Supplier Selection Using Analytical Hierarchy Process & Warehouse Repair Using From-to-Chart

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Abstract

The objective of study in PT. XYZ is to determine the best supplier, warehouse repair procedures, and the level of health and safety. The method used is Analytical Hierarchy Process Method for supplier selection, ABC Analysis and From-to-Chart Method for warehouse improvement, and REBA and Job Hazard Analysis calculation to observe health and work safety level. The results obtained by the best suppliers are Americans with a value of 40.56%, Warehouse arrangement based on the result of attraction 3 with the value of 403 hoist and followed by the calculation of ABC Analysis where classification A has 12 items, classification B with 19 items, and classification C with 32 items. The results of REBA calculations when picking up goods and signatures machines are 6 and 10, which indicates a moderate risk and high risk and requiring a change. Job Hazard Analysis results indicate a risk of danger during the process of unloading and shipping process so that it needs a change

Keywords
ABC Analysis, Analytical Hierarchy Process, From-to-Chart, Job Hazzard Analysis and REBA.

1. Introduction
Visual problems and blindness are problems that need to be addressed. This is because the condition of visual impairment and blindness can affect the quality of life of Indonesian people. Currently, many eye vision problems occur in children. The cause is a refraction disorder caused by changes in lifestyle that rely on technology or addiction to gadgets. This condition can affect the process of receiving in-formation in learning activities. In the end, if the refractive disorder in school-age children is not corrected, it will have fatal consequences, namely a decrease in intelligence and learning achievement. Moeloek (2016)

The Minister of Health, Moeloek (2016) appealed to all governors, regents and mayors throughout Indonesia to support the implementation of the Movement for Overcoming Vision Disorders and Blindness by in-volving all parties, both public, private, NGOs, professions, associations, as well as educational institutions. The socialization, he continued, is an effort to convey information to the entire community, that blindness is a major public health problem in the world that can be prevented, treated and rehabilitated. Increasing the awareness of all parties regarding the importance of preventing and overcoming vision problems and blindness, through promotional activities, screening or early detection of visual disturbances and blindness in the community, which are followed up with corrective action or appropriate treatment.

Based on data from the Rapid Assessment of Avoidable Blindness (RAAB) blindness survey con-ducted by the Association of Indonesian Ophthalmologists (Perdami) and the Research and Development Agency, in 2014-2015 in seven provinces, the main causes of blindness in Indonesia are cataracts (70-80%) and glaucoma. The only way to prevent blindness due to cataracts is surgery. Meanwhile, the main cause of visual disturbances is refractive errors (10-15%). Meanwhile, the World Health Organization (WHO) in 2006 estimated that around 153 million people in the world experienced uncorrected refractive errors. Of these 153 million people, around 13 million are children aged 5-15 years, with the highest prevalence occurring in Southeast Asia (Min et al. 1999, Tahrir et al. 2008, Tam et al. 2001)

For the main supplier of Abbot Medical Optics (AMO) brand cataract eye lens products, PT. XYZ uses Singapore as the main supplier. The problem with this supplier is that the payment due date is too fast while the goods are still not

sold. Then the goods from Singapore have several defects, which cause them to return to their country of origin and be detained by shrimps so they take up space.

The next obstacle is in the PT. XYZ warehouse where the movement of company goods is still not integrated with the system, so space utilization is still considered inefficient (Wind et al. 1987). The placement of goods is carried out irregularly, so that when experiencing pick-up season, employee mobile access is disrupted. Then, the warehouse has entered the overload stage resulting in a buildup in PT. XYZ's temporary warehouse, which should have been accommodated by the central warehouse. So, it must be done to re-place the items that are ordered most often and which are less in demand. The repositioning of these goods must be based on the classification of each product, such as price, the level of consumption of the enthusiasts, and the function of the product which aims to increase productivity and time efficiency in each work process (Abratt 1986, Chen et al. 2006, Dulmin et al. 2003, Ha et al. 2008, Liu et al. 2005, Tahriri et al. 2008, Tam et al. 2001, Varagas 2001, Wang 2009).

The last obstacle lies in the level of work safety of the company, where there is no standard safety procedure carried out by the company. All levels of risk that may occur on the company side have not been overcome and prevention steps are planned. Therefore, to improve the safety and security of PT. XYZ workers, it is necessary to improve based on the problems that have been described.

