TUGAS AKHIR – TI 141501

INVESTIGASI KESIAPAN IMPLEMENTASI CONCURRENT ENGINEERING PADA DIVISI GENERAL ENGINEERING PT. PAL INDONESIA (PERSERO)

ARGON FAISAL MARCONI
NRP 2511 100 108

DOSEN PEMBIMBING
Putu Dana Karningsih, S.T., M.Eng.Sc., Ph.D

Jurusan Teknik Industri
Fakultas Teknologi Industri
Institut Teknologi Sepuluh Nopember
Surabaya 2015

FINAL PROJECT – TI 141501

INVESTIGATION OF CONCURRENT ENGINEERING IMPLEMENTATION READINESS IN GENERAL ENGINEERING DIVISION OF PT. PAL INDONESIA (PERSERO)

ARGON FAISAL MARCONI
NRP 2511 100 108

SUPERVISOR
Putu Dana Karningsih, S.T., M.Eng.Sc., Ph.D

Industrial Engineering Department
Faculty of Industrial Technology
Institut Teknologi Sepuluh Nopember
Surabaya 2015

INVESTIGATION OF CONCURRENT ENGINEERING IMPLEMENTATION READINESS IN GENERAL ENGINEERING DIVISION OF PT. PAL INDONESIA (PERSERO)

FINAL PROJECT

Proposed to Fulfill the Requirement to Obtain
The Bachelor Degree of Engineering in
Bachelor Program of Industrial Engineering
Faculty of Industrial Technology
Institut Teknologi Sepuluh Nopember

Written By:

ARGON FAISAL MARCONI
NRP 2511 100 108

Approved By:

Putu Dana Karningsih, S.T., M.Eng.Sc., Ph.D
NIP. 197405081999032001

SURABAYA
JANUARY 2015

INVESTIGASI KESIAPAN IMPLEMENTASI CONCURRENT ENGINEERING PADA DIVISI GENERAL ENGINEERING PT. PAL INDONESIA (PERSERO)

Nama	: Argon Faisal Marconi
NRP	: 2511100108
Jurusan	: Teknik Industri ITS
Dosen Pembimbing	: Putu Dana Karningsih, S.T., M.Eng.Sc., Ph.D

ABSTRAK

Divisi General Engineering PT PAL Indonesia (Persero) adalah sebuah divisi yang bergerak di bidang industri konstruksi. Permasalahan yang dialami divisi ini adalah keterlambatan jadwal yang disebabkan oleh keterlambatan pengiriman material, kurangnya koordinasi antar pihak-pihak terkait, kurangnya tenaga ahli, dan tingginya frekuensi perubahan desain. Faktor utama yang menyebabkan permasalahan tersebut adalah tingginya frekuensi perubahan desain. Dampak dari permasalahan tersebut adalah berkurangnya keuntungan sebesar 10-20% dari total biaya produksi. *Concurrent Engineering* (CE) adalah sebuah metode yang dapat menyelesaikan permasalahan tersebut karena CE mengintegrasikan seluruh proses dalam sebuah proyek. CE dapat mengurangi 60-95% *engineering changes* dan 60% kegagalan di lapangan. Sebelum dapat mengimplementasikan CE, ada beberapa langkah yang harus dilakukan. Langkah pertama adalah mengukur tingkat kesiapan perusahaan sebelum mengimplementasikan CE. Penelitian ini menggunakan BEACON Model yang dikembangkan oleh Khalfan (2000) untuk mengukur tingkat kesiapan implementasi CE di industri konstruksi. Model ini mengukur kesiapan perusahaan pada 4 element, proses, manusia, proyek dan teknologi. Hasil pengukuran dari Divisi General Engineering PT PAL Indonesia (Persero) menunjukkan bahwa divisi ini belum sepenuhnya siap untuk mengimplementasikan CE karena terdapat beberapa bagian yang memiliki nilai di bawah 60% (*Characterized level*). Walaupun nilai rata-rata totalnya adalah 74,65%. Divisi ini perlu memperbaiki bagian yang memiliki nilai terendah yaitu *team in organization* (58%) dan *integration support* (53%). Saran perbaikan untuk meningkatkan bagian *team in organization* adalah mengimplementasikan sistem penghargaan individu dengan cara "*personal recognition*". Alternatif dari penghargaan tersebut adalah *team member of the month, thank you card* dan ucapan selamat langsung dari manajemen. Untuk bagian *integration support*, alternatif perbaikannya adalah mengimplementasikan SAP R/3 dan Lightweight Access Directory Protocol (LDAP).

Kata Kunci*: BEACON Model, Concurrent Engineering, Industri Konstruksi, Readiness Assessment.*

INVESTIGATION OF CONCURRENT ENGINEERING IMPLEMENTATION READINESS IN GENERAL ENGINEERING DIVISION OF PT. PAL INDONESIA (PERSERO)

Name   : Argon Faisal Marconi
NRP   : 2511100108
Department   : Industrial Engineering ITS
Supervisor   : Putu Dana Karningsih, S.T., M.Eng.Sc., Ph.D

ABSTRACT

General Engineering Division of PT. PAL Indonesia (Persero) is a division that has business process in construction sector. This division experienced problems, which were schedule lateness due to late material delivery, low coordination between project stakeholders, inadequate expert and high frequency of design change. The main factor that caused the problem is high frequency of design change. The impact of the problem is 10-20% loss profit of total production cost. Concurrent Engineering (CE) is one of method that can solve that problem because it provides integration in the whole process of a project. It can reduce 60-95% engineering changes and 60% field failure rate. However before implementing CE, there are several steps that should be followed. The initial step is to ensure readiness of a company before implementing CE or readiness assessment. This research used BEACON Model that has developed by Khalfan (2000) to assess the readiness level of CE implementation in construction companies. This model assesses a company readiness in four elements, which are process, people, project and technology. The assessment result for General Engineering Division of PT PAL Indonesia (Persero) readiness show that this division is not fully ready to implement CE because there are some parts of element that have average score below 60% (Characterized level). Even though total average score is 74.65%. This division needs to improve the parts with lowest value which are team in organization (58%) and integration support (53%). The improvement suggestion to improve team in organization part is implement individual reward system through personal recognition. The alternatives of the reward are team member of the month, thank you card and top management directly congratulate to their employee for doing the job well. For integration support the improvement suggestion is implement advanced IT system which the alternatives are SAP R/3 and Lightweight Access Directory Protocol (LDAP).

Key Words: BEACON Model, Concurrent Engineering, Construction Industry, Readiness Assessment.

PREFACE

Bismillahirrahmanirrahim

Alhamdulillahirabbilalamin, the deepest gratitude and praises are always uttered to the Presence of God Almighty Allah SWT by the author. The author may accomplish this final project which the title is "Investigation of Concurrent Engineering Implementation Readiness in General Engineering Division PT PAL Indonesia (Persero)" because Allah mercy and blessing. Salawat and Salaam are always uttered by the author to the Role Model of Moslems, Great Prophet Muhammad SAW.

This final project is proposed to fulfill the requirement to obtain the Bachelor Degree of Engineering in Industrial Engineering Department, Faculty of Industrial Technology, Institut Teknologi Sepuluh Nopember Surabaya. During conducting this final project, there were so much assists, motivation, supporting suggestion, and many other good things received by the author. For all those good things, in this preface the author would like to convey the deepest thanks to:

1. God Almighty Allah SWT, for Allah's Guidance, Mercy, Blessing, Health, Sanity, and Salvation that have been given to the author during conducting this final project and so this research can be accomplished well.

2. Beloved parents, Ir. Akhmad Mulyadi M.Sc and Ir. Menik Indriyanti that have supported and pray for me every day and night so that author can finished this research. Author also want to thanks for the support to all of author's family that can be mentioned one by one.

3. Putu Dana Karningsih, S.T., M.Eng.Sc., Ph.D as my supervisor who gave me well guidance and patient to give me correction if there is any mistake during conducting this research.

4. Dr. Maria Anityasari and Dewanti Anggrahini, S.T., M.T., as evaluator that gave critic and suggestion to make this research better.

5. Prof.Budi Santosa as head of Industrial Engineering Department ITS.

TABLE OF CONTENT

x

LIST OF TABLE

TABLE OF FIGURE

CHAPTER 1
INTRODUCTION

This chapter consists of background, problem formulation, research scope and thesis outline.

1.1 Background

There are several definitions about construction industry. Construction Industry covers work on new or existing commercial, industrial or domestic buildings or structures. According to Economy Watch (2010), construction industries can be categorized into three categories which are:

- Construction involving heavy and civil engineering e.g. of product such as bridge, road, etc.
- General construction, e.g. of product such as residential or commercial real estate assets.
- Construction projects involving specialty trades, e.g. of product such as power plant, mining building etc.

Construction is one of potential industry sectors in world's economic development. According to Schilling (2013), in 2013 global construction industry contributes around 13% of global GDP and it expected to increase up to 15% in 2020. Global construction industry is estimated to grow over $12 trillion in 2020. In developing or emerging markets construction will increase up to 110% while infrastructure construction will rise into 128%. In Indonesia, construction industries contributed 7.5% of GDP in 2008. Construction market in Indonesia is expected to increase, as a result of the Indonesia economic growth. City Investment Research and Analysis (2013) said that Indonesia will become the 7th largest economy in the world in 2030 and the 4th largest in 2040. Suraji et al (2009) declared that economy is one of strong driving forces to enlarge market for construction industry. Based on the explanation above, construction sector is a potential sector for now and the future. Construction industry also has big

contribution to development of the world economy and especially the Indonesia economy.

Today, world construction companies have to compete each other to win client's orders in order to survive. Therefore, construction companies have to improve its quality in order to answer market demand. Herbert and Biggart (1993) declared that there are several criteria that have to be identified in order to select a good construction companies namely management, delivery capability and experiences, safety and financial stability. Thus, Indonesia construction companies have to improve their quality especially in those criteria in order to get the client's order from local and global.

