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IMPROVEMENT OF THE PROCESS OF NEW BUSINESS OF SHIP BUILDING INDUSTRY

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ABSTRACT

Shipbuilding industry is an industry group which has high risk. For that reason, the management should include risk assessment. The production process of new buildings in the shipbuilding industry is grouped into three major parts, namely the work of design, material procurement and production processes. Each stage of the production process will bring the risk and will accumulate on the overall risk. If the risk is not anticipated, the possibility of delays in the production process will be even greater. Risk assessment performed on each production process by using a probabilistic approach to the principle of multiplication in the theory of opportunity. Risk analysis performed on the construction of fast patrol boats was in the construction number 268, 269 and 270 on the PT. PAL Indonesia. From the analysis, it was obtained the greatest probability of occurrence of sequential delay which is in the process of the material, the production, and design group. The potential for loss is due to the risk of unanticipated costs due to factors affected by delays in production processes. Performance factors are still required for further study.

Key words: *Risk Assessment, Probabilistic, Risk, Shipbuilding Industry.*

PERBAIKAN PROSES BISNIS INDUSTRI GALANGAN KAPAL BARU

ABSTRAK

Industri galangan kapal adalah kelompok industri dengan risiko tinggi, sehingga dalam pengelolaannya harus mengikutkan risk assessment. Proses produksi bangunan baru pada industri galangan kapal dikelompokan dalam tiga bagian besar, yaitu pekerjaan desain, pengadaan material dan proses produksi. Masing-masing tahapan proses produksi akan memunculkan risiko dan akan terakumulasi terhadap risiko secara keseluruhan. Jika risiko ini tidak diantisipasi, peluang terjadinya keterlambatan proses produksi akan semakin besar. Risk assessment dilakukan pada masing-masing proses produksi dengan pendekatan probabilistik menggunakan asas perkalian pada teori peluang. Analisis risiko dilakukan pada proses pembangunan kapal patroli cepat pada nomor pembangunan 268, 269 dan 270 di PT. PAL Indonesia. Dari hasil analisis, diperoleh probabilitas terbesar terjadinya keterlambatan secara berturu-turut adalah pada proses kelompok material, kelompok produksi dan kelompok desain. Potensi terjadinya kerugian akibat risiko yang tidak diantisipasi dipengaruhi oleh faktor biaya akibat keterlambatan proses produksi. Faktor kinerja masih diperlukan studi lebih lanjut.

Kata Kunci: *Risk Assessment, Probabilistik, Risiko, Industri Kapal.*

INTRODUCTION

As noted by Suryohadiprojo (2004), Indonesia shipbuilding industry, with the money velocity for the transportation by sea reaches up to 50.7 trillion rupiahs a year. As such, it is recommended that the shipbuilding should be dragged into a strong and modern industry. In another condition, Japan and Korea currently controls more than 80% world market share. In this case, yet, Indonesia shipbuilding industry absorbs only 0.5% share of the world shipbuilding market. That is why, it indicates the difficulties faced by Indonesia in terms of shipbuilding activities and supporting industries such as steel industry, machinery industry, and electrical industry, chemical industry decreased productivity, and many are bankrupt.

For information dealing with the case above, it is good to see that the world shipbuilding industry has become an international concern as China's economic growth since 2003. For another example is Korea's shipbuilding industry which is also one that has triggered its development. This is one of which it can be seen from up to 236% order growth in the shipbuilding industry during the last five years, and after 2003 orders grew 5.2% per year. In 2006, 496 million CGT of new orders won by Korean 38.3%, China 29.6% and Japan 13.9% (Lee, Shin, and Park, 2007).

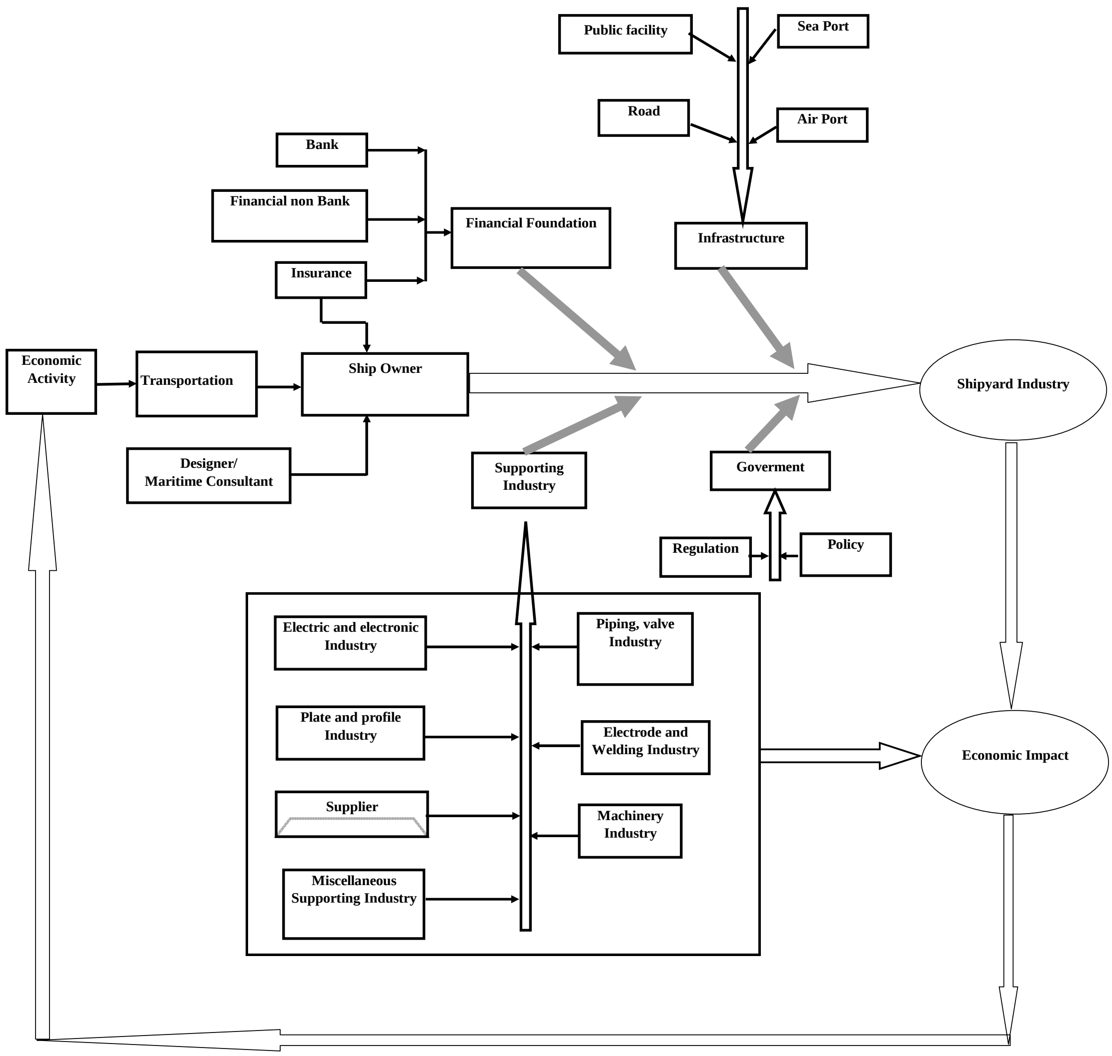
According to China Knowledge (2009), shipbuilding companies in China have received orders for new ships of 4.1 million tones in July 2009. The number of orders is almost to reach by 70% of the total amount of shipbuilding orders worldwide. In addition, the Chinese shipbuilding companies have teamed up with the ship owners to increase market demand for shipping from China. For example of the China's case is in the first half of 2009. It gained the total value of exported ships stood at U.S. $ 9.13 billion, which equates to 70% of China's ship export value. However, the existence of excess capacity in the shipping world, causing the shipping industry in China is facing cancellation of orders, delays in delivery of ships and other financial matters. To overcome the above barriers, China's shipbuilding industry has tried hard to focus on achieving high productivity and efficiency, reduces costs and energy consumption, and is currently able to transform the risk into opportunity.