2. Research Methods

The research method used in the implementation of this research follows the stages presented in the following methodology flow chart (Figure 1):

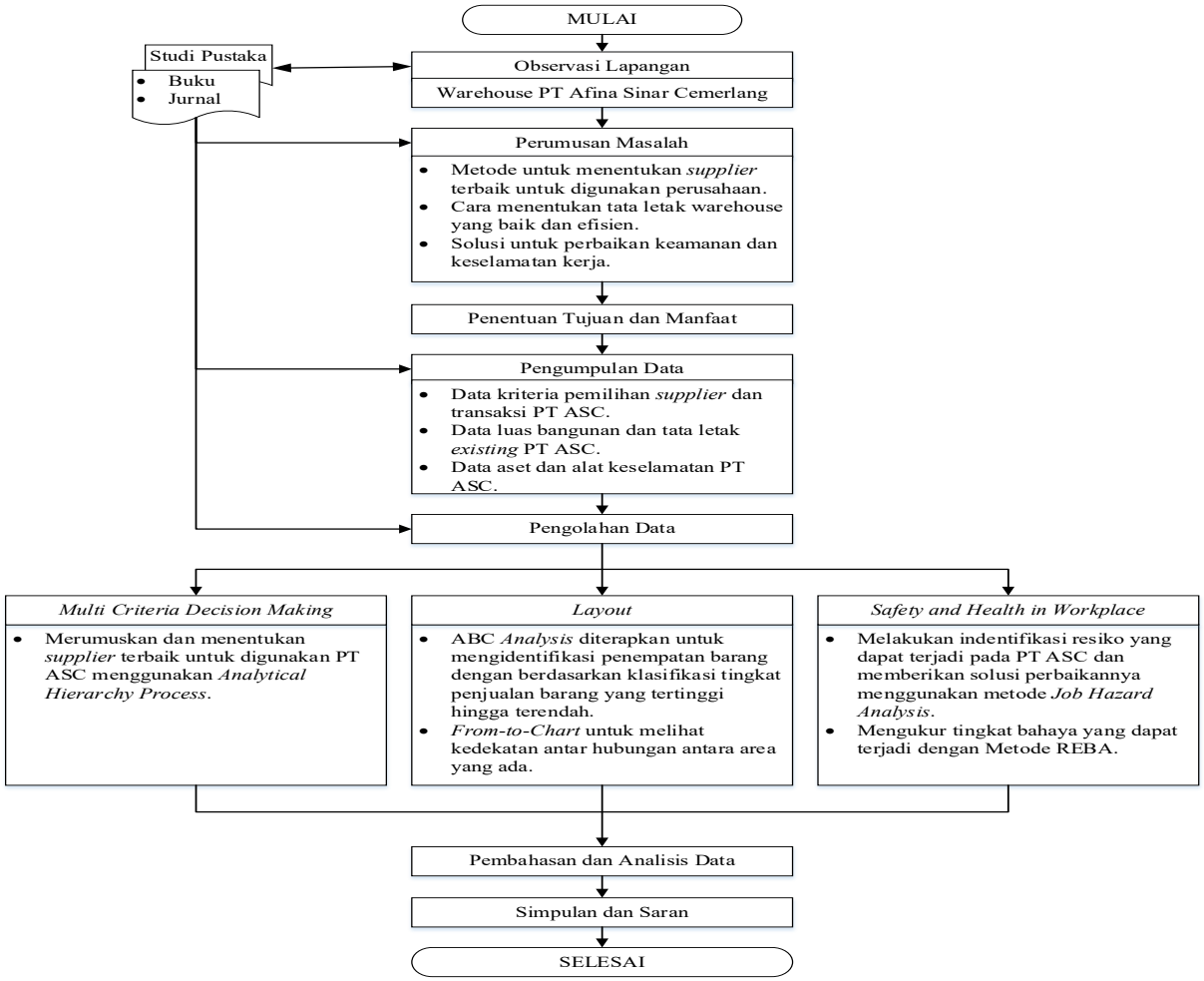

Figure 1. Flowchart observations

2.1 Field Observation
In this step, field observations were made at PT. XYZ to determine the condition of the company layout. In the end, these preliminary observations form the basis for writing the back-ground of the report.

