The Analysis of Work Accident by Using Hazard and Operability Study (HAZOP) Method

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Abstract

Problems in case of Occupational Health and Safety, popularly known as K3 (Keselamatan dan Kesehatan Kerja) in Indonesia, occured in PT. Mayatama Manunggal Sentosa, which is a manufacturing company engaged in safety glass production. In 2013, there were some occupational accidents suffered by employees, especially in production process area. This study began with occupational accidents identification, followed by searching for the source of workplace potential hazards to do prevention using Hazard and Operability Study (HAZOP). The identification process is conducted by using HAZOP worksheet. Based on hazards identification in safety glass production process, nine sources of potential hazards were found, such as: working conditions, broken glass, workers’ attitude, electrical panels, loose cords, hot air, puddles and hazardous chemicals, scattering paper, and puddles.

Keywords: HAZOP, K3, Risk Analysis, Work Accidents.

1. Introduction

PT. Mayatama Manunggal Sentosa is a company engaged in safety glass manufacturing, such as tempered glass and laminated glass. Safety glass is usually applied in field of automotive car body, industry, and building. PT. Mayatama Manunggal Sentosa founded in 1997. In the beginning of establishment, it aimed to meet the needs of automotive car body safety glass in Malang areas. PT. Mayatama began to grow and enter industry and construction (building) sector. Nowadays, PT. Mayatama Manunggal has 285 employees. This great number of employees requires more attention to occupational safety and health that PT. Mayatama Manunggal Sentosa applies K3 program in accordance with (Pasal 87 UU no 13 Tahun 2003) which states that "every company which employs more than 100 employees or whose nature of production process and materials are considered hazardous, as it is able to cause workplace accidents such as explosion, fire, pollution and occupational diseases are required to adopt and implement K3 management systems".

Occupational Health and Safety is one important factor in the smooth production so that K3 program should be applied in the company, instead of merely a discourse. Workplace accidents are accidents occurred in work environment that may happen due to unsafe working conditions or because of human error. Based on historical data, 22 workplace accidents occurred in 2013. Investigation found that there were 90 % of minor workplace accident, 5% of medium accident, and 5 % of mayor accident. K3 management system is also stated in the Law of Labor recently passed (UU No. 13/ 2003), particullary pasal 86 and pasal 87. Pasal 86 stated that every worker/laborer has the right to get health and safety protection, morals and decency protection, as well as good treatment in accordance with
human dignity and religious values. *Pasal 87* stated that every company must implement K3 management system, which is integrated in the company's general management system. In addition, the company is obliged to bear all costs of workers who have an accident.

In order to reduce or eliminate any hazards which cause work accidents, we need a risk management whose activities include hazards identification, potential hazards analysis, risk assessment, risk control, and monitoring and evaluation. The process of potential hazards identification and analysis can be done by using Hazard and Operability Study (HAZOP) method. HAZOP is a study of systematic safety, based on systemic approach toward safety assessment and complex equipment operation process, or production processes [5], the goal is to identify any potential dangers appeared in companies’ material processing facilities, eliminate major source of accidents, such as toxic releases, explosions and fires [2]. HAZOP systematically works by finding various factors (cause) which may lead to accidents and determine adverse consequences as a result of irregularities and provide recommendations or actions that can be taken to reduce the impact of identified potential risks. Juliana (2008) conducted study in Paiton by using HAZOP method, whose research studies resulted in significant risk evaluation.

2. **Material and Methods**

This study used a kind of descriptive research, which described amount of data to be analyzed and compared based on the ongoing fact, whose results became the basic of problem solution recommendation. This study focused on occupational health and safety by using Hazard and Operability Study (HAZOP).

The stages included in this study are as follows:

1. **Preliminary Survey**
   
   This preliminary survey aimed to see the picture and actual conditions in PT. Mayatama Manunggal Sentosa’s production area. By looking at the actual conditions of production area, it will be easier to discuss the existing case studies. The first thing to do at this preliminary survey was interviewing HRD and employees of production area to find out both problems faced by company, especially in term of Occupational Health and Safety (K3), and company policy.