Based on the research that conducted by Hari et al (2009), the competitiveness of Indonesian construction is considered low. In addition, Alwi et al (2002) identified several problems in Indonesia contractors such as late schedule, material damaged in location, and waiting for maintenance. Those problems are caused by high number of design's changes, unskilled labour, decision making lateness, bad coordination between stakeholders, lack of planning and control, material delivery lateness, and inappropriate working method. Sukirno et al, (2007) said that the main causes of problems on construction projects in Indonesia are:

- External conditions (26.79%)
- Change of drawing document (21.43%)
- Condition of the field (19.64%)
- Change of technical specifications (16.07%)
- Other factors (16.07%)

This fact shows that the main cause of problems in construction process is the uncertainty and changes in the scope of work.

PT PAL Indonesia (Persero) is a company that run construction business. PT. PAL Indonesia (Persero) is a shipyard company. It has several divisions which are:

1. Commerce Ships Division. This division produces Merchant Ships product that directed for international market, development of national voyage industry models and passenger and cargo voyage.
2. Fast Ship and Special Ship Division. This division produces special ship that used to fulfil the need of from government institutions.
3. Harkan Service Product Division. This division produces maintenance service and repairmen service deop level with 600.000 DWT per year in docking capacity.
4. General Engineering Division. This division produces a construction product such as steam turbine power plant, and plat form until 1000 tones.

Production director of PT. PAL Indonesia (Persero), Edi Widiarto in tempo.co (2014) declared that engineering project, procurement, construction and installation (EPCO) from General Engineering Division contributed 30% of company revenue. This number is expected to increase based on KMPG international (2013) as figure 1.1 shows below.

Figure 1.1 New Sector Focus of Construction (KMPG International, 2013)

However, General Engineering Division in PT. PAL Indonesia (Persero) which has business process in construction still experienced several problems. According to Nurbudiono as General Engineering Division staff, there are several problems happened during project implementation in General Engineering Division such as schedules delay due to material delivery lateness, low coordination between project stakeholders and low number of expert labour. Agus as General Manager of Division PT PAL Indonesia (Persero) declared that 40% of project is late due to internal factor, such as man power, facility, high frequency of design change and financial. When a project is late, PT. PAL Indonesia (Persero) has to do "recover" in order to meet the schedule of the project. "Recover" of a project is conducted by increasing the speed of work which means using extra engineering support, work hour and man power. Consequently, production cost will increase by 10%-20% of total production cost. Recovery cost has to be paid by PT PAL Indonesia (Persero), and it will reduce the profit margin for the company. Late schedule of a project happened mainly because of high frequency of design's change. High frequency of design's change in construction industry also leads to inability to fully satisfy its customer. Therefore, PT. PAL Indonesia (Persero) has to minimize frequency of design change in every project.

To reduce frequency of design change can be performed using Concurrent Engineering approach. In construction industry context Evboumwan and Anumba (1998) define Concurrent Engineering (CE) as an "...attempt to optimise the design of the project and its construction process to achieve reduced lead times, and improved quality and cost by the integration of design, fabrication, construction and erection activities and by maximising concurrency and collaboration in working practices". CE has the potential to make construction projects less fragmented, improve project quality, reduce project duration and reduce total project cost (Khalfan et al. 2001). Implementing CE properly will cut the lead time of project as can be shown in figure 1.2 below.
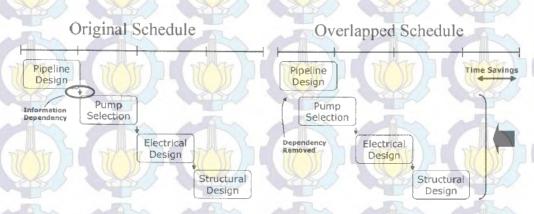
Figure 1.2 Concurrent engineering vs traditional engineering (Bogus, Molenaar, & Diekmann, 2005)

According to Lawson and Karandikar (1994) CE will reduces engineering design changes 60-95%, cut the development time 30-50%, and etc. General Engineering division PT. PAL Indonesia (Persero) is interested in implement CE. It can reduce number of design change significantly by including multi-disciplinary team during design phase, cut the development time and reduce field failure rate.

However implement CE is not an easy task. There are many problems in implementing CE. Some of them are: Lack of experts and experience in internal organisation, lack of training and education, company culture which not conducive, think CE is not important, and etc.
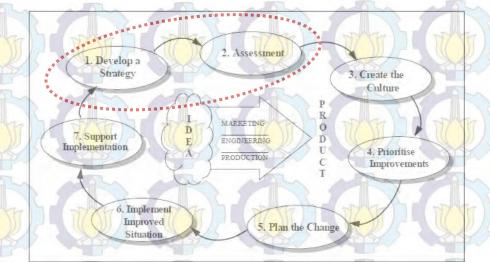
Figure 1.3 CE implementation framework (Pawar, et al., 1996)

There is a framework in implementing CE as figure 1.3 shown above. The framework consists of steps in implementing CE. The first step that the company has to do is develop a strategy. In this step the top management of the company has to commit to implement CE. The next step is readiness assessment. The readiness assessment is conducted to avoid failure during implementing CE.

Based on the explanation above, before implementing CE a company need to assess the readiness to ensure the implementation is effective with fewer problems. By recognizing the readiness level of company to implement Concurrent Engineering, they can improve their readiness before implementing CE fully.

This research assessed the readiness level to implement Concurrent Engineering in General Engineering Division PT. PAL Indonesia (Persero). There are several tools that can be used to assess the level of readiness of company to implement CE. Specifically for construction industry is *The Benchmarking* and *Readiness Assessment for CE in Construction* (BEACON) Model. That model has a benefit to develop a guidelines to implement CE that more appropriate and more effective for construction industry. Besides to measure the readiness level of construction industry to implement CE, BEACON Model can be used to self-assessment in four main elements: process, people, project, and technology even for an organisation which not consider implementing CE (Khalfan, Anumba, & Patricia, 2007).

By conducting CE readiness assessment with BEACON Model, General Engineering Division PT PAL Indonesia (Persero) will know readiness level to implement CE, then improvement on factor or element which has lowest value will be conducted.

1.2   Problem Formulation

Based on background that has explained above, the problem in this research are how to minimize engineering design's change that often occurred in General Engineering Division by implementing CE, and to measure the readiness level of CE implementation in General Engineering Division PT. PAL Indonesia (Persero) with BEACON Model.

1.3 Research Objectives

The objectives of this research which are:

1. To know readiness level of CE implementation in General Engineering division PT. PAL Indonesia (Persero).

2. To provide recommendation for lowest factor of readiness level to implement CE in General Engineering Division PT. PAL Indonesia (Persero). Thus General Engineering Division can be improved the readiness level of implementation.

1.4 Research Benefit

Benefit of this research is divided into two, there are benefits for company and benefits for student.

1.4.1 Benefit for Company

After know the readiness level of CE implementation and get some improvement from this research, the company will get some benefits which are:

1. Decrease the lead time of project through integration and maximising concurrency in design process.

2. Increase client satisfaction through high quality.

3. Cost of production will reduce significantly.

1.5 Research Scope

This subchapter explained about the research scope which contains limitation and assumption. Limitation used to limit and help student to focus the observation. Assumption used to explain the things that hard to be done.

1.5.1 Research Limitation

Limitation of this research which are:

1. This research is done until improvement suggestion and not until improvement implementation.

2. This research conducted in General Engineering Division PT PAL Indonesia (Persero)

1.5.2 Research Assumption

Assumption that used in this research which are:

1. There are no changes in company policy that influence significantly to the research.
2. Financial problem is not influence the project implementation.
3. The improvement suggestion can be conduct by the company

1.6 Thesis Outline

This subchapter explained about the writing system of this research. The writing system of this research is as follows:

CHAPTER 1 INTRODUCTION

This chapter contains the introduction of this research. This chapter contains research background, problem formulation, research objective, research benefit, research scope and thesis outline.

CHAPTER 2 LITERATUR REVIEW

This chapter contains the literature that used as a framework and based theory to do this research.

CHAPTER 3 RESEARCH METHODOLOGY

This chapter contains the steps and explanation of each steps that done in this research

CHAPTER 4 DATA GATHERING AND PROCESSING

This chapter contain the data collecting result which have done in this research. In this chapter the collected data is process and it will be analyse in the next chapter

CHAPTER 5 DATA ANALYSIS AND INTERPRETATION

This chapter contain the analysis of data and interpretation of data which have been collected and processed in the previous chapter.

CONCLUSSION AND SUGGESTION

This chapter contains conclusion of this research and suggestion after this research conducted.

REFERENCE

This part contains the source of reference that used in this research.

APPENDIX

This part contains all documentation that related to the research.

CHAPTER 2
LITERATUR REVIEW

This chapter explained about the literature that used to conduct this research. Theories that used in this research such as Concurrent Engineering, Concurrent engineering in construction industry, Readiness assessment of Concurrent Engineering, and critical review from similar research that has been conducted.

2.1   Concurrent Engineering

Concurrent Engineering by Winner et al. (1988) in Anumba et al. (2007) defined as 'integrated, concurrent design of products and their related processes, including manufacture and support' with the ultimate goal of customer satisfaction through the reduction of cost and time-to-market, and the improvement of product quality (Kamara, Anumba, & Decelle, 2007). *Concurrent engineering* can decrease *lead time* with changing product development phase become integrated and simulant. Comparison between product development phase in traditional and concurrent are shown in figure 2.1 and 2.2

Figure 2.1 Comparison between sequential and concurrent (INCOSE, 1998)
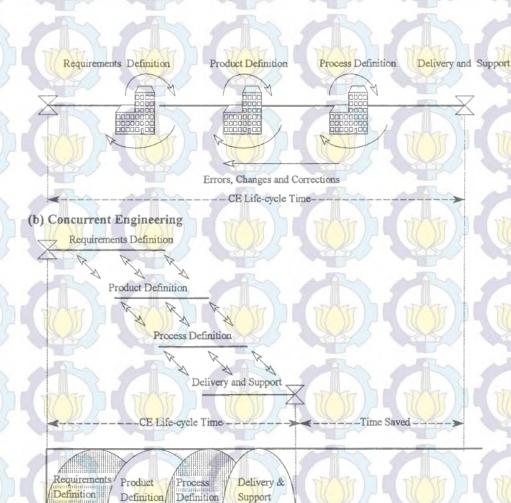
Figure 2.2 concurrent engineering vs sequential (Prasad, 1995)

2.1.1 Elements of Concurrent Engineering

According to Khalfan (2001) there were 8 basic elements in concurrent engineering and were categorize to two main aspects.

