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PREFACE

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THE PERFORMANCE OF IRREGULAR BUILDING STRUCTURES USING PUSHOVER ANALYSIS

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Abstract. High-rise buildings are at risk of collapse due to the earthquake. One method for analyzing earthquake loads is Pushover. Pushover is a non-linear static analysis to determine the behavior of a building collapse. This research was conducted to determine the performance of the setback building with a soft first story due to the earthquake based on the results of the pushover analysis curve. The structure is modeled as a 2-dimensional portal with a form of structural irregularity (setback with the soft first story) which consists of 2 structural models with different setback area ratios. The results of the analysis of this study indicate that the maximum shear force based on capacity curves in type 1 and type 2 buildings are 50260549.81 N and 53560488.63 N. Buildings with smaller setback area ratios, i.e., type 2 buildings have displacement, story drift, and base shear are more significant than type 1 buildings. Performance of type 1 and Type 2 building structures that refer to ATC-40 and FEMA 356 is at the Damage Control level.

Keywords : Pushover, Setback, Soft First Story

1. INTRODUCTION

High-rise buildings will collapse if not properly designed and built under existing rules and regulations [1] [2]. Building design nowadays often uses performance-based building planning or called performance-based design. In this study, the structure is modeled as a 2-dimensional portal in the form of irregular structure (setback with the soft first story) which consists of 2 structural models with different setback area ratios[3].

In this design, the performance of a building against an earthquake can be seen its collapse mechanism in the form of a curve. Pushover analysis or also called static thrust load analysis is needed to determine the pattern of collapse in the building [4]. In addition to obtaining the failure mechanism, with pushover analysis, it can be seen that the performance level of a building that refers to FEMA 356 and ATC 40 [5] [6]. A study on soft-story buildings obtained the maximum deviation occurred before the collapse, the level of structural performance based on FEMA-365 is at the Damage Control level that is the condition of the building has not suffered significant damage and can be re-functioned [3] [7].

2. METHODS

In this study, the authors designed an irregular building that is a setback building with a soft first story. The building functions as an office building, which consists of 10 floors. Ratio setback area to the lower story area of building type 1 is 0.3, and building type 2 is 0.6. Based on preliminary design results, the thickness of the floor plate is 12 cm, the dimensions of the beam are 65x40 cm, while the columns are distinguished on every three floors, on floors 1-4 120x120 cm, on floors 5-7 100x100 cm, and floors 8-10 90x90 cm [8] [9]. The building structure system uses a special moment bearing frame system.

3.1 Design Data

In this research, the building is planned to be in Semarang in a strong earthquake zone, with a soft soil type [10]. The building structure system uses a special moment bearing frame system, with 40 MPa steel quality (fy) and 35 MPa concrete quality (f'c).

Research in this study includes several stages, including preliminary design, calculation of loading, structural modeling, structural analysis, and pushover analysis. The flow chart in this final project research is presented in Figure 1.

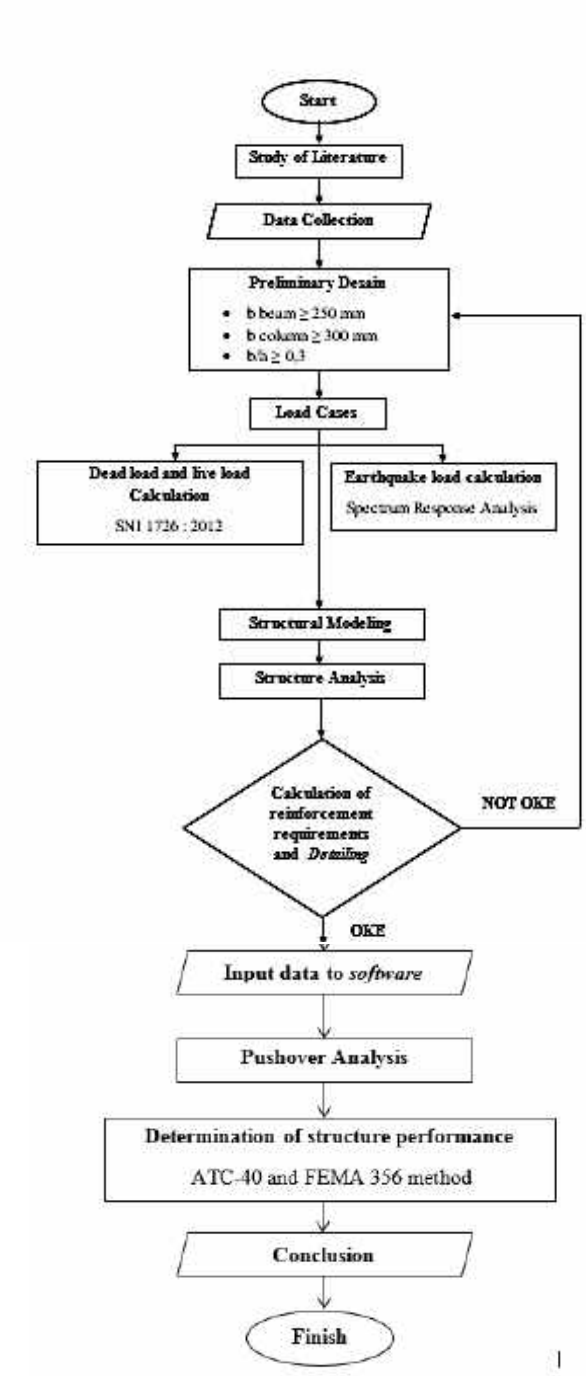

Figure 1. Flow Chart

3. RESULTS AND DISCUSSION

3.1 Modeling and Analysis of Building Type 1

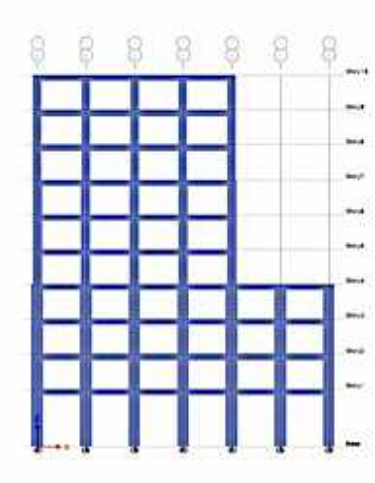

Figure 2. elevation view (Building Type 1)

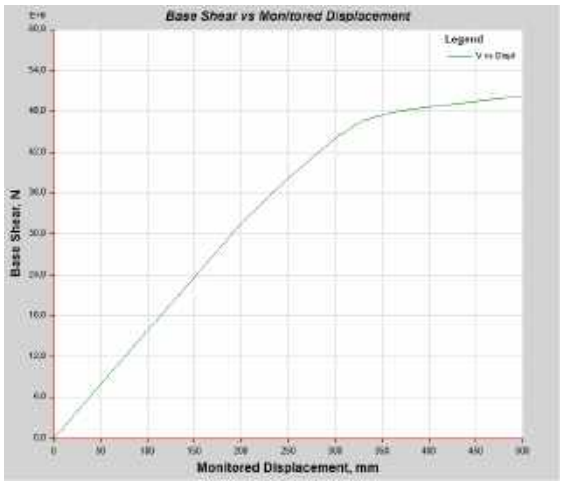

Figure 3. Pushover curve (Building type 1)

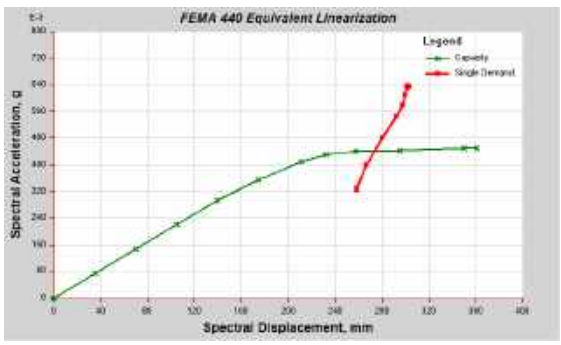

Figure 4. capacity spectrum curve ATC 40 (Building type 1)

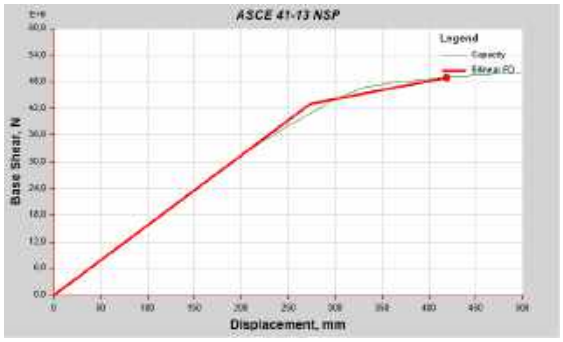

Figure 5. Bilinear curve FEMA 356 (Building type 1)

3.2 Modeling and Analysis of Building Type 2

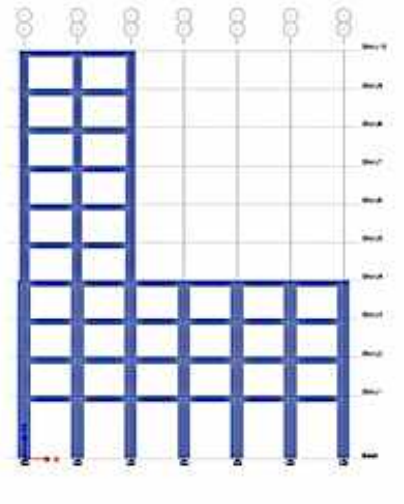

Figure 6. elevation view (Building Type 2)

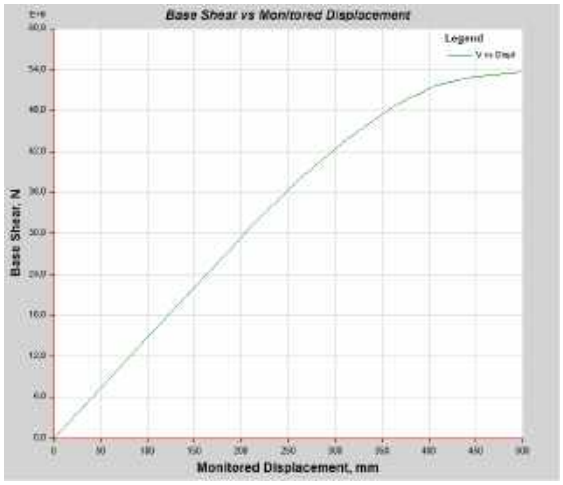

Figure 7. Pushover curve (Building type 1)

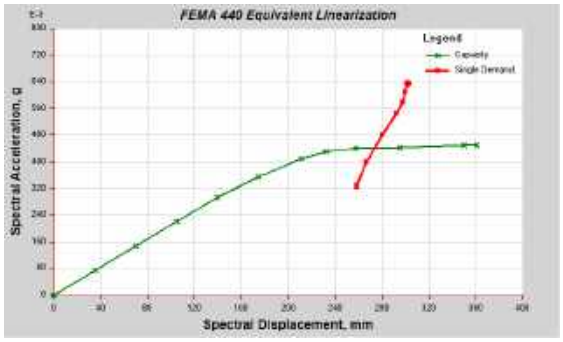

Figure 8. capacity spectrum curve ATC 40 (Building type 2)

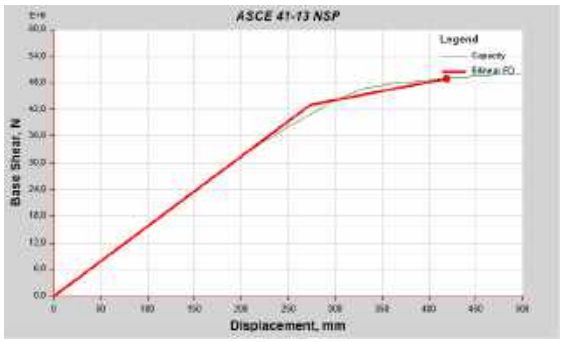

Figure 9. Bilinear curve FEMA 356 (Building type 2)

3.3 Pushover Analysis

3.3.1 Displacement

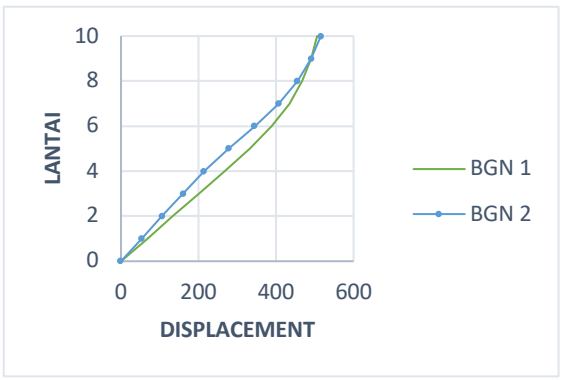

Figure 10. Displacement of Type 1 and Type 2 Building in the X-Direction

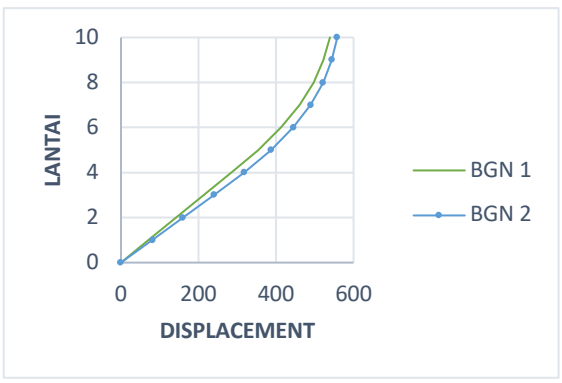

Figure 11. Displacement of Type 1 and Type 2 Building in the Y-Direction

Based on the results of pushover analysis, it is shown that the building that has the maximum displacement in the X direction (Figure 10) and the Y direction (Figure 11) is in type 2 buildings, ie buildings with a ratio of setback area smaller than type 1 buildings namely 515.68 mm in X direction and 558,105 mm in the Y direction. The results are following one of the journals in which the most significant displacement was in a regular building.[1][11].

3.3.2 Story Drift

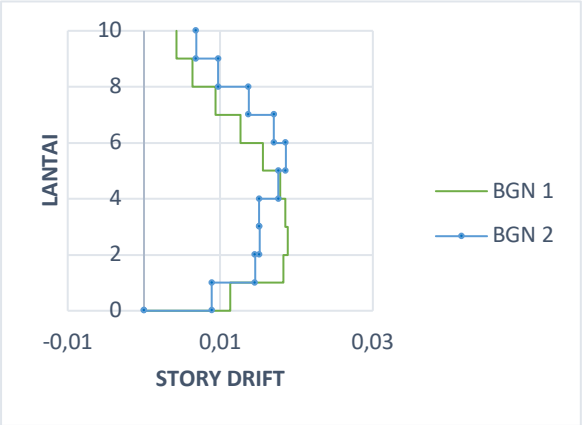

Figure 12. Story Drift of Type 1 and Type 2 Building in the X-Direction

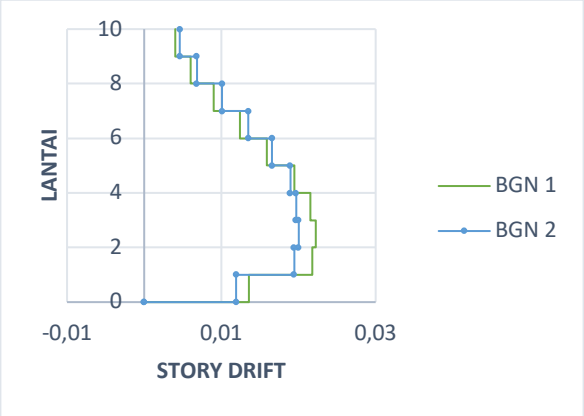

Figure 13. Story Drift of Type 1 and Type 2 Building in the Y-Direction

Based on the results of pushover analysis shows that the building that has the most significant story drift in the X direction (Figure 12) and the Y direction (Figure 13) is in the type 2 building that is the building with a setback area ratio smaller than the type 1 building that is, 0.0186 in the direction X and 0.0043 in the Y-direction. The results are per one of the journals wherein the study the most significant story drift was in a regular building [1] [12][13]

3.3.3 Base Shear

Table 1. Maximum Base Shear

Building Type	Maximum Displacement	Maximum Base Shear
	mm	KN
Type 1	499,308	50260,549
Type 2	499,654	53560,488

3.4 Performance Level Result

Table 2. Performance Level Result

	Direction	Parameter	Pushover Analysis Result	
			ATC-40	FEMA 356
Type 1	x-x	Performance Point, Δ_m (m)	0,432	0,525
		Actual Drift	0,011	0,013
		Performance level	*Damage Control*	*Damage Control*
	y-y	Performance Point, Δ_m (m)	0,445	0,595
		Actual Drift	0,012	0,015
		Performance level	*Damage Control*	*Damage Control*
Type 2	x-x	Performance Point, Δ_m (m)	0,403	0,720
		Actual Drift	0,010	0,018
		Performance level	*Damage Control*	*Damage Control*
	y-y	Performance Point, Δ_m (m)	0,403	0,705
		Actual Drift	0,010	0,018
		Performance level	*Damage Control*	*Damage Control*

Based on Table 2 the level of structural performance based on ATC 40 and FEMA 356 is at the level of Damage Control which means the building is still able to withstand earthquakes that occur with minimal risk of human casualties [14] [15][16]. The results refer to a journal in which the setback building is at the Damage Control level [3].

4. CONCLUSION

From the results of the analysis and discussion of the two types of setback buildings with a soft first story, the following conclusions can be drawn:

1. The building that has the highest displacement in the X direction and the Y direction is in the type 2 building that is the building with a setback area ratio that is smaller than the type 1 building that is 515.68 mm in the X direction and 558.105 mm in the Y direction.
2. The building that has the most significant story drift in the X direction and the Y direction is in the type 2 building that is the building with a setback area ratio that is smaller than the type 1 building that is, 0.0186 in the X and 0 directions. 0043 in the Y direction.
3. Maximum shear forces based on capacity curves in type 1 and type 2 buildings are 50260.55 kN and 53560.49 kN.
4. The Structural performance level based on FEMA 356 displacement coefficient method and ATC-40 capacity spectrum method on both building types are at Damage Control level which means the building is still able to withstand earthquakes that occur and not experience significant damage.
5. In buildings type 1 and type 2, the first yielding occurs in the first beam then the column, which means the building is under the strong column weak beam system.

5. ACKNOWLEDGEMENT

The authors would like to thank the P3M of Politeknik Negeri Jakarta for the funding provided by the BTAM program.

6. REFERENCES

[1] S. Shinde, D N; Patil, "Pushover Analysis To Study Seismic Performances Of Vertical Irregular Structure," *Int. J. Res. Eng. Technol.*, vol. 5, no. 6, pp. 2319–2322, 2016.
[2] A. Nasution, *Analisis dan Desain Struktur Beton Bertulang*. Bandung: Penerbit ITB, 2009.
[3] H. Y. Mamesah, "Analisis Pushover pada Bangunan dengan Soft First Story," *J. Sipil Statik*, vol. 2, no. 4, pp. 214–224, 2014.
[4] V. Verma, "Seismic Analysis And Comparison Of Vertical Irregular Building Cases Using Response Spectrum," *Int. J. Appl. or Innov. Eng. Manag.*, vol. 7, no. 8, pp. 28–35, 2018.
[5] L. R. Wankhede and P. Nikose, "Evaluation and Comparision of Response Reduction Factor (R Value) by Pushover Analysis and Response Spectrum Analysis of Irregular Buildings," *Int. Res. J. Eng. Technol.*, vol. 5, no. 4, pp. 2248–2253, 2018.
[6] Y. A. Pranata, "Evaluasi Kinerja Gedung Beton Bertulang Tahan Gempa dengan Pushover Analysis," *J. Tek. Sipil*, vol. 3, no. 1, pp. 41–52, 2006.
[7] H. . Manalip, R. S. . Windah, and S. O. Dapas, "Analisis Pushover pada Struktur Gedung Bertingkat Tipe Podium," *J. Sipil Statik*, vol. 2, no. 4, pp. 201–213, 2014.
[8] Badan Standardisasi Nasional, "Persyaratan Beton Struktural Untuk Bangunan Gedung (SNI 2847:2013)," *Bsn*, pp. 1–265, 2013.
[9] Badan Standardisasi Nasional Indonesia, "Beban minimum untuk perancangan bangunan gedung dan struktur lain," *Sni 17272013*, 2013.
[10] Badan Standardisasi Nasional Indonesia, "Tata Cara Perencanaan Ketahanan Gempa Untuk Struktur Bangunan Gedung dan Non Gedung (SNI 1726:2012)," *Sni 17262012*, p. 149, 2012.
[11] R. Efrida, "Pengaruh Setback Pada Bangunan Dengan Soft Story Terhadap Kinerja Struktur Akibat Beban Gempa," *J. Educ. Build.*, vol. 4, no. 1, pp. 62–69, 2018.
[12] B. Andreas, E. Rumimper, S. E. Wallah, R. S. Windah, and S. O. Dapas, "Perhitungan Inter Story Drift Pada Bangunan Tanpa Setback Dan Dengan Setback Akibat Gempa," *J. Sipil Statik*, vol. 1, no. 6, pp. 408–414, 2013.
[13] R. S. Lubis, "Kajian Respon Bangunan Soft Story Terhadap Pengaruh Gempa," Universitas Sumatera Utara, 2011.
[14] Tavio and U. Wijaya, *Desain Rekayasa Gempa Berbasis Kinerja (Performance Based Design)*, II. Yogyakarta, 2018.
[15] ATC-40, *Seismic Evaluation and Retrofit of Concrete Buildings*, vol. 1. California: Aplied Technology Council, 1996.
[16] FEMA-356, *Prestandard and Commentary for the Seismic Rehabilitation of Buildings*. Wasington, D.C.: Federal Emergency Management Agency, 2000.

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The Development of Teaching Material Design for Automotive Electrical and Electronics Laboratorium Based on Automotive-SKKNI to Improve the Achievement of Standar Competencies of Polytechnic Students

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Abstract. This progress report contains about the achievement of the implementation of the program of research in the development of teaching materials in the form of an integrated jobsheet. The second stage of the development will be done in 2018 with the goal to find: 1) the evaluation result from the expert, lectures, and students, 2) the obstacles during the try out, and 3) the feasibility of the jobsheet draft as a lab teaching material.
Research using Dick & Carey development model, in review and test the research involving 2 experts, 7 course lectureres,and 24 students in mechanical engineering department. Data obtained using questionnaire enclosed and open questionnaire. Data were collected in the form of comments and suggestions as well as the evaluation result toward the integrated jobsheet were analyzed by descriptive qualitative and quantitative improvement. The test results stated: 1) the content expert test is very decent; design / media expert is very decent; individual very decent; small group is very decent; and field testing of students and lecturer decent and very decent. 2) components that need to be revised from the entire contents of the test results and instructional design experts to field test were: The contents of the summary should be more material-oriented than the summary of jobsheet parts, in addition to trouble shooting ignition problems, it is necessary to add maintenance material that is preventive maintenance, assessment rubrics for evaluation /practical tasks need to be made in more detail from simple to complex practices. Summary and evaluation analysis tools must be clear, the amount of test practice material so that there is a balance of theory and practice, the size of the book should be chosen for an elegant appearance, especially if proposed to ISBN. Based on test data and analysis of the abovementioned, teaching material draft can be declared eligible as the practical of teaching jobsheet. This research only reached the stage of formative evaluation on Jobsheet, it is expected in the future to do more research to determine its effectiveness in an effort to increase the competence of students.

Keywords: Development, jobsheet integrated, competency standards, Polytechnic

1. INTRODUCTION

Polytechnic is a professional institute of higher education oriented to the needs of industry and ready-made resilience of learners become members of the community who have professional skills in their respective fields. In order for students or graduates of Polytechnics to be more competitive in the industrial world can be used in the world of work, of course they must have the competencies needed by the industry. Jobsheet in electricity

and automotive electronics practices based on SKKNI must be able to cover all competencies needed by the industry as formulated in the curriculum [1]. Student hard work also require more intensive practice learning. The course subjects that practice teaching materials are still not classified as the practice of Electricity and Electronics. Based on the preliminary survey of the research team, it concludes that there are two main issues in practical learning: l) the absence of innovative practice learning modules, practical lecture materials as outlined in the lesson plan (RPP) and Jobsheet less relevant to the Indonesian National Work Competency Standards (SKKNI) automotive field [2] and 2) practice teaching method with lecture (conventional) still become habit of teaching team. Based on the background explanation above, the main problem of this development research is how is the draft form of teaching materials in the form of an integrated jobsheet based on SKKNI in automotive field for electrical engineering and automotive electronics courses that can improve the achievement of competence in students majoring in mechanical engineering of Polytechnic.

Jobsheet as a practical teaching material used in the practice of electricity and automotive electronics majoring in mechanical engineering at Bali State Polytechnic has not fulfilled the demands of the applied curriculum, the number is very limited, meaning that it has not fulfilled the number of job practices available in electrical and automotive electronics practices. Judging from the scope of the material content, the number of jobsheets is still lacking which supports the Indonesian National Work Competency Standards (SKKNI) in the automotive sector,nor has the formulation of basic competencies and competency standards been found by students[6]. In addition, the evaluation aspects listed in the jobsheet show learning evaluations that do not focus on measuring the competencies achieved by students every time they finish learning per competency. Likewise, the implementation of evaluations in the form of tests developed by lecturers,emphasizes more on understanding cognitive content, has not focused on measuring attitudes and skills of students in the form of action tests (performance test). This condition has the potential to produce graduates who are not in accordance with the expected competency standards. [3]

As a practical teaching material, an integrated Jobsheet is a practical learning tool where the learning sheets are organized into a single unit. The learning sheets include: information sheets, instruction sheets, operation sheets,self check sheets, and evaluation sheet tools. Measurement of competency achievement in the action test sheet (porphomance test). These learning sheets are not separated from each other or must be an integral whole to achieve learning goals [4]. Referring to the problems above, it is necessary to improve the effectiveness and efficiency of the implementation of the electrical and automotive electronics program which is carried out by increasing the relevance and systematization of the jobsheet structure in accordance with competency requirements.[4] Thus an integrated jobsheet is needed for electrical and automotive electronics practices that are business oriented to support the improvement of student competency achievement. The results of the first year research (2017),have obtained drafts of electrical practice and automotive electronics textbooks based on the Indonesian National Work Competency Standards (SKKNI). Jobsheet's draft or prototype, the material is developed based on competency standards, basic competencies, and indicators of achieving competence. The main material of electrical and automotive electronics practice consists of 5 parts, namely: 1) conventional ignition system 2) electronic ignition system 3)body electrical system 4) filling system and 5) starter system. This development research is carried out in two phases, the first phase is carried out in 2017,and has received a jobsheet draft. The second phase is carried out in 2018 with the aim of knowing: 1) the results of the assessment of experts, lecturers and students, 2)constraints that need to be revised during the trial, and 3)the feasibility of the jobsheet draft as practical teaching materials. [3] Based on the preliminary survey of the research team, it concludes that there are two main issues in practical learning: l) the absence of innovative practice learning modules, practical lecture materials as outlined in the lesson plan and Jobsheet less relevant to the Indonesian National Work Competency Standards (SKKNI) automotive field and 2) practice teaching method with lecture (conventional) still become habit of teaching team. Based on the background explanation above, the main problem of this development research is how is the draft form of teaching materials in the form of an integrated jobsheet based on SKKNI in automotive field for electrical engineering and automotive electronics courses that can improve the achievement of competence in students majoring in mechanical engineering of Polytechnic.[5]

2. METHODS

2.1 Types and Research Design

This research material development study using the model of Dick & Carey (2007) and designed to take place in two years. A summary of key activities, subjects and products to be achieved within two years can be briefly described in the following Table 1.

Table 1. Table Expected Summary Of Activity And Product In The Second Step Of 2018

Step	Main Activities	Subject	Product
II-2018	1. Conduct expert test 2. Analyzes and revisions I 3. Conduct individual testing 4. Analysis and revisions II 5. Conduct group test small 6. Analysis and revision III 7. Conduct a class test 8. Analysis and revision IV 9.Dissemination	1. Field experts Studies 2. Technologist Learning 3. Assessment Expert 4. College student 5. Lecturer/Instructor	Practical teaching materials In the form of an integrated jobsheet that has been Validated

2.2 Population and Sample

The population of the study were students and lecturers of mechanical engineering, where the students were 140 people and 63 lecturers at the State Polytechnic of Bali. Samples were taken as many as 71 students distributed in three classes, namely engineering courses of classes IVA, IVB and IVC classes in 2018, and 7 lecturers special lecturer at Lab.Otomotif. In detail the state of the population is presented in the following Table 2.