2. **Literature Study**

   Literature study was intended to make the relevant theory and knowledge easier to learn. The literature study is available in books, final task, journals, as well as internet access.

3. **Problem identification**

   Problem identification serves as a searcher of hazard centers or causes’ specific points in order to avoid work accidents at PT. Mayatama Manunggal Sentosa’s production area.

4. **Research Problem**

   Following problem identification, the research continued to research problem. The research problem is ‘what hazards are contained in the actual conditions?’

5. **Objective**
The purpose of this study was to resolve expected final results after conducting research. The purpose of this study has basic which is able to align background and research problem.

6. Data Collection and Analysis

The steps conducted on data collection and analysis stage are as follows:

1. Knowing the sequence of the production process.
2. Identify the potential hazards in glass production area, from beginning department to the last one, by directly observing any deviations causing work accidents.
3. Complete the existing criteria in HAZOP worksheet as following orders:
   a. Classifying hazards potential found (source of hazards potential and finding frequency of potential hazards).
   b. Describing deviations occurred during a operational procedures.
   c. Describing the cause.
   d. Describing the consequences of the deviations.
   e. Deciding the emergency actions should be done.
4. Assessing the risk (risk assessment) arisen by defining criteria of Likelihood and Consequences (severity). The likelihood criteria used is a quantitative-calculated frequency at which the quantitative calculations based on 2013 company data. Consequences (severity) criteria is used as a result of what the workers received, which is defined qualitatively by considering the lost working days.
5. Putting the potential hazards, which have been identified by HAZOP worksheet, in orders by considering the likelihood and consequences. After that, use a risk matrix to determine the priority of potential hazards as a basic of problem solving.

6. Analysis and Discussion

Analysis and discussion stage was conducted by describing sources and root causes of the problems causing work accidents and disturbance occurred. The steps are:

a. Analyzing the root causes of accidents or disturbance occurred during work.

b. Conducting a risk assessment analysis to obtain appropriate improvement recommendations which can be applied to research object.

7. Recommendations and Improvement Designs

In improvement recommendations stage, some process improvements designed will be formulated, related to hazard potentials points in PT. Mayatama Manunggal Sentosa in order to reduce or eliminate the risks.

8. Conclusions and Recommendations

Conclusion and recommendation answered all the problems discussed in the research. Based on the conclusion, some improvement advices or inputs were proposed as an effort of improving company’s performance and productivity.

3. Result and Discussion

To identify any potential hazards in PT Mayatama Manunggal Sentosa’s production process, we need to know the flow of production process. The followings are safety glass production process conducted by PT. Mayatama Manunggal Sentosa:

1. Cutting

In this process, the glasses are cut in accordance with market demand’s size.
2. Rubbing Edges of the Glass
   In this process, workers rub edges of the glass using multiple machines with different functions and interests, e.g a double edger machine is used for 244x366 cm glass, etc.
3. Bafle
   Bafle is the the process of diluting glasses’ specific section by using a bafle irregular and bouvonce machine. Therefore, the glasses are more streamlined in shape, in accordance with customers’ demand.
4. Drilling
   This process is carried out by drilling, which is punching holes of the glasses’ part, i.e key place or handle part, based on desired needs.
5. Coak
   This process is carried out by punching holes in the glass in order to make hinge. Coak is done by using manual tools, namely a knife and grindstone.
6. Printing
   This process is conducted by making desired design, which then traced into the glass by using Bouju machine. Hence, the image will looks better on the glass, as well as not easily faded or damaged.
7. Tempered
   The next process is heating the glass to 650°C degree, by using tempered machine. It aims to reduce residual stress, increase toughness and strength of glass. The tempered glass has crystalline flake glass structure.
8. Sandblast
   Sandblast process aims to make the glass non-transparent. The process is done by manual process, which is entering glasses into a tub with etching acid inside. The final result is blurred glass surface, that can diffuse gently with light.
9. Acid
   This process aims to make more rough glass surface. It is carried out by soaking glasses in a large tub contained liquid acid + HCl chemical powder inside.
10. Laminated
    In this process, the two parts of glasses are unified into one.
11. Packing
    Packing is done manually by entering final products into box equipped with styrofoam, which then put into wooden box.
12. Delivery
    The glasses are delivered by rented trucks and other vehicles. Take an example of delivery to East Java, Central Java and Bali which use double tonnage private trucks if the capacity is approximately 4 ton, and L300 car for 700 kg up to 1 ton capacity. In addition, the other expeditions are also available.