When considering the factors causing the above condition, it can be referred to Basuki and Widjaja (2008). They evidenced that there are several reasons why the shipbuilding industry should be develop. The reasons are such as the economic value of the shipbuilding industry, which globally has tremendous value; shipbuilding industry is the main industry of supporting industries. It is argued that the development of this industry will help develop other industries. This finally provides a multiplier-effect of the process of industrialization in a country.

For example, in the construction of a ship, 50% 70% costs is the purchase of raw materials and equipment. Besides that, the shipbuilding industry is labor-intensive industries which are able to create substantial employment with high added value. With the development of this industry, it is expected that the independence of the defense sector with the manufacture of defense equipment in the country will be achieved. As described above, the shipbuilding industry is highly dependent on other industries from upstream to downstream. This dependence will determine the viability and the level of risk faced by the shipbuilding industry. To prove this fact, it can be seen as Figure 1.

When dealing with shipping industries, it is stated that these industries are the businesses which have their own characteristics (the Ministry, 2010). The characteristics cover such as : the capital-intensive (capital intensive), labor-intensive (labor intensive), the payback is slow (slow-yielding), low value added (low value added), the value chain complex (complex value chain), low competitiveness (low competitiveness), high risk business (high risk business), a little ship orders (orders ship low demand), high-

Figure 1
Synergies in Shipbuilding Industry



tech (high technology contents), skilled (high skilled ship design and fabrication), high import content and low local content (high import contents and low local contents), lack of experience (low experience), the length of completion time (long term delivery ship).

The shipbuilding industry is an industry fraught with risk. However, many of them are implementing a risk management to assess the risks involved in the production process. Again, it has still little risk analysis, as well as the limited research and risk analysis in the shipbuilding industry. For example, the shipbuilding industries in Indonesia are spread away by their geographical differences. And, these geographical differences would also pose different risks.

As such a condition, this study discusses the analysis of the risks involved in the production process for each of the shipbuilding, and the overall geographic clusters at the shipbuilding. Risk-based approach to production adopted in assessing the risk to the shipbuilding industry. Risk assessment is done on paper at the strategic and operational (management level) in the shipbuilding industry. Consecutive groups analyzed in the design, the materials and production groups. With the application of risk analysis, the shipbuilding industry to analyze the impact caused when the production process has been delayed.

Some of the new building works have

Table 1
Likelihood Criteria

Likelihood	Note of Likelihood
Rare	< 1% from total work days
Unlikely	1%-5% from total work days
Possible	5%-25% from total work days
Likely	25%-60% from total work days
Almost Certain	> 60% from total work days

Table 2
Definition of Consequence Criteria

Consequences	Note of Consequences
Insignificant	Ineficiency Time < 10 days
Minor	Ineficiency Time 10 s/d 20 days
Moderate	Ineficiency Time 20 s/d 50 days
Major	Ineficiency Time 50 s/d 100 days
Catastrophic	Ineficiency Time > 100 days

been done on PT boats. PAL (the company) Indonesia exposed most of the delayed delivery process, and even some new ship construction work has been stopped completely. This is because a problem in financing that is problem with the burdensome of contract item, materials, production processes, and management. Some of these problems have not actually led to the implementation of risk management in the process of building new ships, so the management of PT. PAL Indonesia can not anticipate the risks that exist.

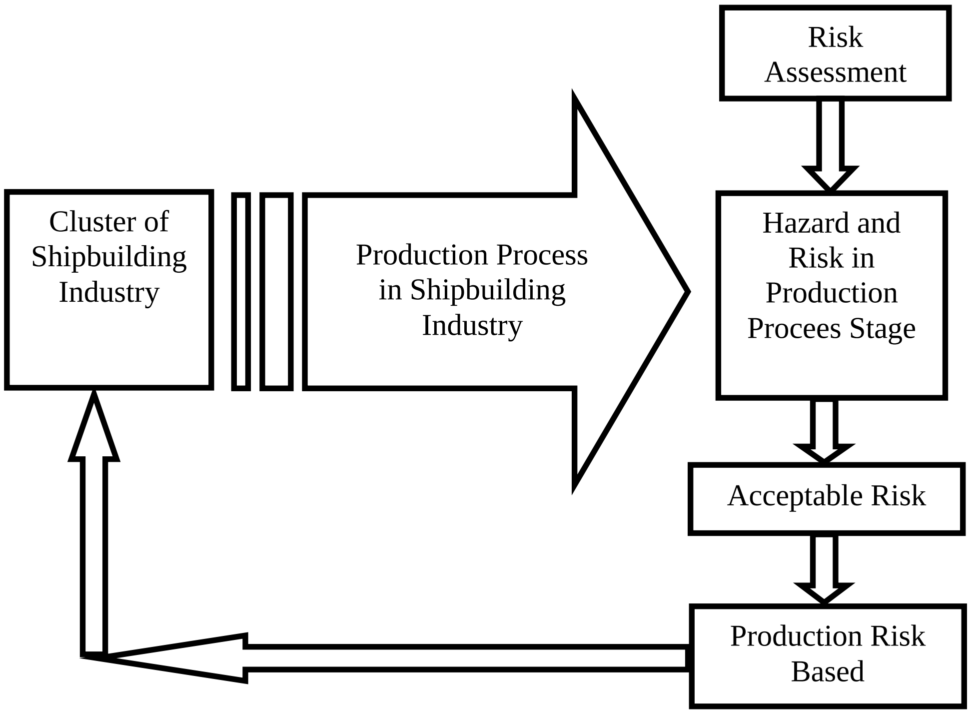
THEORETICAL FRAMEWORK

The Standards Australia or New Zealand (in Basuki and Setyoko, 2009) described that the risk is any possibility of the unexpected event which can affect any activity or object. As such, the risk is measured by considering its consequences and its likelihood (possibility/ probability). In this case, Ben-Azher (2008) also described that a probability of risk occurrence is influenced by three factors such as Maturity factor (Pm) that is a factor that reflects the likelihood of risk for the development of new technologies; Complexity factor (Pc) which is a factor that reflects the likelihood of risk for the development of the system; Dependency factor (Pd) which is a factor that reflects the likelihood of risk due to the dependence of the facilities, contractors and others.