Table 2. Sample Population of Research Preparing the Practice of Practice Materials in the Form of Integrated Jobheet at Bali State Polytechnic

No	Study Program	Number of Classes	Number of people
1.	Student majoring mechanical engineering (Smt IV)	3	71
2.	Lecturer/Instructor of Mechanical Engineering at Lab.Otomotif	-	7
	Amount	3	78

2.3 Second Year Development Procedure

The activities carried out in the development of practical teaching materials in the form of this jobsheet are as follows: a) Determination of Trial design, b) determination of Try Out Subjects, c) Identifying Data, d) Establish Research Instruments.

2.4 Data Analysis

Data collected from questionnaires from expert responses, students, and lecturers were analyzed descriptively. The feasibility and criteria for product revision are as follows [2].

Table 3 Feasibility Level and Product Revision Criteria

Scorecoards (%)	Eligibility
82,3 – 95,0	Very worth it
69,7 – 82,3	Well worth it
44,3 – 69,7	Quite decent
31,7 – 44,3	Less feasible, needs to be revised
19,0 – 31,7	Very unfeasible, it needs to be revised

3. RESULTS AND DISCUSSION

Research on the development of teaching materials in the form of an integrated jobsheet of Electrical Practices and Automotive Electronics based on the Indonesian National Work Competency Standards (SKKNI) in the automotive light vehicle sector at the stage of the 2nd year focused on developing the realm of review and trial, where the discussion focused on presenting and analyzing good data qualitative data in the form of responses and suggestions (revision) and quantitative which are the results of the assessment of teaching materials in the form of jobsheets developed [6]. The development of electricity practice and automotive electronics teaching materials based on the automotive field SKKNI in the second year (2018) stage is conducted the feasibility test of teaching

materials for students and lecturers and feasibility tests through content and design /learning media expert tests, as well as limited individual and field trials. The activities that have been carried out with the following results.

3.1 Test Expert Learning Content

The learning content expert is an expert in mechanical engineering and also at the same time a senior lecturer at Udayana University. As an assessor of the teaching materials for electrical and automotive electronics practices carried out by Ainul Ghurri Ph.D from the Faculty of Engineering, Udayana University, Denpasar. Competence Ainul Ghurri is an expert in mechanical engineering. Based on the data recapitulation the results of the assessment of the content of experts on the draft teaching materials for electricity and automotive electronics based on SKKNI in the automotive field of light vehicles is 95%. In the open questionnaire, there are several inputs from the learning content experts that will be described in the discussion section.

3.2Test Design/Learning Media Expert

Design experts/learning media were also asked to provide an expert in the field of learning technology from Undiksha. As a design and media expert, DR. I Made Pageh, M.Hum. His competence is one of the experts in the field of learning technology at the University of Education Ganesha Singaraja. Based on the data recapitulation of the assessment results of the learning design experts on the draft teaching materials for electrical and automotive electronics teaching practices based on the automotive field SKKNI obtained: 95.93%. Through an open questionnaire, there are several inputs from design experts and learning technology that will be described in the discussion section.

3.3 Field test for lecturer

In this case, the field trial was also given to lecturers on electrical practice and automotive electronics courses through a questionnaire to assess the practical teaching materials being developed. The results of the lecturers' assessment through a closed questionnaire showed a percentage of 86.75%. When converted into a range of feasibility and revision criteria for practical teaching materials with a level of achievement of a scale of 100, this percentage is in a very decent qualification, so that revisions are made to the teaching material only according to suggestions from the lecturer as explained in the discussion section Based on the results of the assessment of content and design experts as well as the assessment of electrical practice lecturers and automotive electronics can be described in the following diagram.

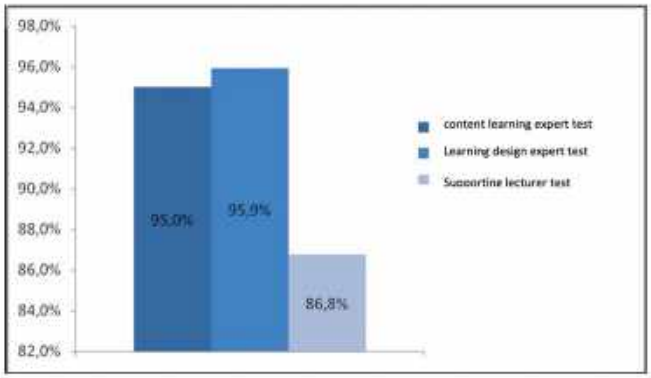

Figure 1. Test Results for Content Experts,Learning Designs and Lecturers.

3.4 Individual and Small Group Test Results

In this case the trial subject was a sixth semester student majoring in mechanical engineering at Bali State Polytechnic. Individual trial subjects are chosen randomly,as well. Small group trial subjects selected 6 students randomly based on the cluster of low, medium, and high ability of each cluster of 2 people.

Based on the calculation of the data recapitulation of the results of individual and small group trials of draft teaching materials on electricity practices and automotive electronics based on SKKNI in the field of automotive light vehicles obtained results: 84.38% and 84.82%. Through an open questionnaire, there are a number of inputs from students which will be described in the discussion section.

3.5 Field Trial Results

The subjects of the field trial were VI semester students and lecturers of electrical and automotive electronics practice in the mechanical engineering department of Bali State Polytechnic. Field trials were conducted at the

Bali State Polytechnic mechanical engineering department. The field test involved 7 lecturers and 24 students of the sixth semester. The average percentage of lecturer and student assessment results on practical teaching materials in the form of integrated jobsheet through an open questionnaire is 86.75% for the average score of the assessment of the lecturer group with some input that will be described in the discussion section.

Based on the results of individual testing, small groups and field tests from students on the design of teaching materials in electronic and automotive electrical practices can be explained in the form of the following diagram.

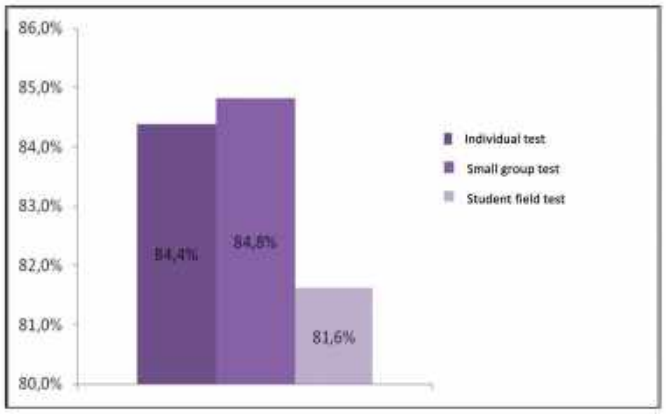

Figure 2. Individual Test Results,Small Groups and Student Field Tests.

Research on the development of teaching materials in the form of an integrated jobsheet of electrical and automotive electronics practices based on the Indonesian National Work Competency Standards (SKKNI) in the light vehicle automotive sector at the stage of the 2nd year focuses on developing the realm of review and trial,where the discussion is focused on the presentation and analysis of good data qualitative data in the form of responses and suggestions (revision) and quantitative which are the results of the assessment of teaching materials in the form of jobsheets developed.

Activities at the review or trial stage, the results of the development are carried out by evaluating the contents and design of learning media through expert content and design assessments. The product implementation in the form of jobsheet is carried out through individual, small group and field trials. The aim is to find out the effect on the quality of learning which ultimately aims to improve the achievement of the competency standards of students. Which includes changes, indicators of learning, content or content of learning materials, summaries, tests, answer keys, and others. Introduction includes completeness and clarity of content, sentence composition, ease, writing, attractiveness, and basic competencies (KD). The learning indicator (IP) includes the conformity of KD with IP, systemic compilation, formulation, presentation, and writing. The learning content includes the suitability of the material with IP, sequence, material description, presentation, and writing. The summary includes relevance to IP, source of test material, distribution of domains, number of items and writing. The answer key includes the correctness of the answer, meaning, writing and display. While others include effectiveness, attractiveness and efficiency of learning [6].

The implementation of this research is carried out only to formative evaluation, which deals with improvements to product development. The implementation carried out in this study is not comprehensive because in general there are only five jobs from the electrical and automotive electronics practice subjects. The last stage is to conduct evaluations which include formative evaluation and summative evaluation. Formative evaluation is carried out to collect results data at each stage that is used as reference in refinement while summative evaluation is carried out at the end of the program to determine its effect on student learning outcomes and the quality of learning broadly. At this stage of the research only formative evaluation was carried out, because this type of evaluation was related to the stages of development research to improve the development of the resulting teaching materials.

Based on the results of expert content and learning design assessment with a closed questionnaire on the subject of the development of teaching materials in the form of jobsheet Electrical Practices and Automotive Electronics, the assessment percentages were 95% and 95.93% respectively. The amount of each percentage if converted into Table 3. Regarding the level of eligibility and revision criteria with the conversion of the achievement level of the second 100 scale the percentage of the percentage is in a very decent qualification. This means that the practical teaching materials in the form of jobsheet are very suitable for the contents of the development material to be used as learning media in Electrical and Automotive Electronics Practices with the aim of increasing the achievement of polytechnic student competency standards and teaching materials only need to be revised sufficiently.

The revisions made to teaching materials based on input from content experts and learning design experts in Electrical and Automotive Electronics Practices are: 1) the details of the contents of the Information Sheet and Operation Sheet need to be detailed in the contents of the table of contents, 4) work safety has not been included in the competency basic and final learning objectives, 5) in addition to trouble shooting ignition problems, it is necessary to add maintenance / maintenance materials that are preventive maintenance, 6) assessment rubrics for evaluation / practical tasks need to be made in more detail (from simple to complex practices; or for example referring to psychomotor level in learning / psychomotor domain of learning), 7) summary and evaluation analysis tool must be clear, 8) the amount of practice test material so that there is a balance of theory and practice, it is recommended to make as many as 20 tests, 9) summary of teaching material transferred after the material of this guidebook, 10)the size of the book should be chosen so that the appearance is elegant, especially if it is proposed to the ISBN.

In the case of individual and small group trial subjects selected 1 and 6 students of the sixth semester majoring in mechanical engineering at Bali State Polytechnic were randomly selected based on the cluster of low, medium,and high ability of each cluster of 2 people. The percentage of their assessment through an open questionnaire on the development of practical teaching materials in the form of jobsheet was 84.38% and 84.82%. When converted into Table 3. About the level of eligibility and revision criteria with the conversion of the level of achievement of scale 100 then the category is very feasible and needs to be revised accordingly according to the input given by the student. Revisions made based on input during individual and small group trials of students on an open questionnaire include:1) the cover should be added to the D3 Mechanical Engineering study program, 2) use brighter colors in the guidebook writing 3) the instructional material was made in more detail, 4) the jobsheet preparation was made as interesting as possible so that it could attract student motivation.

In terms of the subject of field trials of the sixth semester students of mechanical engineering in number of 24 people. Showed that the percentage of the achievement of the development of practical teaching materials according to the student's assessment was 81.62%. If the percentage is converted into Table 3. About the feasibility and revision criteria for practical teaching materials at the level of achievement of 100, this means that the percentage of teaching materials in practice is in a proper qualification, so that teaching materials only require revisions according to suggestions and input from students, namely 1) overall need to add a lot of pictures of the ignition system and explanation, 2) between sample questions and answer keys are multiplied and need to be set more spacing distance, 3) how to assemble the ignition system components need to be explained in more detail, 4)jobsheet material made more detail, 5) need to add some picture information and clarify, 6) overall teaching materials on electrical practices and automotive electronics in the form of integrated jobsheets are good.

In this case, the field trial was also given to the lecturers of the Automotive Electrical and Electronics Practices subject through a questionnaire to assess the practical teaching materials being developed. The results of the lecturers' assessment through a closed questionnaire showed a percentage of 86.75%. When converted into Table 3. Regarding the feasibility and criteria for revising practical teaching materials with a level of achievement of 100, this percentage is in very decent qualifications, so that revisions are made to teaching materials only according to the suggestions of the lecturers, namely: 1)pictures enlarged so that the picture description is clear, 2)technical English terms on the self check sheet and operation sheet are written in italics, 3) real pictures need to be added to the operation sheet component, 4) in summary in addition to the practice procedure it is necessary to add practical material.) instructional material needs to be developed sustainably along with the development of technology in the field, 6) overall the draft materials for teaching electrical and electronic practices are good.

4. CONCLUSION

Based on the level of feasibility and revision criteria for the development of practical teaching materials that, quantitative data from the test results (assessments) of experts in the contents of teaching materials on electrical practices and automotive electronics with an average percentage: 95% stated very feasible, design experts and learning media: 95, 93% said it was very feasible, individuals: 84.38% very decent, small groups: 84.82% very feasible. Whereas the field test from the lecturer at the level of feasibility: 86.75% said it was very feasible,from students: 81.62% said it was very feasible.

All assessment results on the development of teaching materials on electrical and automotive electronics practices, both from content and learning design experts to the results of field tests provide some input in the form of suggestions namely; 1) The contents of the summary should be more material-oriented than the summary of jobsheet parts, 2) in addition to trouble shooting ignition problems, it is necessary to add maintenance/maintenance materials that are preventive maintenance. 3)assessment rubrics for evaluation/ practical assignments need to be made more detailed from simple to complex practices, 4) summary and evaluation analysis tools must be clear, 5) the number of practice test materials so that there are theoretical and practical balances, then 20 tests are recommended , 6) the size of the book should be chosen for an elegant appearance, especially if it is proposed to the ISBN.

Drafts of practical teaching materials in the form of integrated jobsheets material testing practices and metrology can be declared feasible as practical teaching materials.

5. ACKNOWLEDGEMENT

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6. REFERENCES

[1] Trianto, 2007. Constructivism-Driven Innovative Learning Models: Concepts, Theoretical-Practical Basis and Its Implementation. Jakarta: Achievement Library

[2] Depdiknas and BSNP. 2008. Socialization of Standard Instruments for Textbook Appraisal Lesson on Technology, Information and Communication Lessons. Jakarta: BSNP and Bookkeeping Center.

[2] Uhur EW. 2017. KEPMEN Skkni Automotive Light Vehicle, http://www.scribd.com/doc/39310005/Kepmen-Skkni-Automotive,accessedMarch25, 2017.

[3] Akhmad Sudrajat. 2010. How to improve motivation, interest in student learning, http://akhmadsudrajat. wordpress.com/2010/09/11, accessed March 25,2018

[4] Dick, W & L.Carey. 2004. The Systematic Design of Instruction, 3rd USA: Harper Longman [5] Lena Noviana, 2012, Attitude, motivation, interest in learning math, http://www. slideshare.net/Interest_Matematika_2011, accessed March 27, 2017

[5] Depdiknas, 2006. Self Evaluation Documents Majoring in Mechanical Engineering. Denpasar: Politeknik Negeri Bali

[6] Wena, Made. 2009. Contemporary Innovative Learning Strategies. Jakarta: PT. Earth Script.

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THE EFFECTIVENESS OF USING HOLLOW AS COLUMN FORMWORK AMPLIFIER COMPARED WITH WOOD BEAM

(A Case Study of Standard Villa Project, Badung)

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Abstract. In terms of cost utilization, formwork is the largest cost component in concrete work on a building project. The cost for formwork is about 40-60% [6] of the cost of concrete work or about 10% of the total cost of building construction. With two methods of formwork i.e. conventional and half system formwork, the authors want to know the comparison of which formwork method is best in the aspect of cost savings, and the execution time for the formwork of columns on the Standard Villa project. From 2 (two) methods proposed then it is chosen the second method; that is formwork column with method of half system as best alternative. The savings can be done from the first method to the second method as much as 26.17%, while in terms of savings time that can be done with method 2 is equal to 5% of method 1.

Keywords: Formwork, Column, Cost, Time.

1. INTRODUCTION

Construction activities are building activities. Generally existing construction buildings tend to use concrete materials. Concrete works consist of iron reinforcement, formwork, and foundry. Concrete requires a formwork as well to get the planned shape. Formwork is a temporary tool, but formwork plays a very important role, to make the form of concrete as desired and depends on the quality of the formwork material itself. The quality of formwork is greatly influenced by the material itself, therefore, the formwork must be made from material that has sufficient quality and needs to be planned in such a way so that the construction does not suffer damage due to deflection or bending arising from the load and foundry process [1].

With the development of technology and the increasingly high demands, especially on the formwork work on concrete structural work, it has triggered the development of various systems and formwork methods with the use of various types of materials and tools. Generally, the most dominant materials used for formwork are wood or bamboo as scaffolding, because wood is a high-strength material with low density, easy to replace and does not require a long time, able to withstand tensile forces and easy to get on the market [2]. However wood is also a material that cannot be used for long spans, has a relatively large expansion and shrinkage, some types of wood are less durable, less homogeneous with defects - natural defects such as the direction of fibers that form cross sections, spirals, diagonals, wood eyes and so on, and some types of wood are less durable, therefore the use of wood as a formwork material needs special and serious attention. In planning formwork work on a construction work, it requires a lot of consideration so that the use of methods or systems that are used is more economical and efficient. Therefore, good planning, supervision and implementation and adequate evaluation methods are needed to anticipate this [1].

In line with the development of the construction world in Indonesia, construction actors are required to find better methods to choose the type of concrete mold. Currently large-scale building projects are increasingly popular by using semi-conventional formwork that uses plywood and hollow iron, although the price of hollow materials is more expensive and easily absorbs heat, but installation with these hollow tends to be faster because the ability to install does not require skills that are too high, fireproof (hollow iron), anti termites and rodents, and have a pretty good quality because the material is suitable to use for long period of time so that it can be used many times. Hollow can reduce the occurrence of deflection in the formwork, so it does not change the form of the formwork. Therefore, the hollow is used as a formwork stiffener and manufacturing formwork (knock down) [3]. Therefore, it is necessary to examine more deeply about the use of hollow as mold reinforcement, especially in concrete column work.

Based on the above thinking, it is necessary to conduct a study of the comparison of the use between conventional and semi-conventional formworks, and then it is done the calculations so that the cost efficiency in the process is obtained. The problems of this research that can be raised in this writing are: 1) which is more effective and efficient between the use of wood beam as formwork reinforcement compared to hollow on column making work?, 2) how much are the cost and time needed between wood beam as reinforcement and hollow formwork as reinforcement for column formwork. The objectives of this research are: 2) to find out which one is more effective and efficient between the use of wood beam as reinforcement formwork compared to the use hollow as formwork reinforcement, 2) to find out how much the cost and time needed between wood beam as a formwork amplifier and *hollow* as column formwork reinforcement. The benefits of this writing are: 1) it can be calculated the comparison of the cost and the time taken between wood beam as formwork reinforcement and hollow formwork as column formwork reinforcement, 2) it can be provided a general description and input to the parties involved in the construction industry about choosing alternative uses from the two comparisons. The scopes used in this study are: 1) observation studies are only limited to column work, 2) the analysis carried out covers the costs and time of column formwork work, 3) Analysis refers to the final results of the formwork work.

2. METHODS

The research method is used as the basis for successive steps based on the research objectives and become a tool used to draw conclusions, so that the expected solutions can be obtained to achieve the success of the research.

2.1 Location and Time

The research location is in the Standard Villa development project which is part of the Greenhill Resort Jimbaran project located at Batu Meguwung street, Jimbaran, South Kuta. The time of research began on August 1, 2017 (for 10 weeks) along with the time of industrial internship.

2.3 Data Collection

To simplify the analysis of the data needed, namely: Image of the structure of the Standard Villa project, Work Unit Prices (HSP), Value Engineering.

2.4 Stage and Research Process

Phase I (Preparation), Phase II (Research Object Determination Stage), Stage III (Data Collection Stage), Stage IV (Data Analysis Stage), Stage V (Discussion Stage)

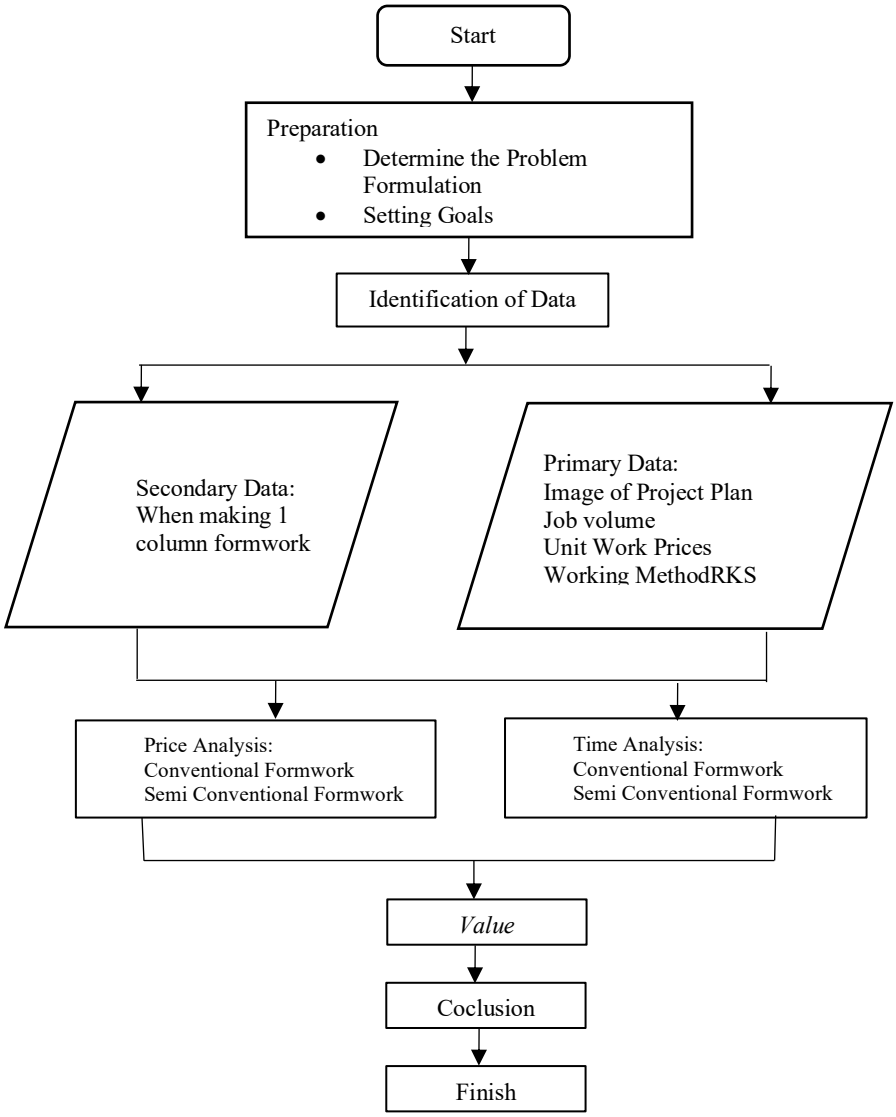

Figure 1. Chart of Research Flow

3. RESULTS AND DISCUSSION

Column is a compressive structural element that plays an important role in a building. Formwork is referred to as a reference and scaffold is a temporary construction that functions as a mold or mall for liquid concrete to finally harden into a building structure [4]-[7]. From the above understanding and according to the plan flow that has been explained previously in carrying out the analysis, it is necessary to analyze it by following step by step.

3.1 Information Stage

The identity of the Standard Villa development project is as follows:

a. The project name : Standard Villa
b. Location : Batu Meguwung street, Jimbaran, South Kuta, Badung, Bali
c. Project owner : PT. Jimbaran Greenhill
d. Cons. Of structure planner : PT. MEINHARDT Indonesia
e. Cons. Of architect planner : GKAI (Grounds Kent Architects Indonesia)
f. Contractor : PT. Tunas Jaya Sanur

3.2 Data Analysis

Calculating the Area of Formwork

Column C1 = 34.74 m^2
Column C2 = 9.264 m^2
Column C3 = 6.176 m^2

3.3 Execution time

a. Conventional Formwork
Installation time = 47 days
Bonding time = 51 days
Time of demolition = 11 days

b. Semi Conventional Formwork
Installation time = 43 days
Bonding time = 47 days
Time of demolition = 11 days

3.4 Cost calculation

a. Conventional Formwork Costs

- For the repetition of formwork for twice, the cost obtained = Rp. 215,731,264.30
- For repetition of formwork for three times, the formwork costs that can be obtained = Rp.176,786,639.87

b. Semi Conventional Formwork Cost

- The use of *hollow* for twelve times and *multiplex* for twice = Rp . 157,160,250.33
- The use of *Hollow* for twenty times and *multiplex* three times = Rp . 130,519,019.39

3.5 Resume

A resume of these costs is shown in Table 1 below:

Table 1. Cost Resume

Description	Conventional		Unit	Semi Conventional		Unit
Time:						
Time installation	47		hour	43		hour
Time Tie it up	4		hour	4		hour
Timetotal	51		hour	47		hour
Time Demolition	11		hour	11		hour
Price	Used 2x	Used 3x	Million	Hollow 12 x and multiplek 2x	Hollow 20x and multiplek 3x	Million
Manufacturing costs 1 unit villa	14.036.042,67	14.036.042,67	Million	32.319.949,76	32.319.949,76	Million
Cost of making a plan	168.432.512,09	112.288.341,39	Million	127.445.905,10	80.190.056,05	Million
Damage fee	24.777.968,22	33.788.138,48	Million	7.193.561,23	9.809.401,67	Million
Wage fee	2.649.504,00	3.612.960,00	Million	2.649.504,00	3.612.960,00	Million
Installation costs	9.935.640,00	13.548.600,00	Million	9.935.640,00	13.548.600,00	Million
Demolition costs	9.935.640,00	13.548.600,00	Million	9.935.640,00	13.548.600,00	Million
Total Cost	215.731.264,30	176.786.639,87	Million	157.160.250,33	130.519.019,39	Million

4. CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusion

a. From the results of cost and time analysis, it is drawn the following conclusions:
   a) Formwork with conventional semi-systems is more effective because the time needed is 5% faster than conventional systems.
   b) Semi conventional formwork is more efficient because the costs required for semi-conventional formwork (1) are 27.12% less than conventional (1), semi-conventional Formwork (2) is more efficient because of the costs required for semi-conventional formwork (2) that is 26.17% less than conventional systems (2) and in this Standard Villa project.
   c) The savings that can be made from conventional formwork (2) is 18.05% from conventional formwork (1), and savings that can be made from semi-conventional formwork (2) is 16.95% compared to semi-conventional formwork (1).

b. From the calculation of costs and time formwork, it can be concluded that:
   a) For the conventional formwork work (1) a fee of Rp.215,731,264.30 is obtained, whereas for conventional formwork (2) the cost obtained is Rp.176,786,639.87 with the implementation time of 61 days.
   b) For semi-conventional formwork work (1) a fee of Rp. 157,160,250.33 is obtained, while for semi-conventional formwork work (2) it is obtained the cost of Rp.130,519,019.39 with a implementation time of 58 days

4.2 Recommendations

a. This comparison is not only done on column formwork structure work but it can also be done on jobs that have the potential to be compared, such as beam formwork, plates formwork, etc.
b. For parties engaged in construction services for large-scale projects, it is better to use semi-conventional systems when doing formwork, especially for column formwork.
c. In order for the implementation of the comparison to be more varied, it is better to use more and broader methods and comparative criteria, considering that at this time a variety of materials that are cheaper, easier and more qualified appear.

REFERENCES

[1] Jago Bangunan. 2018. *Cara Ini Untuk Membuat Bekisting Kokoh dan Anti Amrol.* Available at: http://jagobangunan.com/article/read/lakukan-6-cara-ini-untuk-membuat-bekisting-kokoh-dan-anti-ambrol. Acessed 10th April 2018.
[2] Anonim. 1961. *Peraturan Konstruksi Kayu Indonesia (PKKI) NI-1961*. Bandung. Lembaga Penyelidikan Masalah Bangunan, Departemen Pekerjaan Umum dan Tenaga Listrik.
[3] Mega Baja. 2010. *Baja Kotak.* Available at: http://www.megabajabogor.com/pipa-kotak-hollow. acessed 11th April 2018.
[4] ACI Committee 318. 1961. *Formwork For Concrete (ACI 318-05) and Commentary (318R-05).* Farmington Hills, Mich. American Concrete Institute.
[5] Diphusodo, Istimawan. 1994. *Struktur Beton Bertulang*. Jakarta. Gramedia Pustaka Utama.
[6] Wicaksono, Rachmad Setyo. 2016. *Analisis Perbandingan Pekerjaan Bekisting Kolom dengan Metode Setengah – Sistem dan Konvensional pada Proyek Gedung (Studi Kasus Proyek Hotel Avani, Badung).* Skripsi. Jurusan Teknik Sipil Politeknik Negeri Bali.
[7] Wigbout Ing. F.1992. "*Buku Pedoman Tentang Bekisting (kotak cetak)*". Jakarta: Erlangga.