After that, any direct observation and interviews with credible sources are also conducted to obtain the findings of potential danger (hazard). Here is a table of hazard and risk identification:
<table>
<thead>
<tr>
<th>No</th>
<th>Process</th>
<th>Description of Hazard Findings</th>
<th>Risk</th>
</tr>
</thead>
</table>
| 1  | Cutting               | 1. Broken glass splattered on the floor.  
2. Workers do not wear APD : safety gloves  
3. Too-high glass stucture with no special buffer. | 1. Bleeding feet because of splattered broken glass.  
2. Hand cut by glass.  
3. Strucked down by glass due to too-high glass structure, with no typical buffer. |
|    | Size 130x77 cm        |                                                                                                 |                                                                      |
|    | Size 305x214 cm       |                                                                                                 |                                                                      |
|    | Size 366x244 cm       |                                                                                                 |                                                                      |
|    | Size 3x5 m            |                                                                                                 |                                                                      |
| 2  | Glass Edges Rubbing   | 1. Glasses lifted manually from cutting to smoothing area.  
2. Workers do not use PPE: safety gloves  
3. Too many loose cables scattered on the floor.  
4. The lack of air circulation.  
5. Puddles on the floor. | 1. Strucked down by glass as the lifting process is conducted manually.  
2. Hand cut glass  
3. Stumbled by scattered cables on the floor. Any work accident will inhibit the production process.  
4. Causing discomfort to workers.  
5. Slipped on the slippery puddle. |
| 3  | Colibri Rub           | 1. Wet floor exposed to water spills and hazardous chemicals  
2. Hand cut by glass |
| 4  | Acid Area             | 1. Wet floor exposed to water spills and hazardous chemicals  
2. Workers do not use PPE: mask  
2. Respiratory problems due to hazardous-chemicals-exposed air.  
3. Hand cut by glass  
4. Slipped and fell into scattered broken glass on the floor. |
| 5  | Sandblast             | 1. Workers do not use PPE:  
- Earphone  
- Safety shoes  
- masker  
2. The less lighting in the room. | 1. Impaired hearing and misunderstanding in communications.  
2. Slipped and fell into broken glass sharded on the floor.  
3. Respiratory problems due to hazardous chemicals-exposed air  
4. Workers do not focus on work leading to incapability to achieve the target. |
| 6  | Laminated             | 1. Workers do not use PPE: Safety gloves  
2. Scattered papers on the floor. | 1. Cut by glass  
2. Stumbled by scattered materials on the floor. |
<p>| 7  | Warehouse             | Too-high glass stucture with no special buffer.                                                  | Strucked down by glass due to too-high glass structure, with no typical buffer to avoid it tumbling down. |</p>
<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
</table>
| 8. | Waterjet | 1. Slippery floors exposed to water spills and hazardous chemicals  
2. Scattered cables in the production area. |
|   |   | 1. Slipped on the slippery puddle.  
2. Workers got electric shock due to cable scattered on the floor, any foreign objects can enter opened electrical panel, which leads to short-circuit |
2. Slippery floors exposed to water spills and hazardous chemicals |
|   |   | 1. Eye disorders due to chemicals and splinters of glass.  
2. Slipped on the slippery puddle. |
2. The is no air circulation |
|   |   | 1. Hand exposed to hot glass  
2. Causing discomfort to workers |
| 11. | Tempered | 1. The is no air circulation  
2. Workers do not use PPE: safety gloves |
|   |   | 1. Causing discomfort to workers  
2. Hand exposed to hot glass |