1. Man and Management Aspect

Man and Management aspect include team development, leadership and organisation philosophy. Task that executed such as:

- Cross-functional team using for product design integration and related process in the implementation.

- Organisation philosophy implementation which based on process.

- Commitment and support leadership in the implementation of that philosophy.

- There was a team to execute the philosophy.

12

2. Technological aspect

Technological aspect includes technology to design, communication, coordination and develop a standard. Those things include:

- *Computer Aided Design* (CAD) using, existing process method simulation support product design integration through connected database to whole team members.
- Using several methods to optimize product design, process implementation, and supporting process.
- Using information system which connected between team, communication system and coordination.
- Standard protocol implementation and development and general terms in the work chain.

2.1.2   Concurrent Engineering Team

According to Smith (1995), Concurrent Engineering must consist of 3 main attributes, there are:

1.   They have to adapt with changes of innovation or uncertainty.
2.   Cross functional professional skill is needed such as, engineering, science, marketing, manufacturing and finance
3.   The member that involved is a professional worker who has well knowledge.

Effective Concurrent Engineering generally have characteristics as follows:

1.   Consist no more than 10 persons
2.   Every member has willingness to become a team member
3.   Every team member commit from beginning until the end of project. (fulltime base)
4.   Every member report in routine to project leader and also send a report to general management.
5.   Consist of marketing, engineering and manufacturing, procurement, supplier, and costumer function in the team

13

6. Every member not separate in distance and ease to interact each other.

With adopting Concurrent Engineering (CE) concept, the organisational structure is needed a paradigm change which is in the previous organisational structure more focus on functional, now it must be able to adapt with organisational structure which involved in a project. This organisational structure is must able to make the member ease to report to the project leader (Cleland, 1998). Comparison between functional organisation structure and virtual organisation structure are shown in figure 2.3 and 2.4.

Figure 2.3 Functional Organisation Structure (Cleland, 1998)

Figure 2.4 Stand-Alone or Virtual Organisation Structure (Cleland, 1998)

Based on figure 2.3 and 2.4, it can be seen that the weakness and strength of using those organisation structure. Virtual structure organisation usage can

make a company form CE team and perform it more effective. However the company must have good human resource because in the implementation the members have to separate their concentration to functional and which CE based. This thing is a challenge for CE implementation in a company.

2.1.3   Concurrent Engineering Implementation

According to Pawar et al (1996) generally there are 7 steps in CE implementation. Those 7 steps are shown in figure 2.5.
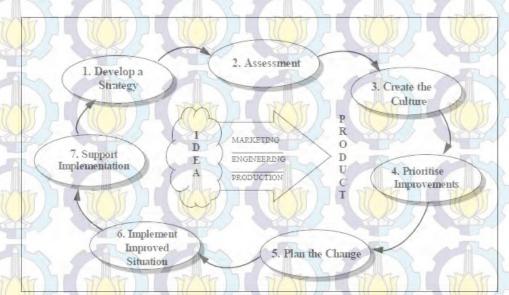
Figure 2.5 Framework of CE Implementation (Pawar, et al., 1996)

The explanation of figure 2.5 is as follows:

1.   Step 1: Develop a Strategy, ideas set by top management has to formulate first before it implemented. Main motivation in implementing CE has to identify together with implementation plan in detail. Strategy development is also include in that, commitment attraction from company in letter in order to avoid the implementation is only a word.

2.   Step 2: Assessment, existing condition of company has to be measure and conducted a research with assessment tools and techniques. Measurement can include benchmarking, questionnaires and performance metrics.

15

3. Step 3: Create the culture, without support and understanding from all of company stakeholder, CE implementation will useless to conduct. Creating a culture can be increasing awareness to CE method and create a training which relate to CE implementation.

4. Step 4: Prioritise improvements, in this step the result from step 2 is analyse to make a priority which factors that needed to conduct an improvement so the implementation can run. One method that can be conduct is using cost benefit analysis.

5. Step 5: Plan the change, the change plans which needed to be set are engage every person to involve in the change, set milestones/targets and anticipate interim result, and analyse the resource that will be involve in CE project.

6. Step 6: Implement improved situation, step where CE implementation has been conducted and the feedback analyse and improvement conduct from factors which not support CE implementation.

7. Step 7: Support Implementation, this step is a step to ensure that CE implementation bring positive impact to the company.

Framework of CE implementation in figure 2.5 has cyclic shape because CE implementation has to be improve continuously.

2.1.4   Benefit of CE Implementation

According to Lawson and Karandikar (1994), there are some benefits when a company implement CE. The benefits of implementing CE are shown in the table 2.1

Table 2.1 CE Implementation Benefit

Performance Measure	Benefits
Development time	30-50% less
Engineering changes	60-95% less
Scrap and rework	75% reduction
Defects	30-85% fewer
Time to market	20-90% less
Field failure rate	60% less

Table 2.1 CE Implementation Benefit (con't)

Performance Measure	Benefits
Service life	100% increase
Overall quality	100-600% higher
White-collar productivity	20-110% higher
Return on assets	20-120% higher

Source: (Lawson and Karandikar, 1994)

The real implementation of CE result in company is shown in the table 2.2

Table 2.2 Benefit of CE implementation in company

Company	The Benefits
Boeing's Ballistic System Division	16% to 46% in cost reduction in manufacturing
	engineering changes reduced from 15-20 to 1-2 drafts per drawing
	materials shortage reduced from 12% to 1%
	inspection costs cut by a factor of 3
NCR	reduction in parts and assembly line
	65% fewer suppliers
	100% fewer screws or fasteners
	100% fewer assembly tools
	44% improvement in manufacturing cost
	a trouble-tree product introduction
Rolls-Royce	reduce the lead-time to develop a new aircraft enginer by 30%
McDonnell Douglas	Reduce production costs by 40%
ITT (waste treatment and water service)	reduced design cycle time by 33%

Soruce: (Moges, 2007)

2.1.5 CE Implementation Difficulties

Generally, CE implementation is not ease. CE implementation needs a significant change in the whole part of organisation. To change from "serial" approach (with clear function separation) become "simulant" (with involving

17

some cross functional in organisation and external part of organisation) is not an easy thing. (Karningsih, 2007)

Research conducted by Yeo and Teo (1994) in 60 big manufacture companies in Singapore shows that obstacle which often comes in CE implementation such as:

- Lack of experts and experience in internal organisation
- Lack of training and education
- Company culture which not conducive
- Formal procedure and policy are not documented.
- Existing organisation structure is not conducive
- Lack of supplier and customer involve
- Think CE is not important
- Lack of facilities to communicate and use information technology.

Because of those difficulties, many companies could not get maximum benefit when the companies implementing CE. Comparison between benefit which can get by the company when the company implement CE in best condition and standard condition is shown in figure 2.6.

Figure 2.6 Benefits that Can Get by Company Based on CE Implementation Condition (Moges, 2007)

18

2.2 *Concurrent engineering* in Construction Industry

This subchapter explains about relationship of construction process with manufacture and reason to adopt CE in construction industry.

2.2.1 Construction as a manufacturing process

Savido and Medeiros (1990), Anumba and Evboumwan (1995), Anumba et al. (1995), Crowley (1996) and Egan (1998) suggested that there is similiarities between construction with manufacturing process, they are:

- Produce engineered products that provide a service to the user
- Area involved in the processing of raw materials and the assembly of many diverse pre-manufactured components in the final products
- Utilise repeated processes in the design and production of their products
- Experience similar problems such as: the high cost of correcting design errors due to late changes, poor resource utilisation, and inadequate information management.

The differences between manufacturing and construction with regard to the location of production activities, and the production of 'one-off' facilities in construction, as opposed to mass production in manufacturing, have led to suggestions that the two industries are profoundly different. However, the parallel between construction and manufacturing are not with respect to repeated (or mass-produced) products, but rather to the repeated processes that are involved in the design and production of products in both industries. The implication of this is that, developments in manufacturing such as CE which have led to improvements in productivity (as a result of process re-engineering) can be used in construction.

2.2.2 Reason to Adopt CE in Construction Industry

Reason to adopt CE in construction industry is shown in table 2.3

Table 2.3 Reason to adopt CE in Construction Industry

Need for change in construction	Goals and principle of CE
The need for change in construction is brought about by the uncompetitive nature of the industry and the inability to fully satisfy its clients with respect to costs, time, and value	The goals and objectives of CE include: customer satisfaction, competitive business, reduction of product development time and cost, improvement of quality and value
Integration of the construction process is seen as one of most important strategies to improve the notoriously fragmented construction industry	The use of CE facilities the integration of the member of the product development team, and the manufacturing process, thereby improving the product development process
Emerging strategies for improving the construction process are inadequate; they only address one aspect of problem, resulting in 'islands of automation' as in the case of computer-integrated construction strategies	As an amalgam of other methodologies, tools and techniques, CE provides a framework for not only integrating the construction process, but also the various tools and technologies that are used in the process

Source: (Khalfan, Anumba, & Patricia, 2007)

Based on the table 2.3 above, it can be seen that CE can be considered and very good potential to implement in construction industry. CE can give effective framework in integrating and increasing construction process (Anumba and Evbuomwan, 1997).