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DESIGN DASHBOARD MODEL FOR FISH PROCESSING SYSTEM (CASE STUDY PT BLUE OCEAN GRACE INTERNATIONAL)

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Abstract. The dashboard system is a graphical analytical model provided for management to present the information summary and quality of fish processing data in each stage processing in specific periods of time, from a company or an organization, the dashboard has been widely adopted by companies or businesses. The background of this research is a huge of complex processing data which is difficult and require sometimes to process and to present data analytical to management to monitor and review processing result and making decision based on data analytical. In this research, we design graphical analytical dashboard which make easy to present the quantity fish processed and seafood product summary analysis in each processing stage start from receiving, cutting, retouching, packing and shipment. By using this dashboard, management enable make quick decision based on analytical information related to how many fish processed, quantity of seafood product resulted per processing periods to decide and determining future plan strategy related to fish supply, market demand. The scope of this research is to present summary analytical data from the periods July until December of 2019. The dashboard model help management decision by presenting data analytical of fish processing.

Keywords : dashboard, data analytical, fish processing, review, management

1. INTRODUCTION

Dashboard as an information system application model provided for management in presenting data analysis information such as quantity of fish received from suppliers to total amount of seafood product produced for each stage of fish processing in specific periods. In this study, the dashboard is used as a monitoring system for fish reception data from suppliers, presenting the number of seafood products and grades at each stage of fish processing from receiving, cutting, retouching, and packing to shipping at PT Blue Ocean Grace International. as a means of measuring the quality of fish received, yield analysis and providing data to make decisions in determining suppliers rating based on quantity of fish delivered and measuring the quality of fish products in each stage of processing. The dashboard system limits in this study are in the form of bar charts and pie charts, and developed based on web application system. Input from the system is in the form of data on fish reception and processing from July to December 2019 at PT Blue Ocean Grace International. The results of data processing and analysis in the form of a dashboard analysis of total fish receipts from suppliers and total seafood products at each stage of processing are presented in graphical chart form. The results of the dashboard analysis that the model can be used as a reference in knowing rating suppliers based on total fish delivered to processing plant, total amount seafood product produced in each period.

2. METHODS

In designing the dashboard model of a fish processing information system, there are several stages that must be carried out. The stages of the research procedure start from identifying the system requirements, collecting data at each stage of processing starting from receiving, cutting, retouching, packing and shipping. Furthermore receiving data is grouped per supplier to determine the amount of fish shipped. Meanwhile cutting, retouching and packing data are grouped per grade of fish to present the quality of seafood products for each stage of fish processing. The next stage of planning, in the form of meta-analysis of the total quantity of fish received, the total quantity of seafood products in the process of cutting, retouching, packing and shipping. The next stage are planning dashboard functionality or the type of dashboard type to be used, in this research we use the dashboard type bar chart and pie chart, for easy to read and understand. The next stage is designing prototype dashboard for fish processing information systems, designing designs and layouts, and designing navigation menus. The last step is to review the dashboard system that was designed and make improvements to the revision of the results of the review.

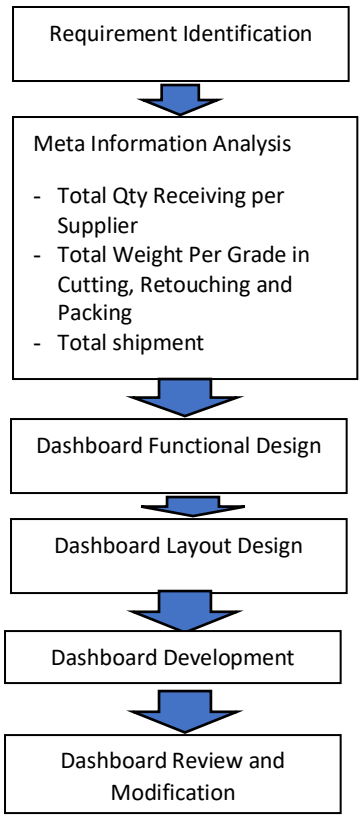

Figure 1. Flowchart Design Dashboard System

From design dashboard system, then continue to design user interface of dashboard system as below

Figure 2. Login User Interface

The function of user interface login, is to make security system enable login only from registered user. To register new user account, it manage by company user administrator, which the user interface design to create new user could be seen as Figure 3.

Figure 3. User Interface New User Account

Once user has been registered, system provide user interface list of user account as seen in Figure 4

Figure 4. User Interface List of User Account

User interface of dashboard each stage of fish processing, presenting total weight and total pieces of fish and total box of seafood product on each stage of fish processing, which enable to generate per periods of date. User interface design could be seen in Figure 5.

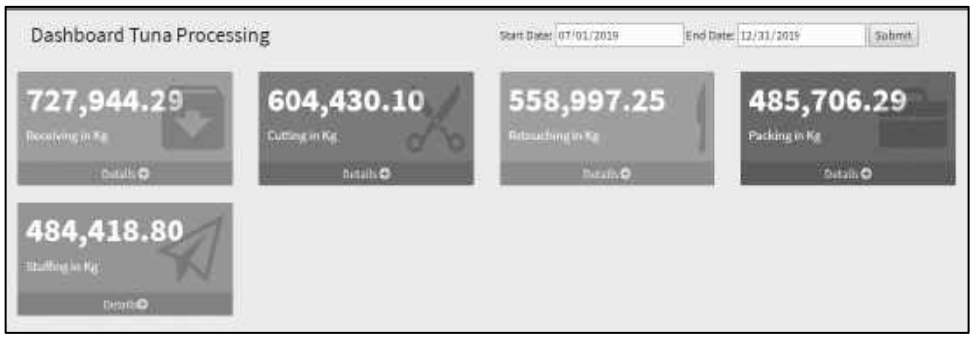

Figure 5. User Interface Design of Dashboard Each Stage of Tuna Processing

For receiving stage, we design dashboard system in the form of bar chart presenting total weight of fish delivered by each fish supplier in specific periods. From this chart, we could analyze the total of fish weight delivered by supplier to know which supplier has deliver the most fish and which deliver the least fish on specific periods. User interface design could be seen in Figure 6.

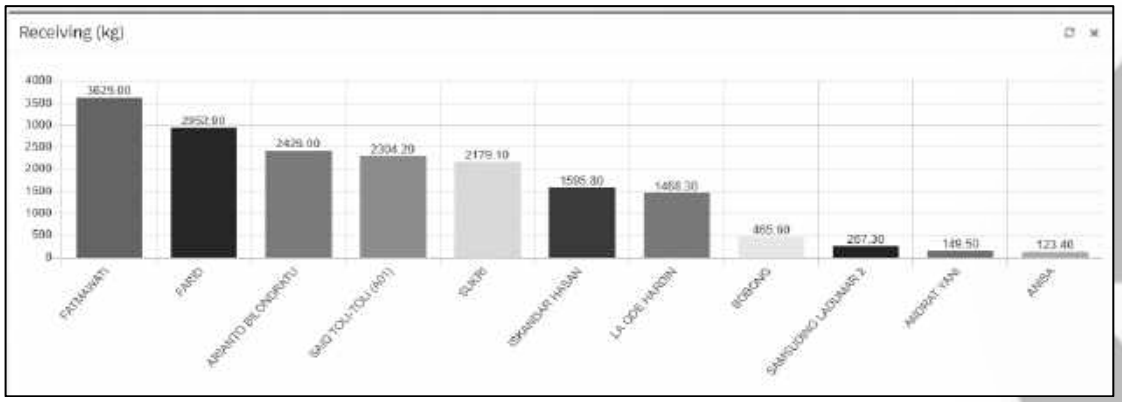

Figure 6. User Interface Design for Receiving Fish Delivered from Each Supplier

After receiving, then process continue to cutting stage. Dashboard system present total fish weight to process cutting per supplier by bar chart, so we could analyze the most fish from which supplier has been process cut in specific periods.

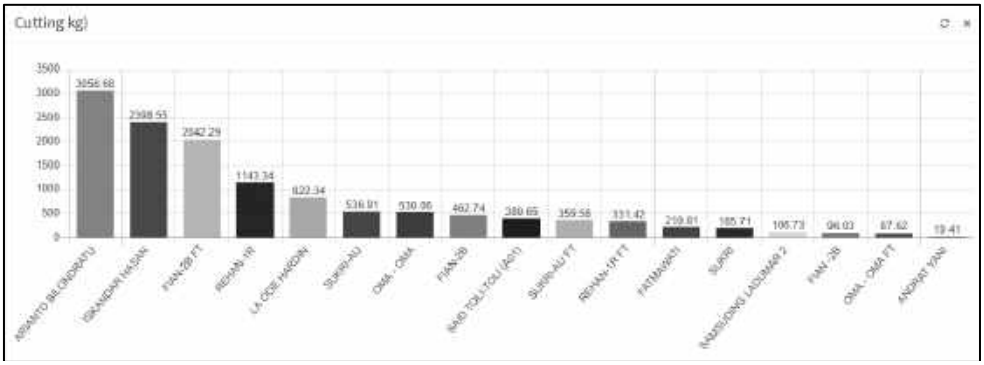

Figure 7. User Interface Design for Cutting

After cutting, then process continue to retouching stage. Dashboard system present total fish weight to process retouching per supplier by bar chart, presenting the most / the least fish processed from which supplier, as seen in Figure 8.

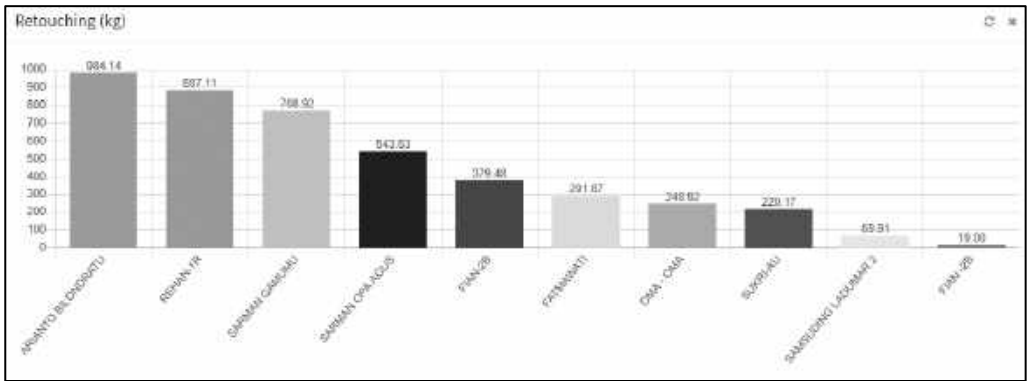

Figure 8. User Interface Design for Retouching

Dashboard system packing present total weight seafood to pack in master carton per month, so graph present pattern level of production, graphical user interface design could be seen in in Figure 9.

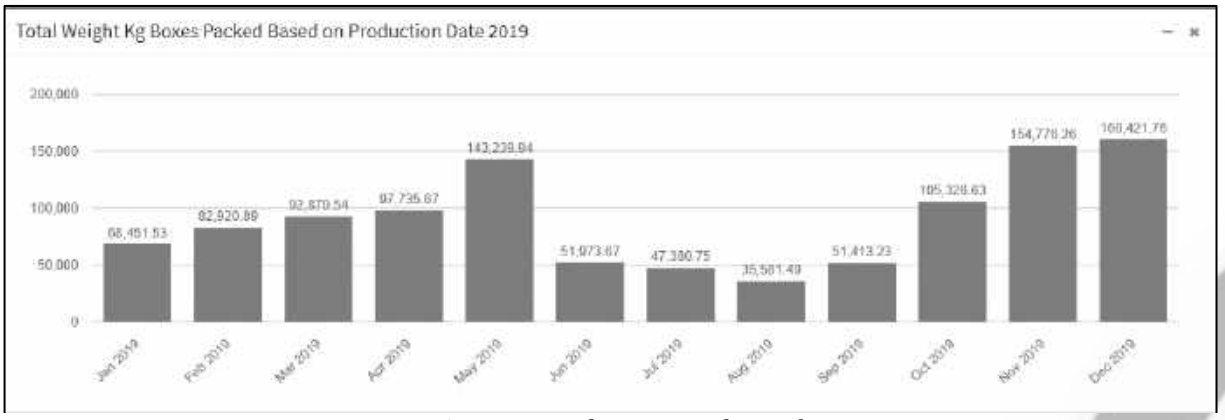

Figure 9. User Interface Design for Packing

Dashboard system stuffing/shipment present total weight seafood to be shipped per shipping transaction, and graph present pattern level of weight seafood product to ship per shipping transaction, graphical user interface design could be seen in in Figure 10.

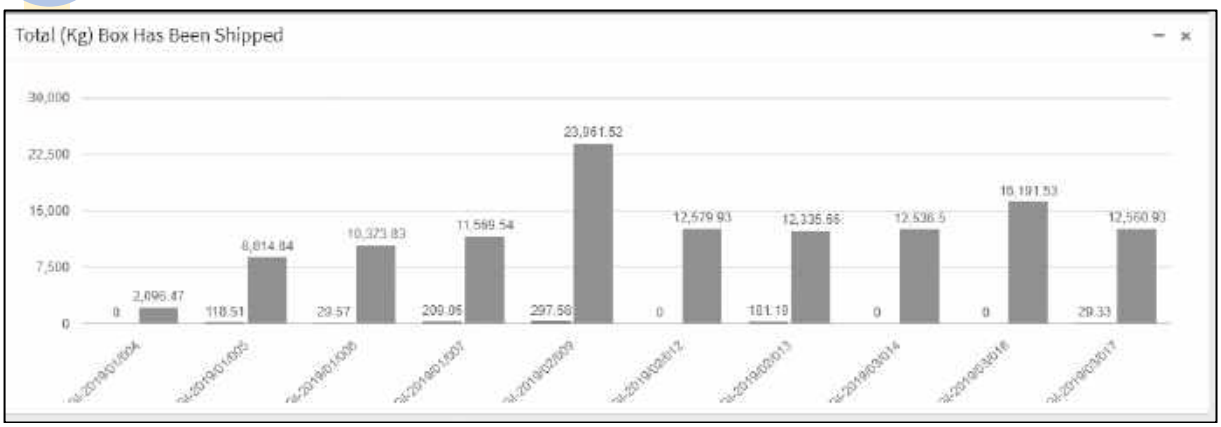

Figure 10. User Interface Design for Shipment

3. RESULTS AND DISCUSSION

3.1 USER INTERFACE SCREEN DISPLAY

User interface login function is to make system secure enable login only from registered user. Login consist of user name by inputting email of users and password to login. User credentials managed by user administrator. User interface login could be seen in Figure 11.

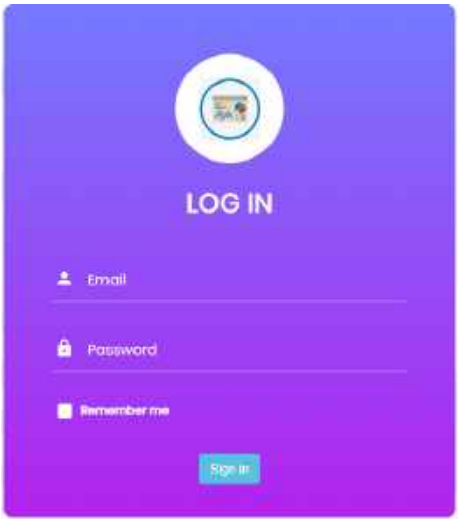

Figure 11. User interface for login system dashboard

User interface create new user function is to register new user, managed by user administrator, could be seen in Figure 12.

Figure 12. User interface Create New User

User has been registered could be present in list of user. Administrator could edit user or remove user from the list. User interface could be seen in Figure 13.

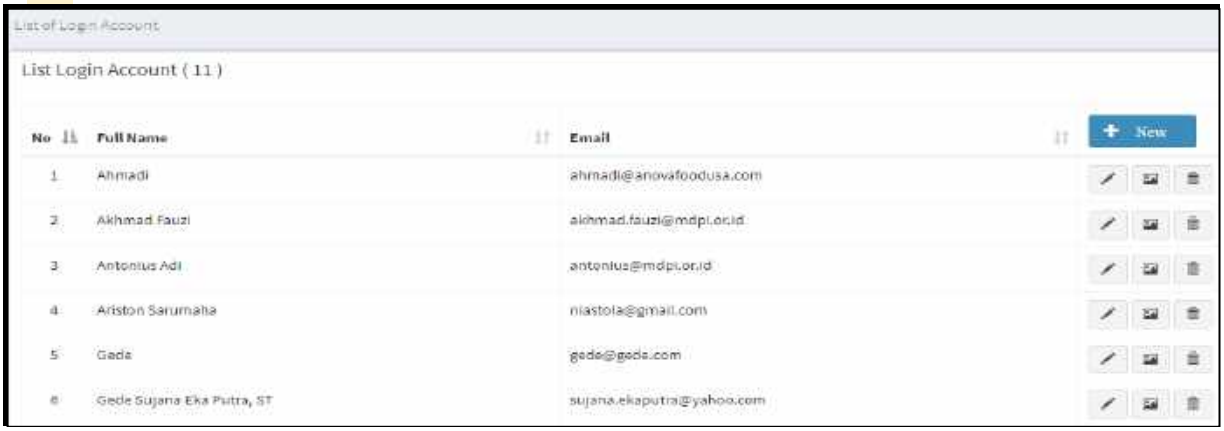

Figure 13. List of User

Once user successfully login into dashboard system, then system present total weight kg per processing stage for receiving stage, cutting stage, retouching stage, packing stage until shipment. Total weight calculated per specific periods present in each stage processing as seen in Figure 14.

Figure 14. Dashboard each stage processing per specific periods

Dashboard system also presenting trend level total weight fish or seafood product processed on each stage processing per month, from receiving stage, cutting stage, retouching stage, until packing stage as seen in Figure 15.

Figure 15. Trend Level Total Weight Fish or
Seafood Product in Each Stage Processing per Month

Dashboard system presenting in pie chart, comparison total receiving, cutting and retouching per periods, and comparison total packing and shipping per periods. This chart shows up percentage of weight fish to process in receiving, cutting and retouching. Also shows up percentage total packing and shipping in specific periods as seen in Figure 16.

Figure 16. Percentage Total Weight Fish in Receiving, Cutting and Retouching and Percentage Total Packing and Shipping Per Specific Periods

Dashboard system for receiving present in bar chart present total weight of fish delivered per supplier. This chart provide information the most or least fish delivered by supplier on specific periods of date as seen in Figure 17.

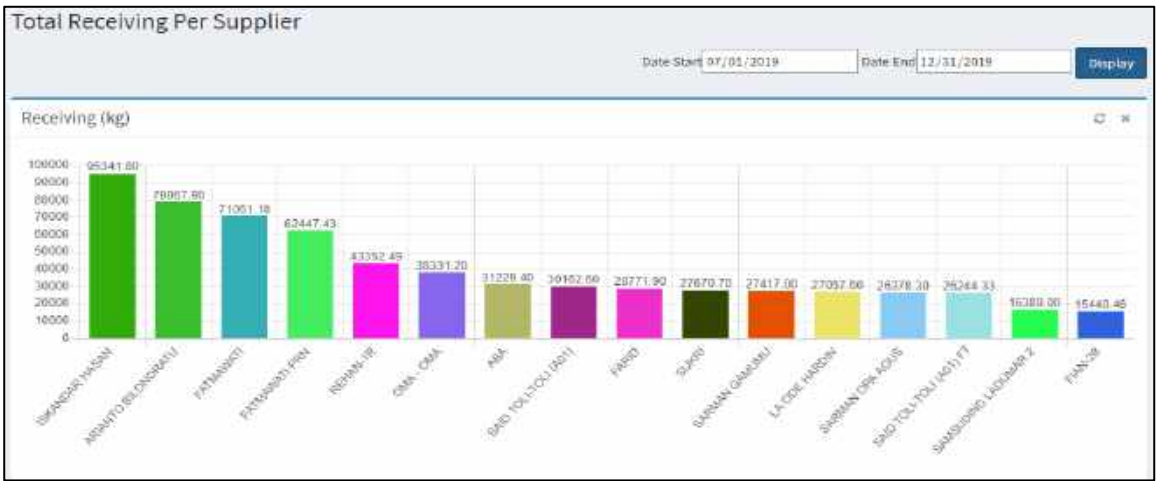

Figure 17. Dashboard Total Weight of Fish Delivered Per Supplier In Receiving per Specific Periods

Dashboard system for cutting present in bar chart present total weight of loin as result of process per supplier in cutting stage. This chart provide information the most or least loin processed in cutting from supplier on specific periods of date as seen in Figure 18.

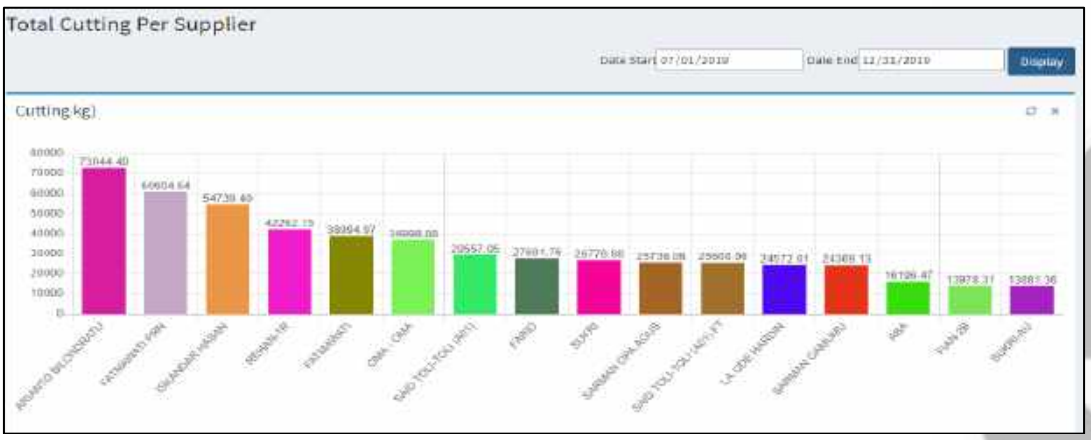

Figure 18. Dashboard Total Weight of Loin Processed in

Cutting Stage per Supplier per Specific Periods

Dashboard system for retouching present in bar chart present total weight of loin as result of process per supplier in retouching stage. This chart provide information the most or least loin processed in retouching from supplier on specific periods of date as seen in Figure 19.

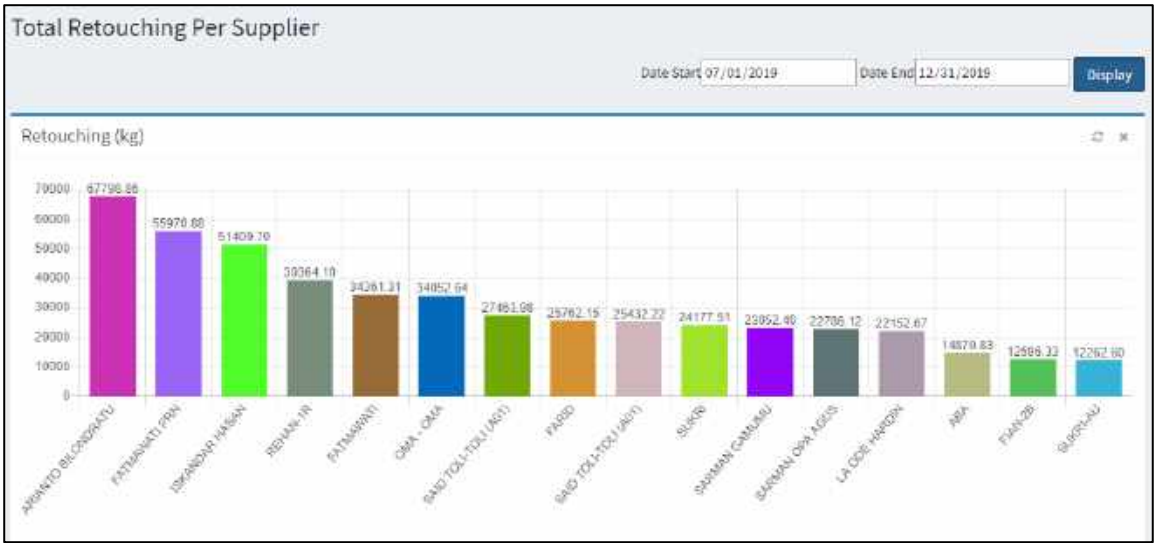

Figure 19. Dashboard Total Weight of Loin Processed in Retouching Stage per Supplier per Specific Periods

Dashboard system for packing present in bar chart present total weight of master carton processed per month. This chart provide information total weight of master carton and trend of level weight loin product to pack per month, as seen in Figure 20.

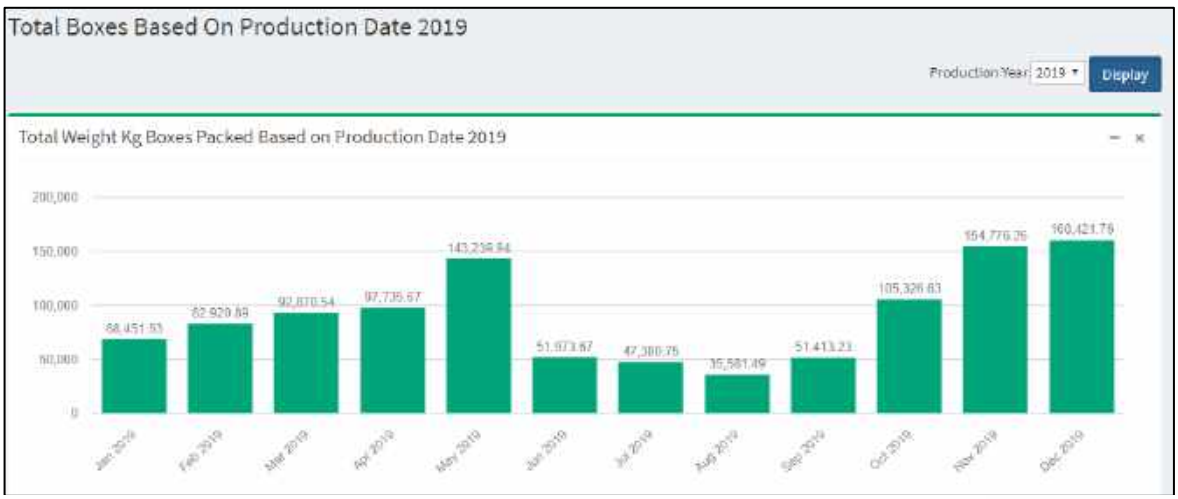

Figure 20. Dashboard Total Weight of Master Carton Processed And Trend of Weight Master Carton for Packing Activity Per Month

Dashboard system for shipment present in bar chart present total weight of master carton shipped to buyer per shipping transaction. This chart provide information total weight of master carton and trend of shipping transaction, as seen in Figure 21.