The consequences of risk occurrence are influenced by three factors such as Performance factor that is the factor that reflects the decline in performance and Cost factor that is the factor that reflects the incremental cost. Schedule factors: the factors that reflect schedule delays or schedule. Under the provisions of the Standards Australia or New Zealand (in Basuki and Setyoko, 2009), the probability criteria (Likelihood) and consequences (Consequences) are observed as presented in Table 1 and 2.

So far, the concept of risk in the industry analyses has been conducted by several researchers under different conditions. The connection in the production design has been developed and recommended by the Design for Production of Storch (Storch et al., 1995) in establishing the correspondence between design and production to reduce the risk of errors that might occur. Analogically the concept which ahs been developed by

Figure 2
Production Risk-Based Concept



Vassalos, Guarin and Konovessis (2006) was on the Design for Safety or the concept of Risk-Based Ship Design. This is the links between the assessment of safety and the design of a ship.

As based on the above description, the risk-based design is a formal method which is systematically integrated in the risk assessment on the design process. This design is established for preventing from or reducing the risk of death, the assets, and the environment which are all the integral part of the design goals. The concept of Risk-Based Design is also used to minimize the failure rate and the cost of the field which has been done by manufacture, Todinov (2008).

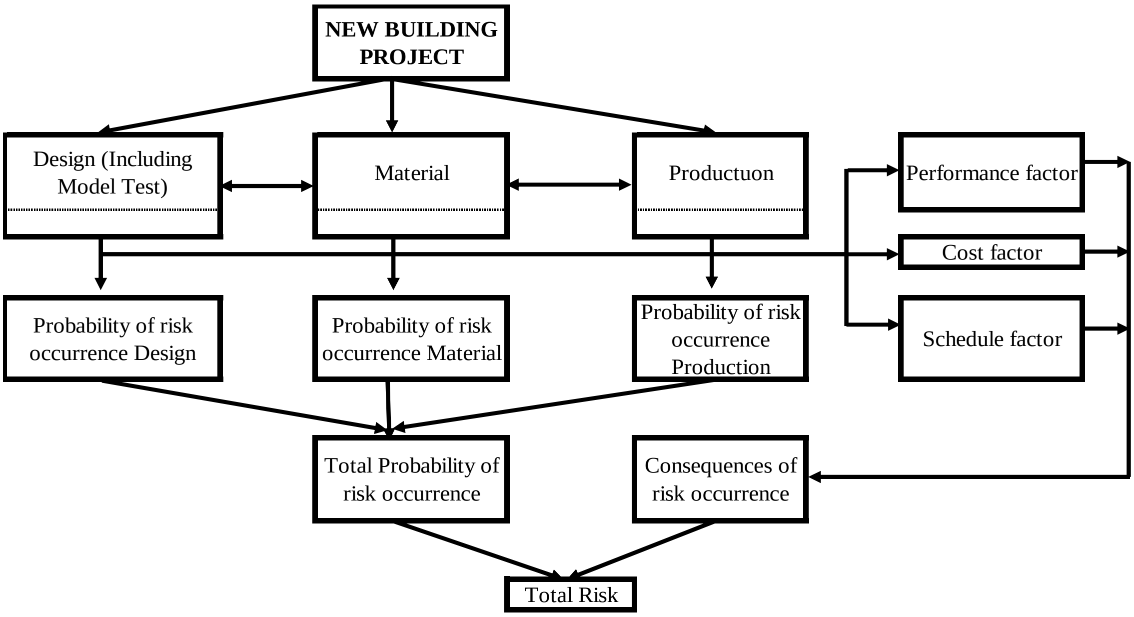
Risk assessment in Shipbuilding Industry

There has been some risk assessments carried out on the shipping industries. Some of them are Asok and Aoyama (2005) to schedule risk using mathematical modeling approaches, Atua (2003) with the cost risk and schedule risk to the deterministic approach. With the statistical approach, the evaluation of risk has been raised by: Basuki and Widjaja (2008), Basuki (2009), Gatti et al (2007), Lee, Shin and Park (2007), Lu and Tang (2000), Moyst and Das (2005). Basuki and Widjaja (2008) has suggested the need for risk mitigation processes in risk analysis with a qualitative approach and deterministic.

Deterministic approach for risk analysis has also been conducted by several researchers, among others: Basuki and Setyoko (2009), Iskanius (2009), Kindinger and Darby (2009), and Novendi Basuki (2010), Li and Culinane (2003), and Geraldine Pujawan (2009), Robu, Gavrilescu, and Macoveanu (2003), Vassalos, Guarin and Konovessis (2006). Analysis of the optimization approach in the evaluation of risks has been carried out by Brown and Mierzwicki (2008), Lee, Park and Shin (2009), Yang et al. (2009).

Basuki and Widjaja (2008) has conducted an evaluation of risk in the development process to approach by statistic analysis which was started early in the process of production to the stage of establishment. The evaluation of risk has been done from the

Figure 3
Frame Work of Research



design stage until delivery by Setyoko Basuki (2009) and Basuki and Novendi (2010) with standard analytical Australia. Asok and Aoyama (2005) evaluate the risks involved in the development process at this stage of assembly to the ship building schedule risk by using a mathematical model.

Others can be used as evidence. For example, Lee, Shin and Park (2007) evaluate the risk in the shipbuilding industry from contract stage up to delivery by the statistical approach. Each carried out a risk in the assessment phase. Evaluation of the risk for the Bayesian network has also been done by Lee, Park and Shin (2009) in the shipbuilding process. Risk assessment at the design stage has been done by Brown and Mierzwicki (2008) with the inclusion of new technological approaches. Atua (2003) evaluates cost and schedule risk and the risk of ship building in the shipbuilding industry.

Risk Assessment Model Using Probability

For considering the risk assessment model, it is known that there have been models developed by several previous investigators, particularly in the fields of nuclear, aerospace, medicine and other humanities fields. In addition, risk assessment models are developed in which one of them is done by means of a probabilistic approach. For examples, Khericha and Mitman (2008), Satoh, Kumamoto and Kino (2008), Meshkat and Shapiro (2005), Wreathall and Nemeth (2004) using a combination of fault trees and event trees in probabilistic risk assessment analysis.

Again, the fact is that there have been several studies developed by means of a probabilistic model. It was the Monte Carlo simulation method and this used the help of computer software, among others: Nejad, Zhu and Mosleh (2007), Abdullah et al. (2010), Kruizinga et al. (2008), Khericha and Mitman (2008), Satoh, Kumamoto and Kino (2008), Craney (2003), Yang (2003), Schleiher (2009). Deterministic and statistical methods in probabilistic risk assessment has also been done by previous researchers among others: Kruizinga et al. (2008), Bashiri (2010), Craney (2003), Yang et al. (2003), Schleiher et al. (2009), Meshkat and Shapiro (2005).

