8234$$

$$38{,}67 \leq SNR_{confirmation} \leq 42{,}31$$

After obtaining the results of the confidence interval calculation for the confirmation experiment, the results will be compared with the optimal condition confidence interval. The following is a comparison of the optimal confidence interval with confirmation for each average value and SNR.

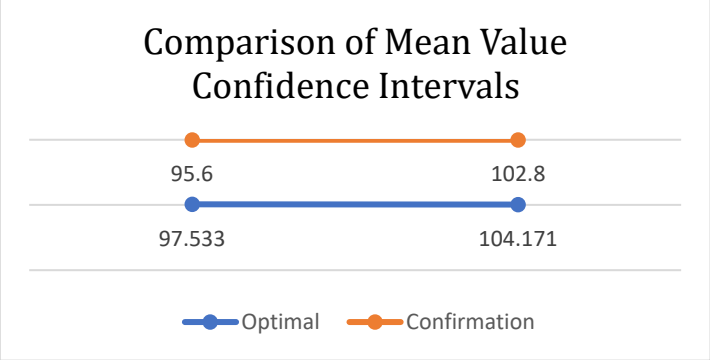

Figure 4 Comparasion of Mean Value Confidence Intervals

Based on Figure 4 above, it can be concluded that the results of the confirmation experiment for the average value are acceptable. It can be seen that the confirmation experiment confidence interval line intersects with the optimal condition confidence interval line.

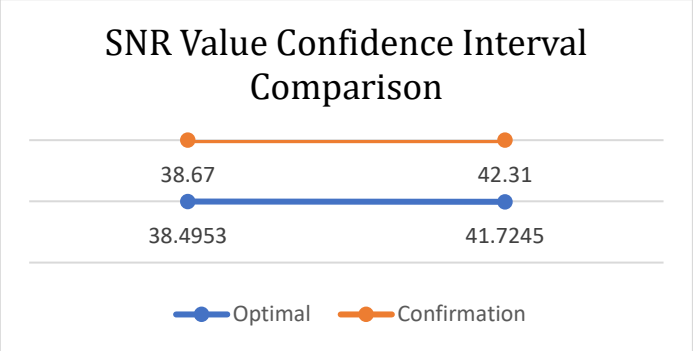

Figure 5 Comparison of SNR Value Confidence Intervals

Figure 5 above also shows that the results of the confirmation experiment for the SNR value are acceptable. It can be seen that the confirmation experiment confidence interval line intersects with the optimal condition confidence interval line.

After conducting the confirmation experiment stage, this comparison is carried out to determine whether there is an increase in productivity value or not, and whether there is a decrease in variation in productivity value after the experimental design is carried out with the optimal level combination. The following tables and graphs show the comparison of the productivity values of the initial and proposed fillet divisions.

Table 9 Comparison of Initial and Proposed fillet Division Productivity

Hour	Initial Productivity (Pre Study Data)	Proposed Productivity
3	98,96471	99,33334
4	92,36364	98,66667
5	92,84848	100,33334
7	99,26471	99,33334
Average	95,86	99,416