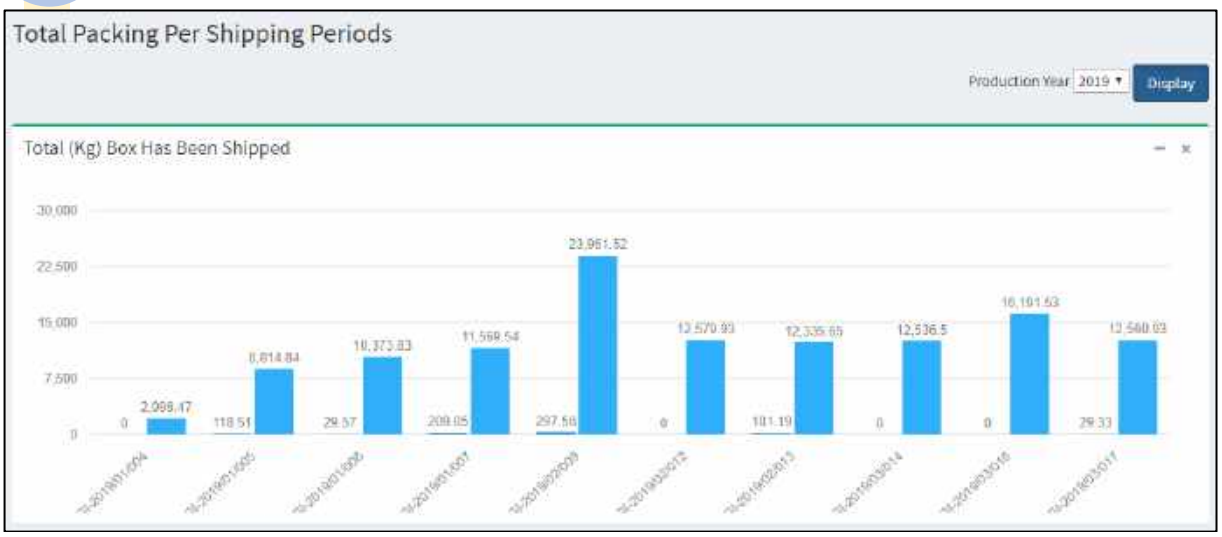

Figure 21. Dashboard Total Weight of Master Carton
Shipped and Trend Weight Master Carton Shipped per Shipping Transaction

3.2 Citation and References

Some related research are Design of Interactive Sales Dashboard (Case Study: PT Jaya Bakery) 2018 by Sulistiawati [1] which is motivated by sales monitoring at PT Jaya Bakery is still done from looking at sales reports in tabular form presented in a spreadsheet application by the sales department. This interactive dashboard system can simplify the sales department in presenting sales reports in real time and make it easier for leaders to see sales developments and perform sales data processing. Other research is Monitoring Accountant User Performance Using Dashboard on Online Web Based Accounting in University by Untung Raharja [2].The other research is Dashboard Optimization in the Assessment System as Information Media in University by Untung Raharja [3]. The other research is Design of Dashboard Model for Monitoring Student Evaluation, 2017 by Ilhamsyah [4]. In this study, the dashboard is used as a monitoring system for student evaluation in education in the Department of Information Systems FMIPA Pontianak Tanjungpura University as a means for measuring the quality of students and make decisions in determining the future strategy of student coaching environment in the Department of Information Systems FMIPA Untan Pontianak. The results of the analysis using the tectical dashboard model show that the model can be used as a reference as a parameter in establishing KPI monitoring for Information Systems Department students. Other research is Design Dashboard of New Student Performance by I Gusti Ngurah Nyoman Bagiarta [5]. Next other research is design a Performance Monitoring Dashboard System with the Balanced Scorecard Model (Case Study: BMT Beringharjo Yogyakarta) by Milasari [6]. And another research is Design of Dashboard System for Monitoring University Performance Indicators by Eva Hariyanti [7]. The purpose of this study is to design a dashboard system for monitoring and evaluating performance based on the university's key performance indicators (KPI). The research took a case study at the Faculty of Science and Technology, Airlangga University. The prototype test results show that the dashboard created has produced information that suits the needs of users at each level. Other research is Information System Dashboard Based on Key Performance Indicator by Henderi [8].

4. CONCLUSION

The conclusion of this study is that fish processing system design stage consist of requirement identification, meta-information analysis, dashboard functional design, dashboard layout design, dashboard developmemt and dashboard review and modification. Based on dashboard developed, it could be used for management to analyze production result of each stage production from stage receiving, cutting, retouching, packing and shipping and to get information of trend total weight of seafood product processed and shipped per month or per shipment transaction, to have initial information for better planning strategy to make better production planning.

5. REFERENCES

[1] Sulistiawati, Heni Sulistiani, " Designing an Interactive Sales Dashboard (Case Study: PT Jaya Bakery)", Journal TEKNO KOMPAK, Vol. 12, No. 1, page 15-17. ISSN 1412-9663, 2018
[2] Untung Rahardja, Qurotul Aini, Alfiah Khoirunisa, " Monitoring Accountant User Performance Using Dashboard on Online Web Based Accounting in University", SATIN - Sains and Information Technology,

Vol. 4, No. 2, December 2018
[3] Untung Rahardja, Qurotul Aini, Neng Enay, "Dashboard Optimization in the Assessment System as Information Media in University ", Vol 7, No 2, 2017
[4] Ilhamsyah, Syahru Rahmayudha, " Designing a Dashboard Model for Student Evaluation Monitoring", Journal Informatika: Journal of IT Development (JPIT) , Vol. 2, No. 1, January 2017
[5] I Gusti Ngurah Nyoman Bagiarta, I Ketut Dedy Suryawan, " Design Dashboard of New Student Performance", Information and System Journal, Vol. 10, No. 1, Nopember 2015
[6] Milasari, Bayu Waspodo dan Qurrotul Aini, "Design a Performance Monitoring Dashboard System with the Balanced Scorecard Model (Case Study: BMT Beringharjo Yogyakarta)", Journal Sains, Technology and Industry, Vol. 12, No. 1, pp. 23 - 31, December 2014
[7] Eva Hariyanti, Endah Purwanti," Design of Dashboard System for Monitoring University Performance Indicators ", National Seminar on Indonesian Information Systems, 22 September 2014
[8] Henderi, Sri Rahayu, Bangun Mukti Prasetyo, "Information System Dashboard Based on Key Performance Indicator", Informatics National Seminar ISSN: 1979-2328, UPN ”Veteran” Yogyakarta, 30 Juni 2012

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PERFORMANCE INSULATOR COVER TYPE : YSL-70-AP POST VOLTAGE BREAK DOWN TEST

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Abstract. Electrical energy affect to economic, electrical energy consumption will increase and decrease likely economics. In this globalization era, electricity consumption was increased trend yearly since industrialization era. The reliability Electrical energy is very important for economic growth. The lower SAIDI and SAIFI is the bench mark for reliability of electrical energy supply. The reliable of insulator cover type: YSL-70-AP affect to the reliability electrical distribution energy on over head distribution circuit. Insulator cover protected to over head distribution circuit againt animal, bird, tree ang other temporary disturbance. Insulator cover also to protect half insulated medium voltage cable againt partial discharge and flashover. Over voltage stress more often during operation, to impact to the material insulation performance. This quantitative research founding: insulator cover type: YSL-70-AP still feasible to use after voltage breakdown stress. The fault current is still under the maximum allowable leakage current (11,600 micro ampere) which is 41.61 micro ampere, and breakdown voltage is still higher than minimum that specified (24 kilo volt), which is 49.63 kilo volt. Post breakdown voltage the material insulation performance of insulator cover type: YSL-70-AP is good, and reliable to continuous operation over head distribution circuit.

Keywords : Cover, breakdown, performance.

1. INTRODUCTION

Energy consumption in globalization can also go up and down and may not always increase yearly, although it tends to increase in period 1992 to 2011 [1]. Energy consumption includes: oil, electricity and others. The world economic activity strongly influenced by electrical energy consumption. There was bidirectional causality between economic growth and electricity consumption [2]. Indonesian Economic growing also need electricity growth. Electricity growth includes: capacity and reliability.

There are several problems to reliability of electricity. The remote power plant impacted the problems. This reliable system is designed to guarantee the electrical energy availability. Systems standard that meet reliability and secure operation, consumer rights protection, the National Electricity Company (PLN) benefit, and economic growth. Electricity System reliability measured by the lower of SAIDI and SAIFI value [3].

The height SAIDI and SAIFI is caused by many disturbances. Disturbance in the electrical distribution can be caused by abnormal equipment and by nature. That disturbance can be supply over voltage condition. Over voltage over than equipment capacity, can damage equipment in the electric power distribution system. Continuity of operation after temporary voltage breakdown stress will only occur if the isolation performance is still in provided to protect in normal voltage. The general principle of insulation co-ordination requires a reasonable margin between the voltage level held by the protective device (the protectable level) and the various basic levels themselves to insure that adequate protection is provided [4].

This research is very important to answer, the insulation cover performance after breakdown voltage stress. In this study the breakdown voltage was simulated in the test of breakdown voltage of the insulation cover. The good electrical insulation for medium voltage performance is more than 100 mega ohm [5]. Based on this, insulator cover post voltage break down stress must also have insulation resistance more than 100 mega ohm. After voltage

break down stress the voids and oxidation cover insulator is not increase, because the performance of electrical insulation is strongly influenced by high oxidation, voids, and a mixture of non-homogeneous [6].

2. METHODS

This research is quantitative research trough value measured, calculation and analysis. The formulation of these problems will be discussed by samples testing of post voltage breakdown stress tested to Insulator Cover type : YSL-70-AP at the high voltage laboratory of Malang Brawijaya University. The test results analyzed statistically and mathematically to obtain resistance and voltage breakdown value, comparing to the standard, and than taken conclusions.

This research was conducted by measuring three samples post voltage break down tested. The three samples is the samples were taken from laboratory after voltage break down stress tested. Before first voltage break down stress, the samples randomly taken in PT. Adi Putra warehouse.

In this study, the observed magnitude of voltage test, leakage current and the breakdown voltage post voltage break down tested. Transformer tester is the source of voltage test in this study. Leakage current is the value of current flowed in to the sample test, due to discharged test voltage. The breakdown voltage is the value of voltage at the time of insulation failure.

Electrical test voltage against minimal insulation is tested with a voltage equal to the operating voltage. the minimum voltage for testing 20 KV equipment is 20 KV. The source of voltage test is variable step-up transformers. The value of this study is measured by volt meters and ampere meters. The ampere meter protected from over current with parallel spark gap. All material and equipment are connected to grounding system for securely process. Tested are made between phase and grounding.

For current leakage tested, each test sample (insulator cover post voltage break down stress tested) is placed between the electrodes of the AAAC conductor, the first electrode is given a 50 Hz AC voltage and the second electrode is grounded trough ampere meter. The voltage at the first electrode is increased step by step from 5 KV until 25 KV. Every 5 KV step, current leakage was measured with ampere meter. That current leakage tested process are repeated three time for each sample.

For breakdown voltage tested, one by one sample (insulator cover) is placed between two electrodes. The electrode made from the AAAC conductor. The first electrode charged by a 50 Hz AC voltage and the second electrode is grounded directly. The voltage at the first electrode is increased step by step, until the beginning of the corona, until a breakdown and this voltage is recorded as a breakdown voltage.

Data from the measurement are processed quantitatively. The resistance value result by the value of the test voltage divided by the leakage current. The average value is all resistance results are summed, then divided by the amount of data.

The value of the breakdown voltage obtained by summing the value of breakdown voltage measurement, divided by the amount of data. In this way, the insulator cover breakdown voltage rate obtained.

3. RESULTS AND DISCUSSION

3.1 Result

Unlimited resistance is a perfect insulating material. In the reality no once material is a perfect isolator. So many problem infected to the insolation, that are: material, production process, saving behaviour, shipping, installing process, operating dan disturbance [6]. One of the disturbance is breakdown voltage discharge. Breakdown voltage discharge results in excessive heat stress on to insulation materials. Age and heat stress will be decrease the insulator performance [7]. All electrical insulating materials flowed by current. That is leakage current trough insulation material. This problem justify that the resistance of insulating material is not unlimited. The value of insulation material resistance according to Ohm's Law is voltage divided by leakage current equation below.

$$R=V/I \quad (1)$$

Remark:
R = Insulating Resistance (M Ω)
V = Voltage charge due the sample (K V)
I = Leakage Current (μ A)

The result of this research described by figure and table. The data post voltage break down stress test collected by measured voltage between conductor and electrode test, and current leakage trough conductor-sample post voltage break down -electrode test-ampere meter, like describe at Figure 1. Voltage breakdown test just measured voltage between conductor and electrode test insulated by sample post voltage break down, and without ampere meter to measure the current, like describe at Figure 2.

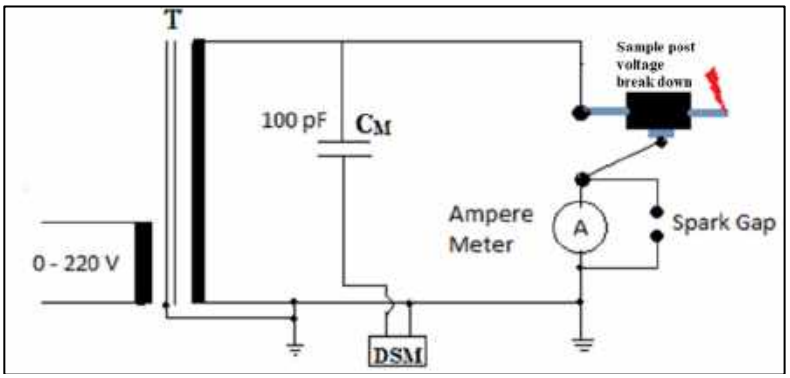

Figure 1. Post Voltage Break Down Current Leakage Test

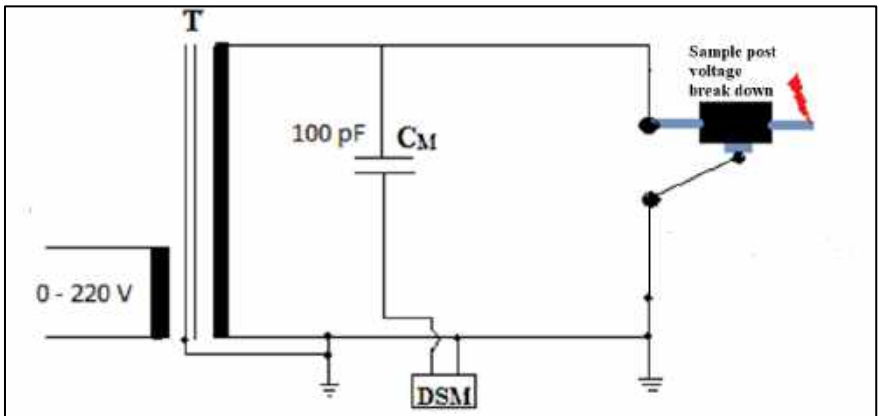

Figure 2. Post Voltage Break Down Voltage Break Down Test

The voltage value to charge at flash over discharge is noted voltage breakdown. Data noted from value displayed at measuring equipment like volt meter and ampere meter. The data analyzed by formula :

$R=V/I = 5.28/16.82 = 316.18\ M\ \Omega$

The other data analyzed with the same role. The data and output analysis is describe at the table 1.
Table 1. Data And Analysis Insulation Resistance Of Insulator Cover Type : YSL-70 AP Post Voltage Breakdown Stress.

Voltage (k V)	Leakage Current (μ A)	Resistance (M Ω)
5.18	16.12	322.48
10.37	33.30	313.06
15.43	50.47	308.20
20.03	70.70	285.93
24.11	108.89	225.27
Temperature (°C)		24.56
Humidity		74%
Pressure (m BAR)		954.67
Voltage corona (k V)		23.93
Voltage Breakdown (k V)		49.53
Average resistance (Ω)		290.99

Like describe on the tabel 1, if voltage test are increase, he leakage current also increase. Figure 3 was display that increase.

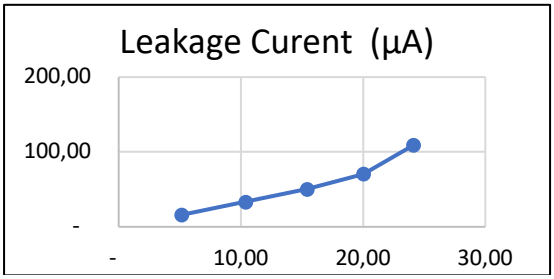

Figure 3. The Current Leakage Vs Voltage Test Post Voltage Break Down Stress

3.2 Discussion

Based on Table 1, the value of insulation resistance of the insulator cover post voltage break down stress is obtained as follows: 322.48; 313.06; 308.20; 285.93; 225.27; M Ω. The average results are 290.99 M Ω. If Cover Insulator Type YSL-70 AP post voltage stress continuous operated on 20 KV system, the voltage phase to ground is : $20/\sqrt{3} = 11.6$ KV. When there is a ground fault disturbance by temporary interference, the ground fault current post voltage break down stress are : 11,600/290.990,000 = 39.86µA. The interference current is 39.86µA, only 0.34% from the allowable maximum leakage current its mean 1,000µA/KV x 11.6 KV =11,600 µ A.
Based on Table 1, the breakdown voltage of 49.53 KV is obtained. Resistance to breakdown of 49.63 KV is equal to 206,38% higher than that specified in SPLN 1: 1995. This study found that after breakdown voltage stress, isolators cover are still feasible to use continuously in over head distribution system with AAAC or AAAS-S conductors.

4. CONCLUSION

Based on the results of the research and discussion, conclusions of performance insulator cover post voltage breakdown stress disturbance, can be drawn as described. The insulation resistance of insulator cover type : YSL-70AP post voltage breakdown stress disturbance is increase from 278.80 M Ω to 290,99 M Ω. The breakdown voltage of insulator cover type : YSL-70AP more decrease from 49.63 KV to 49.53 KV. Insulator cover type : YSL-70AP is still reliable to cover the pin post insulator on 20KV over head distribution system after voltage breakdown stress disturbance, because: (a) The fault current is still under the maximum allowable leakage current (11,600 µ A) which is 41.61µA; and (b) Breakdown voltage is still higher than minimum that specified (24 KV), which is 49.63 KV.

Based on the results of this study, there are many suggestions as describe: (a) PLN must utilize Insulator cover type : YSL-70 AP optimally, because the results of this study indicate the performance after voltage breakdown stress disturbance still feasible to use continuously. (b) For further researchers, further research needs to be done, how many times the voltage breakdown can be held by insulator cover type : YSL-70-AP, but still reliable to use continuously.

5. ACKNOWLEDGEMENT

That is no funded for this research, we will to cover if waive each fee.

6. REFERENCES

[1] Bayar. Limas and Hasan Alp Ozel, “Electricity consumption and economic growth, in emerging economic,” Scientific Paper, Vol. IV, Issue 2, April 2014.
[2] Bayar. Limas and Hasan Alp Ozel, “Electricity consumption and economic growth, in emerging economic,” Scientific Paper, Vol. IV, Issue 2, April 2014.
[3] Math H. Bollen, “Understanding power quality problems:voltage sags and interruptions,” Wiley-IEEE Press, ISBN:9780470546840, 2000.
[3] McCarley S., T&D Protecting Wildlife and Minimizing World Magazine, Outages, Sep 05, 2013.
[4] IEEE, Standard basic impulse insulation levels, Electrical Engineering, Vol: 60 Issue 3, March 1941.
[5] Sanjay Gothwal, Kaustubh Dwivedi, and Priyanka Maheshwari, “Partial Discharge Characteristics and Insulation Life with Voltage Waveform,” International Research Journal of Engineering and Technology (IRJET), Volume: 05 Issue: 07 July 2018.
[6] Alan Melo, Manuel Martinez, dan Alvaro Antonio Alencar De Queiroz, Analysis of the XLPE Insulation of Distribution Covered Conductors in Brazil, Journal of Materials Engineering and Performance, February 2014.
[7] Catalin Rusu-Zagar, Petru V. Notingher, and Cristina Stancu, 2014, Ageing and degradation of electrical machines insulation, Journal of International Scientific Publications: Materials, Methods and Technologies, Volume 8, ISSN 1314-7269 (Online).

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ORGANIC WASTE CHOPPER TOOL DESIGN USING AUTODESK INVENTOR 2015 SOFTWARE

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Abstract. In the program of mechanical engineering, the software used to draw is Autodesk Inventor. Autodesk inventor is a CAD program in the program of engineering that is applied to the design of mechanics in 3D. In designing a tool, of course, it is preceded by a planned design concept. In making a design a tool requires a process or steps for making the design. These steps include the size, dimensions, and materials used in making organic waste chopper tool. The drawing process uses the 2015 Autodesk Inventor program, the first is the making of sketches, components on the machine, followed by assembly of each component, then rendering images, animation as the final stages of drawing design input into "IDW" complete with size, scale, material. Image projection to make it easier for designers to make tools. Drawings of plan and complete details covering the scale dimensions will be able to simplify the manufacturing process (production) of the components of the tool and can reduce the risk of errors in the process of making tools.

Keywords: organic waste chopper tool design, Autodesk Inventor, CAD Program

1. INTRODUCTION

Autodesk inventor is a CAD software in mechanical engineering program that is applied to the design of mechanics in 3D. *Autodesk Inventor* is software specifically designed for the needs of engineering programs such as product design, machinery design, construction design, or other engineering products. This software is a series of refinement software from Autocad and Autodesk Mechanical Desktop. This software is perfect for Autodesk Autocad users who want to improve their capabilities because this software has almost the same concept in 3D drawing. Autodesk inventor is one of the CAD (Computer Aided Drawing and Design) software released by an American company called Autodesk. As CAD software, the design steps of a tool include the scale, dimensions, and materials used in the tool. Therefore, every planning of making a tool must be based on planning a design.

Basically, from the description above, it will be easier to do the depiction using Autodesk Inventor software, so the author tries to raise the issue about “Organic Waste Chopper Tool Design”. Autodesk inventor is very suitable to be applied in mechanical component design work, mechanical system design to mechanical strength analysis of mechanical components designed.

The definition of drawing mechanical engineering according to ISO Standard, is a very clear form of scratches from real objects, technical drawings are often also referred to as technical languages, images must have objective rules that can be understood by people who are experts and the rules of this drawing are made Standard ISO [1]. European projection is also called the first angle, and there is also a mention of quadrant I projections. US projection are usually often called the third angle and there is also a mention of quadrant III projections [2].

To get a picture of the hidden parts, so that the covering part is discarded, the image is called a section drawing, or can be simplify as section. To draw the span drawing, a deep understanding of building space is needed which will produce space objects. Even though using Autodesk Inventor, in graphically viewing the stretch image is a very complicated task [3]. Sketch functions to make images on 3 axes (X, Y, Z), while 2D sketch is only on 2 axes (X, Y). With 3D sketch we can make sketch not only on 2 axes [4]. In Autodesk Inventor Professional 2015, 2D sketch is the Default Sketch [5]. To activate 3D sketch we have to finish Sketch on 2D sketch then click 3D Sketch [6]. Ordinary design is translated as applied art, architecture, and various other creative achievements. The design process generally

takes into account the functions, aesthetics, data, thinking, brainstorming, and pre-existing designs. Design comes from several languages, one of which is the word "designo" (Italian) which grammatically means draw [7] [8].

Based on the description above, it is deemed necessary to know how to make the Design of Organic Waste Chopper Tool by using the 2015 Autodesk Inventor Software, and whether the design of the tools made can simplify the process. The purpose of this research is to be able to make the design of Organic Waste Chopper Tool by using 2015 Autodesk Inventor Software, as well as knowing the phase of design both in 3D, working drawings, assembly and animation methods.

2. METHODS

2.1 Design Planning

The 2015 Autodesk Inventor program was used to speed up the process of designing design drawings. The design of the design for making this organic waste counter tool includes the creation of parts, 3D image components, assembly work drawings and animations (like figure 1)

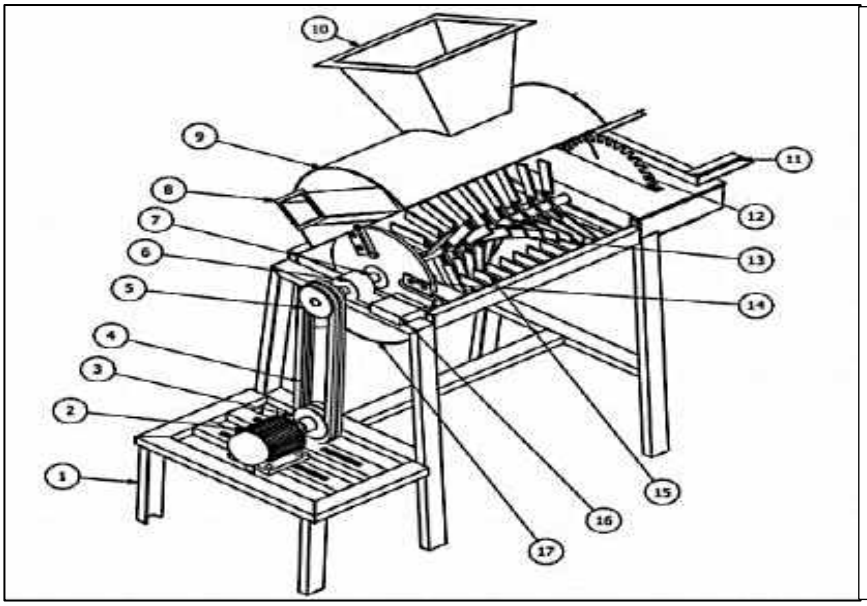


Figure 1 Organic Waste Chopper Tool Design Plan

The specifications of the tool are planned: The main driver is 220v electric motor, V-belt transmission, U channel iron frame, blade chopper blade model, eser plate casing, capacity 50kg / hour, dimensions 90cm x 40cm x 120cm, weight 180kg.

2.2 Location and Time of Design Making

Design location in the Lab. Computer Design Program of Mechanical Engineering, Politeknik Negeri Bali. Time to carry out 5- month design making (March to July 2017).

2.3 Determination of Data Sources

The data source is obtained from the results of the survey with Ergonomic design, analyze and adjust towards Anthropometric Standards, safety, security, comfort, and aspects related to human physiology, as well as from the Mechanical Engineering Drawing literature by using the 2015 Autodesk Inventor program.

3. RESULTS AND DISCUSSION

3.1 Design

How to make a design of an Organic Waste Chopper Tool by using the 2015 Autodesk Inventor Software, through several steps, consisting of:

Frame Design

Click new then select metric then look for standard (mm).ipt (like Figure 2), then click create then select one of the axis of the plane.

Figure 2 Main Menu

then create a sketch, then open the origin, select the xy plane then drag along 660 mm, and make the sketch according to the image size, open the origin again, select the pull up xz plane along 750 mm then create new, make the sketch according to the image then click finish (like Figure 3).

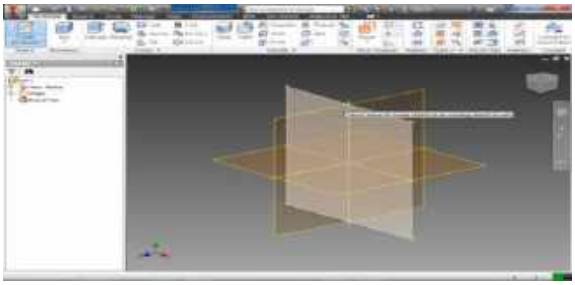


Figure 3 Plane Axis

After finishing sketch, open origin, select the pull up xz plane along 280 mm then click Create new sketch then create a design pattern, open the origin again, select the xy plane then drag along 1000 mm and click Create new sketch in the work plane created then create sketch according to the image then click finish sketch, then click new sketch in work plane 3 in the browser bar, then make sketch according to the design, then click after finish sketch.

Then click new sketch in work plane 3 in the browser bar, then make sketch according to the image with a length of 410 mm so that you can design the desired one, then click save then the file name is saved with the name "order" then click save. Then click new select metric then select standard (mm), then click create, then click place select the file "order". Then click open, then click the menu bar then click insert frame and click yes on the generator frame menu, continue click save .iam file with file name "frame assembly" then click save. After the save menu appears insert in the frame member selection menu select the size variant according to the design that will be made. Then click the sketch line that will be made the frame continue click ok on the create new frame menu, after the save menu appears insert in the frame member selection menu select the size variant according to the design that will be made. Then click the sketch line to be created, click ok on the frame member name. After the save menu appears insert in the frame member selection menu select the size variant according to the design that will be made. Then click the line of the image that will be made the frame, click ok on the frame member name which is the finished frame image then right click on the frame located on the left browser bar then click visibility and the following view is already visibility, then click the design menu then select change to change the position of the frame so that the change menu appears then select the frame we will change its position. Here is the frame view that we have changed. Then select the design menu then click the miter corner which functions as making angles on two frames, then displaying two frames who have cornered and also displayed the frame that has been mitered, then select the design menu then click trim and extend to face which functions as cutting or lengthening the frame to one of the frame fields, then clicking the trim or extend menu on the select frame member menu we select the blue and face or surface we click the yellow part then click apply, then l I'll trim -extend the other frames, then double-click left on one of the frames that will be sketched, then click the new sketch in the previous frame then make the sketch match the image, then extrude the sketch previously made to make the bolt holes in the frame then click ok, and click the save icon, save the file with the Assembly Frame name and click save (like Figure 4).