After everything is complete, a ranking system was conducted. It is performed based on the criteria of severity or risk level in PT. Mayatama Manunggal Sentosa, which is listed as follows:

1. Likelihood (L) is the possibility of accidents
2. Severity or Consequences (C) is the severity of injuries and lost workdays.

After determining the value of likelihood and consequences of each potential source of danger, the next step is multiplying the value of likelihood and consequences to obtain the risk level on a risk matrix, which will be used in conducting sources of danger ranking. The ranking will be used as referring to suitable improvement recommendations in accordance with the existing problems.
<table>
<thead>
<tr>
<th>No</th>
<th>Process</th>
<th>Hazard Findings</th>
<th>Risk</th>
<th>Source of Hazard</th>
<th>Likelihood</th>
<th>Consequence</th>
<th>Riskscore</th>
<th>Risk Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cutting Size 130x7 7 cm</td>
<td>There are a lot of broken glass scattered on the floor. Workers do not wear APD: safety gloves</td>
<td>Bleeding feet because of splattered broken glass.</td>
<td>Broken glass</td>
<td>3</td>
<td>2</td>
<td>6</td>
<td>Medium Risk</td>
</tr>
<tr>
<td></td>
<td>Size 305x21 4 cm</td>
<td>Glass structure</td>
<td>Hand cut glass</td>
<td>Workers’ attitude</td>
<td>3</td>
<td>2</td>
<td>6</td>
<td>Medium Risk</td>
</tr>
<tr>
<td></td>
<td>Size 366x24 4 cm</td>
<td>Strucked down by glass due to too-high glass structure, with no typical buffer.</td>
<td>Work-place condition</td>
<td>Work-place condition</td>
<td>3</td>
<td>3</td>
<td>9</td>
<td>High Risk</td>
</tr>
<tr>
<td>2</td>
<td>Glass Edges Rubbing</td>
<td>Manual glass lifting</td>
<td>Strucked down by glass as the lifting process is conducted manually. Hand cut glass</td>
<td>Workers’ attitude</td>
<td>3</td>
<td>3</td>
<td>9</td>
<td>High Risk</td>
</tr>
<tr>
<td></td>
<td>Workers do not use PPE: safety gloves</td>
<td></td>
<td>Stumbled by scattered cables on the floor. Any work accident will inhibit the production</td>
<td>Workers’ attitude</td>
<td>3</td>
<td>2</td>
<td>6</td>
<td>Medium Risk</td>
</tr>
<tr>
<td></td>
<td>Too many loose cables scattered on the floor.</td>
<td></td>
<td>Scattered cables</td>
<td>Scattered cables</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>Low Risk</td>
</tr>
<tr>
<td>3</td>
<td>Colibri Rub</td>
<td>Wet floor exposed to water spills and hazardous chemicals</td>
<td>Slipped on the slippery puddle.</td>
<td>Puddles and chemicals</td>
<td>4</td>
<td>3</td>
<td>12</td>
<td>High Risk</td>
</tr>
<tr>
<td></td>
<td>Workers do not use PPE: safety gloves</td>
<td></td>
<td>Hand cut by glass</td>
<td>Workers’ attitude</td>
<td>3</td>
<td>2</td>
<td>6</td>
<td>Medium Risk</td>
</tr>
<tr>
<td>4</td>
<td>Acid Area</td>
<td>Wet floor exposed to water spills and hazardous chemicals</td>
<td>Slipped on the slippery puddle.</td>
<td>Puddles and hazardous chemicals</td>
<td>4</td>
<td>3</td>
<td>12</td>
<td>High Risk</td>
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<tr>
<td></td>
<td></td>
<td>Workers do not use PPE: mask</td>
<td></td>
<td>Workers’ attitude</td>
<td>4</td>
<td>3</td>
<td>12</td>
<td>High Risk</td>
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<td></td>
<td></td>
<td>Workers do not use PPE: safety gloves</td>
<td></td>
<td>Workers’ attitude</td>
<td>3</td>
<td>2</td>
<td>6</td>
<td>Medium Risk</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Workers do not use PPE: Safety shoes</td>
<td></td>
<td>Workers’ attitude</td>
<td>4</td>
<td>2</td>
<td>8</td>
<td>High Risk</td>
</tr>
<tr>
<td>5</td>
<td>Sandblast</td>
<td>Workers do not use PPE: Earphone</td>
<td>Impaired hearing and misunderstanding in communication s. Slipped and fell into broken glass shards on the floor</td>
<td>Respiratory problems due to hazardous-chemicals- exposed air</td>
<td>3</td>
<td>3</td>
<td>9</td>
<td>High Risk</td>
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<tr>
<td></td>
<td></td>
<td>Workers do not use Safety shoes</td>
<td></td>
<td>Workers’ attitude</td>
<td>4</td>
<td>2</td>
<td>8</td>
<td>High Risk</td>