2.2 Problem Identification and Formulation
Furthermore, problem identification is carried out during observation so that we can find out the problems that arise. The formulation of the problem contains questions that direct the writer to find the existing problem. Here the writer becomes more focused in determining what will be examined in the report. Furthermore, the formulation of the problem will be studied further to find a solution for evaluation.

2.3 Goal Setting
After obtaining the problem formulation, at this stage the objective of the observations made at PT. XYZ was determined.

2.4 Submission of Thesis Proposals
The next step is to submit a thesis proposal entitled Criteria for Best Supplier Selection and Repair of PT. XYZ Warehouse Layout. If the proposal has not been received, periodic revisions will be made until the proposal is accepted. After the proposal is accepted, the research can proceed to the next step.

2.5 Data Collection
This step contains data collection that will be used in solving the questions in the problem formulation. If the data obtained is sufficient, then you can proceed to the next step. The data used include the current warehouse area, process flow of goods and workers, criteria and results of transactions to company lens suppliers, and all threats that can endanger work activities.

2.6 Data Processing
After getting the data in the field, the next step is data processing. Data processing is done by calculating the research data in the form of numbers. This data processing is useful to assist researchers in conducting analysis and discussion. If the data that is processed is sufficient, then this data will go to the next step.

2.7 Analysis and Discussion
In this step, the data that has been processed in the previous step will be analyzed using the Multi Criteria Decision Making, From-to-Chart, and Safety & Health in Workplace methods**.**

2.8 Conclusions and Suggestions
After the analysis results are obtained, the final step is the conclusions and suggestions from the final project report. In the conclusion contains the answers to the questions from the problem formulation in outline. Suggestions contain things in the form of suggestions that can be submitted to the company to be implemented in PT. XYZ.

3. Results and Discussions
3.1 Analytical Hierarchy Process
In selecting the criteria for PT. XYZ suppliers, there are 5 criteria, 9 sub-criteria, and 4 sub-criteria in selecting the best supplier from its five potential suppliers (Table 1, Table 2, Table 3).

Table 1. Description of supplier performance

ABOTT Medical Optics Suppliers			
	America	Singapore	Hong Kong

P1	Gives 5% discount if company purchase 7000 or more	Gives 2% discount if company purchase 5000	Gives 5% discount if company purchase 5000
P2	Free shipping if company purchase 10000 pieces	Free shipping if company purchase 10000 pieces	Free shipping if company purchase 7000 pieces
D1	80% on time	100% on time	100% on time
D2	100% accuracy	100% accuracy	80% accuracy
D3	Lead time: 5 days	Lead time: 1 days	Lead time: 3 days
Qa	Receives changes of orders for 24 hours	Receives changes of orders for 8 hours	Cannot changes
Qb	Respond to services and complaints anytime	Respond to services and complaints in 24 hour	Respond to services and complaints in 24 hour
Qc	Defect: 0%	Defect: 8%	Defect: 10%
Qd	100% Fulfilled	100% Fulfilled	100% Fulfilled
T1	Payment period no later than 30 days after item is received	Payment period no later than 7 days after item is received	No payment period after item is received
C1	100% Fulfilled	100% Fulfilled	90% Fulfilled

To determine the best supplier from five potential suppliers, the company uses Analytical Hierarchy Process (AHP). By using AHP, the company can find out the best or worst supplier.

Table 2. Weighting and eigen between criteria

Inter Criteria	P	D	Q	T	C	***Eigen Factor***
P	1	3	1/3	1/6	1/9	0,10
D	1/3	1	5	1/4	4	0,24
Q	3	1/5	1	4	5	0,28
T	6	4	1/4	1	3	0,24
C	9	1/4	1/5	1/3	1	0,13
Total	19,33	8,45	6,78	5,75	13,11	

Table 3. Priority value between alternatives in sub-criteria

	P1	**P2**	**D1**	**D2**	**D3**	**Qa**	**Qb**	**Qc**	**Qd**	**T1**	**C1**	**Total**	**Percentage (%)**	***Rank***
USA	0,0089	0,0109	0,0039	0,0560	0,0215	0,0054	0,0182	0,0711	0,0124	0,1468	0,0501	0,4003	40,56%	1
SNG	0,0122	0,0257	0,0168	0,0506	0,0194	0,0028	0,0140	0,0677	0,0124	0,0734	0,0477	0,3399	34,32%	2
HKG	0,0035	0,0372	0,0127	0,0455	0,0175	0,0010	0,0145	0,0482	0,0124	0,0245	0,0339	0,2597	25,12%	3