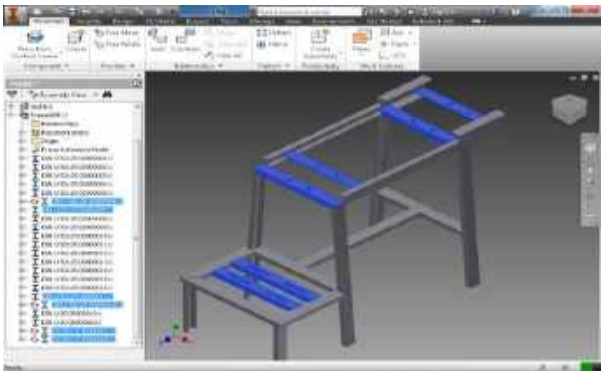


Figure 4 Framework

Upper Casing Design
For the top tube design, first click new then select metric then look for metal sheet (mm). Then click create, then select one axis of the plane and make N sketch according to the image then finish sketch, then click contour flange then change distance to 600 mm , continue to click unfold to make the image become a stretched image, then sketch on the stretched image to make an inlet of organic waste, then click the cut menu bar then click the sketch that was created then ok, then click refold to restore the stretched image to its original state. To see the results of the image in the form of a stretch image click "go to plate pettren". To reverse part click "go to folded part" on the top right menu then save the ipt file in a folder with the top case name then click save.

Leaf Chopper Casing Design
Click new then select metric then look for standard (mm). Click click create then select one of the axis of the plane and then make the sketch according to the image then click finish sketch, then open origin click the xy plane then drag up along 25 mm, then right click on the work plane. Then make the sketch according to the image then click finish sketch and then click Loft on the menu bar then on the menu section click icon 1 and icon 2 then click ok. Then click the shell on the menu bar to make solid objects become hollow, set the thickness of the sides as thick as 2 mm then click ok, then click the new sketch in the upper field then make the sketch according to the image then click finish sketch, then click extrude on the menu bar then click sketch the new one is made to make 2 dimensions into 3 dimensions then set the distortion along 2 mm, click ok, then click origin then right click on the xy plane then click new sketch then make sketch according to the image then click finish sketch, then click extrude then select extens all cut icon with 2-way cut and click save with file name casing leaf counter.

Branch Cutter Casing Design
The steps for making the image are almost the same as making the drawing of the leaf chopper casing.

Assembly Upper Casing Component
Click new then select standard click metric (mm). Then create, continue click place on the menu bar, then click the component file we want to assemble then click open then the file is opened, Part appears in the assembly menu then right click ok, then click constrain, in selection 1 click radius from the tube cap in selection 2 click on the side of the tube and the two components will merge into one, then click ok then click the save icon to save the file name, (like Figure 5).

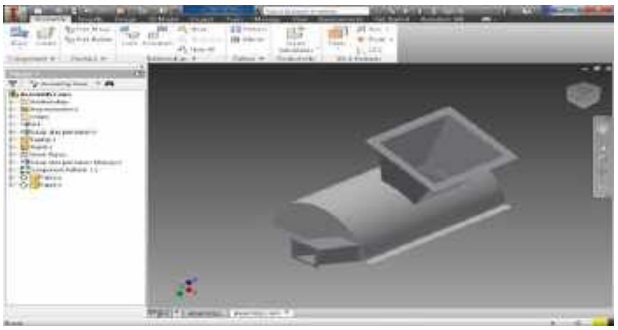


Figure 5 Assembly Upper Casing Component

Lower Casing Design
At the lower casing steps to make the drawing is almost the same as making the upper casing design drawings with different 2 holes.

Waste Casing Design
Click new then select *metric* then look for *sheet metal* (mm) .ipt then click *create* then select one of the axis of the plane and make *sketch* according to the image then click ***face*** on the menu bar then click *profile* and click the newly created *sketch* then click *ok*, then click *icon flange* on the *edge column* select one side that will add the length of the plate with a length of 120 mm, and click the next side then click *flange* along 175 mm, then click *unfold* to see the stretch of part, then click the *new sketch* on the surface of the part and make the sketch according to the image , then click the cut icon then click the new sketch then click ok. Then click refold to restore the stretch image to its original state and click "go to plate pattern" and click the save icon to save the *file name*.

Assembly Lower Casing Component
For the assembly of the lower casing components the steps for making the drawing are almost the same as making an image of the upper casing component assembly, (like Figure 6).

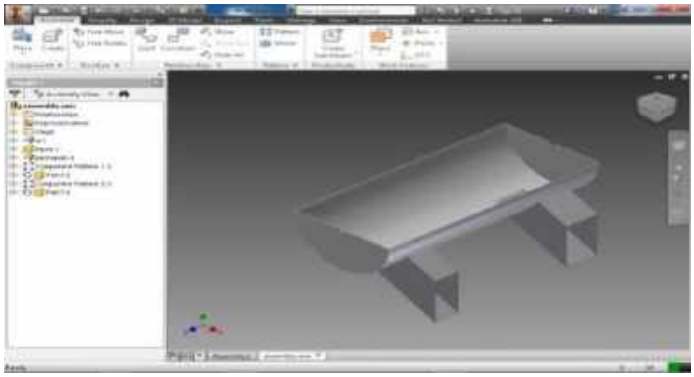


Figure 6. Assembly Lower Casing Component

Axis Design
Click *new* then select *metric* then look for *standard* (mm) .ipt, then click *create* and select one of the axis of the *plane*, then create a circular *sketch* with a diameter of 25.4 mm according to the image, then click *extrude* with a distance of 1000 mm, then click one right side of the *new sketch*, continue to sketch with a diameter of 25 then click finish sketch, then click the extrude icon, then cut along 130 mm, after finishing extrude click the *thread menu* then click the *surface* with a diameter of 25 mm to make a thread. On the reverse side click on the surface then right-click *new sketch*, continue to make the sketch according to the image and then click *extrude* on the sketch that was created earlier, and click the *save icon* for the *file name*

Branch Chopper Knife Design
Click new select *metric* then look for standard (mm) .ipt, then click *create* and select one of the axis of the *plane*, then create a sketch with a diameter of 300 mm according to the image, then click the *extrude icon*, then select the 10 mm thick *extrude*, continue click the *new sketch* on the surface of the part then make the sketch according to the image then click the *extrude icon* select the cut on the field that was previously sketched, then click the *circular pattern icon* then click the *features* that were extrude then click the *circle side* and change *placement to 3* with 360 degrees then right-click on the surface of the *part* then click *new sketch*, make sketch with a diameter of 50 mm Then *extrude* as thick as 20 mm, then click the *filled icon* on the menu bar then click on the part that will make a radius according to the image, then right click on the surface then click new sketch, *continue* to make a circular sketch with a diameter of 25.4 mm, *extrude* cut on that field, and click *chamfer* on the bottom of the component that was previously made uat. Then click the edge on the edge of the part and give a distance of 5 mm, then click the *circular pattern icon*, then click on the *features* that were *extrude* and click the *side of the circle* and change the *placement to 3* with an angle of 360 degrees, then click *origin select xz plane* then visibility, then Click the *plane* on the menu bar then *drag the plane xz up along 25 mm*, then click *new sketch* on the work plane that was created then create a circle sketch according to the image, then extrude cut on the sketch circle until it translates according to the image, and click the thread icon to make the thread thread on the hole that was made, click the save icon with the name of the branch chopper knife.

Leaf Chopper Knife Design
Click *new* select *metric* then look for *standard* (mm) .ipt, then click *create* and select one of the axis of the *plane*, then create a *sketch* with a length of 130 mm and a width of 30 mm according to the image then *finish sketch*, then click the *extrude icon* then select the field will be extruded 5 mm thick then click *ok*. Then click *chamfer*, then *chamfer* the edges of the knife with a *distance* of 2.5 mm then click *apply* and right click on the surface of the *part* then click *new sketch*, then create a *sketch* with a circle with a diameter of 8 mm according to the image, then click the *extrude icon* then cut on the *sketch* field that was created, and click on the *icon* with the *file name* leaf chopper knife

Circular Saw Design
For the circular saw design the steps - the steps for making the drawing are almost the same as the making of the knife chopper design drawings with different shapes and the number of 40 gear.

Assembly Knife Component with Axis
Steps for making drawings Assembly of knife components with axis is almost the same as making assembly drawings on the upper casing components (like figure 7).

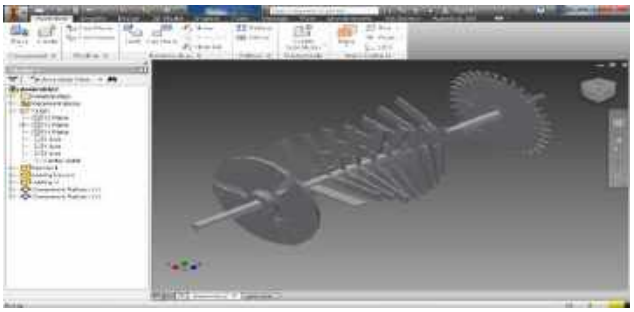


Figure 7 Assembly of knife with axis

Assembly All Components
start clicking *new* select *metric* Then find the *standard* (mm) iam, then click *create*, then click *place* on the *menu bar* then click the component *file* that we want to *assemble* then click *open* and click *assembly* display then *ok*, then click the *constraint* icon select *join* menu, and *selection* 1 shows on the width of the bearing, then click *selection 2* on the iron side U, then click *apply*, and open the *constraints* again, select the *join* menu, in *selection* 1 click on the iron U field, the xyz axis will be locked, then click *apply* , then set the distance by measuring *distance assembly* according to the image, and so on for the assembly steps of the other components and finally click the *save icon* with the file name *assembly component*, (like figure 8).

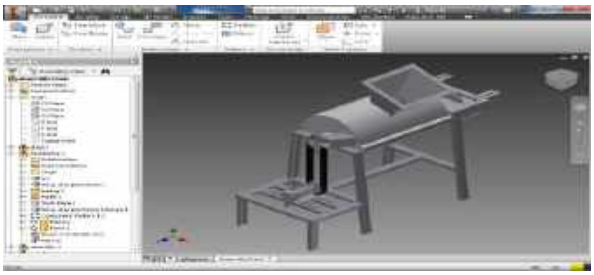


Figure 8. *Assembly All Component*

3.2 Working Drawing (Projection).
Working drawings are images that are used as a reference in the process of working on a product.

(a) The Making of Axis
In the process of making this transmission axis, using steel material ST 42 Ø 25.4 mm, (such as work Figure 9).

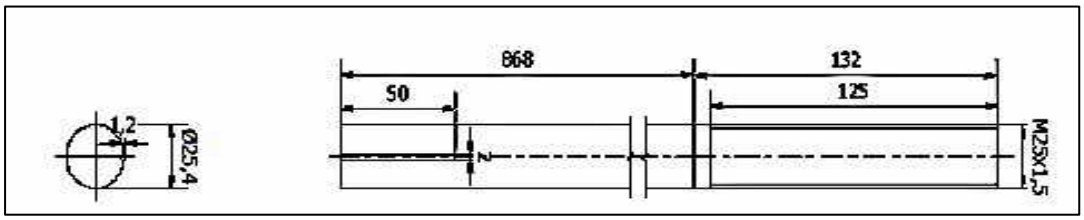


Figure 9 Axis

The Making of Framwork

Making frames using Iron Unp 50 mm x 32 mm x 23 mm, (like working Figure 10).

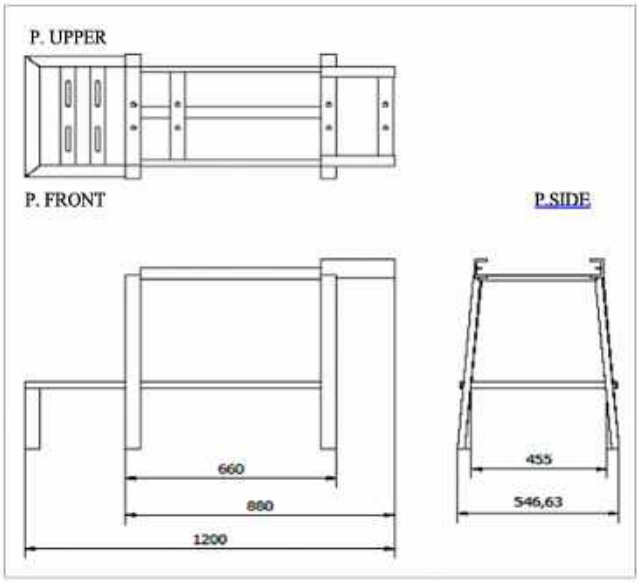


Figure 10 Frame

The Making of Leaf Chopper Knife

In the process of making knives, cut the strip plate 40 mm x 32 mm with a length of 150 mm as many as 27 pieces, on the cut-off machine, (like image 11).

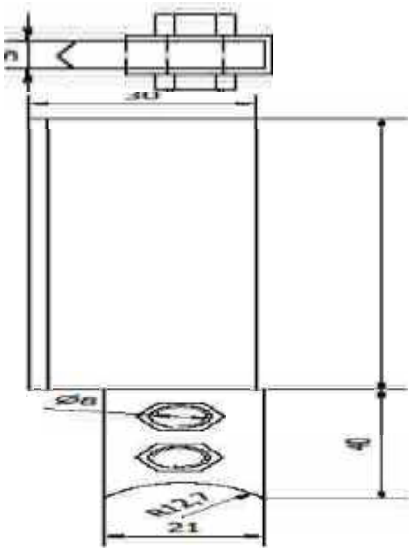


Figure 11 Leaf Chopper Knife

The Making of Branch Cutter Knife

In the process of making this knife, using an 8 mm thick plate of eser cut with a length of 100 mm as many as 3 pieces, on the cut off machine with an angle of 450, (as shown in Figure 12).

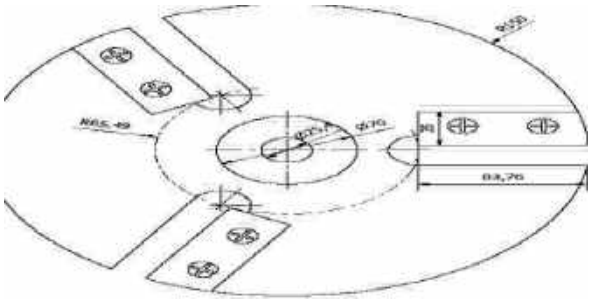


Figure 12. Branch cutter knife

The Making of Casing

In the process of making this tube, cut the eser plate 2400 mm x 1200 mm x 2 mm with a length of 600 mm x 600 mm as many as 2 pieces, on hydraulic cutters, 1800 semicircular shapes, (as shown in Figure 13).

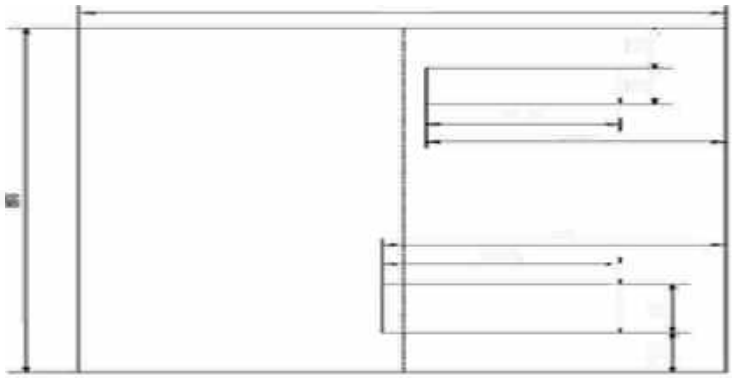


Figure 13 Casing

3.3 Plan Design Results

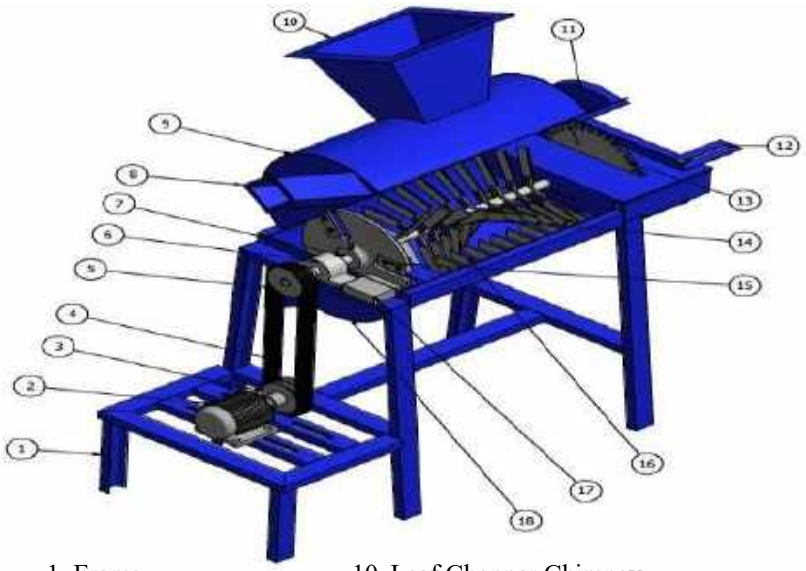
Design Result Product

Based on the planned design construction as shown in Figure 1, the results of designs and plans can be seen as shown in Figure 14 and 15 and its specifications.

Figure 14 Multifunctional Organic Waste Chopper Products

Specifications of Organic Waste Chopper

Type Multi Function Waste Counter Machine 01, Capacity 50 kg / hour, Blade Type 10 fixed seeds, 27 seeds move 3 seeds, Circule Church 1 seed, 1 inch shaft, FrameUnp 5, Type V - A43 Belt, and V-Block Bearing UCP 6205.



1. Frame
2. Electric Motor
3. Pulley
4. V-belt
5. Waste Chimney
6. Bearing
7. Axis
8. Branch entry chimney
9. Upper Cylinder
10. Leaf Chopper Chimney
11. Wood Cutter Set
12. Circular saw
13. Leaf chopper knife
14. Branch cutter knife
15. Motionless knife
16. Cut distance adjusment
17. Lower Cylinder

Figure 15 Organic Waste Chopper Tool Design

4. CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

In making the design of the organic waste chopper design, the first is the design idea, then the drawing process using the 2015 autodesk inventor program includes the making of sketches, component images from machine parts, followed by assembly, then rendering and animation. The final stage of the design is entered into "IDW" complete with size, scale, material, working drawings so as to make it easier for designers to make tools. With the design drawings complete with working drawings (projections, scales and dimensions) can simplify the process of making components of the tool and can reduce the risk of errors in the process of making tools

4.2 Recommendation

In making the design, it is better to make the right size of equipment, especially between the hole and the shaft so that when the assembly process can blend easily. Each component size must take into consideration the ingredients on the market so that later in making the tools used the ingredients are easily available, and each component of the image must be as complete and clear as possible so that the reader is easy to understand

5. REFERENCES

[1] Arifien Koko. 2015. *Menggambar Teknik dasar manual pra-AutoCAD.* Bandung: PT Sarana Tutorial Nurani Sejahtera
[2] Daryanto, 2013. *Teknik Las.* Jakarta: Alfa beta
[3] Ginting Rosnani. 2010. *Perancangan Produk*. Jakarta: Graha Ilmu
[4] Takeshi Sato, N.Sugiarto,H. Menggambar Mesin Standar ISO, PT. Pradnya Paramita Jakarta 1986.
[5] Hidayat Nur. 2011. *Autodesk Inventor. Mastering 3D Mechanical Design.* Bandung: Informatika
[6] Mott, Robert L, 2004. *Elemen-elemen mesin dalam perancangan Mekanis jilid 1.* Yogyakarta: ANDI
[7] Hadiyono, Yatin, 2015. "Gambar Teknik*". Modul Pembelajaran Autodesk Inventor.* 4.
[8] Prasetyowibowo Bagas. 1999. *Desain Produk Industri*. Bandung: Yayasan Delapan – Sepuluh.

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REDESIGN AND IMPROVEMENT OF POTTERY SPINNER TO INCREASE WORKER PRODUCIVITY

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Abstract. *Many small industries produce handicrafts related to art in Bali, one of which is pottery. Pottery is an object made of clay which is formed and then burned to be a unique shape such as: jugs, glassware, cauldron, brazier, piggy bank, and other objects. The process of producing pottery required the complex steps, from preparing clay, printing by turning, drying and burning. The main difficulty of pottery producers is in the process of forming shapes which involved the rotating spinner. Most of small industries still use the manual spin control to rotate clay bucket holder. This research aims to re-design of a rotating spin machine from the existing pottery industries to increase the productivity. The sample was overtaken from 12 craftsmen in Singakerta Village, District of Ubud Gianyar, Bali. Sample P0 was given to craftsmen is still used the old design and P1 was given to sample modified and re-designed the old machine with added automatic control of rotating spinner. Workload is calculated based on the worker's pulse rate which is measured using a pulse meter. Research data were analyzed using descriptive and inferential statistics. T-test method was performed to analyzing the differences range between groups P0 and P1 at significance level of 5%. The results showed a workload was decreased from heavy to moderate by 12.09%. Production rate was increased by 282.1%, and productivity increased by 334.6%*

Keywords: Re-design Pottery Machine, Workload, Work Productivity.

1. INTRODUCTION

Bali area currently stands many small industries that produce crafts related to art, one of which is pottery. Pottery in general is an object made of clay which is formed and then burned and then used as tools to help human activities, such as jugs, pots, pots, jars, bobs, piggy banks, and other objects. However, because Bali is famous for its culture and art, pottery artisans innovate to pour art into pottery.

The process of producing pottery required the complex steps, from preparing clay, printing by turning, drying and burning. The main difficulty of pottery producers is in the process of forming shapes which involved the rotating spinner. Most of small industries still use the manual spin control to rotate clay bucket holder and is still complained because it does not suitable to the needs, limitations, and anthropometry of the user. The production process will take place optimally if the demands of the task, organization and work environment in accordance with the abilities, permissibility and limitations of workers [1]-[3].

A preliminary survey was carried out on pottery craftsmen in Singakerta Village, Ubud District, Gianyar Regency. Most of them was complained about the high cost of spinning machines, ineffective production if using manual method and discomfort in certain body parts after the finished work. In addition, the risk of health problems will increase and eventually the productive age will decrease. Through ergonomic intervention in small-scale industries using ergonomic work equipment is proposed to reduce workload and subjective disorders [4]

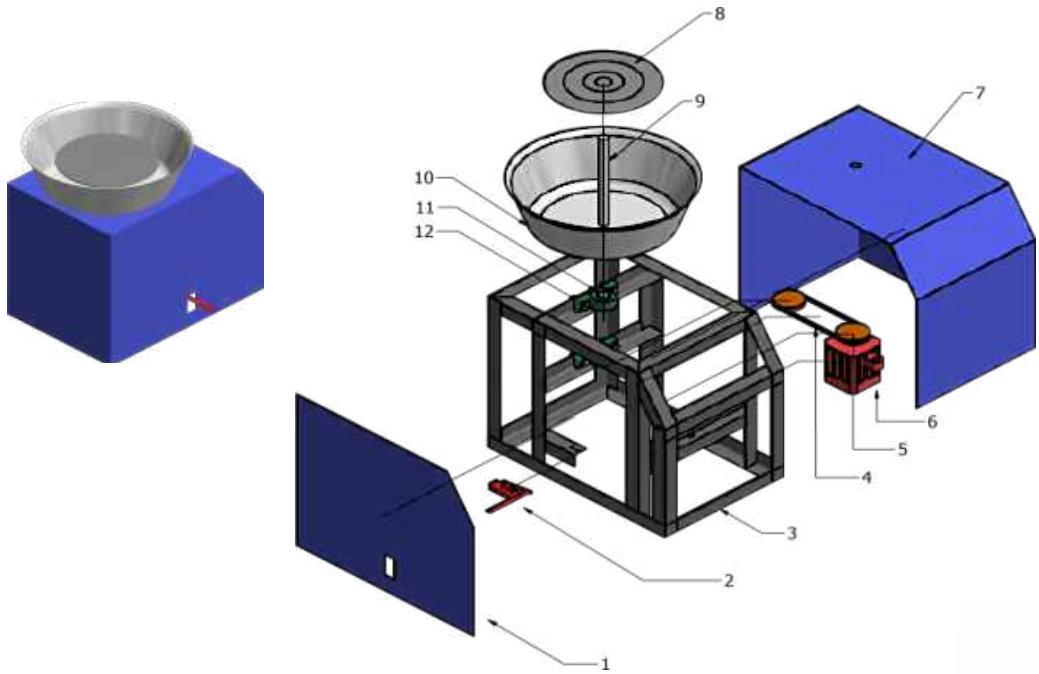
To resolve the problem of this craftsman not only about suitable tools, but needed an ergonomic comprehensive approach. Improvements in working conditions and environments should take into account all aspects of ergonomics, such as the utilization of appropriate technology, the improvement of the whole production

process with a systematic, comprehensive approach, involving various discipline and active participation both physically and psychologically in all components involved in the production process. The application of the concept of appropriate technology and the overall improvement of the production process of the SHIP (Systemic Holistic Interdisciplinary Participatory) approach should be done in a consistent and sustainable manner [2]. And the various factors that need to be considered in relation to the production process such as work tools and work stations include the size, dimension, way of work, work attitude to match the abilities, permissibility and limitations of workers [2],[3].

Based on the above description it is deemed necessary to research the improvement of working conditions by redesign and modification of the existing rotating spinner machine on the appropriateness of the function, the anthropometric dimensions of workers and easy user maintenance by an ergonomic approach.

2. METHODS

The experimental method was conducted by redesign of the existing rotating spinner machine. The sample was overtaken from 12 craftsmen in Singakerta Village, District of Ubud Gianyar, Bali. Sample P0 was given to craftsmen is still used the old design and P1 was given to sample modified and re-designed the old machine with added automatic control of rotating spinner. Workload is calculated based on the worker's pulse rate which is measured using a pulse meter. Fatigue was predicted from 30 items of general fatigue questionnaire. Skeletal muscle complaints were predicted from the Nordic Body Map questionnaire. The work productivity of the subjects is recorded based on the ratio of amount of production (output) to the workload (input) at a certain time unit. Research data were analyzed using descriptive and inferential statistics. T-test method was performed to analyzing the differences range between groups P0 and P1 at significance level of 5%. The rotating spinner with semi-automatic control driven by electrical motor was designed as the Figure 1 below



1. External cover
2. Variable speed control
3. Metal frame
4. V-belt
5. Driven pulley
6. Electrical motor
7. Upper safety cover
8. Rotating plate
9. Main shaft
10. Bucket clay
11. Bearing
12. Bolt

Figure1. The schematic design of rotating spinner using semi-automatic control

The working principle of this machine is the rotation of the motor electricity as the primary power source is forwarded to the pulley, v-belt, and finally the main shaft which is connected directly to the rotating plate. The speed of motor was controlled by stepping on a pedal connected to variable speed control. The dimension of each component was designed to the size of the worker anthropometry. The height of the tool is adjusted to the height of the sitting elbow of the worker. The length or width of the tool is adjusted to the length of the worker's hand. The position of the driving pedal is adjusted to the position of the worker's feet.

3. RESULTS AND DISCUSSION

3.1 Subject Characteristic

The number of subject samples in this study was taken from 12 craftsmen. Subject characteristics include age, height, weight, and work experience. The mean characteristics of the subjects are presented in Table 1.

Table1. Research Subjects Characteristic Summary

Variable	Mean	SD	Range
Age (year)	32.25	1.50	26-47
Body Weight (kg)	62.85	3.58	57-74
Body Height (cm)	167.48	4.37	159.5-175.5
Working Experience (year)	6.15	1.25	4-10

Mean age of subject is 32.25 ± 1.50 year and age range still included the working age group at 26 - 47 years old. The age range still includes a productive workforce with the age limit of the labor force applicable in Indonesia that is aged 15 to 64 years. The optimum muscle strength for recommended work is between 20 to 30 years [5] and the mean age of this study subjects has decreased since the optimum muscle strength. Age conditions affect the ability of physical work or muscle strength of a person. Maximum physical ability of a person is achieved at the age between 25 - 35 years and will continue to decline with age [3]. Organ systems such as the cardiovascular, respiratory, and muscular systems may decrease by 2% per year after the age of 30 years [6]. Based on the characteristics of the research subjects, the work experiences of the craftsmen that is normally considered to be experienced with an average working in their field of 6.15 years. This work experience supports the expertise of a worker in the production process. Work experience is one of the factors that influence the level of skills of workers, complaints that occur in the musculoskeletal system, as well as on productivity [3].