RESEARCH METHOD

The researchers propose the concept risk-based approach as one of the production

Table 3
Risk of Agent

Number	Risk of Agent
1	Revised and modification design because equipment size.
2	New Technology transfer problem.
3	Revised design from Owner and Classification.
4	Customs Clearence of material or equipment in Port.
5	Delay of Purchase Order.
6	Delay of Material in Shipbuilding
7	Performance of worker in Production Procees.
8	Delay of Production because delay of material.
9	Revised of production Request from Owner and Classification.
10	Instruction not responsibility.
11	Performance of worker from Sub-Contractor
12	Mistake of Design.

Table 4
Risk Event, Agent of Risk, Internal and External Risk

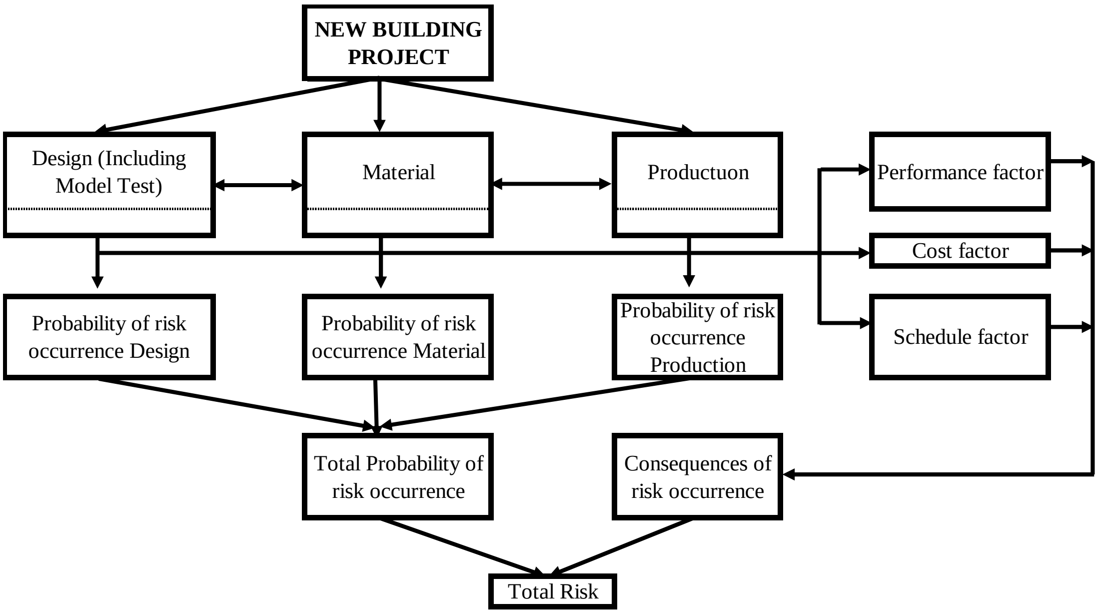
No.	Event	Risk	Objective	Agent	
				Internal	External
1.	Delay of Design Procees	Delay of Schedule Project	Minimized Delay of Schedule Project	Revised and modification design because equipment size. New Technology transfer problem.	Revised design from Owner and Classification.
2.	Delay of Procurement			Customs Clearence of material or equipment in Port. Delay of Purchase Order.	Delay of Material in Shipbuilding
3.	Delay of production Procees			Performance of worker in Production Procees.	Delay of Production because delay of material.
				Performance of worker from Sub-Contractor	Revised of production Request from Owner and Classification.
				Instruction not responsibility.	Mistake of Design.

process of risk assessment in ship-building approach to the concept of probability as shown drawn in Figure 2.

Risk Model Development

Risk terminology is developed at the level of management because the operational risk analysis is conducted in which it includes such as the risk of productivity, technological risks, risks of innovation, risk systems and risk processes. Therefore, risk approach for each component of the production proc-

Figure 4
Main Network Model



ess can be used with the following formula.
Risk = Probability of risk occurrence × Consequences of risk occurrence (1)

In reference to Ben-Azher (2008), probability of risk occurrence is influenced by three factors, namely: Maturity factor (Pm) that is a factor that reflects the likelihood of risk for the development of new technologies, Complexity factor (Pc) that is a factor that reflects the likelihood of risk for the development system, and the Dependency factor (Pd) that is a factor that reflects the likelihood of risk due to the dependence of the facilities, contractors and others. In addition, the consequences of risk occurrence are influenced by three factors, namely: Performance factor: the factor that reflects the decline in performance, cost factor: the factor that reflects the incremental cost of, and Schedule factors: the factor that reflects the delay in the schedule or schedules.

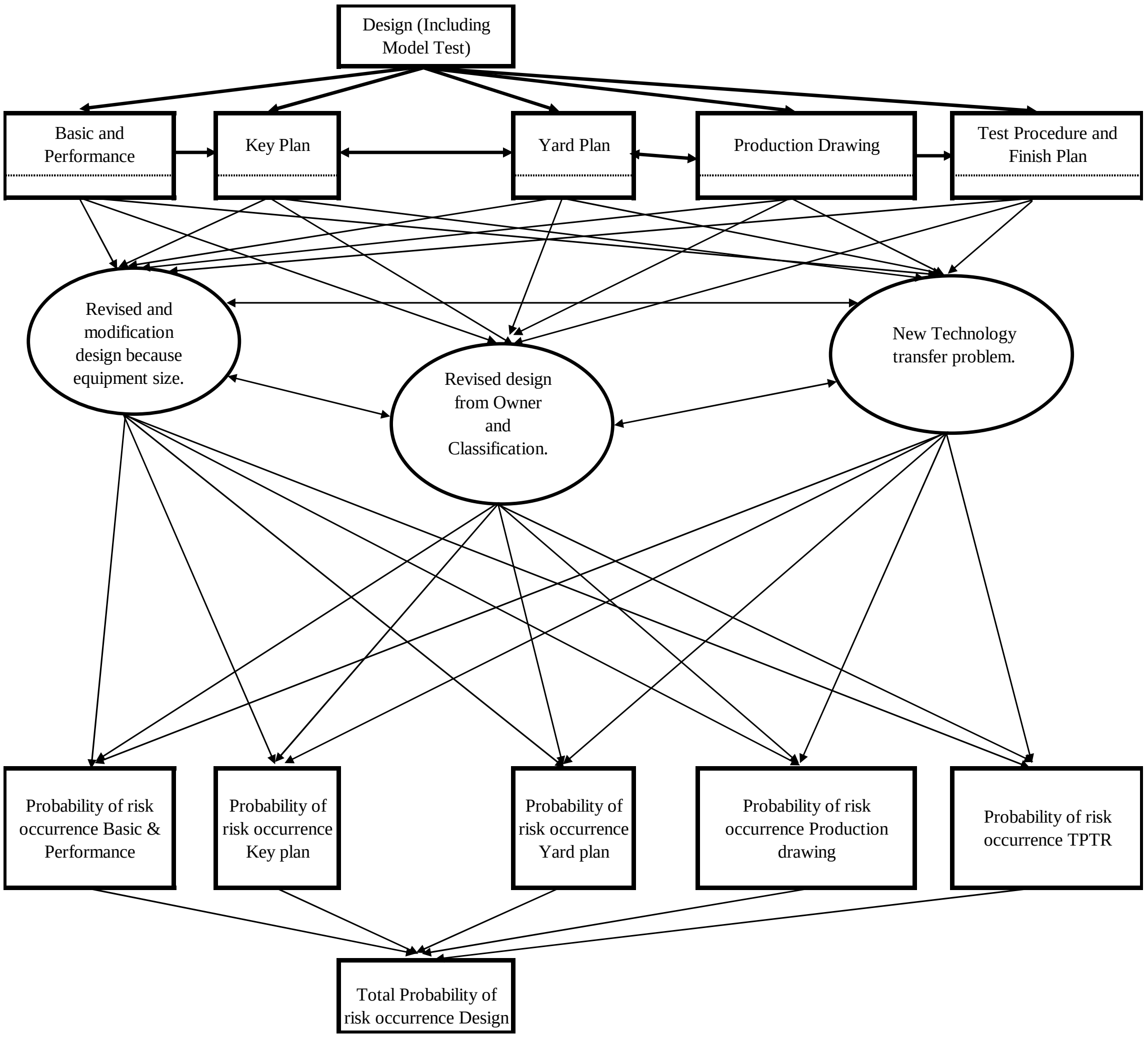
Framework
Framework for problem-solving research for this study is to use risk assessment procedures developed by the researchers (Figure 3) and frameworks such as those contained in Figure 3.