3.2 Layout

Flow Matrix is part of the from-to-chart which is useful for moving goods, visitors, employees and in-formation to the better according to the many needs that are done in the department. The following is a Flow Matrix of the number of visitors visiting existing departments (Figure 2, Table 4, Table 5, table 6):

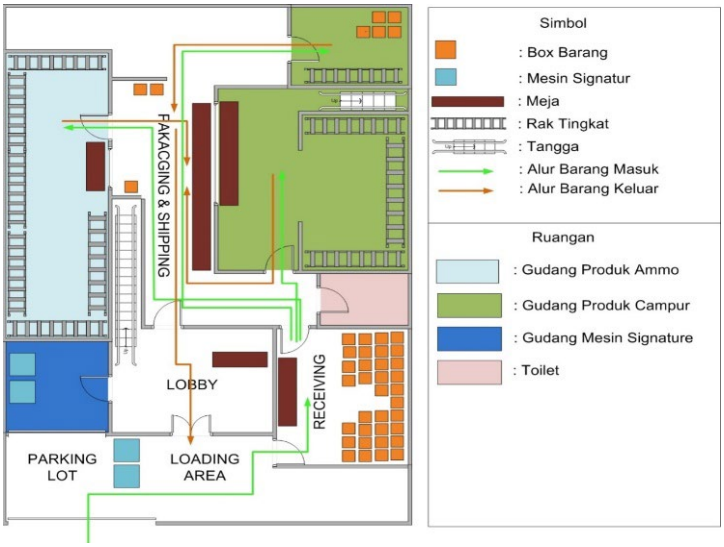

Figure 2. PT. XYZ warehouse layout (now)

Table 4. Layout description

No.	Room or Department Name	Function
1.	Entrance	The door used to enter and exit the vehicle
2.	*Loading dock*	A place to drop off items that have arrived
3.	*Lobby*	A place to find out the characteristics of the company in which there are tables and chairs
4.	*Receiving*	A place for temporary storage and data collection of incoming goods
5.	Lenses product warehouse	A place to store all types of lenses
6.	Ammo product warehouse	A place for storing Ammo items
7.	*Shipping and Packaging*	Place for preparation of goods before shipment
8.	*Signature* Machine Warehouse	A place for storing goods that are ready to be shipped and
9.	Toilet	Place to urinate or defecate
10.	*Parking lot*	A place to park motorbikes and cars
11.	Additional warehouse	As an additional place for lens products when the warehouse for lens products is not able to accommodate them

Table 5. Flow matrix

	A	B	C	D	E	F	G	H	I	J	K
A		8	5	4	3	3	6	0	8	6	5
B	5		5	12	9	9	5	2	9	8	8
C	0	2		0	2	3	5	0	10	2	5

D	6	4	3		12	12	7	3	7	0	8
E	2	0	2	8		6	14	8	8	0	0
F	2	0	2	15	6		14	5	5	0	0
G	0	10	8	0	12	15		5	8	15	2
H	0	2	3	3	2	0	2		3	1	2
I	1	2	2	1	1	1	2	0		1	0
J	5	5	0	5	0	0	2	0	1		0
K	3	0	2	0	0	0	0	0	3	0	

Information:
A = Entrance
B = Loading Dock
C = Lobby
D = Receiving
E = Mixed Lens Warehouse
F = Ammo Lens Warehouse
G = Shipping & Packaging
H = Additional Warehouse
J = Parking Lot
K = Signature Machine Warehouse
I = Toilet

Table 6. Triangularized matrix

	A	B	C	D	E	F	G	H	I	J	K
A		13	5	10	5	5	6	0	9	11	8
B			7	16	9	9	15	4	11	13	8
C				3	4	5	13	3	12	2	7
D					20	27	7	6	8	5	8
E						12	26	10	9	0	0
F							29	5	5	0	0
G								7	10	17	2
H									3	1	2
I										2	3
J											0
K											

Quantitative Flow Measurement is useful for workers so that activities in the warehouse can be better, such as the absence of repetitive activities or long distances from one area to another. From-to-chart is a calculation method to measure the value of the closeness of the relationship between existing areas (Figure 3-5).