2.3 Readiness Assessment of Concurrent Engineering

As explained in the previous chapter, CE implementation is not easy. Because of that, according to Componation and Byrd (1996) it needed a readiness

assessment in organisation before introducing CE in order to increase success of CE implementation plan (Khalfan, Anumba, & Carrilla, 2007).

According to Khalfan, Anumba, & Carrilla, (2007) assessment of readiness was success used to help CE implementation planning in several industry sector. Because of that, to get maximum benefits of implement CE in construction industry, readiness assessment for construction industry has to be conduct. It will ensure that whole sectors of industry reach acceptable level in critical success factor to implement CE and get some benefits such as:

- More effective and better in implementing CE in construction industry.
- Makethe industry can evaluate and benchmark its project operation process.
- Develop appropriate tools to implement CE in the industry
- Make the industry can identify which area that need an improvement or changes
- Make the industry realized the needs of implement CE for bring improvement in whole project operation process.

According to Khalfan & Anumba (2000) paper which title is "*implementation of concurrent engineering in construction – readiness assessment*", there are several tools that can be used to conduct readiness assessment in an organisation, such as:

a) RACE (Readiness Assessment for Concurrent Engineering)

This tools is used in the software engineering, automotive and electronic industries. The RACE-model could be modified for use in the construction and other industries. The RACE-model is conceptualised in terms of two major components: Process and Technology.

b) PMO (The Process Model of Organisation)

This model was developed to assess and analyse the processes and technology of an organisation. The model is can be used for analysing and designing an

21

organisation, its processes, and technology in the context of the market in which that organisation operates. The model is used to detect bottlenecks which become an obstacle to organisation to achieve its goals.

c) PMO-RACE (A Combination of PMO & RACE)

PMO-RACE is the combination of two models (PMO and RACE) which was developed by the researchers at University of Twente and Eindhoven University of Technology (Netherlands) in the mid 90's. Since the Process Model of Organisations (PMO) can support the identification of key problem areas and the definition of business drivers while the RACE-method is good at determining the performance level of the product development process, it was suggested that both methods could be combined to support improvement cycles. The combination would deliver 'the best of both worlds.

d) PRODEVO (A Swedish Model Based on RACE)

PRODEVO was developed at SISU (Swedish Institute for Systems Development) and this development was parallel to the development of PMO-RACE tool. Some of the dimensions and also a couple of the questions are assimilated in the presented tool from RACE model, and to indicate a relation the working name, "Extended RACE"

e) CMM (Capability Maturity Model)

CMM was basically developed for software development and evaluation and was developed by the Software Engineering Institute at Carnegie Mellon University in order to manage the development of software for the US government, particularly that which was to be used by the Department of Defence in late 80's. This model can be used as readiness assessment model and, in fact, the RACE model was developed based on ideas from CMM.

f) SPICE (Standardised Process Improvement for Construction Enterprises)

This tool was developed at the University of Salford, United Kingdom, and is in the form of a questionnaire, which is designed to evaluate the key construction

processes within a construction organisation (SPICE Questionnaire, 1998). SPICE is basically intended for evaluating the maturity of the processes of construction organisations. It is based on CMM and is presently a research prototype

g) Project Management Process Maturity (PM)^2 Model

This 5-Level (PM)^2 Model was developed at University of California, Berkeley in late nineties. The primary purpose of the 5-Level (PM)^2 Model is to use as a reference point or a yardstick for an organisation applying PM practices and processes. This 5-Level (PM)^2 Model further suggest an organisation's application expertise and the organisation's use of technology, or it might produce recommendations on how to hire, motivate, and retain competent people

h) SIMPLOFI Positioning Tool

The tool was designed and developed by the Department of Manufacturing Engineering at Loughborough University. It formed part of the output of the SIMPLOFI (Simultaneous Engineering through People, Organisation and Functional Integration) project in the mid- nineties. The tool focuses on the introduction of one specific product in an organisation. This tool assists those people who are responsible for product introduction within an organisation in answering the question: "I know what product I want to introduce – How do I organise the introduction of this product to achieve this most effectively?"

Comparison between those models and tools are shown in the table 2.4.

Table 2.4 Comparison between the Tools and Models for CE Readiness Assessment

Tools/Models→ Criteria↓	RACE	PMO	PMO-RACE	PRODEVO	CMM	SPICE	(PM)²	SIMPLOFI
Aspects covered	Process • Customer focus • Product assurance • Leadership • Team formation • Strategy deployment • Agility • Teams within the organisation • Process focus • Management system • Discipline Technology • Project architecture • Application tools • Communication • Co-ordination • Information	Organisational environment • Task environment • General environment Processes • Primary processes • Control processes: Strategic level, Adaptive level, and Operational level • Support processes	Aspects covered are the same as PMO and RACE because this is the combination of both of these tools	• Customer and user focus • Process focus • Team and project focus • Life-cycle perspective • Communication	Process • Pre-project phase • Pre-construction phase • Construction phase • Post-construction phase Information technology • Simulation • Integration • Intelligence • Communications • Visualisation • IT support	• Brief management • Project planning • Project tracking and monitoring • Contract management • Quality assurance • Project change management • Risk management • Organisation process focus • Organisation process definition • Training programme • Inter-disciplinary Co-ordination	• Planning to execute a project • Definition of project activities • Cost estimates for the project • Project Management (PM) process • PM-related data collection and analysis • Utilisation of PM tools and techniques • Working as a team • Senior management support	• The structure of teams • Control mechanisms (whether control mechanisms should reside with functions or projects) • The degree to which the process should be parallelised • How specialised people operating the process should be • The degree of automation in the tools used

Tabel 2.4 Comparison between the Tools and Models for CE Readiness Assessment (con't)

Tools/ Models→ Criteria↓	RACE	PMO	PMO-RACE	PRODEVO	CMM	SPICE	(PM)²	SIMPLOFI
	sharing • Integration					• Peer review • Technology management		
Status of tool/ method	Commercial	Development ongoing	Development ongoing	Development ongoing	Commercial	Research prototype	Development ongoing	Commercial
Survey method	Questionnaire and interview	Interviews and description of and current projects, formal procedures and quality hand book	Questionnaire and interview	Questionnaire	Questionnaire and interview	Questionnaire and semi-structured interview	Questionnaire	Questionnaire
Software availability	Yes, also uses other software (e.g. SPSS)	Can use any modelling software	Yes	None	Yes, but also use other software (e.g. SPSS)	None	None	Yes
Ease of use	Yes, but technological aspect is complicated to answer and is only for specialists	Yes, but seemed to be incomplete, that's why merged with RACE later on	Yes, and it seems to be completed after the combination of PMO and RACE	Yes	Yes	Yes, MCQs are developed with additional space for comments	Yes	Yes, user-friendly software

Tabel 2.4 Comparison between the Tools and Models for CE Readiness Assessment (con't)

Can be used for CE readiness assessment?	Yes, basically made for this purpose	Basically used for analysing and designing organisations	Yes, mainly for readiness assessment but also used for CE implementation process	Basically developed for assessing CE process	Yes, but basically used for CE implementation process	Basically used for process improvement	Basically used as a yardstick for an organisation applying PM practices and processes	Basically used to assist those, who are responsible for product introduction within an organisation
Appropriate-ness for use in construction	Yes, but requires some modifications	Yes, but basically used for analyzing and designing an organisation, its process and technology	Yes, but RACE model requires modification before applying to construction	Yes, but it requires changes to address construction specifically	Yes, but basically developed for software industry, therefore it requires changes before applying to construction	Yes, but this tool is basically made for process improvement within construction projects	Yes, but this tool is basically developed to determine and to position an organisation's relative PM level with other organisations	Yes, but this tool focuses on the introduction of one specific product in an organisation. Therefore, in any construction organisation, it can be used for a specific project and it would give the position of the project and not the position of the organisation.

Source: (Khalfan dan Anumba 2000)

2.3.1 BEACON Model

The initial version of the BEACON model, which is shown in figure 2.7, was developed with an associated questionnaire from the RACE model.
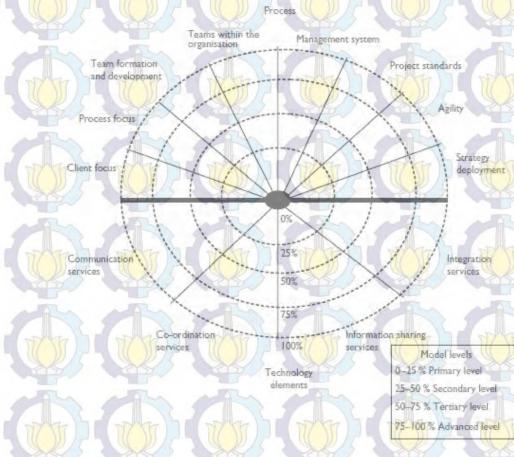
Figure 2.7 CERAM Construct Model (Khalfan dan Anumba, 2000)

The BEACON model was developed and it contains 4 quadrant which represents 4 elements or aspect of model, Process, People, Project, and Technology. First quadrant consists of five critical process factors which used to measure maturity level of process in a construction industry. Second quadrant consists of four critical people factors which used to measure team level issues in construction industry. Third quadrant consists of three critical project factors which used to measure client demand and design. Fourth quadrant consists of five technology which relate to critical factor of technology usage in an organisation. Model BEACON shown in figure 2.8 below.
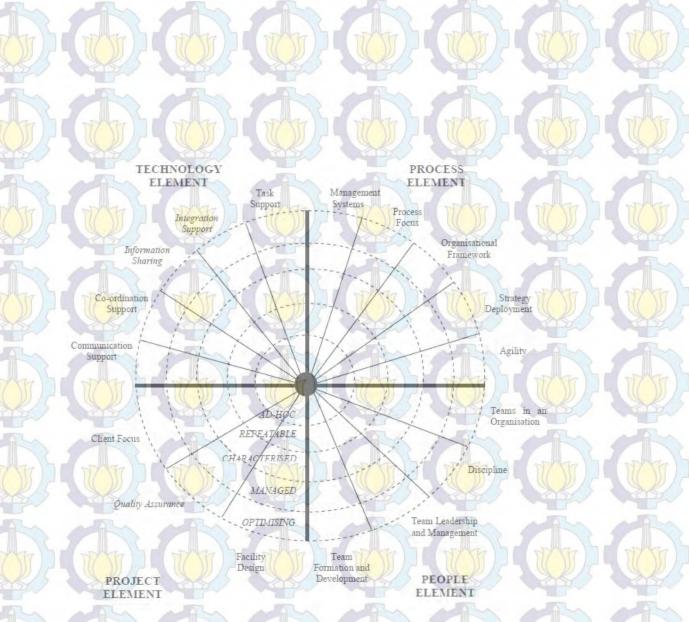
Figure 2.8 BEACON Model (Khalfan dan Anumba, 2000)