Hazard Analysis
As presented in Figure 3, each production process brings a different hazard and has different risk levels. In this case, Basuki and Widjaja (2008) have developed a hazard model of the relation "*n to n*" in the statistical analysis of risk and hazard models which were developed with *n to n +1* relation with the probabilistic approach. In this model, the hazard may pose some risks, and vice versa.

Probabilistic Model
This likelihood assessment analysis has actually been by several methods, such as: deterministic approach, the model simulation, the model of decision trees, a dynamic model approach, and an approach using the software. For example risk assessment models, particularly the assessment of likelihood can be done by means of a combination of decision trees, probability approach and the optimization approach.

DATA ANALYSIS AND DISCUSSION
Hazard Identification
According to Basuki and Widjaja (2008), the identified hazard in the development process of new vessels include such as high-risk categories, including job erratum, moderate

Figure 5
Design Network Model



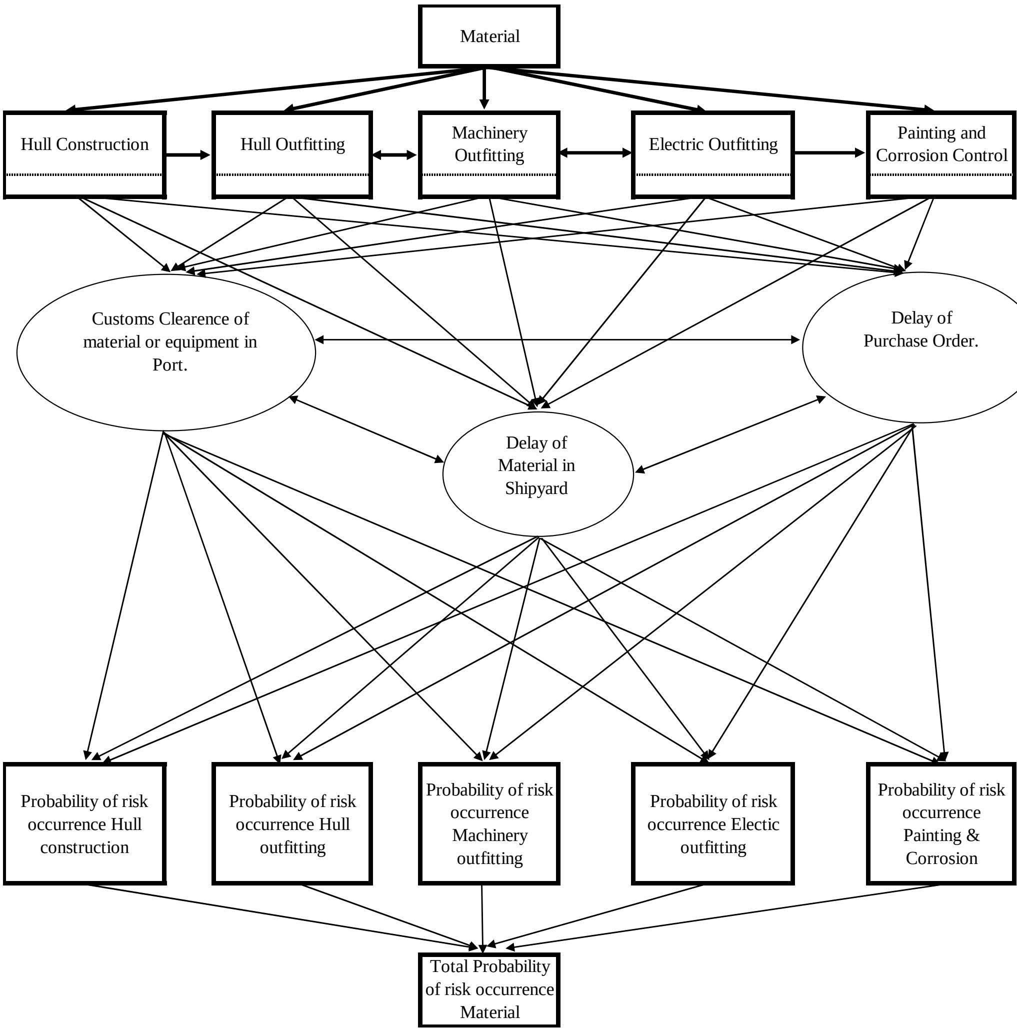
risk category or medium enterprises, including labor skill, low-risk categories, including: one to enter order or report, delayed processing time, less labor, tools and environments have not been verified.

Therefore, the process above is considered to have very low risk categories, including: employment information is incomplete, late material, production process is interrupted, an error making signs or products, verification tools have not been done, many reject the product, not ready to changes in the system, Subcontractors difficult to follow the process, the addition of materials or components, not progress as planned, faulty equipment, wrong understanding, the work environment has not been verified, the document is incomplete and sometimes software errors. Again, Basuki and Setyoko (2009), defined that the identified hazard in the process of fast patrol boats in the construction number 268, 269 and 270 on the PT. PAL Indonesia. This description can be seen in Table 3 and Table 4.

Network Model

The network model is used to analyze the relationship among the factors used in the production process and the identified hazard. The network which is developed is divided into two parts, the main network models and network models of design, material, and production, as in Figure 4, Figure 5, Figure 6, and Figure 7.