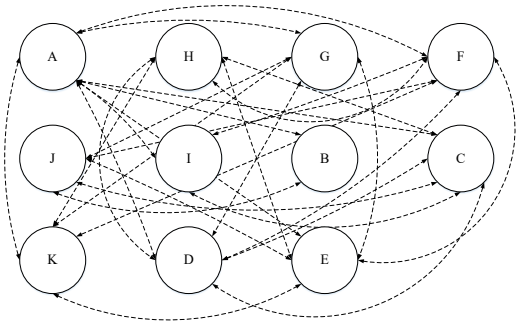

Figure 3. Third initial layout

Atraction 1			*Attraction 2*			*Attraction 3*			*Attraciton 4*		
No	***Pairs***	***Flow Distance***	**No**	***Pairs***	***Flow Distance***	**No**	***Pairs***	***Flow Distance***	**No**	***Pairs***	***Flow Distance***
1	AC	10	1	AE	10	1	AF	10	1	AF	10
2	AD	30	2	AG	18	2	AK	33	2	AG	18
3	AG	12	3	AI	18	3	AB	26	3	AE	10
4	AH	0	4	AH	33	4	AD	30	4	AI	27
5	AI	18	5	AK	16	5	AI	18	5	AJ	22
6	AJ	22	6	AJ	22	6	AC	10	6	AH	0
7	AK	16	7	AC	10	7	AE	15	7	AC	15
8	BD	32	8	DG	14	8	HK	4	8	KG	4
9	BH	8	9	DH	12	9	HD	12	9	KI	6
10	BI	22	10	DK	16	10	HI	6	10	KJ	0
11	BJ	26	11	DJ	10	11	HC	6	11	KH	4
12	BK	16	12	DC	6	12	HE	20	12	KC	14
13	CE	8	13	EB	18	13	FJ	0	13	FB	18
14	CI	24	14	EK	0	14	FI	10	14	FJ	0
15	CJ	4	15	EJ	0	15	FC	10	15	FH	10
16	CK	14	16	EC	8	16	FE	24	16	FC	10
17	DE	60	17	GB	45	17	KJ	0	17	GB	45
18	DF	54	18	GF	58	18	KG	4	18	GD	14
19	DI	24	19	GK	6	19	KI	6	19	GJ	34
20	DJ	10	20	GI	20	20	KC	14	20	GH	14
21	DK	16	21	GC	26	21	KE	0	21	GC	26
22	EG	52	22	BI	22	22	JB	26	22	BE	18
23	EH	30	23	BH	12	23	JD	15	23	BI	33
24	EK	0	24	BC	14	24	JC	4	24	BH	8
25	FH	10	25	FH	10	25	JE	0	25	BC	21
26	GI	20	26	IK	6	26	GD	14	26	DI	16
27	HI	9	27	HK	6	27	GE	52	27	DC	6
28	HJ	1	28	HJ	2	28	DI	16	28	IJ	4
29	IK	6	29	KC	14	29	IE	18	29	JC	4
Total		554	Total		452	Total		403	Total		411
Max		60	*Max*		58	*Max*		52	*Max*		45

Figure 4. Attraction calculation table

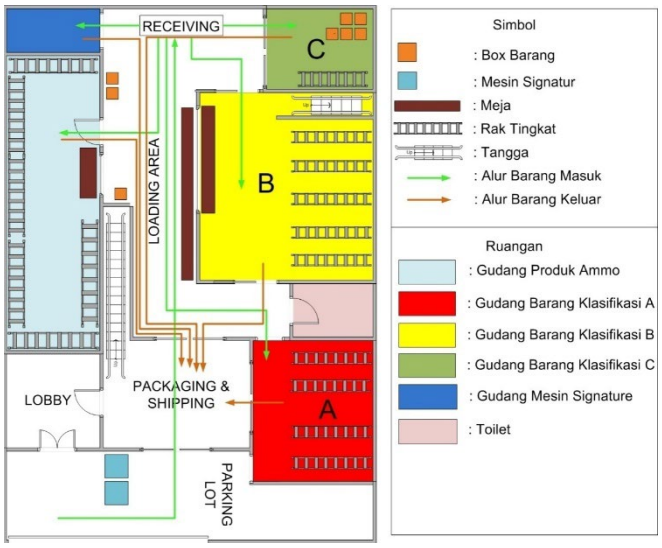

Figure 5. PT. XYZ warehouse layout (proposed)

3.3 Safety and Health in Workplace

After observing the unloading of goods at PT. XYZ, we found work activities that could cause accidents at work. The following is a collection of data in the form of a fault tree analysis from several possibilities that could occur to employees at PT. XYZ's warehouse.