3.2 Anthropometry of Craftsmen

The suitability between the work station and the workers will affect to the ergonomic work attitude of the craftsmen. Unnatural work attitude occurs if the work equipment is not in suitable with the anthropometry of the worker's body. This will increase the physical workload of workers. Anthropometry is a one method to fitting of body dimensions and other physical characteristics of the body that are used to design a product or device [3]. Anthropometry model used in this study considered of dimensions and design of the machine to working attitude of the craftsmen. The height of the rotating spinner machine adjusted to the height of the crafter's elbow in a sitting position. The rotate plate which is above of the instrument should be within the reach of the hand of the craftsman. The length and width of the machine also need to be adjusted when forming the shape in order to ideal position with the body of the craftsman. The position of the variable speeds control pedal is adjusted to the position of the worker's feet when sitting.

Anthropometric data in design model considerations is best presented in the percentiles form [3]. Therefore, the calculation of the size and dimensions of the machine is used 5% percentile that occurs workers can use the rotating spinner machine more comfortably.

3.3 Workloads

Pulse frequency was used an objective measure, quantitative and accurate assessment of workload [7]. The work pulse frequency of working hours can be used as a basis for evaluating of physical workload. The pulse at rest is called the resting pulse and the pulse at work is called the working pulse. The results of workload measurements from pottery craftsmen are shown in Table 2 below:

Table2. Workloads Results Analysis of Pottery Craftsmen

Variable	P1		P2		t	p
	Mean	SD	Mean	SD		
Resting pulse (beat/minute)	72.12	2.31	71.76	2.19	1.328	0.419
Working pulse (beat/minute)	125.27	4.26	110.12	3.37	3.721	0.000

From the results of the t-test on the resting pulse showed p value > 0.05, indicates the initial conditions of the craftsmen pulse are in the same condition or not significantly different. While on the pulse of work (workload) tested proved there was significant difference between P1 and P2 ($p < 0.05$). The average working pulse value deceased from 125.27 beats per minute (P1) to 110.12 beats per second (P2). The classification of workloads in P1 is included in the category of “heavy” workload due to the range 125-150 / min while in P2 includes “medium” work load that is in the range of 100 - 125 beats per minute [3]. The results of the comparison between

P1 and P2 showed the workload decreased from heavy to moderate with a value decreasing at 12.09%.

The decreased of workload due to used rotating spinner machine in the manufacturing process can reduced the physical work. The results of this study are show good agreement with other studies which indicates the ergonomic interventions can reduce the workload of workers [8].

3.4 Work Productivity

The work productivity of the subjects was calculated based on the ratio of output to the input at a certain time unit. Output generated by the amount of produced the pottery shape during the working hour (average 7 hours per day), while the input is the craftsmen workload (work pulse).

Table3. Work Productivity Results Analysis of Pottery Craftsmen

Variable	P1		P2		t	p
	Mean	SD	Mean	SD		
Work Productivity	0.362	0.013	1.571	0.017	1.216	0.000

The result of the analysis showed that there was a significant difference ($p > 0.005$) between P1 and P2 indicated work productivity was increased from 0.362 (P1) to 1.571 (P2) or an increase of 334.6%. Increased work productivity can be done by improving machine tools and work systems based on ergonomic principles [9,10,11]. The principles of ergonomic also increase the influence of the work more effective and efficient [12].

4. CONCLUSION

Based on the results of the discussion above, the conclusions can be conveyed as follows: a) redesigned and improved the rotating spinner machine based on an ergonomic approach reduces the workload of pottery craftsmen by 12.09%. The rotating spinner machine design increases the work productivity of pottery craftsmen by 334.6%.

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6. REFERENCES

[1] Manuaba, A. (2006) 'Total approach is a must for small and medium enterprises to attain sustainable working conditions and environment, with special reference to Bali, Indonesia', Industrial health, 44(1), pp. 22–26. doi: 10.2486/indhealth.44.22.

[2] A. Manuaba, "'Ship' Approach is a Must to Attain Sustainable Results in Ergonomics," Proceedings of the Human Factors and Ergonomics Society Annual Meeting, vol. 44, no. 33, 2000.

[3] Kroemer, K. H. E. and Grandjean, E. (2009) Fitting the Task to the Human, Fifth Editione A Textbook Of Occupational Ergonomics. London: CRC Press.

[4] Kretschmer, T, Bloom, N & van Reenen, J 2009, Work Life Balance, Management Practices and Productivity. in Insider Studies of the Performance of Multinational Firms. The National Bureau of Economic Research, Cambridge/MA, Cambridge, Massachusetts, pp. 15-54.

[5] Jasobanta S., Jaspal S.S., and Vijay I. 2011. Effect of Body Mass Index on work related musculoskeletal discomfort and occupational stress of computer workers in a developed ergonomic setup. National Center for Biotechnology Information, U.S. National Library of Medicine 8600 Rockville Pike, Bethesda MD, 20894 USA.

[6] Sehl, M.E., and Yates, F.E. 2001. Kinetics of human aging: I. Rates of senescence between ages 30 and 70 years in healthy people. J. Gerontol. Biol. Sci. Med. Sci. 56: B198–B208. PMID:11320100.

[7] Adiputra, N. (2002) 'Pulse Rate and Its Use in Ergonomics', The Indonesian Journal of Ergonomic, 3(1), pp. 1–6.

[8] IKGJ Suarbawa, M Arsawan, M Yusuf, IM Anom Santiana (2018) 'Improvement of environment and work posture through ergonomic approach to increase productivity of balinese kepeng coin workers in Kamasan village Klungkung Bali', in Journal of Physics: Conference Series. doi: 10.1088/1742-6596/953/1/012105.

[9] K. Edwards and P. L. Jensen, "Design of systems for productivity and well being," Applied Ergonomics, vol. 45, no. 1, pp. 26–32, 2014.

[10]. I. K. G. J. Suarbawa, N. Adiputra, J. A. Pangkahila, and I. D. P. Sutjana, "Work Posture Improvement Using Ergonomic Approach Decreases Subjective Disorders of Perapen Workers on the Process of Nguwad Gamelan in Bali," International Research Journal of Engineering, IT & Scientific Research, vol. 2, no. 9, p. 7, Mar. 2016.

[11] E. Tompa, R. Dolinschi, and J. Natale, "Economic evaluation of a participatory ergonomics intervention in a textile plant," Applied Ergonomics, vol. 44, no. 3, pp. 480–487, 2013.

[12] H. Loo and P. H. Yeow, "Effects of two ergonomic improvements in brazing coils of air-handler units," Applied Ergonomics, vol. 51, pp. 383–391, 2015.

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CHARACTERISTICS TEST OF DIESEL FUEL PROTECTION ON NOZEL MAINTENANCE, ISUZU PANTHER MACHINE EARLY GENERATION

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Abstract. Even though it is old / old, the existence and existence of Isuzu Panther cars in the 90s are still widely used, this is because in addition to the well-known / tested engine stubborn but also fuel efficient. To maintain the condition of the engine to stay fit, vehicle owners must pay attention to the maintenance of their cars regularly. One engine component that is vital and must receive special care is the Nozzle. The treatment of the nozzle is physical condition checking, cleaning and proper testing. This test is done by giving pressurized fuel to the nozzle, then we observe and analyze how the character of the spray. Testing pressure variations of 90 bar, 100 bar, 110 bar, 120 bar, and 130 bar (range of nozzle working pressure from the factory) using diesel, The characteristics of the fuel spray tested are the length of the spray penetration tip (L), speed spray (v or Uin), spray angle (Ɵ), and large distribution of granules formed at each pressure variation. From the test it is known, at 110 bar testing pressure has the best characteristics, both in terms of spray and the number of grains.

Keywords : Pressure nozzle, the length of the spray, spray time, spray angle, the distribution of grain.

1. INTRODUCTION

The treatment of the nozzle is physical condition checking, cleaning and proper testing. This test is done by giving pressurized fuel to the nozzle, then we observe and analyze how the character of the spray. Test pressure variations of 90 bar, 100 bar, 110 bar, 120 bar, and 130 bar (range of the nozzle working pressure from the factory [1]) using diesel, The characteristics of the fuel spray tested are the length of the spray penetration tip (L), speed spray (v or Uin), spray angle (Ɵ), and large distribution of granules formed at each pressure variation.

The test aims to determine the pressure that has the best characteristics, both from the angle of the spray and the number of grains.

In testing data from video camera observations in the form of: Spray penetration tip length (L), Penetration tip speed (Uin), Spray angle (Ɵ), Spray area area (A), and diameter size distribution of the grain / droplet (D) that occur on fuel spray. To be able to find the values of the spray characters mentioned above, the raw data is then changed in the format (jpg).

2. METHODS

In conducting the test, the test equipment is made similar to the original diesel engine spray system. The series of simulation tools can be seen in Figure 1 below:

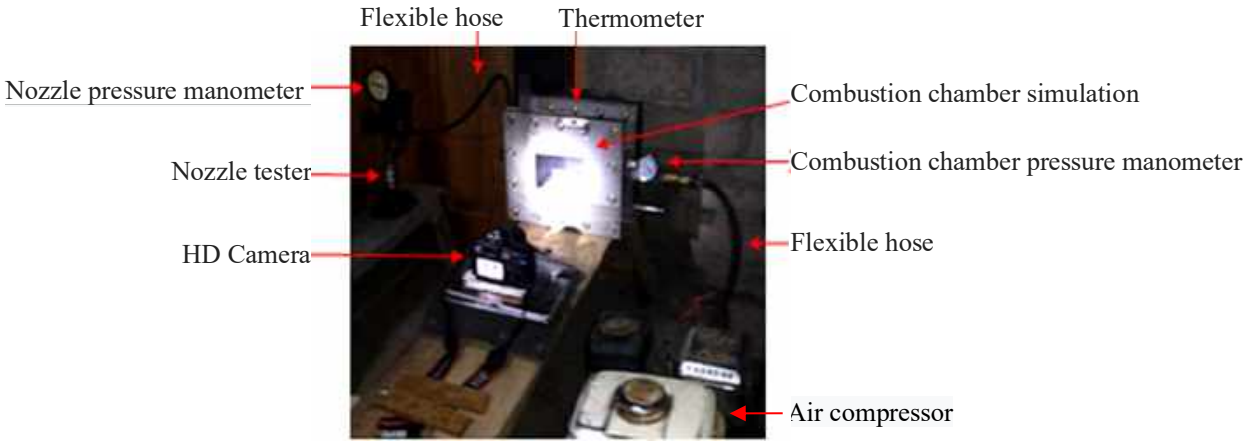

Figure 1. Photograph of the spray tool used in the test

To get the right spray, an injection tester / nozzle is used as a source of pressure, the injector or nozzle as a fogger and a beam-shaped test chamber that has conditions similar to the actual combustion chamber, then the fuel that enters the combustion chamber simulation is recorded with high divination (HD) the camera to get the image of the spray angle, grain size, and length of the spray [2].

3. RESULTS AND DISCUSSION

3.1. Research data

Research data obtained from video camera observations are as follows, Spray penetration tip length (L), penetration tip speed (Uin), spray angle (Θ), and diameter size distribution of the droplet / D (grain) that occurs in the oil spray material burn it. To be able to find the value of the spray character mentioned above, the raw data is then changed in the format (jpg). Figure 2 shows a spray of test results that has been converted to an image format (jpg).

Figure 2. Initial spray data processing with Image J program

3.2. Data processing

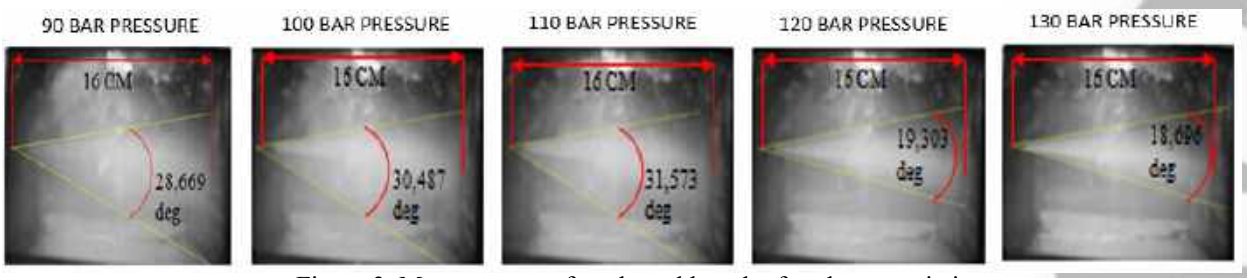

Figure 3. Measurement of angle and length of each test variation

The length of the spray penetration tip (L) formed in each of the tests mentioned above shows a length of 160 mm (the spray reaches the test chamber wall) and has a varying speed for its formation, different penetration for each test [3]. The following is a complete table of the spray results that occur in each test.

Table 1. Angle data, spray velocity and length for each variation of the nozzle pressure

No	Pressure P (Bar)	Angle θ (Deg)	Distance L (10^{-3}m)	Time T (10^{-3}s)	Speed V (m/s)
1	90	28,67	160	54,95	2,91
2	100	30,49	160	47,95	3,34
3	110	31,57	160	44,95	3,56
4	120	19,3	160	41,95	3,81
5	130	18,7	160	37,95	4,22

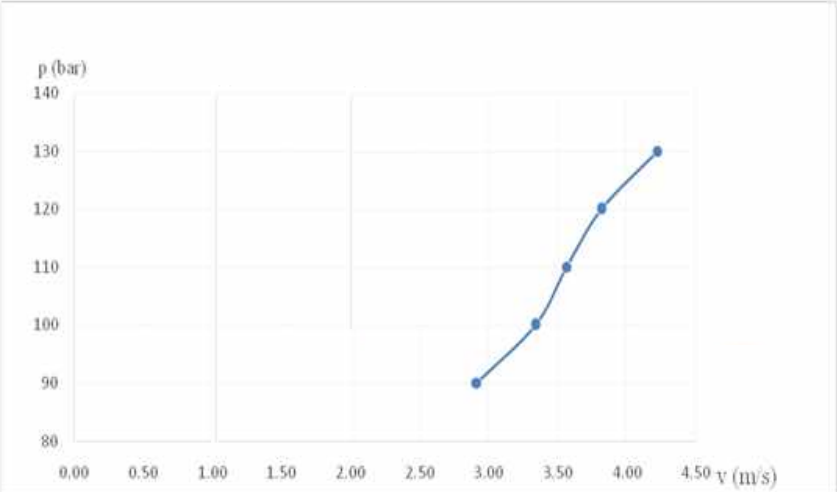

Figure 4. Graph of influence of nozzle pressure variation on the nozzle spray speed

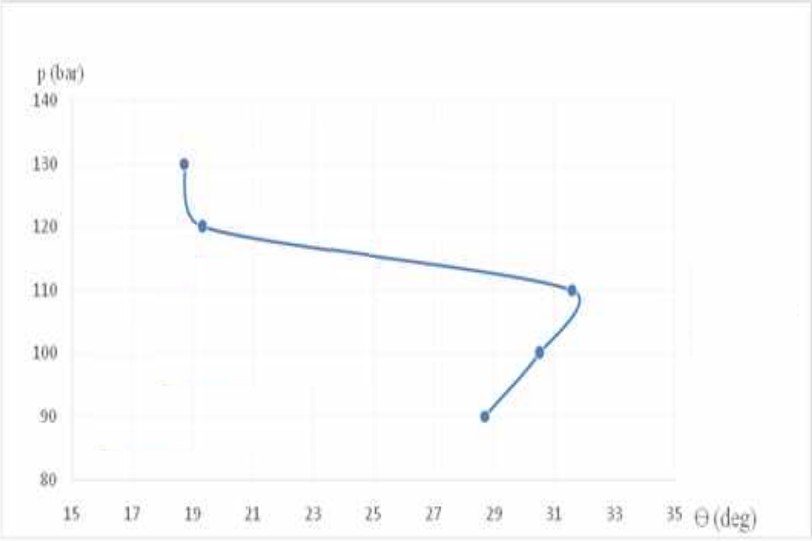

Figure 5. Graphic Effect of nozzle pressure variations on the nozzle spray angle

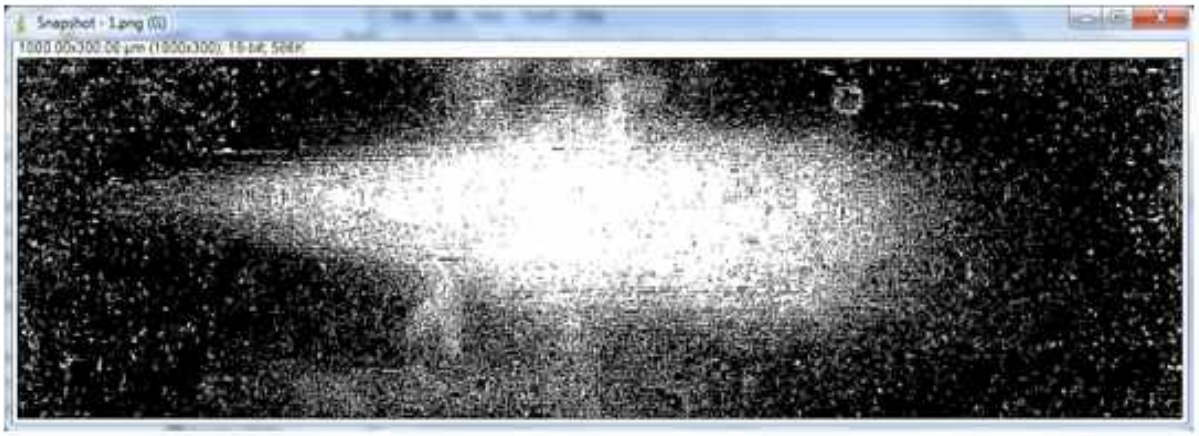

Figure 6. Results of data processing using the Image J program

Table 2. Total data distribution of granules for each test oil.

No	Nozzle Pressure (Bar)	Number of grains (n)	D Min		D Max		Total Area
			(μm)	%	(μm)	%	(μm^2)
1	90	3968	2,31	46,40	20,24	0,03	15.463,58
2	100	4285	2,31	44,43	23,29	0,02	17.089,23
3	110	4651	2,31	48,72	26,50	0,02	19.041,12
4	120	3830	2,31	48,77	36,10	0,03	16.365,67
5	130	3657	2,31	53,57	25,27	0,03	13.525,47

It can be seen from the table that the greater the pressure on the nozzle will have an impact on increasing the tip tip speed, the lowest tip tip speed is found at the 90 bar nozzle pressure where the tip tip penetration value is only about 2.91 m / s far smaller than the speed value at 130 bar nozzle pressure.

Theoretically the length of this penetration tip can also be estimated using equation 1 [4], and the results obtained as the table below:

$$\frac{L}{L_b} = 0.0349\left(\frac{\rho_a}{\rho_l}\right)^{\frac{1}{2}}\left(\frac{t}{do}\right)\left(\frac{\Delta p}{\rho_l}\right)^{1/2} \quad \text{.....1}$$

$$L = 83{,}61\ x\ 0{,}0349\left(\frac{1{,}2}{840}\right)^{\frac{1}{2}}\left(\frac{54{,}95}{0{,}2}\right)\left(\frac{0{,}9\ x\ 10^6}{840}\right)^{\frac{1}{2}}$$

L = 307 mm

Table 3. Difference in the length of tip penetration test results with the results of theoretical calculations

No	Pressure (Bar)	Actual distance (mm)	Time		Theoretical distance (mm)
			(ms)	(s)	
1	90	160	54,95	0,05495	306,76
2	100	160	47,95	0,04795	297,43
3	110	160	44,95	0,04495	306,70
4	120	160	41,95	0,04195	312,25
5	130	160	37,95	0,03795	306,02

The penetration tip length obtained through calculations has a difference with the length of the penetration tip obtained by testing, this can be due to limitations in this study both in terms of testing tools, software, and the level of accuracy of the scale in the testing data processing which is done manually.

For the theoretical spray angle, you can use equation 2 [4], as follows:

$$\theta = 0.05 \left(\frac{\Delta p d_0^2}{\rho_a v_a^2}\right)^{1/4} \quad \text{.....2}$$

$$\theta = 0.05 \left(\frac{0{,}9x10^7 . 0.002^2}{840x5{,}724x10^{-6}}\right)^{\frac{1}{4}}$$

$\theta = 16{,}35^{O}$

While the velocity (v or Uin) of the spray can be estimated theoretically using equation 3 [3] :

$$U_{in} = C_d\sqrt{\frac{2\Delta P_{inj}}{\rho_L}};\ \rho_a = \frac{\rho_a}{\rho_L} \quad \text{.....3}$$

$$Uin = 0{,}08\sqrt{\frac{2\,x\,0{,}9\,x\,10^6}{840}}$$

Uin= 3,70 m/s

While the average diameter value of this spray can be calculated using the Sauter Mean Diameter (SMD) equation 4 [5] :

$$SMD = 10^{-3}\left[\frac{\sqrt{(\sigma\rho_L)}}{\rho_a v_a}\right]\left(1+\frac{1}{AFR}\right)^{0{,}5} + 6\,x\,10^{-5}\left[\frac{\mu_L^Z}{\sigma\rho_a}\right]^{0.425}\left(1+\frac{1}{AFR}\right)^{0{,}5} \quad \text{.....4}$$

$$SMD = 10^{-3}\left[\frac{\sqrt{(0.068x940)}}{1.2x103.55}\right]\left(1+\frac{1}{10}\right)^{0.5} + 6\,x\,10^{-5}\left[\frac{(5{,}724x10^{-6})^2}{0.068x1.2}\right]^{0.425}\left(1+\frac{1}{10}\right)^{0.5}$$

SMD = 67.48 µm

4. CONCLUSION

From the tests that have been done, it can be concluded that at a pressure of 110 bar has the best characteristics, both from the angle of the spray and the number of grains.

5. ACKNOWLEDGEMENT

Finally, I would like to thank everybody who was important to the successful realization of this paper. This paper is far from perfect, but it is expected that it will be useful not only for the researcher, but also for the readers. For this reason, constructive thoughtfull suggestion and critics are welcomed.

6. REFERENCES

[1] Anonim, 2005, *Astra International Isuzu*, Sistem bahan bakar isuzu panther 2.3: http:/www.astrainternational.com;
[2] Pinto, Agapito., I G B Wijaya Kusuma, dan I W Bandem Adnyana, "Uji karakteristik penyemprotan bahan bakar biodiesel pada nosel mesin diesel dengan sistem injeksi langsung", Jurnal Logic. Vol.15. No.1 Maret 2015;
[3] Ghurri Ainul et. al, 2010, *Qualitative and quantitative analysis of spray characteristics of diesel and biodiesel blend on common-rail injection system.journal of mechanical science and technology available* from:URL: http:/www.springerlink.com/content;
[4] Borman Gary L. et. al, 1998, *Combustion engineering international editions*, Oxford, USA;
[5] Viriato, S.1,Pedro Andrade2, Maria da Graca Carvalho3, 1996. Spray Characterization: numerical prediction of Sauter mean diameter and droplet size distribution. Departamento de Engeharia Mecanical, Instituto Superior *Tecnic, Universidade Tecnico de Lisboa, Portugal.*

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ANALYTICAL ANALYSIS OF EXTREME POSITION MECHANISMS FOR CONVEYOR LIFITNG SEGMENTS USING KINEMATIC SYSTEM

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Abstract. The process of moving an item in the industrial world has an influence on productivity produced by the company. The company's productivity can be supported by using a conveyor when the transfer process takes place. This study aims to determine the extreme position of the conveyor lift segment mechanism using the kinematic system. The method used is an analytical analysis method with a kinematic system using SAM 6.0 software. The stages of the research process are measuring conveyor segments, drawing kinematic diagrams, depicting movement mechanisms, calculating degrees of freedom (DoF), calculating geometry, and ending the stroke link follower measurements. The results of the study resulted in a degree of freedom that is 1 which shows the movement of the conveyor freedom only 1 direction, and the calculation result of follower link stroke is 22.6o which shows the maximum range that can be done from the movement of the conveyor lifting segment.

Keywords :Productivity, Mechanism, Conveyor, SAM.

1. INTRODUCTION

Technology and science that are increasingly advanced have an impact on the number of companies that develop equipment to support productivity. The process of moving an item in the industrial world has an influence on productivity produced by the company. The company's productivity can be supported by using a conveyor when the transfer process takes place.

Conveyor is a common part of mechanical material handling equipment that moves from one location to another location [1]. The productivity of conveyor use can be known through faster distribution times and minimal expenditure costs [2]. The productivity of conveyor use can be determined by analyzing the distribution process when the conveyor is working.

Valid analysis results are obtained using analytical methods with kinematic systems. An analytical analysis is used to describe the process of knowing each stage to obtain results. The kinematic system description is carried out to describe the process of moving a moving conveyor segment. Analysis of the movement of conveyor segments is known by using SAM 6.0 software. The use of SAM 6.0 software to facilitate the process of elaborating the results of kinematic charts and movement graphs.

2. METHODS

This research was conducted using analytical methods to obtain valid results in order to obtain the right solution. Analytic method is a method that satisfies the original equation exact [3]. The analytical method is carried out through several stages [4]. The stages of the analytical method are described in the following flowchart methodology:

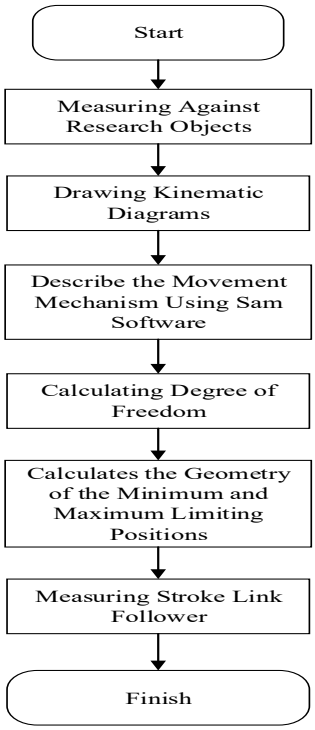

Figure 1. Flow Chart

The first stage measures the conveyor segment that is the object of research, the second depicts kinematic diagrams, the third stage illustrates the mechanism of conveyor lifter segment movement using SAM software, the fourth performs DOF (Degree of Freedom) calculations to determine the direction of conveyor segment movement, the fifth performs the geometry calculation of the position minimum and maximum limit, and end with a stroke link follower measurement.

3. RESULTS AND DISCUSSION

This section outlines the results and discussion of the stages of the research conducted.

3.1 Measurement of Conveyor Lifting Segments

This section is carried out by measuring the segment of the conveyor device using a length measuring instrument (a ruler). The results of the measurements made are shown in the following figure:

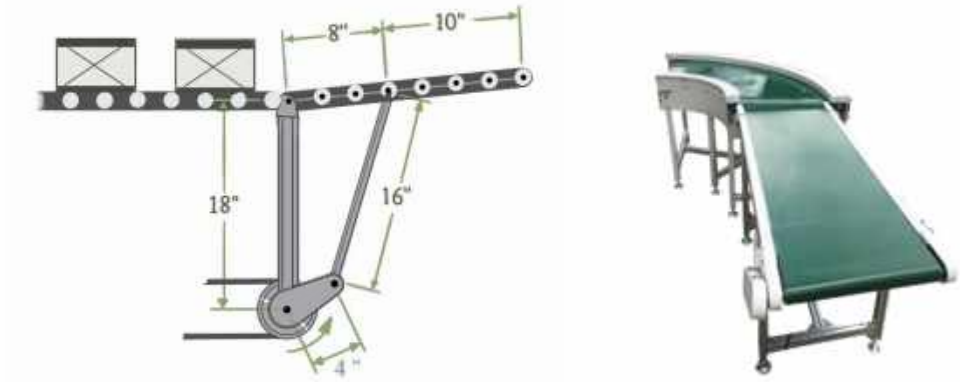

Figure 2. Conveyor Segment Size Details

In the description of Figure 1, it is known that the length of the flexible segment on the conveyor is 18 inch with 8 inch between the driving lever and the fixed lever and 10 inch in front of the driving lever. The length of the drive lever is 16 inches. The length of the connecting lever is 4 inches, and the length of the lever is fixed at 18 inches.