A model-based questionnaire (called the BEACON Questionnaire) has been developed for use in assessing construction organisations such that the elements covered in this model in this model would be assessed using the questionnaire. The assessment scale has five possible options: 'Always', 'Most of the Time', 'Sometimes', 'Rarely' and 'Never'. The BEACON Questionnaire can be used for assessing CE readiness of:

a. A static construction organisation, for example an architectural or construction organisation, etc., which has different teams for different on-going projects, and

b. A virtual construction organisation, which consists of various members from different construction organisations, forming a Project Development Team (PDT) and working on a single project.

There are five maturity level in BEACON model that adopted from RACE Model. The five maturity level are explained in table 2.5.

Table 2.5 Maturity Level of BEACON Model

Maturity Level	Description
Ad hoc	This level is characterized by ill-defined and controls, and by confused and disordered teams that do not understand their assignment nor how to operate effectively. Informal interaction with the client is observed, management of the project development process is not applied consistently in projects and modern tools and technology are not used consistently
Repeatable	Standard methods and practices are used for monitoring the project development process, requirements changes, cost estimation, etc. The process is repeatable. There are barriers to communicate within the project development team. Interaction with the client is structured but it is only at the inception of the project. Minimal use of computer and computer-based tools
Characterized	The project development process is well characterized and reasonably well understood. A series of organizational and the process improvements have been implemented. Teams may struggle and fall apart as conflicts are addressed but a team begins to respect individual differences. Most individuals are well aware of client's requirements but client is not involved in the process. Moderate use of proven technology for increasing group effectiveness.

Table 2.5 Maturity Level of BEACON Model (Con't)

Maturity Level	Description
Managed	The project development process is not only characterized and understood but is also quantified measured and reasonably well controlled. Tools are used to control and manage the process. The uncertainty concerning the process outcome is reduced. Work is accomplished by the project development team and conflicts are addressed. Client is involved throughout the process. Appropriate utilization of available technology and computer-based tools.
Optimizing	A high degree of control is used over the project development process and there is a major focus on significantly and continually improving development operations. Team performance is regularly measured and performance measures are continuously validated. Client is a part of project development team from inception and all project decisions are prioritized based on client's needs. Optimal utilization of appropriate plant and technology and technology-mediated group work is observed.

Source: (Khalfan, Anumba, & Carrilla, 2007).

2.4   Summary of Previous Research

This research has an objective to assess the readiness of CE implementation with BEACON Model in PT. PAL Indonesia (Persero). This subchapter explains about previous research that has become a critical review of this research. This subchapter has an objective to show the different between this research and the researches that have conducted before.

1. Malik M. A. Khalfan e, al. (2001), Concurrent engineering readiness assessment of sub-contractors within the UK construction industry.

   In this research, assessment for concurrent engineering readiness was conducted for measure readiness level of UK construction industry, Researcher sent BEACON Questionnaire to twelve construction industry and 25% of them has fill the questionnaire. The result of this research, organisation A is not ready to adopt CE, organisation B and organisation C is ready to adopt CE.

2. Malik M. A. Khalfan et al. (2000), An investigation of the readiness of the construction industry for concurrent engineering

   This research conducted an assessment to measure concurrent engineering readiness level with BEACON model. The assessment conducted by separating BEACON questionnaire to construction industry supply chain. The construction industry supply chain includes client, consultant, contractor, sub-contractor, material supplier and manufacturer. Researches separate questionnaire to some industries. For the result, the consultant industry has to do significance improvement to adopt CE, the contractor industry is ready to adopt CE, the sub-contractor industry is ready to adopt CE, and the material supplier and manufacturer have long way to go to adopt CE.

3. Cheria, S (2014), Preparing concurrent engineering implementation for VRLA battery in PT. X

This research conducted an assessment to measure concurrent engineering readiness level with modified RACE model and BEACON Model. This assessment conducted within a battery manufacturer. Result of this research, PT. X is not fully ready to implement CE because there is an element which has socre below 60%.

CHAPTER 3
RESEARCH METHODOLOGY

This chapter explains about research methodology that is followed in this research they are problem formulation, defining research objectives, readiness assessment of Concurrent Engineering implementation, gap analysis, and improvement suggestion. Detail description of each stage is explained next.

Figure 3.1 Research Methodology Flowchart

Figure 3.1 Research Methodology Flowchart (con't)

3.1 Problem Identification and Formulation Phase

This phase is the first phase of this research. This phase contains steps to identify and formulate the problem, such as:

3.1.1 Problem Formulation

In this phase, problems that face by General Engineering Division PT. PAL Indonesia (Persero) will be formulated.

3.1.2 Research Objective

In this phase the research objectives will be determined based on the problems that have been identified. This phase will be used as a direction for conducting this research.

3.1.3 Literature Review and Field Study

In this phase, related theories about CE is reviewed, namely Concurrent Engineering, Concurrent Engineering in construction and Readiness Assessment for Concurrent Engineering implementation. In depth interview and Focus Group Discussion (FGD) are utilized as method to gain the big picture of the problem in General Engineering Division of PT. PAL Indonesia (Persero).

3.2 Readiness Assessment Phase

After problems of this research were identified and determined. The next phase is preparation phase, it consist of data collection and development of CE team. The steps in this phase are:

3.2.1 Data Gathering

In this chapter data gathering will be conduct as preparation before assessment. The data that needed are organizational structure of the project, top management of General Engineering Division, new project of General Engineering Division of PT PAL Indonesia (Persero), and new project development phase.

3.2.2 Development of CE Team

Concurrent Engineering team in General Engineering Division PT. PAL Indonesia (Persero) develop as pilot project team and consist of people from various departments in this phase.

3.3 Assessment of CE *Readiness Phase*

When conducting CE Readiness assessment, there are several steps that has to be followed, they are:

3.3.1 BEACON Questionnaire Filling

BEACON questionnaire is a tools to measure the readiness level of Concurrent Engineering implementation in General Engineering PT. PAL Indonesia (Persero). BEACON questionnaire is developed based on BEACON questionnaire template in Khalfan (2000). BEACON questionnaire filling is conducted by selecting score for each criteria according to existing condition of GE and expected condition of GE. The score for each criteria is, score 4 for "always", score 3 for "often", score 2 for "sometime", score 1 for "seldom", and score 0 for "never". BEACON Questionnaire is filled by representative CE team to investigate the readiness level of CE Implementation existing condition of the

company and representative of a top management who has a know the desirable condition of company.

3.3.2 Measuring of CE Implementation Readiness

After BEACON questionnaire is filled in previous phase, result of filled questionnaire is measured in this phase. Score of questionnaire is calculated by summarizing all of score from each question then is divided by number of questions and multiple by 4. The result is plotted in the graph so the readiness level of CE implementation and also project team performance in General Engineering Division in PT PAL Indonesia (Persero) can be determined.

3.4 Analysis and Improvement Phase

Analysis of all research activities that have been conducted and improvement recommendation suggestion are conduct in this phase. The steps in this phase are as follows:

3.4.1 Gap Analysis

Gap analysis is conducted to understand the gap score between result of questionnaires filled by CE team and top management representative.

3.4.2 Improvement

Improvement suggestion to increase the level of readiness of element that has the lowest score to implement CE is conducted in this phase. The improvement suggestion is developed to increase readiness to implement CE specifically and also to improve company performance generally.

3.5 Conclusion and Suggestion Phase

This is the final phase in this research where conclusion of research is formulated. Suggestions are also delivered to suggest improvement in further research.

CHAPTER 4
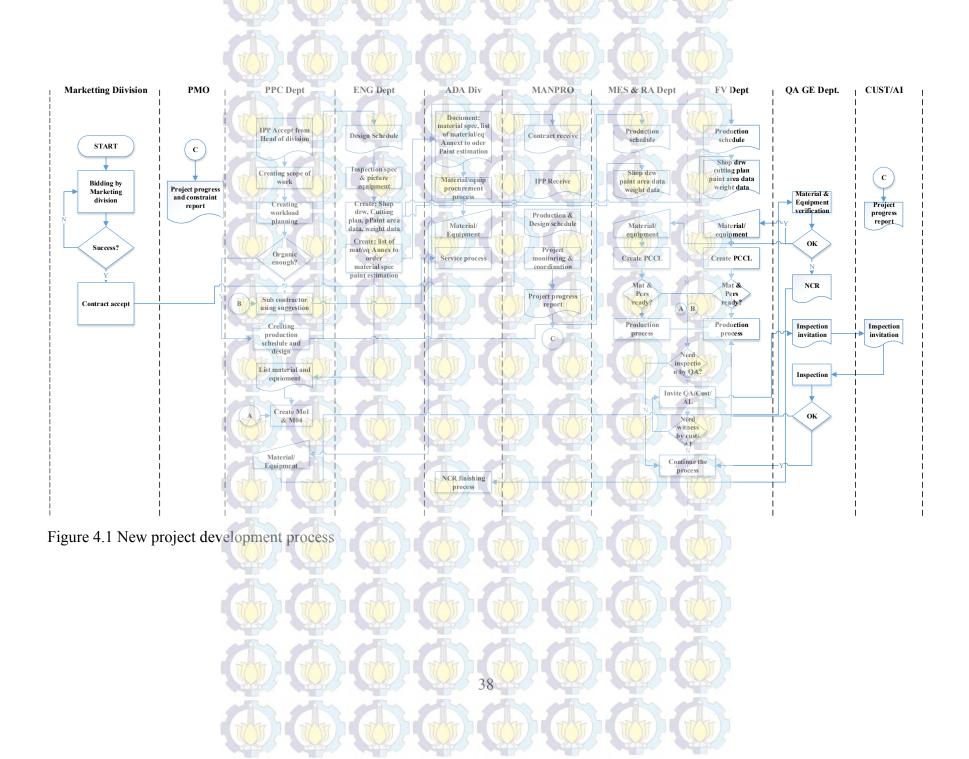
DATA GATHERING AND PROCESSING

This chapter explains about how data that is required for this research is gathered and processed. This chapter explains about existing new project development process in General Engineering Division PT PAL Indonesia (Persero), CE implementation planning, and CE readiness assessment.