Figure 6
Material Network Model



Assessment of VaR

The assessment of value at risk (VaR) is based on the multiplication law of probability with the approach in the theorem opportunities. Each model is calculated for the probability values and the results are as presented in Table 5, Table 6, and Table 7 in Appendices.

Concerning the probability values, it is shown at each production process. From this, then they are compared with the standard, and finally compiled as in Table 8 in Appendices.

Through the first contract, ship building project should be completed in May 2009, with the addendum to be conducted as well. Later on, it should entail the revised settlement until December 28, 2009. The real accomplishment of the new ship was handed out on 1 April 2010. In this time span, there is a delay of 3 months, 3 days (93 days). For that reason, it can be determined as the value of Consequences in the Table 9 in Appendices.

Again, with the contract, any delay of 1 day is to be fined a maximum of 5 per mill with the fine of 5% from the total contract value. In other words, the fine per day is USD. 435 million, - and the maximum one is Rp. 4.35 billion, - with a contract value of Rp. 87 billion, - per vessel. For the fact, it can be seen in Table 10 in Appendices.

CONCLUSION, IMPLICATION, SUGGESTION AND LIMITATIONS

All in all, it can be concluded as the fol-

Figure 7
Production Network Model

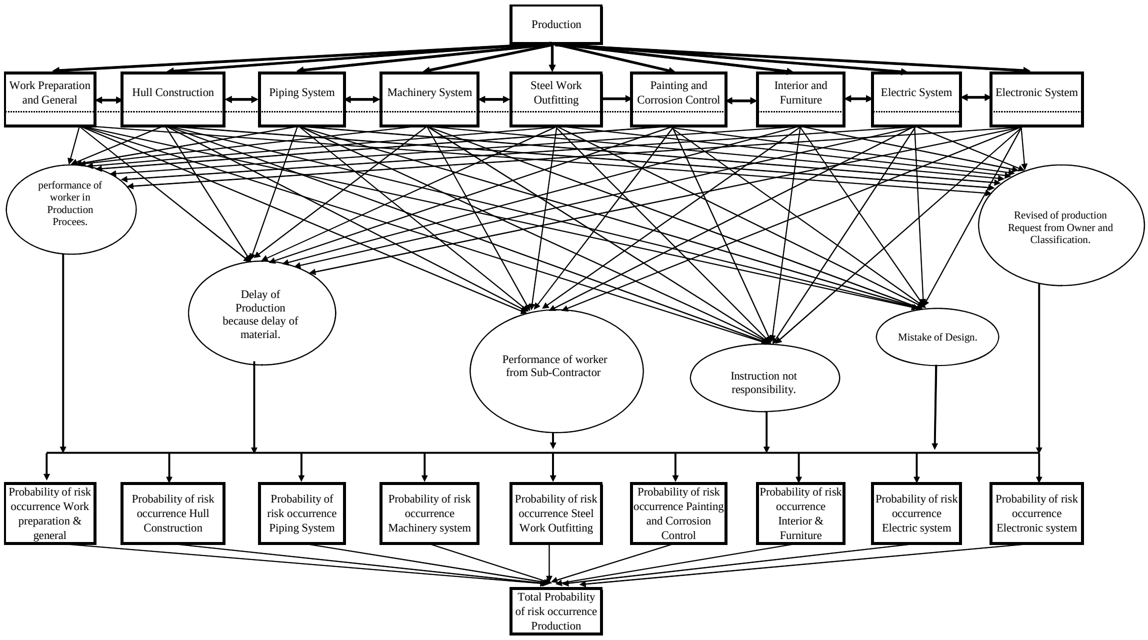


Table 5
Probability of the Delay of Design

Activity	Hazard	Probability
Basic and performance	Revised and modification design because equipment size.	0.033
	Revised design from Owner and Classification.	0.033
	New Technology transfer problem.	0.033
	Sub Total	0.100
Key plan	Revised and modification design because equipment size.	0.040
	Revised design from Owner and Classification.	0.040
	New Technology transfer problem.	0.040
	Sub Total	0.120
Yard plan	Revised and modification design because equipment size.	0.043
	Revised design from Owner and Classification.	0.043
	New Technology transfer problem.	0.043
	Sub Total	0.129
Production drawing	Revised and modification design because equipment size.	0.043
	Revised design from Owner and Classification.	0.043
	New Technology transfer problem.	0.043
	Sub Total	0.129
Test procedure & finished plan	Revised and modification design because equipment size.	0.027
	Revised design from Owner and Classification.	0.027
	New Technology transfer problem.	0.027
	Sub Total	0.091

lowing. First, the shipbuilding production process is divided into three activities, namely in the design process (design), procurement of materials and production processes. These three inter-related activities influence the construction of ships in the settlement process. In addition, the probability of delay in the process of shipbuilding is also related to those activities.

Second, now that the evidence has been

Table 6
Probability Delay of Material

Activity	Hazard	Probability
Electric outfitting	Customs Clearence of material or equipment in Port.	0.243
	Delay of Material in Shipbuilding	0.243
	Delay of Purchase Order.	0.243
	Sub Total	0.729
Machinery outfitting	Customs Clearence of material or equipment in Port.	0.276
	Delay of Material in Shipbuilding	0.276
	Delay of Purchase Order.	0.276
	Sub Total	0.828
Hull outfitting	Customs Clearence of material or equipment in Port.	0.243
	Delay of Material in Shipbuilding	0.243
	Delay of Purchase Order.	0.243
	Sub Total	0.729
Painting and Corrosion control	Customs Clearence of material or equipment in Port.	0.234
	Delay of Material in Shipbuilding	0.234
	Delay of Purchase Order.	0.234
	Sub Total	0.702
Hull construction	Customs Clearence of material or equipment in Port.	0.239
	Delay of Material in Shipbuilding	0.239
	Delay of Purchase Order.	0.239
	Sub Total	0.717

described in the findings, it can also be generalized that the greatest probability is concerned with the factors as the following: on the material, when the materials arrived late, late booking or order made late payments, then the possibility of late would be a great project. Another effect is a delay in the production process. The main effect is the loss of a chance to get profit from the penalty.

Finally, PT. PAL Indonesia (the company) should also again and again conduct a study regarding the application of risk management for all construction projects of new ships. Any risk that occurs should be anticipated sooner. They should also begin such anticipation in the contract stage, the design, material purchase, production process until delivery stages of the ship to the buyer. Almost all new building projects undertaken by PT. PAL Indonesia have been delayed. Another implication of the delay of a project is a project loss that is due to fines, loss of profit opportunities as well as the implications of trust of outsiders (the ship owner, the financial institution).

It is advisable that they should anticipate all the matters by the management of PT. PAL Indonesia in conducting business in the construction of new vessels by applying the risk management policy. Furthermore, the process of risk analysis and risk assessment needs to be done by the management of PT. PAL Indonesia, including the risk mitigation process. It is also required that they start the process early, the stage of a new shipbuilding contract, PT. PAL Indonesia has to anticipate the risks that will occur. This is for reducing the delay factor in the new ship construction projects, both commissioned by the private sector, the state and a foreign party. Given to the present order of about 270 ships, almost everything has been delayed.