3.2 Kinematic Portrayal of Diagrams

This sub-chapter is carried out to describe the kinematic diagram of the conveyor device segment. The kinematic diagram illustrates the connectivity of the link and joints mechanism of the dimensions of the

component shapes [5]. Kinematic Diagramming Results are shown in the following figure:

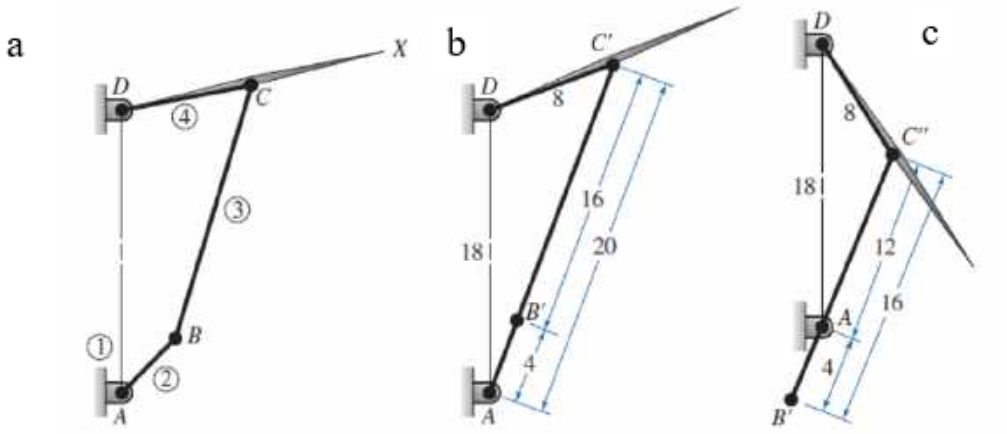

Figure 3. (a) Starting Position from Mechanism of the Conveyor Segment Movement. (b) Up Position from Mechanism of the Conveyor Segment Movement. (c) Down Position from Mechanism of the Conveyor Segment Movement

The translation of Figure 2 shows that the process of conveyor segment movement is preceded by a left image where the condition of the conveyor segment is normal and does not lead to a specific destination. Image of the movement of the conveyor segment directing the flow of an object that is distributed upward is shown by the middle image where the position of the driving lever and the connecting lever forms a straight line along 20 inches.

3.3 Portrayal of Conveyor Movement Mechanism Using SAM Software

This section explains the mechanism of movement of conveyor using SAM software. SAM (Simulation and Analysis of Mechanisms) is an interactive PC-software package for the motion and force analysis of arbitrary planar mechanisms, which can be assembled from basic components including beams, sliders, gears, belts, springs, dampers and friction elements [6]. The high school software is used to find out in detail every movement that occurs in changing the position of the conveyor lifting segment. The results of depicting the mechanism of conveyor movement are divided into 3 phases where there is a starting position, a half movement position, and a final position. The phases contained in the movement of conveyor segments are explained by the following figure:

Figure 4. Initial Position of the Conveyor Segment Movement Mechanism in SAM Software

The explanation of Figure 3 shows that the initial position of the conveyor segment consists of two fixed pins, the first pin to move the conveyor and the second pin to make the drive lever move up and down. There are 3

links shown by link 2 as the connecting lever is in a position parallel to link 3. Then there is link 3 as the driving lever that is moving the link in the direction of the conveyor going down. Finally, there is link 4 as a form of the final output of the movement produced by the conveyor segment.

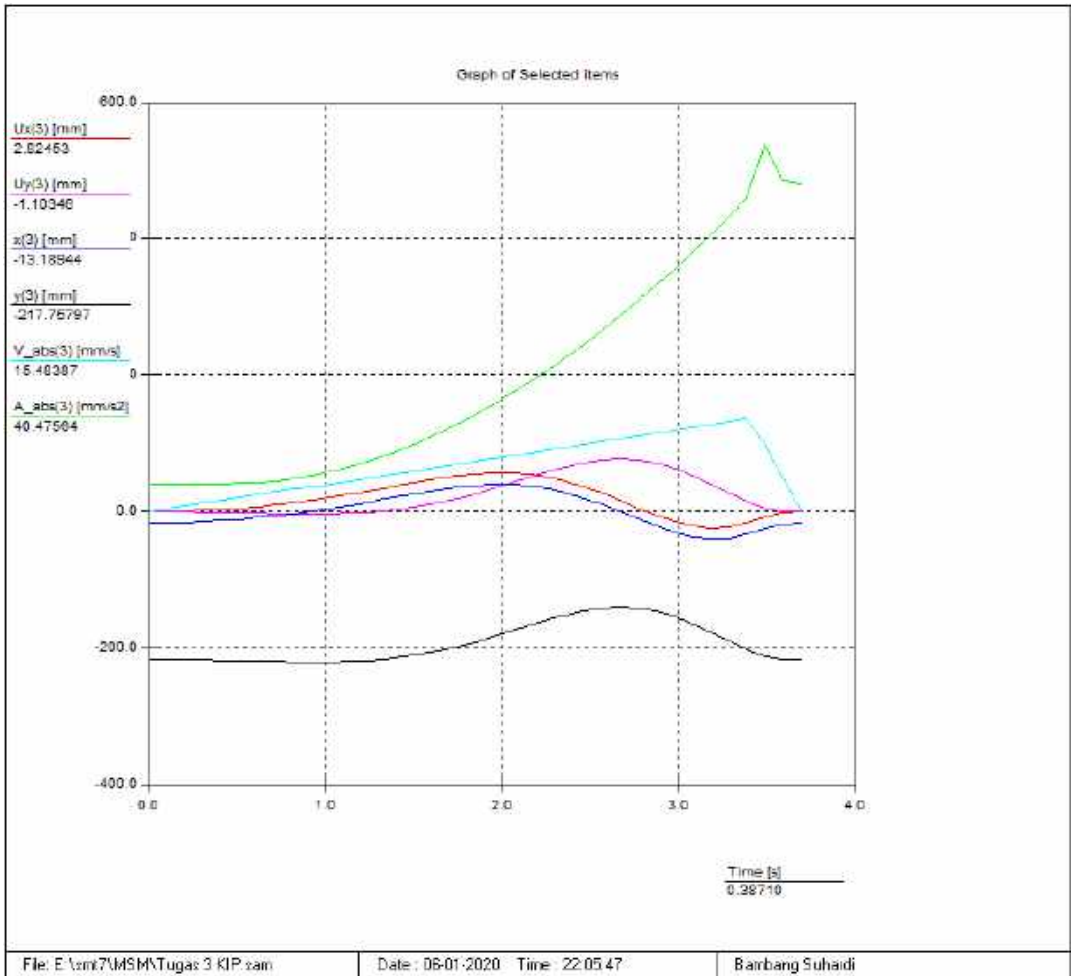

Figure 5. Initial Position Graph of Conveyor Segment Movement in SAM Software

The translation of the initial position graph image of the conveyor segment using SAM software is known that the indicators listed include x and y positions, x and y displacement, displacement speed and displacement acceleration. The initial position indicates that the x and y positions are at point 0. The x and y displacements are still 0 (not moved). Transfer speed 0 mm / s. The acceleration is 4.0 mm/s^2.

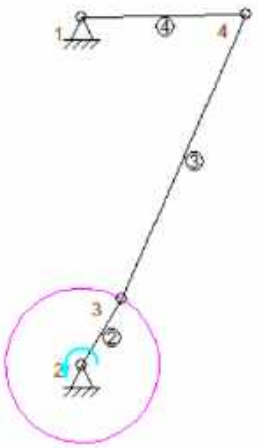

Figure 6. Position of Half Movement Mechanism of Conveyor Segment Movement in SAM Software

The elucidation of Figure 5 shows that the position of the half conveyor segment consists of two fixed pins and 3 links. The first link is shown by link 2 as the connecting lever which is connected with pin 2 and link 3. Then there is link 3 as the driving lever that is moving the conveyor direction link to the top. Finally there is link 4 connected to pin 1 and link 3. Link 4 is the form of the final output of the movement produced by the conveyor segment to the top.

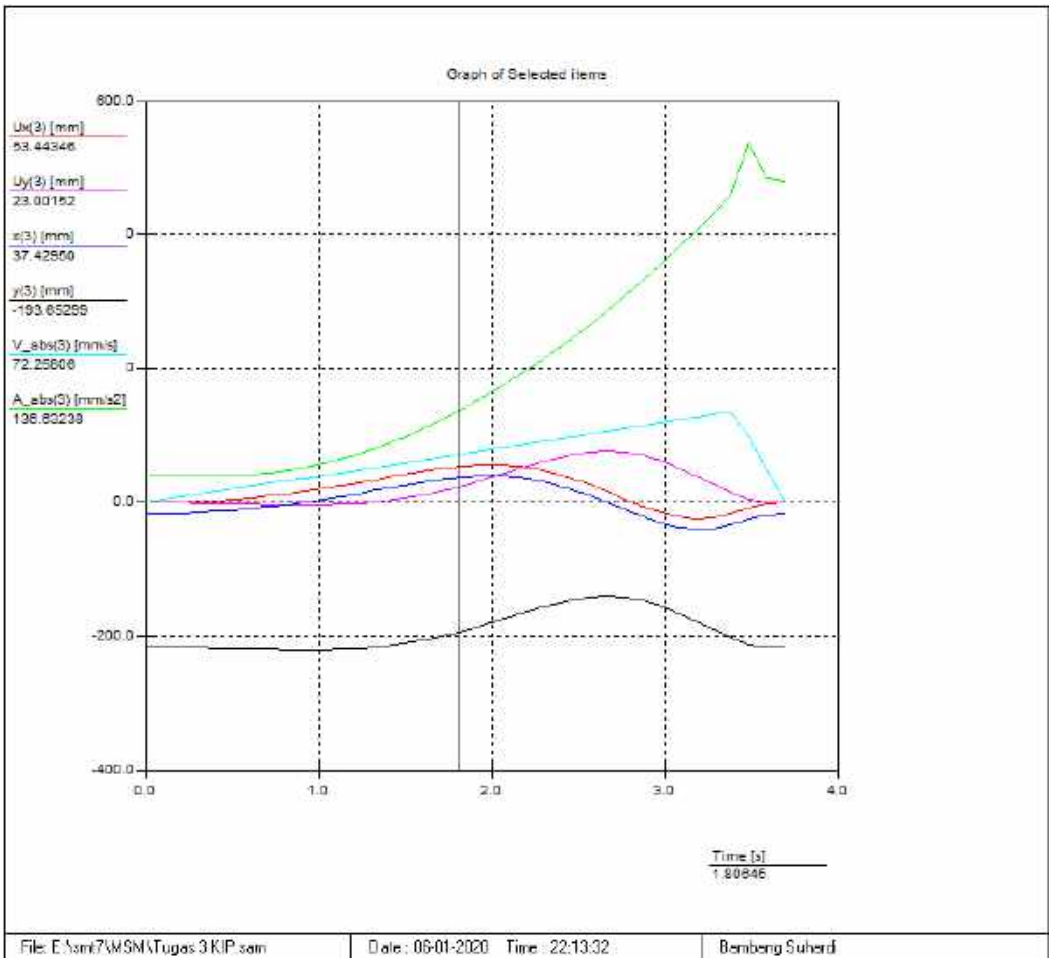

Figure 7. Graph Position of Half Moving Segment Conveyor in SAM Software

The elaboration of the half-position graph movement of conveyor segments using SAM software is known that the indicators listed include x and y positions, x and y displacement, displacement speed and displacement acceleration. The initial position indicates that the positions x and y are at the points of 10.704 and (-141.159). The displacement of x and y is 26.718 at x and 75.196 at y. The displacement speed is 102,490 mm/s and the acceleration is 265,636 mm/s^2.

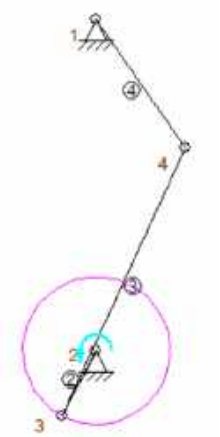

Figure 8. Final Position of the Conveyor Segment Movement Mechanism in SAM Software

The elucidation of Figure 7 shows that the final position of the conveyor segment consists of two fixed pins and 3 links. The first link is shown by link 2 as the connecting lever that returns to the initial position or the right will be parallel to link 3. Then there is link 3 as a driving lever that is moving the conveyor direction link back to the starting position. Finally there is link 4 connected to pin 1 and link 3. Link 4 is a form of the final output of the movement generated by the conveyor segment back to the initial position.

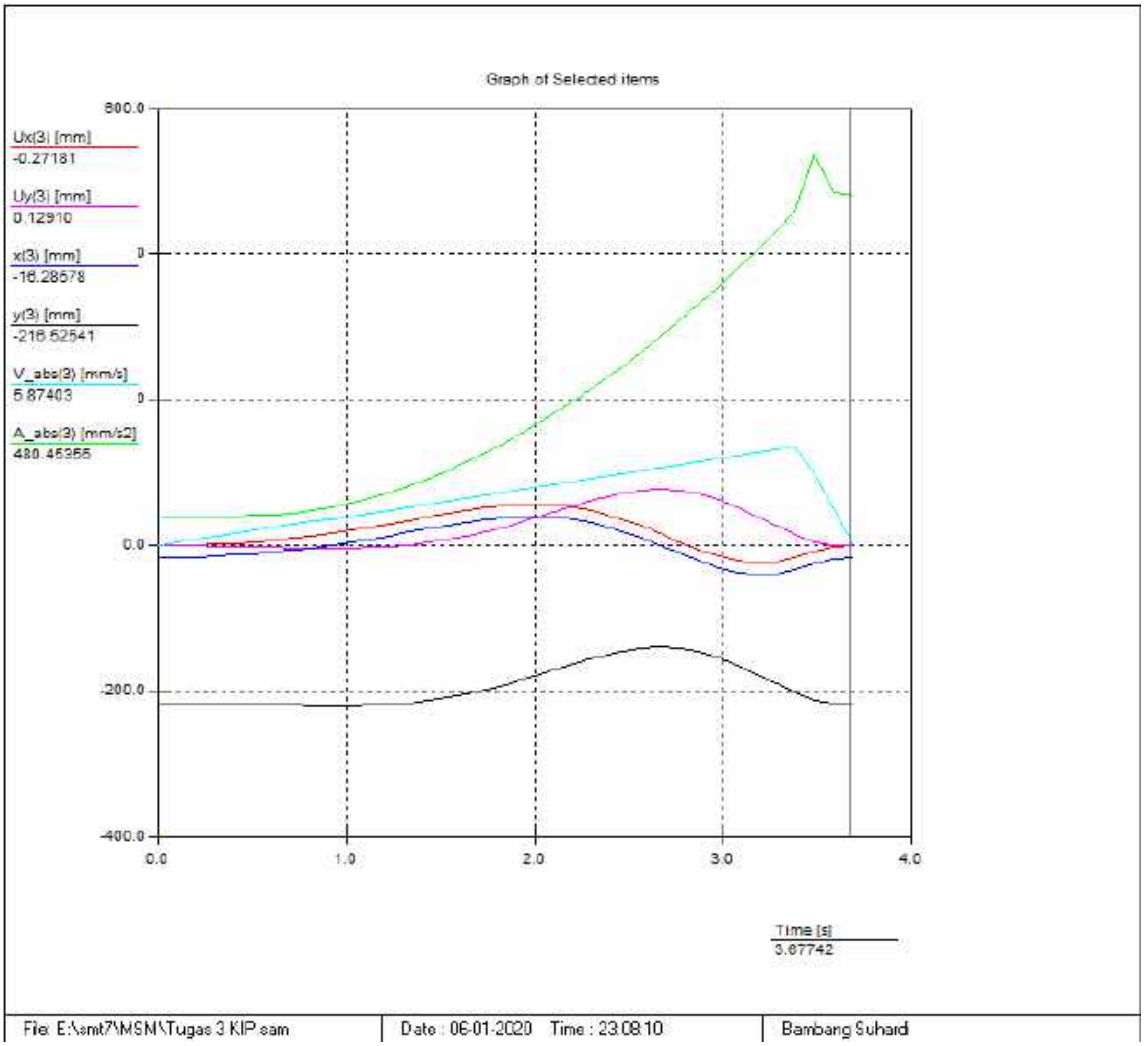

Figure 8. Graph Position of Half Moving Segment Conveyor in SAM Software

The elaboration of the final position graph image of the conveyor segment using SAM software is known that the indicators listed include the x and y positions, x and y displacement, displacement speed and displacement acceleration. The initial position shows that the positions x and y are at points (-18,291) and (-215,573). The x and y transfers of (-2,277) on the minus x form on the displacement indicate that the position returns to its previous position and 1.081 to y. The displacement speed is 49,195 mm / s and the acceleration is 483,798 mm / s^2.

Table 1. Acquisition of Movement Mechanism Results Using SAM Software

Nr: [-]	Time [s]	Ux(3) [mm]	Uy(3) [mm]	x(3) [mm]	y(3) [mm]	V_abs(3) [mm/s]	A_abs(3) [mm/s2]
0	0.000	0.000	0.000	-16.014	-216.655	0.000	40.000
1	0.102	0.193	-0.084	-15.821	-216.738	4.100	40.002
2	0.205	0.774	-0.328	-15.240	-216.983	8.199	40.035
3	0.307	1.750	-0.716	-14.264	-217.370	12.299	40.178
4	0.410	3.133	-1.215	-12.881	-217.869	16.398	40.561
5	0.512	4.937	-1.781	-11.077	-218.436	20.498	41.356
6	0.615	7.175	-2.357	-8.839	-219.011	24.598	42.764
7	0.717	9.857	-2.869	-6.157	-219.523	28.697	44.988
8	0.820	12.986	-3.231	-3.028	-219.885	32.797	48.199
9	0.922	16.555	-3.342	0.541	-219.996	36.897	52.520
10	1.025	20.537	-3.089	4.523	-219.743	40.996	58.012
11	1.127	24.884	-2.350	8.870	-219.004	45.096	64.690
12	1.230	29.520	-0.996	13.506	-217.651	49.195	72.531
13	1.332	34.333	1.096	18.319	-215.559	53.295	81.500
14	1.435	39.175	4.042	23.161	-212.613	57.395	91.554
15	1.537	43.855	7.934	27.841	-208.721	61.494	102.653
16	1.640	48.142	12.826	32.128	-203.828	65.594	114.761
17	1.742	51.770	18.724	35.756	-197.931	69.694	127.848
18	1.845	54.445	25.562	38.431	-191.093	73.793	141.890
19	1.947	55.864	33.192	39.850	-183.462	77.893	156.867
20	2.050	55.735	41.370	39.721	-175.284	81.992	172.763
21	2.152	53.810	49.749	37.796	-166.906	86.092	189.564
22	2.255	49.918	57.880	33.904	-158.775	90.192	207.260
23	2.357	44.006	65.228	27.992	-151.426	94.291	225.841
24	2.460	36.175	71.202	20.161	-145.452	98.391	245.302
25	2.562	26.718	75.196	10.704	-141.459	102.490	265.636
26	2.665	16.135	76.654	0.121	-140.000	106.590	286.839
27	2.767	5.140	75.148	-10.874	-141.507	110.690	308.906
28	2.870	-5.375	70.455	-21.389	-146.199	114.789	331.834
29	2.972	-14.393	62.644	-30.407	-154.011	118.889	355.621
30	3.075	-20.870	52.134	-36.884	-164.521	122.989	380.264
31	3.177	-23.868	39.730	-39.882	-176.924	127.088	405.761
32	3.280	-22.703	26.607	-38.717	-190.048	131.188	432.111
33	3.382	-17.105	14.224	-33.119	-202.430	135.287	459.312
34	3.485	-8.637	5.153	-24.651	-211.501	98.391	537.563
35	3.587	-2.277	1.081	-18.291	-215.573	49.195	483.798
36	3.690	0.000	-0.000	-16.014	-216.655	0.000	480.000

Explanation of table 1. Explain that the indicators listed include 36 movement segments, time of movement, position displacement x and y, position x and y in each displacement segment, speed of movement each time, and acceleration of movement each time of movement. The highest speed value occurs in the 33rd displacement segment of 135.287 mm / s. The highest acceleration occurred in the 34th displacement segment at 459,312 mm/s^2.

3.4 DOF (*Degree of Freedom*) Measurement

The degree of freedom is the number of independent inputs required to precisely position all links of the mechanism with respect to the ground [7]. This section explains the calculation of DOF (Degrees of Freedom) using the Gruebler's equation. DOF (Degrees of Freedom) calculation has a function to determine how the direction can be achieved by the mechanism of conveyor segment movement. The following is the Gruebler's equation used to determine the DOF (Degrees of Freedom) mechanism of the conveyor lifting segment:

M = DoF = 3 (n-1) - $2J_p - J_n$
n = Number of links on the mechanism
Jp = Primary total connection (pin connection or slide connection)
Jn = Total higher-order connections (cam or gear connections)
Diketahui : n = 4

$J_p = 4$ *pin connections* $= 4$

$J_n = 0$

$$DOF = 3\,(n-1) - 2J_p - J_n \quad (1)$$
$$= 3\,(4-1) - 2(4) - (0)$$
$$= 1$$

Thus, *Degrees of Freedom* of mechanism *Conveyor* is 1.

3.5 Geometry Calculation of Minimum and Maximum Positions

This section explains geometry calculations for the minimum and maximum positions when the conveyor segment is distributing goods. The minimum position is obtained when the conveyor segment reaches the lowest point on the y axis or is pointing down. The maximum position is obtained when the conveyor segment reaches the highest point on the y axis or when the conveyor segment is pointing up.1

3.5.1 Geometry Calculation of Minimum Position Conveyor Segments

This section explains the calculation of the geometry of the conveyor segment at a minimum position. Calculations are obtained by using the equations cos, sin and trigonometry so as to obtain an angle in the geometry of the minimum limiting position. The calculation of the geometry of the minimum position conveyor segment is elaborated as follows:

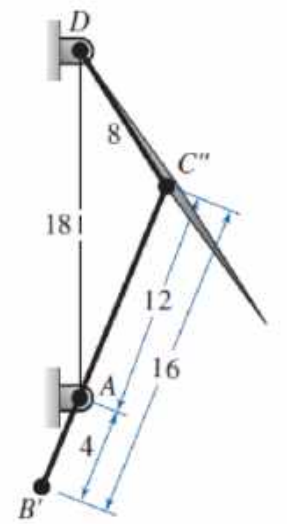

Figure 9. Movement Mechanism for Conveyor Segment Minimum Position

Internal *joint* on point A :

$$C''D^2 = AD^2 + AC''^2 - 2(AC'' \times AD)cos\angle C''AD \quad (2)$$

$$8^2 = 18^2 + 12^2 - 2(12 \times 18)cos\angle C''AD$$

$$(432)cos\angle C'AD = 468 - 64os\angle C''AD = \frac{404}{432}$$

$$cos\angle C''AD = \frac{101}{108} rc\ cos \frac{101}{108} = cos^{-1}\frac{101}{108} = 20{,}74°$$

$$\angle C''AD = 20{,}74°$$

Internal *joint* on point D :

$$\frac{\sin(\angle C''AD)}{8} = \frac{\sin(\angle AC''D)}{18} \quad (3)$$

$$\sin(\angle AC''D) = \frac{\sin(\angle C''AD)}{8} \times 18$$

$$\sin(\angle AC''D) = \frac{\sin(20{,}74)}{8} \times 18$$

$$\sin(\angle AC''D) = \frac{0{,}35}{8} \times 18$$

$$\sin(\angle AC''D) = \frac{6{,}3}{8}$$

$$\sin(\angle AC''D) = 0{,}7875$$

$$\arcsin(\angle AC''D) = \sin^{-1}(0{,}7875) = 51{,}95°$$

Internal *joint* pada titik C'' :

$\angle ADC'' = 180° - (\angle C''AD + \angle AC''D)$

$\angle ADC'' = 180° - (\angle 20{,}74° + 51{,}95°)$

$\angle ADC'' = 107{,}3°$

The geometry at the boundary position drawn from the conveyor has an inner angle of:

1. $\angle C''AD = 20{,}74°$
2. $\angle AC''D = 51{,}95°$
3. $\angle ADC'' = 107{,}3°$

3.5.2 Perhitungan Geometri Segmen Conveyor Posisi Maksimal

This section explains the calculation of the geometry of the conveyor segment at its maximum position. Calculations are obtained using the equations cos, sin and trigonometry so that the angle in the geometry of the maximum limiting position is obtained. Calculation of the geometry of the maximum position conveyor segment is described as follows:

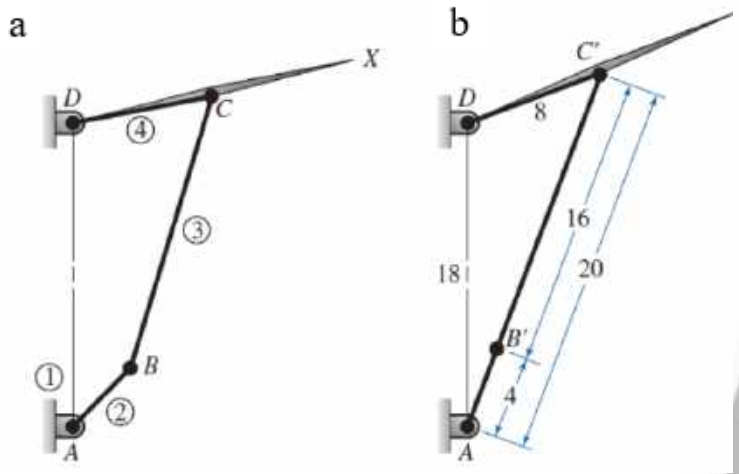

Figure 10. (a) Starting Position Conveyor Segment Movement Mechanism. (b) Maximum Position Conveyor Segment Movement Mechanism

Internal *joint* on point A :

$$C'D^2 = AD^2 + AC'^2 - 2(AC' \times AD)cos\angle C'AD$$

$$8^2 = 18^2 + 20^2 - 2(20 \times 18)cos\angle C'AD$$

$$2(20 \times 18)cos\angle C'AD = 18^2 + 20^2 - 8^2 os\angle C'AD = \frac{660}{720}$$

$$cos\angle C'AD = \frac{11}{12} rc\ cos\frac{11}{12} = cos^{-1}\frac{11}{12} = 14{,}8351$$

$$\angle C'AD = 14{,}8351°$$

$$\frac{\sin(\angle C'AD)}{8} = \frac{\sin(\angle AC'D)}{18}$$

$$\sin(\angle AC'D) = \frac{\sin(\angle C'AD)}{8} \times 18$$

$$\sin(\angle AC'D) = \frac{\sin(14{,}8351)}{8} \times 18$$

$$\sin(\angle AC'D) = \frac{0{,}256038}{8} \times 18$$

$$\sin(\angle AC'D) = \frac{2{,}304342}{4}$$

$$\sin(\angle AC'D) = 0{,}5760855$$

$$\text{arc}\sin(\angle AC'D) = \sin^{-1}(0{,}5760855) = 35{,}17568592°$$

$$\angle AC'D = 35{,}17568592°$$

$$\angle ADC' = 180° -$$

$$(\angle C'AD + \angle AC'D)$$

$$\angle ADC' = 180° - (\angle 14{,}8351° + 35{,}17568592°)$$

$$\angle ADC' = 129{,}9°$$

The geometry at the boundary position extended from the conveyor has an inner angle of :

1. $\angle C'AD = 14{,}84°$
2. $\angle AC'D = 35{,}18°$
3. $\angle ADC' = 129{,}9°$

3.6 Measurement of Link Follower Stroke

Stroke link follower measurement is used to determine the maximum range that can be done from the movement of the conveyor lifting segment. The measurement of the stroke link follower of the internal angle conveyor segment in the connection cycle between 129.9 ° and 107.3 °, which is measured upwards from the vertical axis, is described by the following equation:

$$107{,}3° < \theta < 129{,}9°$$

$$|\Delta\theta| = 129{,}9° - 107{,}3° = 22{,}6°$$

4. CONCLUSION

Analysis using analytical methods with kinematic systems produces findings of various factors needed in optimizing the conveyor lifting segment. Factors that can optimize the conveyor device segment include the required size of the conveyor device segment in accordance with the use in distributing goods, depicting kinematic diagrams to determine the moving parts of the conveyor, depicting conveyor motion mechanism using SAM software to determine the movement of conveyor segments when carrying out the distribution of goods , calculation of degree of freedom (DOF) to determine the direction of motion of the conveyor when working, calculation of the geometry of the position of the minimum and maximum to know the maximum range of movement of the conveyor lifting segment mechanism. The conveyor segment moves with different

speed and acceleration in each segment of the trailer due to the adjustment of motion requirements in distributing different types of goods. Separation of conveyor direction based on weight of distributed object. The maximum speed is obtained when the conveyor is heading downwards due to the influence of the force of gravity. The minimum speed is obtained when the conveyor is going upwards due to opposing gravity. The weight of the object so that the conveyor segment can be stable work adjusted, with heavy objects poured down and light objects directed upwards. The direction of the conveyor that moves up and down shows that the mechanism of the conveyor segment only moves in one axis (y axis), this shows that the conveyor segment lifter mechanism has only 1 degree of freedom.