4.1 Existing New Project Development Process

As a job order company, General Engineering Division PT PAL Indonesia (Persero) develops new project after got an order from client. The products of General Engineering Division PT PAL Indonesia (Persero) are power plant component, oil distillation, off shore construction, diesel machine, crane, turbine and bridge, include frame, steel press, BMPP, cooler and heavy equipment for off shore project. Customer's orders are changing over time. Moreover there is high variation of demand between different customers. Also, the customer demand want to get high quality of product. Thus, PT PAL Indonesia (Persero) has to continue improve its quality of project implementation in order to meet customer demand.

New project development is started when Marketing Division PT PAL Indonesia (Persero) winning in a bidding process. A project that has been won by PT PAL Indonesia (Persero) will be sent to General Engineering Division. Project team consists of several members from all departments in General Engineering Division of PT PAL Indonesia (Persero). The flow of new project development in General Engineering Division PT PAL Indonesia (Persero) is shown in figure 4.1

Figure 4.1 New project development process

Client order will be processed first in engineering department. In engineering department, client's design will be breakdown into detail material and equipment. The required material and equipment will be sent to procurement department and fabrication department. If the required material and equipment that sent by engineering department is difficult and too expensive, procurement department and fabrication department will sent a "message" to engineering department to change the design. After the design or material and requirement was approved by procurement and fabrication department, the design will sent to the client. If there is no revision, the client's order is ready to be produce.

4.2   CE Implementation Planning

This subchapter explained about the initial steps to implement concurrent engineering. The steps are identifying new project of PT PAL Indonesia (Persero) and establishing CE team.

4.2.1   PT. PAL Indonesia (Persero) Project

Project that becomes the object of this research is EPCI of Madura BD Field. This project is a "consortium project" between PT PAL Indonesia (Persero), COOEC and HCML. PT PAL Indonesia (Persero). PT PAL produces three components; there are Jacket, Topside, and Pile.

Jacket has 100 Meters x 75 Meters in dimension. In fabricating Jacket, PT PAL Indonesia (Persero) needs large area and heavy equipment. One of equipment that needed is Crawler Crane 400 Ton. The picture of Jacket is shown in figure 4.2

Topside has 75 meters x 25 meters x 19 meters in dimension. In fabricating Topside PT PAL Indonesia (Persero) needs large area and heavy equipment. One of heavy equipment that needed to fabricate Topside is OH Crane capacity 80 Tons. PT PAL Indonesia (Persero) also needs two workshops in fabricating Topside component. Topside component is shown in figure 4.3

Figure 4.2 Jacket 100 Meters x 75 Meters

Figure 4.3 Topside component

Pile has 100 Meters x 20 Meters in dimension. Similar with Jacket and Topside, in fabricating Pile needs large space and heavy equipment. One of heavy equipment that needed to fabricate Pile is LLC crane capacity 15 Tons. Pile picture is shown in figure 4.4 below.

Figure 4.4 Pile component

Based on the explanation above, it can be seen that fabricating those three components needs a lot of resources. It will be a problem, when the project team is not integrated well during project implementation. The integration of project team member is very essential for the whole phase of the project especially in design phase. When the design is not appropriate and difficult to fabricate, it will cause schedule lateness. If that condition happened, the cost of production will be higher. It also make the competitiveness of PT PAL Indonesia (Persero) will be decrease so it difficult to compete with other national and international companies.

4.2.2 Establishing CE Team

According to Smith (1995) CE team consists of cross functional professional skill members. CE team is formed based on project organizational structure. Figure 4.5 shows the organizational structure of a project in General Engineering Division PT PAL Indonesia (Persero).

The initial CE team of General Engineering Division PT PAL Indonesia (Persero) is developed to support this research and the role is determined. The CE team consists of staff from various department, they are:

➢ Engineering department

In charged in coordinating of all of members during design phase of project implementation.

> Procurement department

In charged of purchasing materials that is needed to fabricate the component after design phase.

> Fabrication & installation department

In charged in fabricating component after design and material arrived.

> PPC department

In charged in planning all activities from beginning of the project until the end of the project.

> QA/QC department

In charged of product or component's quality. The quality of components that have been fabricated has to meet customer requirement and quality regulation.

> Finance & Tax department

In charged of managing budget in project development process.

> Marketing department

In charged in getting order from client. Marketing member is also in charged to inform clear information about requirement of customer to all member of team

All of member from those departments is selected by head or manager of the department or division.

4.3   CE Readiness Assessment
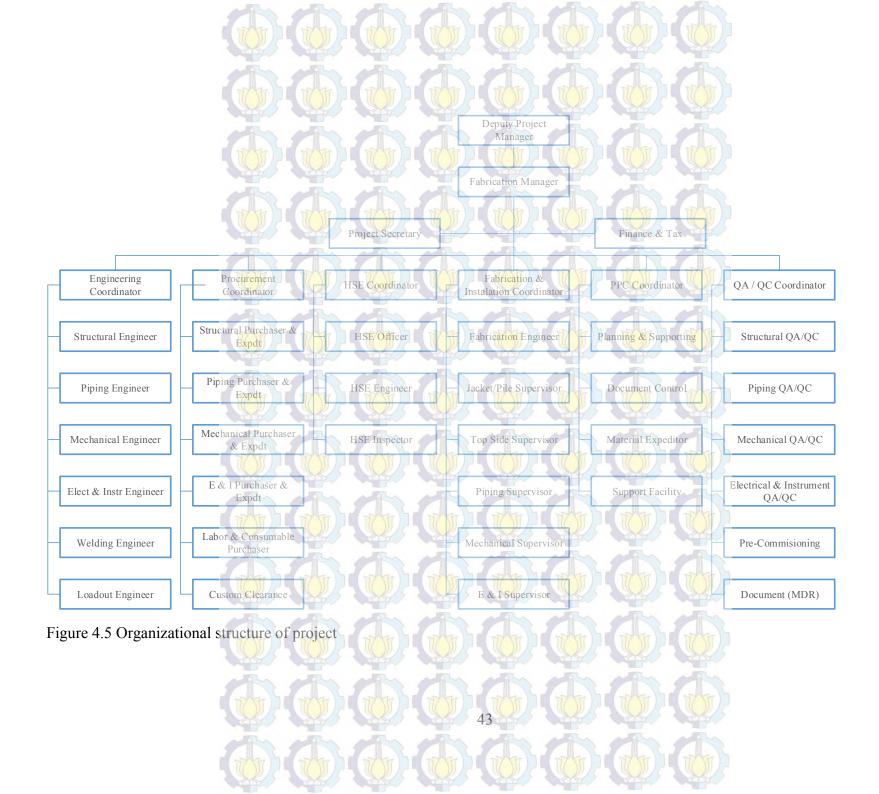
This subchapter describes about Concurrent Engineering Readiness Assessment. This subchapter consists of the questionnaire verification, questionnaire filling, and questionnaire recap and mapping.

4.3.1   Questionnaire Verification

In this research, BEACON Model is selected to assess CE readiness level in General Engineering Division PT PAL Indonesia (Persero). BEACON Model was developed by Khalfan (2000). This Model is specifically used to assess CE readiness level in construction industries.

42

Figure 4.5 Organizational structure of project

Although BEACON Model was developed specifically to assess construction industry, before it is filled by PT PAL Indonesia (Persero), questions in the BEACON questionnaire need to be firstly verified by top management of General Engineering Division PT PAL Indonesia (Persero).

Verification method that used to verify the BEACON questionnaire is expert judgment. By selecting a person in General Engineering Division PT PAL Indonesia (Persero) that considered as the suitably representation to verify each question in the BEACON questionnaire. Mr. Agus Budiyanto as General Manager of General Engineering Division PT PAL Indonesia (Persero) is selected the representation for verify BEACON questionnaire.

Before verification process, firstly CE is explained in detail to General Engineering Division top management and BEACON Model in order to ensure General Engineering Division of PT PAL Indonesia (Persero) representative has understand. During the verification process, each question is examined to check its relevance and suitability with condition in General Engineering Division. After verification, all questions in BEACON Model are fit with condition in General Engineering Division of PT PAL Indonesia (Persero).

4.3.2 Questionnaire Filling

In this research, BEACON questionnaire is utilized to assess CE readiness level General Engineering Division of PT PAL Indonesia (Persero) existing condition and desired condition. In General Engineering Division of PT PAL Indonesia (Persero) BEACON questionnaire is distributed to two person: one representative of CE team Mr. Bambang Setyawan in order to know the existing condition and one representative of General Engineering Division PT PAL Indonesia (Persero) top management Mr. Agus Budiyanto in order to get the desired condition.