Last but not least is that the performance factor is still not done in this study because the broad scope and difficulty in quantitative measurement. This must be a challenge for further research, both by researchers themselves and others.

REFERENCES

Abdullah T, Mateen A, Sattar AR, and Mustafa, T 2010, 'Risk Analysis of Various Phases of Software Development Models', *European Journal of Scientific Research*, Vol 40, No. 3, pp.369-376.

Asok, KA and Aoyama K 2005, *Risk Management in Modular Ship Hull Construction Cinsidering Indefinite Nature of Task*, Paper ICCAS.

Atua, KI 2003, 'Schedule Risk Assessment in Planning Ship Production', *Alexandria Engineering Journal*, Vol. 42, no. 5.

Bashiri, E 2010, 'Statistical Analysis-Driven Risk Assessment of Criteria Air Pollutants: A Sulfur Dioxide Case Study', *Journal World Academy of Science, Engineering and Technology*, 63.

Basuki, M and Widjaja, S 2008, 'Studi Pengembangan Model Manajemen Risiko Usaha Bangunan Baru Pada Industri Galangan Kapal, Prosiding Seminar Nasional Teknologi Produksi', Jurusan Teknik Perkapalan, FTMK ITATS.

Basuki, M dan Setyoko, T 2009, 'Risiko Operasional Pada Proses Pembangunan Kapal FPB 38 Dengan Material Aluminium di PT. PAL Indonesia', Prosiding Seminar Nasional Teknologi Kelautan, FTK, ITS.

Basuki, M 2009, 'A Concept Risk Management Model for Ship Construction Process with Externality Factors,' *Proceeding Seminar Nasional Applied Technology and Arts*, LPPM ITS.

Basuki, M and Novendi, I 2010, 'Analisa Risiko Operasional Pada Proses Konversi Workboat Menjadi Supply Vessel Kapal MV', Sam Prosper I di PT. Dok dan Perkapalan Surabaya, Prosiding SENTA 2010, FTK, ITS.

Ben-Azher, JZ 2008, 'Development Program Risk Assessment Based on Utility Theory', *Journal Risk Management*, Volume 10, pp 285-299.

Brown and Mierzwicki, 2008, 'Risk metric for multi-objective design of naval ships', *Naval Engineers Journal*, Vol. 116, No. 2, pp 55-71.

Craney, TA 2003, 'Probabilistic Engineering Design, Paper Reliability Review', *The R & M Engineering Journal*, Volume 23 No. 2, Juni 2003.

Deperindag Jawa Timur, 2010, 'Laporan Akhir Kajian Industri Perkapalan di Jawa Timur'.

Gatti S, Rigamown A, Satta F and Senah, M 2007, 'Measuring Value at Risk in Project Finance Transaction', *Europen Financial Management*, Volume 13, No 1, Page 135-158.

Industri Galangan Kapal Cina Menunjukkan Sinyal Pemulihan, 2009, China Knowledge.

Iskanius, P 2009, 'The ERP Project Risk Assessment – A Case Study', *Proceedings of the World Congress on Engineering 2009*, Vol. 1, 2009.

Khericha, S and Mitman, J 2008, 'Development of standardized probabilistic risk assessment models for shutdown operation integrated in SPAR level 1 model', Paper.

Kindinger, JP and Darby, JL 2000, 'Risk Factor Analyis – A New Qualitative Risk Management Tool', *Proceedings of the project Management Institute Annual Seminars & Symposium*.

Kruizinga, AG, Briggs D, Crevel RWR and Knulst, AC 2008, Probabilistic Risk Assessment Model for Allergens in Food: Sensitivity Analysis of the Minimum Eliciting Dose and Food Consumption, *Food and Chemical Toxicology*, Vol. 46, pp. 1437-1443.

Lee E, Shin JG and Park, Y 2007, 'A Statistical Analysis of Engineering Project Risk in the Korean Shipbuilding Industry', *Journal Ship Production*, Volume 23, No 4, Page 223-230.

Lee E, Park Y, and Shin JG 2009, 'Large Engineering Project Risk Management Using a Bayesian Belief Network', *Expert Systems with Applications: An Journal International*, Vol 36, Issue 3, 2009, pp 5880-5887.

Li KX, and Culinane, K 2003, ‘An Economic Approach to Maritime Risk Management and Safety Regulation’, *Journal Maritime Economics & Logistic*, 2003, 5, (268-284).

Lu BZ and Tang AST 2000, ‘China shipbuilding management challenges in the 1980s’, *Maritime Policy & Management*, Volume 27, No 1, page 71-78

Meshkat L, and Shapiro A 2005, ‘Probabilistic risk assessment for concurrent, conceptual design of space missions’, paper.

Moyst H and Das B 2005, ‘Factors Affecting Ship Design and Construction Lead Time and Cost’, *Journal Ship Production*, Volume 21, No 3, Page 186-194.

Nejad HS, Zhu D, and Mosleh A 2007, ‘Hierarchical Planning and Multi-Level Scheduling for Simulation-Based Probablistic Risk Assessment’, *Proceedings of the 2007 Winter Simulation Conference*.

Pujawan, IN, and Geraldine, LH 2009, ‘House of risk: a model for proactive supply chain risk management’, *Journal Business Process Management*, Vol. 15, No. 6, 2009, pp 953-967.

Robu B, Gavrilescu M, and Macoveanu M 2003, ‘Risk Assessment for a Shipbuilding From Romanian Black Sea Coast’, *Environmental Engineering and Management Journal*, Vol. 2, No. 4, pp 303-316, December 2003.

Satoh N, Kumamoto H, and Kino Y 2008, ‘Viewpoint if ISO GMITS and Probabilistic Risk Assessment in Information Security’, *International Journal of systems applications Engineering & Development*, Issue 4, Volume 2.

Schleiher, JJ, Davis, RS, Barber, LM, Marcedo ,PA and Peterson, RKD 2009, ‘A probabilistic risk assessment for deployed military personnel after the implementation of the “leishmaniasis control program” at Tallil air base, Iraq’, *Journal Risk Assessment*.

Storch, RL, Moore, RC, Hammon, CP, and Bunch, HM 1995, *Ship Production*, Second Edition, Cornel Maritime Press.

Suryohadiprojo, A 2004, ‘Prospek Pengembangan Industri Galangan Kapal’, Majalah BKI, Jakarta.

Todinov, MT 2008, ‘Risk-Based Design Based on Limiting the Probability of System Failure at a Minimum Total Cost’, *Journal Risk Management*, Volume 10, (104-121).

Vassalos, D, Guarin, J, and Konovessis, D 2006, ‘Risk-based ship design: Concept’, methodology and Framework, 3rd International ASRANet Colloquium.