5. ACKNOWLEDGEMENT

Writing this paper can be completed because of the involvement of various parties. Therefore, the authors feel thankful for the guidance of the lecturer in mechanical system mechanics Dr. Ir. Lobes Herdiman, M.T. Thank you also to my classmates in mechanical systems mechanics for the discussion and joint learning that has been done.

6. REFERENCES

[1] Phoenix, Phoenix Conveyor Belts Design Fundamentals, Hamburg, 2014.

[2] A. Lhestari, “Pengaruh Waktu Tunda Giling Tebu Dan Penambahan Natrium Metabisulfit Terhadap Mutu Gula Merah Tebu,” Institut Pertanian Bogor, Bogor, 2006.

[3] R. Munir, Metode Numerik, Bandung: Informatika, 2006.

[4] M. David H, Machines & Mechanisms Applied Kinematic Analysis, Upper Saddle River: Prentice Hall, 2012.

[5] J. Uicker, G. Pennock dan J. and Sighley, Theory of Machines and Mechanisms 4th Edition, New York: Oxford University Press, 2010.

[6] R. Dr. Ir Ardian M, “SAM (Simulation and Analysis of Mechanisms),” dalam *ASME 2002 Design Engineering Technical Conferences (Special Session on Computer Aided Linkage Design)*, Montreal, 2002.

[7] R. Norton, Design of Machinery 4th Edition, New York: McGraw-Hill Book Company, 2008.

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EXPERIMENTATION OF AN ACTIVATED CARBON/METHANOL SOLAR REFRIGERATOR

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Abstract. Adsorption refrigeration systems become promising alternative cooling technology for refrigeration and air conditioning applications. Thermal energy is a primary source of such systems for producing cooling capacity with less electricity usage compared to vapour compression systems. Solar energy with free-access and abundant availability in the tropics have great potential as a renewable heat source to drive the adsorption refrigeration systems through direct conversion from solar irradiation to the thermal energy. This paper describes experimental work on the performance of a solar adsorption refrigerator working with activated carbon/methanol pair in Bali area. The solar refrigerator has an adsorber with an effective surface area of 0.259 m^2 enclosed in a double-glazed collector box. The cooling load of the evaporator is 1 kg of water sited inside a cooler box of 0.37 x 0.25 x 0.345 m size. The experimental tests were performed outdoor to determine system cooling capacity and solar COP. Test results indicated that the refrigerator capable of bringing down water temperature at 18 ºC, while the system cooling capacity and COP reach 47.5 kJ and 0.046. Moreover, it is supposed that the solar adsorption refrigerator can be applied to pre-cooling post-harvest agricultural products, mainly tomatoes, before distribution to the grocery stores or end consumers.

Keywords : Activated carbon/methanol, Adsorption refrigerator, Intermittent, Solar energy

1. INTRODUCTION

Refrigeration machines, which mostly work based on vapour compression cycles, have been known as intensive electricity equipment. The electricity supply mainly comes from fossil-energy based power generators, which contribute indirectly to global warming by CO_2 gas emissions. Moreover, the refrigerant types used, namely chlorofluorocarbons (CFCs), hydrofluorocarbons (HCFCs), and hydrofluorocarbons (HFCs), have a significant ozone-layer depletion potential that very harmful to the environment [1-2].

Solar adsorption refrigeration (SAR) systems offer an attractive solution to provide more environmentally friendly cooling by using natural refrigerants (e.g., water, methanol, ethanol, and ammonia) and easily accessible renewable energy resources. Solar thermal energy, which delivered with or without heat transfer fluids, becomes a primary driving power to run such systems instead of electricity. Importantly, the solar irradiation availability period is coincident with the cooling demands and potential to reduce the peak load of electricity [3-5].

The SAR systems employ refrigerant and adsorbent as a working pair and operate under pressurised or partial vacuum conditions [5]. Some important working pairs are silica gel/water, zeolite/water, activated carbon/ammonia, activated carbon/ethanol, and activated carbon/methanol [6-7]. The activated carbon/methanol can be driven with a heat source of low-grade temperatures, such as solar energy [8]. Its maximum desorption temperature is 120 ºC, and working at a high vacuum pressure [9]. Activated carbon is a sorbent material that has a large adsorption capacity of 0.45 kg/kg with a specific surface of 400-2500 m2/gram and low desorption heat of 1800-2000 kJ/kg [10-11]. Methanol is a refrigerant with the high latent heat of evaporation and freezing point lower than water, which is suitable for ice-making and refrigeration applications [12].

Many researchers reported experimental works on the activated carbon/methanol SAR system. Buchter et al. [13] built and tested an adsorptive solar refrigerator equipped with a 2 m^2 of single-glazed solar collector/adsorber in Burkina-Faso. The gross solar COP obtained was 0.09-0.13, with the water of 40 L immersed in the evaporator. The solar irradiance during the test was 19-25 MJ/m^2. Santori et al. [14] carried out a field test of a stand-alone solar adsorption refrigerator for vaccine storage in Messina, Italy. They used a solar collector exposed area of 1.2 m2. A solar COP of 0.08 was achieved by producing 5 kg of ice.

Anyanwu and Ezekwe [15] conducted an experimental test on a solid adsorption solar refrigerator in Nsukka, Nigeria. The refrigerator used a flat type collector with an effective exposed area of 1.2 m^2. The best cooling capacity yielded of 266.8 kJ/m^2 per day, and the useful cycle COP achieved of 0.056-0.093. Li et al. [16] developed a no valve flat plate solar ice maker in the West of China. The solar collector area was 1 m2, which produce 4-5 kg ice under solar irradiation of 18-22 MJ/m^2. The solar COP obtained was 0.12-0.14. Leite et al. [17] tested a solar adsorptive ice maker in Brazil. The collector-adsorber used multi-tubular with transparent insulation material and a projected area of 0.61 x 1.65 m. The solar COP gained was 0.085 at solar irradiation of 23.7 MJ/m^2. The ice produced was 6.05 kg.

Lemmini and Errougani [18] experimentally tested a flat plate solar adsorption refrigerator in Marocco under Mediterranean climate. They found that solar COP achieved was 0.05-0.08 at 12-28 MJ/m^2 solar insolation and daily mean ambient temperature of 20 ºC. The lowest evaporator temperature was at -11 ºC. Ambarita et al. [19] reported the experimental test of a flat plate type solar-power adsorption refrigeration cycle with adsorbent of activated alumina and activated carbon in Medan city. The solar collector area used was 0.25 m^2. They concluded that the pair of activated carbon/methanol was better than activated alumina/methanol. The solar COP yield was 0.074 with solar irradiation of 13.63 MJ/m^2. The lowest evaporator temperature achieved was 7.3 ºC, while the maximum generator temperature was 110.1 ºC.

To the author's knowledge, only a few research reported performances of an intermittent solar adsorption refrigeration system under Indonesia's climate conditions, particularly in Bali island. Accordingly, this paper presents an experimental investigation of a solar adsorption refrigerator by utilising activated carbon/methanol pair with an intermittent working cycle in the Bali area. The system performance in terms of cooling capacity, solar COP, and the evolution of the pressure and temperature during the adsorption cycle are discussed. Furthermore, the developed refrigerator prototype is expected to be used as a pre-cooling device for post-harvest agricultural products, mainly tomatoes, before distribution to the grocery stores or end consumers.

2. METHODS

2.1 Experimental Setup and Materials

Figure 1 shows a photograph of the prototype of an experimental setup. It composes of three major parts, namely a solar collector/adsorber, a condenser, and an evaporator/cooler box. The solar collector is a flat plate type made of steel plate with a 0.259 m^2 effective exposed area and tilt angle of 9 º. The solar collector is insulated with polyurethane of 40 mm and 60 mm thickness for the side and bottom walls, respectively, to prevent heat losses and painted using black-doff colour to absorb more heat. The top side of the solar collector is covered by double glass layer of 3 mm thickness each with a 40 mm gap.

The adsorber is placed inside the solar collector and connected to the condenser through a pipe header. The adsorber consists of 10 rows copper pipe with the outer pipe size of 41.3 mm OD, 39.1 mm ID, and 420 mm long, whereas the coaxial inner one is a perforated copper pipe of 2 mm in diameter with a dimension of 9.5 mm OD, 8 mm ID, and 480 mm long. The activated carbon is loaded about 5.4 kg in between of the two pipes. The condenser is made of copper pipe of 19.05 OD, 175 mm long arranged in five rows vertically, and connected to the two headers. The evaporator uses a copper plate of 1.8 mm thickness with a trapezoidal surface and a heat transfer area of 0.119 m^2. The cooler box has 16 L capacity and 0.37 x 0.25 x 0.345 m size.

Figure 2 shows a working pair of activated carbon/methanol employed for the experimental prototype. The activated carbon is a granular type of coconut-based carbon, and the methanol is a product of Merck with a purity of 99.9%.

(a) (b)

Figure 2. Working pair: (a) methanol, (b) activated carbon

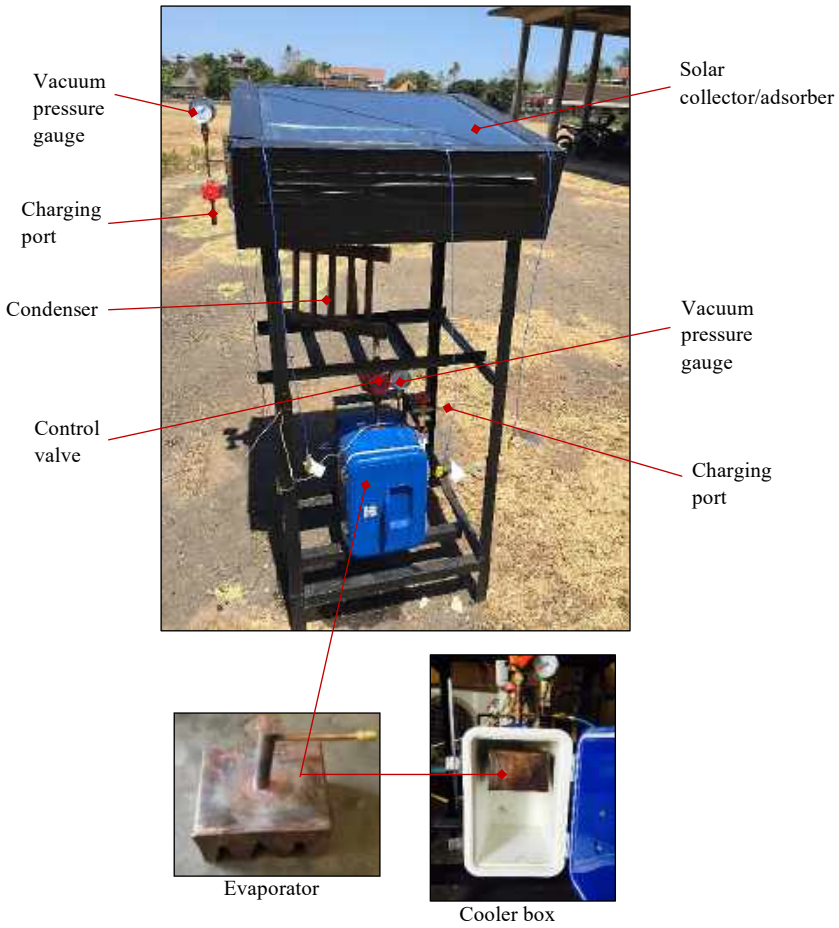

Figure 1. Experimental prototype

2.2 Procedures

The adsorption refrigerator prototype is firstly heated up to the adsorber temperature of 110 ºC using 2 x 500 W halogen lamps. At the same time, deeply vacuum to the pressure of -76 cmHg using a vacuum pump to ensure no gases trapped inside the system. This step is called degassing process to achieve proper system vacuum by releasing non-condensable gases, which bonded to the activated carbon in the adsorber. The system vacuum condition is maintained and monitored for 48 hours to ensure that no leakage occurs. Subsequently, 425 ml of methanol is charged into the system via a charging port closed to the evaporator/cooler box. The system is then ready for the outdoor performance test.

The performance test has been carried out on 21 July 2019 at Politeknik Negeri Bali for one day at the local time started from 08.30 to 05.30 the next day by using 1 kg of water as a cooling load. The evaporator is immersed in the water. The control valve between the condenser and the evaporator is kept fully opened during the test period to perform a no valve adsorption cycle operation.

The experimental data is collected from the reading of measurement instruments in 30 minutes interval. The K-type thermocouples measure the temperature in the adsorber, condenser, evaporator, water, and ambient air, and the readings are displayed on a Krisbow (KW-06-283 model) digital thermometer. Two analog vacuum pressure gauges are placed adjacent to the adsorber and evaporator. For solar irradiation measurement, a solar power meter (SM206 model) is employed.

The system cooling capacity is calculated by using Eq. 1, while solar energy received by the collector/adsorber and the solar COP calculation refer to Eq. 2 and Eq. 3 [10], [15]. The cooling capacity is determined from the product of water quantity (mw), specific heat of water (cp,w) and temperature change from initial temperature (Ti) to final temperature (Tf).

$$Q_c = m_w \, x \, c_{p,w} \, x \, (T_i - T_f) \quad (1)$$

The total solar irradiation energy incident (E_s) to the collector is determined by the product of solar irradiation intensity over the whole day from sunrise (tsr) to sunset (tss) and the collector exposed surface area (A_c).

$$E_s = \int_{tsr}^{tss} I_{s(t)}\, x\, A_c\, dt \quad (2)$$

$$COP_s = \frac{Q_c}{E_s} \quad (3)$$

3. RESULTS AND DISCUSSION

The temperature evolution of the adsorber and evaporator with the solar irradiation profile in a day are depicted in Figure 3. The solar irradiation reaches the peak of 866 W/m^2 at 12.00. The partly cloud is observed at 10.30, and the solar irradiation drops to 101 W/m^2. From 15.30 to 18.00, the solar irradiation decreases gradually from 479 W/m^2 to 87 W/m^2. The total solar irradiation energy received by the solar collector in a day is 14.35 MJ/m^2. The ambient temperature fluctuates 28.3-35 ºC during day time from 08:30 to 18.00. Accumulated heat in the solar collector increases the temperature of the adsorber along with the solar radiation evolution, reaching the maximum adsorber temperature of 77.8 0C from the start point of 37 ºC at 08.30. However, the condenser temperature fluctuates slightly, achieving a peak of 38.2 ºC at 12.00. The maximum temperature difference between condenser and ambient air is 5 ºC at 12.30. The response of the adsorber temperature increment is slower than that of the solar radiation received by the solar collector, due to the low thermal conductivity of the activated carbon and heat losses in the solar collector.

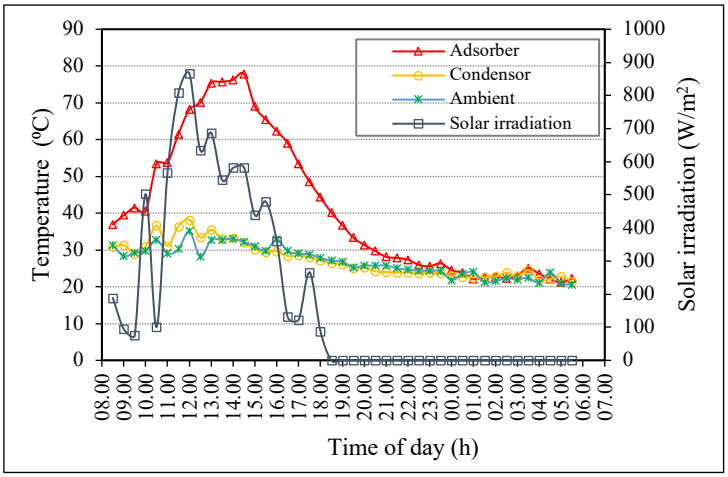

Figure 3. Variation of adsorber and evaporator temperatures, and solar irradiation with time

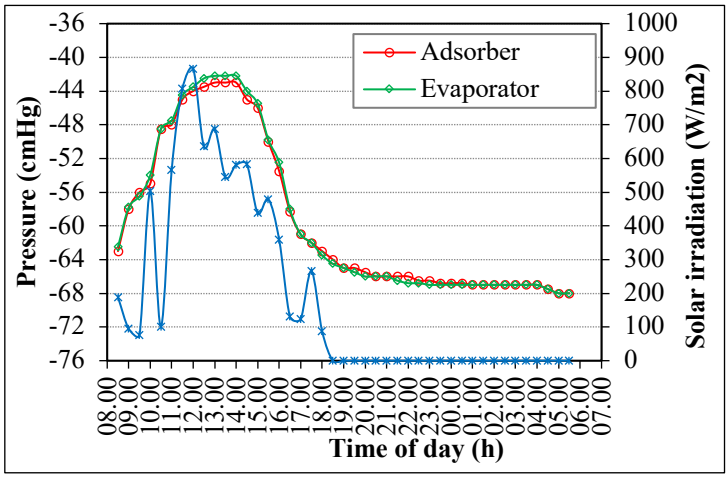

Figure 4. Variation of adsorber and evaporator pressures, and solar irradiation with time

Figure 4 shows the variation of the adsorber and evaporator pressure with the solar irradiation in a day. At th e starting point at 08.30, the adsorber pressure is -62.5 cmHg and increases upon the peak of -43 cmHg at 14.00. The adsorber pressure increases dramatically between 08.30 and 12.00 and stable at -43 cmHg for about 2 hours and then decreases significantly to -64.5 cmHg at 18.00. The stable period of the adsorber pressure indicates the condensation of the vapor methanol occurs. The evaporator pressure increases proportionally with the adsorber pressure. A slight pressure difference of 0.5 cmHg between the adsorber and the evaporator observed during the

exposure of the solar irradiation. It is the effect of no valve operation, and pressure drop occurs in the adsorption system line. During the night-time (18:30-05:30), the adsorber and evaporator pressure decrease following the decrease of ambient temperature from 27.8 ºC down to 20.6 ºC.

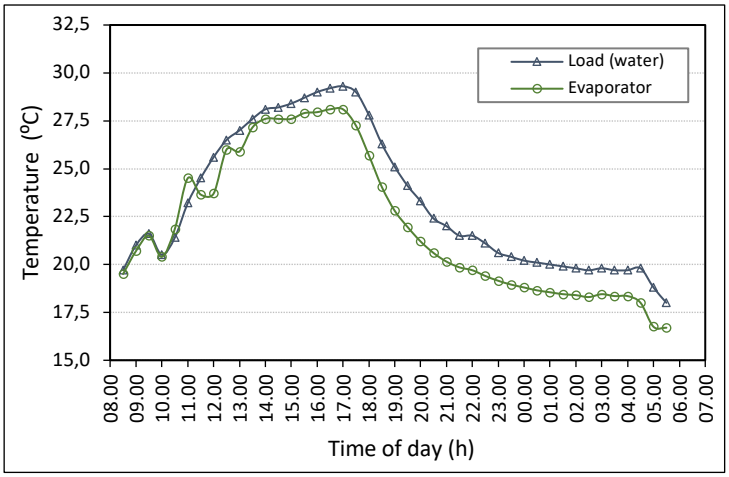

Figure 5. Variation of evaporator and water temperatures with time

The fluctuation of the evaporator and water temperature during the test period are shown in Figure 5. At the beginning of the test at 08.30, both of the temperatures is at 19.5 ºC. The evaporator and water temperature increase to a maximum of 28.1 ºC and 29.3 ºC, respectively, at 17.00. Accordingly, both of the temperatures decrease significantly down to 19.2 ºC and 20.6 ºC, at 23.00, and being stable for about 5 hours at 18 ºC and 19.8 ºC. It indicates that the evaporation process is being completed. The minimum temperature by the evaporator and water is 16.7 ºC and 18 ºC and keep stable for about 1 hour.

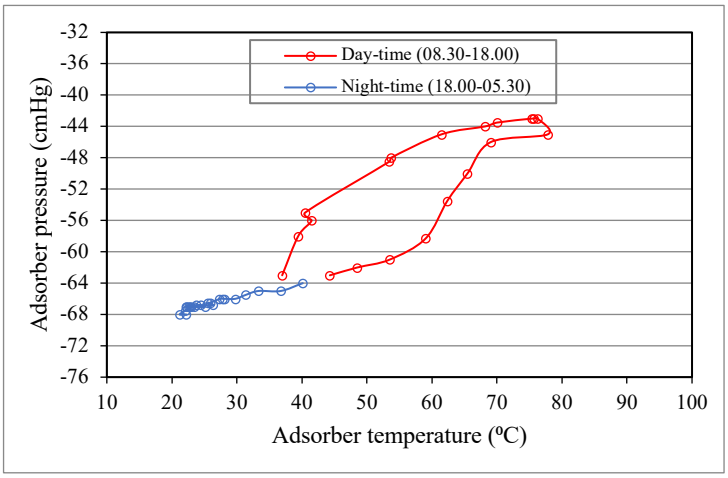

Figure 6. Actual characteristics of a solar adsorption refrigeration cycle

Figure 6 shows actual characteristics of the no valve solar adsorption refrigerator represented by the evolution of temperature and pressure in the adsorber. Referring to stages of the process of the theoretical adsorption cycle (Fig.2), the heating, desorption, and part of the cooling processes occur during day-time (08.30-18.00). It is apparent that the condensation process starts at the adsorber temperature of 61.5 ºC (-45 cmHg) until the respected temperature reaches a maximum of 77.8 ºC (-43 cmHg). During the night-time (18.00-05.30), the adsorber temperature drops about 18.9 ºC from starting at 40.1 ºC then ends close to the ambient temperature. It can be seen from the figure that the solar adsorption prototype works appropriately, similar to the theoretical adsorption cycle.

The cooling capacity is calculated based on the temperature changes of the water from a maximum of 29.3 ºC to a minimum of 18 ºC. Taking specific heat of the water is 4.2 kJ/kgK, the cooling capacity obtained is 47.5 kJ. The solar coefficient of performance (COP) is the ratio of the cooling capacity to the solar irradiation received by the solar collector. The solar COP obtained is 0.046 based on the effective exposed area of the solar collector of 0.259 m^2 and total solar irradiation energy of 14.35 MJ/m^2.

4. CONCLUSION

The experimental prototype of an activated carbon/methanol solar refrigerator has been built and tested with the exposure of solar irradiation in Bali Province, Indonesia. The solar adsorption refrigerator works up to a maximum adsorber temperature of 77.8 ºC by receiving total solar energy of 14.35 MJ/m^2. The cooling capacity produced is 47.5 kJ, and the solar COP yields 0.046. The minimum temperature by the water as a cooling load medium is 18 ºC. Further investigation is needed to improve the solar collector design to capture more heat, thus increasing the adsorber temperature to obtain more methanol flowing to the evaporator and optimising the system cooling capacity and solar COP.

5. REFERENCES

[1] M. Attalla, S. Sadek, M. S. Ahmed, I.M. Shafie, and M. Hassan, "Experimental study of solar powered ice maker using adsorption pair of activated carbon and methanol", *Applied Thermal Engineering*, vol. 141 pp. 877-886, 2018.

[2] I.I. El-Sharkawy, M. Hassan, B.B. Saha, S. Koyama, and M.M. Nasr, "Study on adsorption of methanol onto carbon based adsorbents", *International Journal of Refrigeration*, vol. 32, pp. 1579-1586, 2009.

[3] Y. Wang, M. Li, X. Ji, Q. Yu, G. Li, and X. Ma, "Experimental study of the effect of enhanced mass transfer on the performance improvement of a solar-driven adsorption refrigeration system", *Applied Energy*, vol. 224, pp. 417-425, 2018.

[4] M.S. Fernandes, G.J.V.N. Brites, J.J. Costa, A.R. Gaspar, and V.A.F. Costa, "Review and future trends of solar adsorption refrigeration systems", *Renewable and Sustainable Energy Reviews*, vol. 39, pp. 02-123, 2014.

[5] K. Habib, B.B. Saha, and S. Koyama, "Study of various adsorbent-refrigerant pairs for the application of solar driven adsorption cooling in tropical climates", *Applied Thermal Engineering*, vo. 72, pp. 266-274, 2014.

[6] A. Sur and R.K. Das, "Review on solar adsorption refrigeration cycle", *International Journal of Mechanical Engineering*, vol. 1, pp. 190-226, 2010.

[7] A. Frazzica, V. Palomba, B. Dawoud, G. Dulli, V. Brancato, A. Sapienza, S. Vasta, A. Freni, F. Costa, and G. Restuccia, "Design, realization and testing of an adsorption refrigerator based on activated carbon/ethanol working pair", *Applied Energy*, vol.174, pp. 15-24, 2016.

[8] H.H. El-Ghetany, W. I.A. Aly, M.H. Ahmed, and M. Helmy, "Experimental investigation of an activated-methanol solar powered adsorption refrigeration system utilizing metallic additives", *International Research Journal of Engineering and Technology*, vol. 6, no. 1, pp. 882-889, 2019.

[9] D.C. Wang, YH. Li, D. Li, Y.Z. Xia, and J.P. Zhang, "A review on adsorption refrigeration technology and adsorption deterioration in physical adsorption systems", *Renewable and Sutainable Energy Reviews*, vol.14, pp. 344-353, 2010.

[10] A. Allouhi, T. Kousksou, A. Jamil, T. El Rhafiki, Y. Mourad, and Y. Zeraoulli, Optimal working pairs for solar adsorption cooling applications", *Energy*, vol. 79, pp. 235-247, 2015.

[11] N.A.A. Qasem and M.A.I. El-Sharkawy, " Thermal analysis and modeling study of an activated carbon solar adsorption icemaker: Dhahran case study", *Energy Conversion and Management*, vol. 100, pp. 310-323, 2015.

[12] J. W. Wu, S.H. Madani, M.J. Biiggs, P. Phillip, C. Lei, and E.J. Hu, "Characterizations of activated carbon-methanol adsorption pair including the heat of adsorptions", *J. Chem. Eng. Data*, vol. 60, pp. 1727-1731, 2015.

[13] F. Buchter, Ph. Dind, and M. Pons, "An experimental solar-powered adsorptive refrigerator tested in Burkina-Faso", *International Journal of Refrigeration*, vol. 26, pp. 79-86, 2003.

[14] G. Santori, S. Santamaria, A. Sapienza, S. Brandani, and A. Freni, "A stand-alone solar adsorption refrigerator for humanitarian aid", *Solar Energy*, vol. 100, pp. 172-178, 2014.

[15] E.E. Anyanwu and C.I. Ezekwe, "Design, construction and test run of a solid adsorption solar refrigerator using activated carbon/methanol as adsorbent/adsorbate pair", *Energy Converison and Management*, vol. 44, pp. 2879-2892, 2003.

[16] M. Li, C.J. Sun, R.Z. Wang, and W.D. Cai, "Development of no valve solar ice maker", *Applied Thermal Engineering*, vol. 24, pp. 865-872, 2004.

[17] A.P.F. Leite, M.B. Grilo, R.R.D. Andrade, F.A. Belo, and F. Meunier, "Experimental thermodynamic cycles and performance analysis of a solar-powered adsorptive icemaker in hot humid climate", *Renewable Energy*, vol. 32, pp. 697-712, 2007.

[18] F. Lemmini and A. Errougani, "Experimentation of a solar adsorption refrigerator in Marocco", *Renewable Energy*, vol. 32, pp. 2629-2641, 2007.

[19] H. Ambarita and H. Kawai, "Experimental study on solar-powered adsorption refrigeration cycle with activated alumina and activated carbon as adsorbent", *Case Studies in Thermal Engineering*, vol. 7, pp. 36-46, 2016.

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