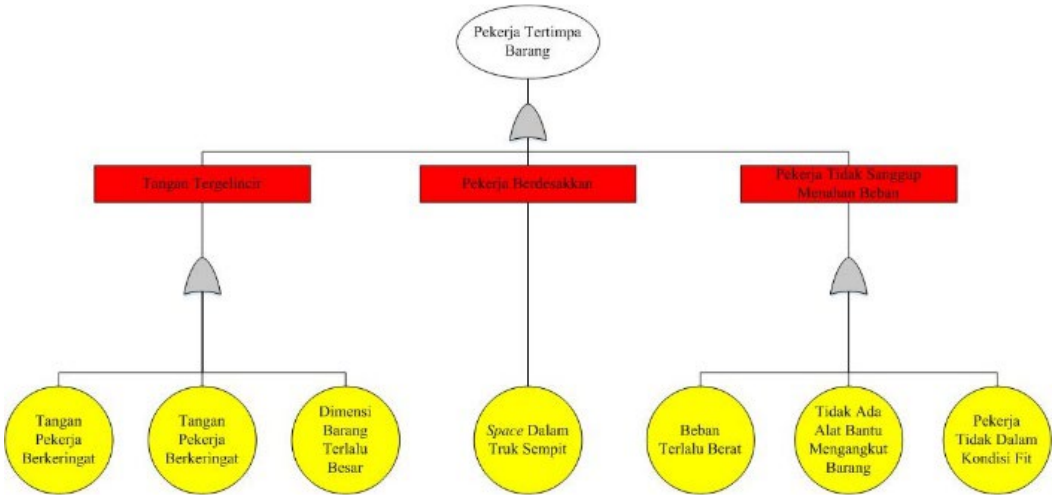

Figure 6. Fault tree analysis 1

The following is a collection of data in the form of a fault tree analysis of several possibilities that could occur to PT. XYZ employees when shipping goods using a motorcycle (Figure 6, Figure 7):