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<td></td>
<td></td>
<td>Workers do not use mask</td>
<td></td>
<td>Workers’ attitude</td>
<td>4</td>
<td>3</td>
<td>12</td>
<td>High Risk</td>
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<td></td>
<td></td>
<td>The lighting in the room.</td>
<td></td>
<td>Workplace condition</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td>Medium Risk</td>
</tr>
<tr>
<td>6</td>
<td>Laminate d</td>
<td>Workers do not use Safety gloves</td>
<td>Cut by glass</td>
<td>Workers’ attitude</td>
<td>3</td>
<td>2</td>
<td>6</td>
<td>Medium Risk</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Scattered papers on the floor.</td>
<td>Stumbled by scattered materials on the floor.</td>
<td>Scattered paper</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>Low Risk</td>
</tr>
<tr>
<td>No.</td>
<td>Process</td>
<td>Description</td>
<td>Workplace Condition</td>
<td>Risk Level</td>
<td></td>
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<tr>
<td>7</td>
<td>Warehouse</td>
<td>Too-high glass structure with no special buffer.</td>
<td>Struck down by glass due to too-high glass structure, with no typical buffer to avoid it tumbling down.</td>
<td>4</td>
<td>3</td>
<td>12</td>
<td>High Risk</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Waterjet</td>
<td>Slippery floors exposed to water spills and hazardous chemicals. Scattered cables in the production area.</td>
<td>Slipped on the slippery puddle.</td>
<td>4</td>
<td>2</td>
<td>8</td>
<td>High Risk</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Workers got electric shock due to cable scattered on the floor, any foreign objects can enter opened electrical panel, which leads to short-circuit hubungan arus pendek</td>
<td>5</td>
<td>4</td>
<td>20</td>
<td>Extreme</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Manual Drilling</td>
<td>Not using safety goggles. Slippery floors exposed to water spills and hazardous chemicals</td>
<td>Eye disorders due to chemicals and splinters of glass. Slipped on the slippery puddle.</td>
<td>4</td>
<td>2</td>
<td>8</td>
<td>High Risk</td>
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<td></td>
<td></td>
<td></td>
<td>Workers' attitude</td>
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<td>3</td>
<td>12</td>
<td>High Risk</td>
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<td></td>
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<td></td>
<td>Puddles and hazardous chemicals</td>
<td>4</td>
<td>3</td>
<td>12</td>
<td>High Risk</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Printing</td>
<td>Workers do not use safety gloves. The is no air circulation.</td>
<td>Hand exposed to hot glass</td>
<td>4</td>
<td>2</td>
<td>8</td>
<td>High Risk</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Workers' attitude</td>
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<td>2</td>
<td>8</td>
<td>High Risk</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Hot air</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>Low Risk</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Tempered</td>
<td>The is no air circulation. Workers do not use safety gloves.</td>
<td>Causing discomfort to workers</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>Low Risk</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hand exposed to hot glass</td>
<td>4</td>
<td>2</td>
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<td>High Risk</td>
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<td>Workers' attitude</td>
<td>4</td>
<td>2</td>
<td>8</td>
<td>High Risk</td>
<td></td>
</tr>
</tbody>
</table>
The next step designing recommendations for improvement. The designing of improvement recommendations or proposals made by hazard (risk potential) occurred. Here, the authors analyze and provide improvements design for all sources of hazards. It aims to have all problems related to existing hazards overcome. With the proposed improvements given, the company can reduce the rate of accidents and prevent any similar accidents. Here is the analysis of occurrence and proposed improvements given:

1. **Recommendations for Workers’ Attitude Problems**
   Some recommendations for improvement proposed by authors, in order to tackling the potential hazards caused by workers’s attitude, are:
   a. In form of K3 training schedule of PPE, held by the management. Those do not attend the training will be penalized. The sanctions to be imposed in accordance with company agreement.
   b. Creating worksheet of PPE use in workplace area, so workers can directly read any potential hazards of forgetting
   c. Making a visual display on the use of Personal Protective Equipment (PPE), which is placed in some potentially dangerous areas, as well as providing a Standard Operating Procedure (SOP) Personal Protective Equipment (PPE) usage. Visual display will later be installed in some places as reminder of PPE properly usage.

2. **Recommendations for Work Environment Problems.**
   Many materials are piled too high, not put orderly, and have no typical buffer. This is due to the lack of management control in working environment condition. The absence of good procedures also affect the violations which leads to potential work accidents caused by messy material arrangement. To overcome this, some recommendations are given for improvement, namely making structuring procedures and arranging raw materials, or other materials, neatly and cleanly to decrease the risk of potential accidents. In addition, it’s better for management to reinforce regulations that will be made so the production process run smoothly, while the level of safety is also become higher.

3. **Recommendations for Electrical Panel Problems.**
   The opened electrical panels and cable plugs are scattered on the floor became one cause of workplace accidents hazards. The particular cause of open electrical panel is the lack of attention from operators, in which they often forget to close the electrical panel cover back after use. Therefore, any further action and proposed improvements are needed to prevent occupational accidents caused by the opened electrical panel. One thing we can do is giving warning signs reminding workers to close it after use. It must be always read by operators working on electrical panel to avoid ignorance. Scattered cable on the floor should be mounted on the wall of production area in order to avoid accidents.

4. **Recommendations for Broken Glass Problems**
   As there are a lot of broken glass in glass cutting area, in addition to the absence of broken glass shelters, the improvement recommendations given is providing special shelters right on the cut glass area.

5. **Recommendations for Scattered Cables Problems**
   As the work environment is full of scattered cables one production floor, in addition to workers’ lack attention to the cables placement, it is recommended for managements to provide cable places, to avoid it scattered. One way is by clipping it on the wall so it
6. Recommendations for Heat Problems
   As the particular work area get less attention to heat, as well as workers’ comfort, the recommendation is providing ventilation in less air circulation area, so that the air is changed everyday to avoid heat in the room.

7. Recommendation for Puddles and Hazardous Chemicals Problems
   Some particular work areas have many puddles on the floor due to management and workers’ less attention in working environments. The recommendation given is to provide direct water channels and sufficient PPE.

8. Recommendations for Scattered Paper Problems
   There are many unused paper scattered in particular work areas due to management’s less attention, as well as workers' lack of awareness about working hygiene. Recommendations given is doing routine control in production processes, which is performed by the management, and paying attention to the unused paper in production area by giving trash bin.