The BEACON questionnaire is divided into five parts. The part A consists of questions about respondents. From part B until part E consist of question about each element (process, people, project, and technology). Each question in every element need to be answered by put a tick ($\sqrt{}$) in the suitable box. The available answer option for each question are "Always" (score 4),

"Mostly" (score 3), "Sometimes" (score 2), "Rarely" (score 1) and "Never" (score 0).

4.3.3 Questionnaire Recap and Mapping

There are two questionnaire results. First is questionnaire of existing condition. Second is questionnaire of desired condition.

4.3.3.1 Existing Condition Questionnaire

Questionnaire to assess existing condition of readiness level of CE implementation is filled by Mr. Bambang. The recap of questionnaire result is shown in table 4.1

Table 4.1 Existing condition recap value in each part of element
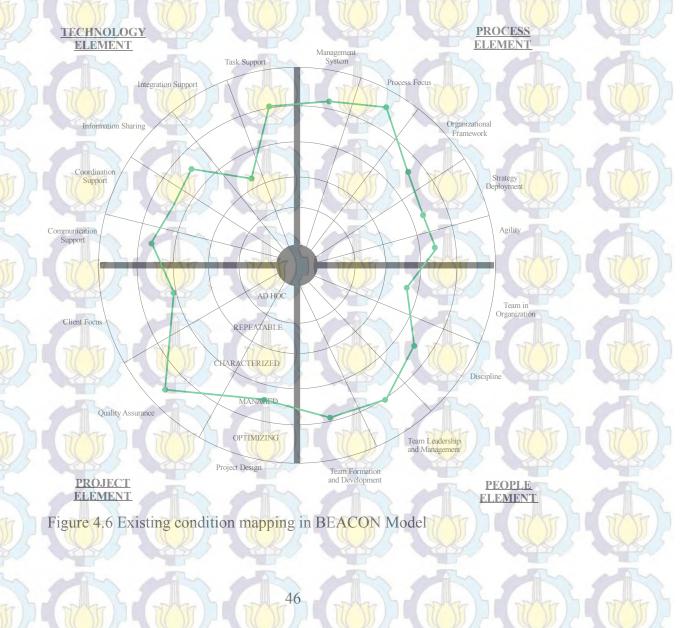
Element	Part of element	Score	Total Score	Percentage
Process	Management system	45	52	87%
	Process focus	49	52	94%
	Organizational framework	29	40	73%
	Strategy deployment	27	40	68%
	Agility	28	40	70%
People	Team formation and development	32	40	80%
	Team leadership and management	26	32	81%
	Discipline	22	32	69%
	Teams in organization	28	48	58%
Project	Client focus	23	36	64%
	Quality assurance	30	32	94%
	Project design	26	36	72%
Technology	Communication support	31	40	78%
	Coordination support	26	36	72%
	Information sharing	30	40	75%
	Integration support	17	32	53%
	Task support	42	52	81%

Each part of element percentage is calculated by dividing score with total score of that the particular part. To get the score of each element is conducted by calculating average of the percentage of each part in the elements. The summary

of element average score and the readiness level of CE implementation can be seen in the table 4.2

Table 4.2 Existing condition readiness level of CE implementation

element average score		Total Average Score	Level
element	average score		
Process	78%	74.65%	Managed
People	72%		
Project	77%		
Technology	72%		

After the all calculation has been finalized, score of each part of element in BEACON Model is plotted on spider diagram. As a result, existing condition of CE readiness level based on BEACON Model is shown in figure 4.6

Figure 4.6 Existing condition mapping in BEACON Model

A company that has position in "Managed" level is has total score average between 60% until 80%. Total score average of General Engineering Division PT PAL Indonesia (Persero) is 74, 65%. Based on table 4.1 and figure 4.6, all of elements are in the "Managed" level.

4.3.3.2 Desired Condition Questionnaire

This questionnaire is also filled by a top management of General Engineering Division PT PAL Indonesia (Persero) in order to know the desired condition of readiness level of CE implementation. The recap of score in each part of element is shown in table 4.3

Table 4.3 Recap of desired condition score in each part of element

Element	Part of element	Score	Total Score	Percentage
Process	Management system	50	52	96%
	Process focus	49	52	94%
	Organizational framework	38	40	95%
	Strategy deployment	39	40	98%
	Agility	39	40	98%
People	Team formation and development	39	40	98%
	Team leadership and management	32	32	100%
	Discipline	32	32	100%
	Teams in organization	48	48	100%
Project	Client focus	35	36	97%
	Quality assurance	32	32	100%
	Project design	36	36	100%
Technology	Communication support	40	40	100%
	Coordination support	36	36	100%
	Information sharing	39	40	98%
	Integration support	32	32	100%
	Task support	47	52	90%

The summary of element average score and the readiness level of CE implementation can be seen in the table 4.4

Table 4.4 Desired condition readiness level of CE implementation

element average score		Total Average Score	Level
element	average score		
Process	96%	98.03%	Optimize
People	99%		
Project	99%		
Technology	98%		

After the all calculation has been done, then plot the score of each part of element in BEACON Model. Existing condition result in BEACON Model is shown in figure 4.7

Figure 4.7 Desired condition mapping in BEACON Model

CHAPTER 5
CE READINESS ASSESSMENT ANALYSIS

This chapter explained about analysis of CE Readiness Assessment that has been conducted. This chapter consists of gap analysis and improvement suggestion.

5.1 Gap Analysis

This subchapter explained about gap analysis of the result of existing condition assessment and desired condition.

5.1.1 Existing Condition Analysis

Based on the table 4.2 in the previous chapter, PT PAL Indonesia (Persero) has average of total score is 74, 65%. The average score for each element are 78% for process element, 72% for people element, 77% for project element and 72% for technology element. Thus PT PAL Indonesia (Persero) is categorized to managed level of readiness in existing condition prior to Concurrent Engineering implementation.

After the score of each part of each element known, then the result is plotted in the diagram which is shown in figure 4.6. Based on the figure 4.6, it can be seen that most of the parts of the elements plotted in the managed level or optimized level except team in organization part in people element (58%) and integration on support in technology element (53%). With this situation, even average of total score PT PAL Indonesia (Persero) is in managed level and considered as ready to implement Concurrent Engineering, however there are two part that plotted below managed level has to be improved first.

Based on the list of question in team in organization part in people element, "The teams have the authority to reward their team members" question and "There are rewards for acting as a team member instead of looking out for individual interests" question have 0 score. This condition happened because in General Engineering Division PT PAL Indonesia (Persero) has rewarding system

that not allowed team to give reward to its members. The rewarding system that applied in General Engineering Division PT PAL Indonesia (Persero) is "reward by target". It means management will set a target to the team and if the team performance reaches its target, the team allowed getting the reward.

In integration support part in technology element, "The IT systems used by team members can be linked to those the company's most frequent business partners" has 0 score. According to Mr. Bambang Setyawan, this condition is happened because PT PAL Indonesia (Persero) does not have a central server database system that can be accessed by every person easily and fast. PT PAL Indonesia (Persero) use internet to process any data that comes from another company. After data is received, the data deliver is processed by document control and sent to the related division. For storing data and sharing data PT PAL Indonesia (Persero) used Compact Disc (CD) and *dropbox*.

5.1.2 Existing Condition and Desired Condition Gap Analysis

One way to analyse which factor that the most critical and need to be improve is by conducting gap analysis. The gap analysis is conducted by looking for any gap between existing condition and desired condition. In order to make the analysis easier to be conduct, comparison of existing condition and desired condition can be plotted in one graph. The comparison between the existing condition and the desired condition is shown in figure 5.1.

Based on the figure 5.1, the desired condition is in optimizing level with total average score is 98.03%. It means top management of General Engineering Division PT PAL Indonesia (Persero) want the company reaches the highest maturity level. In the existing condition, there is no part of element that reached the level that desired. It means General Engineering Division PT PAL Indonesia (Persero) has not reached the desired condition yet.

There is still a gap between existing condition and desired condition. Some parts of element has reached optimizing level, there are quality assurance part in project element, team leadership and management part in people element, management system part and process focus in process element.

Figure 5.1 Comparison between the existing and desired condition

The parts of element that have biggest gap with desired condition are team in organization part in people element and integration support part in technology element. Therefore those parts have to improve in order to increase the level of concurrent engineering implementation readiness.

5.2 Improvement Suggestion

Based on the subchapter 5.1.2, team in organization part in people element and integration support part in technology element have to be improve in order to increase the level of concurrent engineering implementation readiness. In team in organization part in people element, reward system in General Engineering Division of PT PAL Indonesia (Persero) is the focus that needs to be

improved. In integration support part in technology element, information technology system is the focus that needs to be improved.

5.2.1 Improvement Recommendation for Reward System

This subchapter explains about the improvement recommendation for reward system which consists of alternatives of improvement, implementation plan of the improvement, and benefit analysis of the improvement.

5.2.1.1 Improvement Recommendation Alternatives

According to Stajkovic & Luthans, (1997), rewards can be classified as tangible or intangible. The examples of tangible reward are cash bonuses and salary increases. The example of intangible reward is praise or public recognition.

In General Engineering Division of PT PAL Indonesia (Persero), intangible reward (cash bonuses) is paid to the team when the team reach target that is set by management. There is no reward that paid by a team to its member when its member do the work with best performance compare to other team member. In order to increase the performance of team member, it needs a reward that is given by the team to its member. In this case, intangible reward is suitable to be implemented.

One of intangible reward is personal recognition. Towers (2003) argues in favor of the recognition based reward rather than performance incentives. Based on his research which is conducted over high performing companies in U.S. and Canada and conclude that (57%) of them made significantly greater use of recognition plans rather than incentives compared to the low performers (36%). The examples of personal recognition reward that the project team can implement are:

1. Team member of the month

   Management of General Engineering Division PT PAL Indonesia (Persero) can give a staff or a member of the team recognition as "team member of the month" because the team member has done a great performance in a month. But in General Engineering Division it can be changes from "a month" to "every project milestone". The staff or team

member can receive a good recognition through this reward. Many companies were implementing the "team member of the month" such as Kodak, Honeywell, American Express, IBM, GTE, Procter & Gamble (Nelson, 1994).