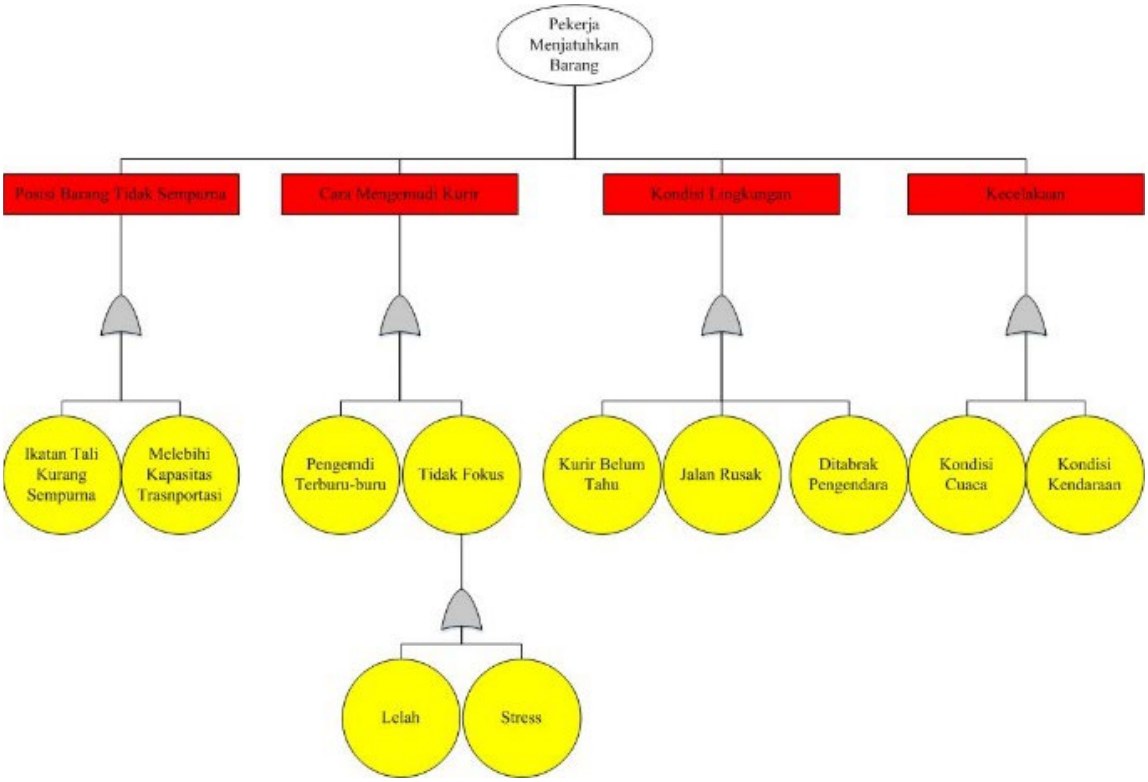

Figure 7. Fault tree analysis 2

The following is a job hazard analysis Table 7 for moving and unloading goods as follows:

Table 7. Job hazard analysis table of goods unloading process

Job Description *Item Unloading* Process		*Prepared by* Thesis Team	
Issuing Department *Warehouse*		*Reviewed By* Thesis Team	
Location DKI Jakarta, Indonesia		*Date* 8 May 2017	
No.	***Key Job Steps***	***Potential Health and Injury Hazard***	***Safe Practices Apparel and Equipment***
1	Hand over the pile of goods from the truck to the trolley	- Dropping of goods - Workers hit by goods - Damage to goods	Workers can use worker gloves when moving goods.
2	Disburse machine *signature* of the truck	- Dropping of goods - Physical injury / disability - Damage to goods	Using a *forklift* , because the *signature* engine dimensions are large.
3	Move items that are in the *unloading* towards the door *receiving*	- Dropping of Goods - Physical Injury / Disability - Damage to goods	Use worker gloves and *safety shoes.*

Then another activity that is declared dangerous is during the process of sending goods to customers using motorbikes. So the job hazard analysis Table 8 for goods delivery activities is as follows:

Table 8. Table job hazard analysis of delivery activities

Job Description Delivery Activities		*Prepared by* Thesis Team	
Issuing Department *Warehouse*		*Reviewed By* Thesis Team	
Location DKI Jakarta, Indonesia		*Date* 8 May 2017	
No.	***Key Job Steps***	***Potential Health and Injury Hazard***	***Safe Practices Apparel and Equipment***
1	Carrying piles of goods from the warehouse to the *loading dock* for shipment	- Dropping of goods - Regarding other people - Damage to goods	Using trolysates to move goods.
2	Put the item on the back seat of the motorcycle	- Dropping of goods - Theft	Using a special box to put things on the motorbike.
3	Do not use complete safety equipment when shipping	- Physical injury / disability - Traffic violations	Using *safety shoes* or *riding shoes when* delivery.

4. Conclusions and Suggestions

Based on the results of the analysis and discussion at the PT. XYZ warehouse, it can be concluded as follows:

1. To determine the best supplier by weighting the criteria for all PT. XYZ suppliers using the analytical hierarchy process method, which prioritizes the quality aspect of its delivery. It can be concluded that American suppliers with a selection percentage of 40.56% are the best among other suppliers.
2. To determine a good and efficient warehouse layout, PT. XYZ uses the From-to-chart (FTC) method and ABC Analysis in grouping goods. The best results were obtained after doing the calculation 3 times with a total flow distance value of 403 movements and a max value of 52. The proposed layout is based on the level of activity between one area and another which has a very important relationship so that the area becomes close together. That way all the activities and time spent by workers at the PT. XYZ warehouse are optimal.
3. To determine the recommendations for work safety and security for PT. XYZ employees, the REBA calculation method & job hazzard analysis are used. In the process of lifting goods and signature machines, the REBA calculations obtained are 6 & 10, which means that it is risky and at risk of living, it requires a change in the way of working. Then the results of the job hazzard analysis, found several things that are potentially dangerous, namely when receiving goods and delivery of goods, where the process requires improvement.

After a conclusion is drawn, the suggestions that can be given are:

1. Making suppliers America as a supplier of PT. XYZ. However, it is possible to order goods from other countries to cover urgent needs by using a smaller lead time from American suppliers.
2. Employees can use trolleys when moving goods, both on receiving and packaging. Then when sending employees who use motorbikes can use additional delivery boxes. This aims to minimize the possibility of accidents.

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