9. Recommendations for Puddles Problems
   As there are many puddles in the particular work area, as a result of lack of attention in working conditions, the recommendations can be given is to provide direct drainage channel to prevent waterlogging on production floor.

4. Conclusion

The conclusions can be drawn from this study, based on the research problems, are:

1. The work-accidents danger potential in the area of safety glass manufacturing process is derived from any source of danger classified into nine, include:
   - The Work Environment Condition, the absence of glass holder and clamp.
   - Broken glass.
   - Workers’ attitude, lack of awareness, knowledge, discipline in doing any activities other than management’s attitude who is less assertive in addressing workers’ attitude.
   - Electrical Panels, electrical wires are strewn on the floor; electrical panel’s cover is reclosed after use.
   - Loose cords, not pay attention in cable placement results in workers slipped by cable.
   - Air heat, lack of management’s attention to workers’ comfort.
   - Puddles and hazardous chemicals, lack of attention and awareness of workplace conditions and harmful chemicals pollution.
   - Scattered paper, lack of management’s attention and workers' awareness about workplace environment hygiene.
   - Puddle, lack of attention to workplace conditions.

2. Danger risk posed to the area of safety glass manufacturing process include:
   - Extreme risk may occured in waterjet area, where there are a lot of open electrical panel and strewn wires. It is extremely harmful to workers.
   - Extreme risks placed in some work areas with a risk description as follows:
     - Strucked down by glass due to glass structure, which is too high and have no typical buffer.
     - Slipped into slippery puddle.
– Respiratory problems due to hazardous-chemicals-exposed air.
– Slipped and fell into broken glass sharded on the floor.
– Impaired hearing and misunderstanding in communications.
– Eye disorders due to chemicals and broken glass.
– Hand exposed to hot glass.
– Medium risks in work area are described as follows:
  – Legs bleeding due to scattered broken glass.
  – Low lighting workplace so the workers are less focused during work. As a result, they to achieve target.
– Low risks are also found in some work areas with the descriptions as follows:
  – Stumbled by scattered cables on the floor. Any workplace accidents will inhibit production process.
  – The air is too hot, resulting in workers’ inconvenience.
  – Stumbled by scattered materials on the floor

5. Some recommendations given to the company, based on the existing hazards, are:
   a. As the source of danger is Workers’ Attitude:
      Making Standard Operating Procedure (SOP). Using Personal Protective Equipment (PPE) and being discipline in work. Making visual display on Personal Protective Equipment (PPE) usage in work area. Workers are required to understand the part PPE should be used for work activities. Preparing the examples of Occupational Health and Safety (K3) training schedule, on the use of Personal Protective Equipment (PPE), within one year. Making Violation Control Sheet of Personal Protective Equipment (PPE) for workers committing violations. Providing good workings insight, while the management is obliged to provide tools (forklift) in the process of glass lifting.
   b. If the source of danger is work environment conditions, it is necessary to regularly check equipments and building available. In addition, restructuring and improving working area is also important, as well as checking schedule to prevent the any danger.
   c. If the source of danger is the power panel, the thing we can do is making warnings sign affixed on the side of the electrical panel so that workers are always read and remember to close the open panel.
   d. If the source of danger is the broken glass, we need to provide particular disposal, right on the cutting glass area.
   e. If the source of danger is the loose wire/cords, it is necessary to provide typical place for the cables so it is not scattered on the floor, for example by clipping the wires on the wall.
   f. If the source of danger is scattered cables on the floor, the prevention action can be conducted by
   g. If the source of danger is air heat, we should provide air vents in low air circulation area so that air changed regularly to prevent heat in the room.
   h. If the source of danger is puddles and hazardous chemicals, we need to provide direct water drainage, as well as give enough PPE.
   i. If the source of danger is scattered paper, we need to perform routine control in production process area, which is conducted by management, and pay attention to the production area by providing trash can.
   j. If the source of danger is puddle, all we can do is providing direct water drainage to
avoid any puddle on the floor.

6. References