Wreathall, J, and Nemeth, C 2004, ‘Assessing risk: the role of probabilistic risk assessment (PRA) in patient safety improvement’, *Paper jurnal Qual Saf health care*, 2004, 13, 206-212.

Yang Y, Shi X, Xu F, Liu W, and Tao S 2003, ‘Probabilistic ecological risk assessment of polycyclic aromatic hydrocarbon (PAHs) in surface water from Tianjin’, Paper.

Yang ZL, Wang J, Bonsall S and Fang QG 2009, ‘Use of Fuzzy Evidential Reasoning in Maritime Security Assessment’, *Jurnal Risk Analysis*, Vol 29, No: 1, Page: 95-120.

APPENDICES

Table 7
Probability of Delay of Production

Activity	Hazard	Probability
Work preparation & general	Performance of worker in Production Procees.	0.077
	Delay of Production because delay of material.	0.077
	Performance of worker from Sub-Contractor	0.077
	Revised of production Request from Owner and Classification.	0.077
	Instruction not responsibility.	0.077
	Mistake of Design.	0.077
	Sub Total	0.462
Hull Construction	Performance of worker in Production Procees.	0.082
	Delay of Production because delay of material.	0.082
	Performance of worker from Sub-Contractor	0.082
	Revised of production Request from Owner and Classification.	0.082
	Instruction no responsibility.	0.082
	Mistake of Design.	0.082
	Sub Total	0.492
Painting & corrosion protection	Performance of worker in Production Procees.	0.077
	Delay of Production because delay of material.	0.077
	Performance of worker from Sub-Contractor	0.077
	Revised of production Request from Owner and Classification.	0.077
	Instruction not responsibility.	0.077
	Mistake of Design.	0.077
	Sub Total	0.462
Piping system	Performance of worker in Production Procees.	0.080
	Delay of Production because delay of material.	0.080
	Performance of worker from Sub-Contractor	0.080
	Revised of production Request from Owner and Classification.	0.080
	Instruction not responsibility.	0.080
	Mistake of Design.	0.080
	Sub Total	0.480
Machinery system	Performance of worker in Production Procees.	0.079
	Delay of Production because delay of material.	0.079
	Performance of worker from Sub-Contractor	0.079
	Revised of production Request from Owner and Classification.	0.079
	Instruction not responsibility.	0.079
	Mistake of Design.	0.079
	Sub Total	0.474
Steel work outfitting	Performance of worker in Production Procees.	0.078
	Delay of Production because delay of material.	0.078
	Performance of worker from Sub-Contractor	0.078
	Revised of production Request from Owner and Classification.	0.078
	Instruction not responsibility.	0.078
	Mistake of Design.	0.078
	Sub Total	0.468

Activity	Hazard	Probability
Interior & furniture	Performance of worker in Production Procees.	0.078
	Delay of Production because delay of material.	0.078
	Performance of worker from Sub-Contractor	0.078
	Revised of production Request from Owner and Classification.	0.078
	Instruction no responsibility.	0.078
	Mistake of Design.	0.078
	Sub Total	0.468
Electric system	Performance of worker in Production Procees.	0.079
	Delay of Production because delay of material.	0.079
	Performance of worker from Sub-Contractor	0.079
	Revised of production Request from Owner and Classification.	0.079
	Instruction no responsibility.	0.079
	Mistake of Design.	0.079
	Sub Total	0.474
Electronic system	Performance of worker in Production Procees.	0.077
	Delay of Production because delay of material.	0.077
	Performance of worker from Sub-Contractor	0.077
	Revised of production Request from Owner and Classification.	0.077
	Instruction no responsibility.	0.077
	Mistake of Design.	0.077
	Sub Total	0.462

Table 8
Criteria of Likelihood

No.	Process	Probability	Criteria *Likelihood*
1.	Design		
	Basic and performance	0.10 (10%)	Possible
	Key plan	0.12 (12%)	Possible
	Yard plan	0.13 (13%)	Possible
	Production drawing	0.13 (13%)	Possible
	Test procedure & finished plan	0.09 (9%)	Possible
2.	Material		
	Electric outfitting	0.73 (73%)	Almost Certain
	Machinery outfitting	0.83 (83%)	Almost Certain
	Hull outfitting	0.73 (73%)	Almost Certain
	Painting and Corrosion control	0.70 (70%)	Almost Certain
	Hull construction	0.72 (72%)	Almost Certain
3.	Production		
	Work preparation and general	0.46 (46%)	Likely
	Hull Construction	0.49 (49%)	Likely
	Painting and corrosion protection	0.46 (46%)	Likely
	Piping system	0.48 (48%)	Likely
	Machinery system	0.47 (47%)	Likely
	Steel work outfitting	0.47 (47%)	Likely
	Interior & furniture	0.47 (47%)	Likely
	Electric system	0.47 (47%)	Likely
	Electronic system	0.46 (46%)	Likely

Table 9
Criteria of Consequences

No.	Process	*Consequences* (days)	Criteria *Consequences*
1.	Design		
	Basic and performance	9.3	Insignificant
	Key plan	11.16	Minor
	Yard plan	12.09	Minor
	Production drawing	12.09	Minor
	Test procedure and finished plan	7.44	Insignificant
2.	Material		
	Electric outfitting	67.89	Major
	Machinery outfitting	77.19	Major
	Hull outfitting	67.89	Major
	Painting and Corrosion control	65.10	Major
	Hull construction	66.96	Major
3.	Production		
	Work preparation and general	42.78	Moderate
	Hull Construction	45.57	Moderate
	Painting and corrosion protection	42.78	Moderate
	Piping system	44.64	Moderate
	Machinery system	43.71	Moderate
	Steel work outfitting	43.71	Moderate
	Interior and furniture	43.71	Moderate
	Electric system	43.71	Moderate
	Electronic system	42.78	Moderate

Table 10
Penalty of Delay

No.	Process	*Delay* (days)	Total Penalty (IDR.)
1.	Design		
	Basic and performance	9.30	4,045,500,000.00
	Key plan	11.16	4,854,600,000.00
	Yard plan	12.09	5,259,150,000.00
	Production drawing	12.09	5,259,150,000.00
	Test procedure and finished plan	7.44	3,236,400,000.00
2.	Material		
	Electric outfitting	67.89	29,532,150,000.00
	Machinery outfitting	77.19	33,577,650,000.00
	Hull outfitting	67.89	29,532,150,000.00
	Painting & Corrosion control	65.10	28,318,500,000.00
	Hull construction	66.96	29,127,600,000.00
3.	Production		
	Work preparation and general	42.78	18,609,300,000.00
	Hull Construction	45.57	19,822,950,000.00
	Painting and corrosion protection	42.78	18,609,300,000.00
	Piping system	44.64	19,418,400,000.00
	Machinery system	43.71	19,013,850,000.00
	Steel work outfitting	43.71	19,013,850,000.00
	Interior and furniture	43.71	19,013,850,000.00
	Electric system	43.71	19,013,850,000.00
	Electronic system	42.78	18,609,300,000.00