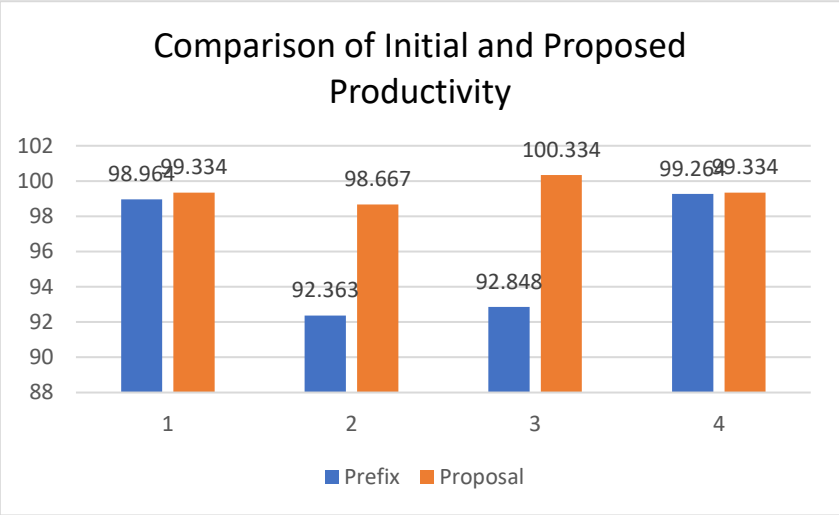

Figure 6 Comparison of Initial and Proposed Productivity

It can be seen in Table 9 and Figure 6 after the confirmation experiment, the average productivity value of the fillet division in the confirmation experiment is 99.416 which was previously only 95.86 which means an increase of 3.556. It can be concluded that the level setting in this confirmation experiment is considered to increase the productivity of the salmon fillet division at PT Bumi Menara Internusa.

4. Conclusions

From the Taguchi experiments conducted, an optimal physical environment tuning design was obtained for filleting activities in the production of frozen salmon products. The tuning design is a combination of levels and factors that can produce productivity values that are close to the target value and have the minimum variation possible. It can be seen from the comparison of initial and proposed productivity which has increased by 3.556. From the analysis that has been done, it is concluded that the factors that have a significant effect on the productivity of salmon fillet employees are sound intensity and song type. The optimal tuning design for these factors is sound intensity set at level 3 (85-90 dB), and music type at level 1 (dangdut).

References

Hadi, Y., Irawan, R., & Kelana, O. H. (2018). Peningkatan Produktivitas UMKM Menggunakan Metode American Productivity Center. *Jurnal Metris*, *19*(01), 7-18.

Iriawan, N., & Astuti, S. P. (2006). *Mengolah Data Statistik dengan Mudah Menggunakan Minitab 14*. Yogyakarta: Andi.

Komariah, A., & Lestari, M. S. (2016). Pengaruh Suhu dan Intensitas Cahaya terhadap Waktu Penyelesaian Target Pekerjaan Perakitan. *Prosiding SNAST*, 206-211.

Montgomery, D.C. (2013). *Design and Analysis of Experiments (8th ed.)*. Massachusetts: John Wiley and Sons, Inc.

Nugroho, A.J. (2021). *Tinjauan Produktivitas dari Sudut Pandang Ergonomi (1st ed.)*. Padang: PACE.

Sedarmayanti. (2011). *Tata Kerja dan Produktivitas Kerja (3rd ed.)*. Bandung: CV. Mandar Maju.

Setiyanto, H. (2011). *Study Identifikasi Pengaruh Jenis Musik terhadap Produktivitas Kerja* [Unpublished undergraduate thesis]. Universitas Islam Indonesia.

Sijoatmodjo, R., & Hadi, Y. (2021). Analisis Produktivitas Unit Produksi di Perusahaan Abon UD Sumber Hasil Malang dengan Menggunakan Metode Objective Matrix (Omax). *Jurnal Sains dan Aplikasi Keilmuan Teknik Industri (SAKTI), 1*(1), 39-42. https://doi.org/10.33479/jtiumc.v1i1.6

Padmanaba, C. G. R. (2006). Pengaruh penerangan dalam ruang terhadap produktivitas kerja mahasiswa desain interior. *Dimensi Interior*, *4*(2), 57-63.

Pranogyo, A.B. (2020*). Modul Pembelajaran Manajemen Operasional 1*. Jakarta: Sekolah Tinggi Ilmu Ekonomi Jakarta.

Puspitaratna, M., & Dwiyanti, E. (2013). Perbedaan sebelum dan sesudah pemberian musik pengiring kerja terhadap peningkatan produktivitas pada pekerja wanita pabrik rokok gagak hitam kabupaten bondowoso. *The Indonesian Journal of Occupational Safety and Health*, *2*(2), 167-174.

Yusuf, M. (2013). Pengaruh Kebisingan terhadap Waktu Penyelesaian Pekerjaan Operator. *Prosiding Industrial Engineering National Conference (IENACO).*

This page is intentionally left blank