2. Thank you card

Management or team leader and coordinator give a "thank you card" to the employee who performs best in a certain period. In General Engineering Division, it may be best give the "thank you card" in every milestone of a project. Thank you card that is received by a team member can be exchanged with a certain prizes based on the number of the cards that received. The example of companies that implemented this reward is Communication Briefings/ Newstrack Communication Services. The examples of exchanged prizes are:

- 1 thank you card = a voucher for car wash.
- 5 thank you card = a voucher for dinner in a restaurant
- 10 thank you card = a voucher for shopping in a department store
- Etc.

3. The project team leader or manager personally congratulates their employee for doing the job well.

Management or project leader is praise directly a team member who did their work in best performance. Example of company that has implemented this reward is Hewlett-Packard. Hewlett-Packard called the reward with "Golden Banana Award". Golden Banana Award is conducted when an employee can solved a problem in the group that had been struggling for many weeks. Manager will say "Well done!" and "Congratulation" and give the employee a banana from his lunch. This reward became one of the most prestigious honors given on an inventive employee.

5.2.1.2 Implementation Plan

There are some principles that have to be follow to implementing the intangible individual reward system.

- Top management understand and support "Why", "Who", and "How" of allocate some funding intangible reward system will be given to.
- All employees have to know that there are new policy about the intangible reward system in General Engineering Division of PT PAL Indonesia (Persero).

In General Engineering Division PT PAL Indonesia (Persero) "Why", "Who", and "How" of individual intangible reward system will be are explained below.

- o "Why": the individual intangible reward system is an effort to increase motivation of team member. So, it can increase the readiness level of Concurrent Engineering Implementation.
- o "How": the reward will be given at every project milestone.
- o "Who": the reward will be given to a team member in each teams that has best performance during a certain project milestone.

5.2.1.3 Benefit Analysis

Implementing intangible individual reward system is expected to be less cost but there are also some expected benefits when General Engineering Division PT PAL Indonesia (Persero), such as.

- Motivation of all member of team will increase
- Build a better work environment

By achieving those benefits, General Engineering Division PT PAL Indonesia (Persero) potentially to get savings about $125,000 in a year. The amount of savings is come from the assumption that those benefits will reduce the "recover" cost which the amount is 5% of total cost of production in a project which has $1,250,000 in cost of production in a year and this division gets two projects in a year.

One method that can be used to analyze the benefit that a company can get is Benefit Cost Ratio (BCR). In this case assumed that there are 4 milestones in a project and the reward is given to a person from each team. The calculation of BCR is shown below.

1. Team of the month

The cost to conduct team of the month reward is assumed Rp 200.000 once or equal to $15.9. The calculation of total cost in a year is shown below.

Total cost = total cost of reward x times conduct x number of team

$$= \$15.9 \times 4 \times 2$$

$$= \$127.22$$

After get the total cost, BCR calculation can be conducted. The calculation of BCR is shown below.

BCR = savings/total cost

$$= \$125000.0/\$127.22$$

$$= 982.5499135$$

Based on BCR calculation result, it can be seen that the ratio is more than 1. It can be conclude that the value of benefit in implementing the reward is more than the cost to implement the reward.

2. Thank you card

The cost to conduct thank you card reward is assumed Rp 1.000.000 once or equal to $79.51. The calculation of total cost in a year is shown below.

Total cost = total cost of reward x times conduct x number of team

$$= \$79.51 \times 4 \times 2$$

$$= \$636.08$$

After get the total cost, BCR calculation can be conducted. The calculation of BCR is shown below.

BCR = savings/total cost

$$= \$125000.0/\$636.08$$

$$= 196.5161615$$

Based on BCR calculation result, it can be seen that the ratio is more than 1. It can be conclude that the value of benefit in implementing the reward is more than the cost to implement the reward.

3. The project team leader or manager personally congratulates their employee for doing the job well.

The cost to conduct manager congratulates directly reward is assumed Rp 50.000 once or equal to $3.98. The calculation of total cost in a year is shown below.

Total cost = total cost of reward x times conduct x number of team

$$= \$3.98 \times 4 \times 2$$
$$= \$31.81$$

After get the total cost, BCR calculation can be conducted. The calculation of BCR is shown below.

BCR = savings/total cost

$$= \$125000.0/\$31.81$$
$$= 3929.581892$$

Based on BCR calculation result, it can be seen that the ratio is more than 1. It can be conclude that the value of benefit in implementing the reward is more than the cost to implement the reward.

5.2.2   Improvement Recommendation for IT System

This subchapter explains about the improvement recommendation for IT system which consists of alternatives of improvement, implementation plan of the improvement, and benefit analysis of the improvement.

5.2.2.1   Improvement Recommendation Alternatives

At this moment General Engineering Division of PT PAL Indonesia (Persero) uses *dropbox* to support the data storage. However Mr. Bambang Setyawan as Deputy Project Manager said that it needs a better tool that can integrate the whole process and can be easily access by every person in the whole division. There are some alternatives to support integration in a company such as implement Enterprise Resource Planning (ERP) and use IT sub-contractor to

handle the data sharing. The detail explanation about the alternatives is explained below.

1. Enterprise Resource Planning (ERP)

    According to O'Brien (2005), Enterprise Resource Planning (ERP) is an integrated cross-functional software that re-engineering the manufacturing process, distribution, finance, human resource and other business process in a company to increase the efficiency, agility, and profitability. For construction industry, Shi and Halpin (2002) presented a 3-tier architecture to implement ERP systems in the construction firms which is shown in figure 5.2
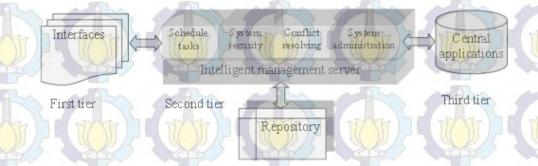
Figure 5.2 A 3-tier architecture of Construct-ERP (Shi and Halpin, 2002)

One good ERP software designed for the construction industry is "R/3". In the study of R/3 software made by Connor and Dodd (2000), there are 15 functions provided by R/3. These are: unit price tracking, job cost reports, labor cost report and work hour forecasting, change order cost tracking, work breakdown structure model, project conceptual/milestone schedule, detailed activity precedence network, project schedule reports, short interval planning, purchase order development and issuance, monitoring of change orders, rework, and back-charges, management of contractor retainage, tracking and documenting percentage of physical completion, field warehouse inventory management and warehouse inventory reorder management. One company that has implemented ERP R/3 is MORSE (Ahmed et al., 2003). MORSE is a marine construction company that located in 84 Knox Street, Thomaston, ME 04861 United States.

MORSE has implemented a major Enterprise Resource Planning project for a marine construction company to help it analyze accurately, its business profile, carry out remote procurement and inventory management and integrate electronically with its approved suppliers. MORSE implementing ERP R/3 by 3 stages, there are:

- Stage 1: Morse project managed the entire implementation, providing advice on technology strategy, operational analysis, solution planning, business change management, development and support. Technology selected included Oracle Database, Oracle applications (General Ledger, Accounts receivable, Accounts payable, Purchasing, Human resources and Inventory) and bespoke integrated Oracle solutions. A vessel-based system is used to record offshore labor activities through project and maintenance cycles, which interfaces with Oracle applications (General Ledger and Human Resources) for cost analysis and payroll processing.

- Stage 2: In this stage procurement was distributed and inventory processes while retaining effective central control and reporting capabilities. Morse successfully deployed remote requisition and materials management systems on the vessels and remote bases.

- Stage 3: Managing approved supplier catalogues and the electronic integration improved efficiency of the procurement cycle with key partner suppliers.

2. Lightweight Directory Access Protocol (LDAP)

The second alternative is contracting an IT sub-contractor to handle data sharing by using Lightweight Directory Access Protocol (LDAP). LDAP defines the content of messages exchanged between an LDAP client and an LDAP server. The messages specify the operations requested by the client (search, modify, delete, and so on), the responses from the server, and the format of data carried in the messages. LDAP messages are carried over TCP/IP, a connection-oriented protocol; so there are also operations

to establish and disconnect a session between the client and server. The general architecture of LDAP is shown in figure 5.3 below.

Figure 5.3 LDAP architecture

1. Client sends modification to replica
2. Replica returns referral to master
3. Client resubmits modification to master
4. Master returns results to client
5. Master updates replica with change

5.2.2.2 Implementation Plan

This subchapter explains about the implementation plan of the alternatives that has been developed in the previous chapter. The implementation plan of each alternative is explained below.

1. Enterprise Resource Planning (ERP) R/3

In developing implementation ERP R/3 plan, some assumptions is used, there are:

- The top management of PT PAL Indonesia (Persero) is commit to implement ERP R/3
- PT PAL Indonesia (Persero) has good financial ability to implement ERP R/3

- Understand why company want to implementer so they support ERP implementation
- All employee support the implementation process

There are some methods to implemented ERP R/3 such as phased approach by module, phased approach by location, and Accelerated SAP (ASAP) especially for implementing SAP R/3. The method that suggested is ASAP because it needs rapid implementation to implement SAP R/3 before implementing Concurrent Engineering (CE).

The steps to implement SAP R/3 by ASAP methods are shown in figure 5.4.

Figure 5.4 ASAP implementation steps

Average time needed by a company to implement SAP R/3 is 12 months. So if it assumed time need is 12 months, so the time needed for each process is estimated as follows: project preparation, 2 weeks; business blue print, 6 weeks; simulation, 10 weeks; validation, 21 weeks; and final preparation, 13 weeks. After estimated the project duration, then

calculated the cost to implement SAP R/3. The cost needed to implement SAP R/3 is shown in table 5.1.

Table 5.1 Implementation Cost of SAP R/3

No	Account	Cost
1	R/3 Consulting	$ 1,000,000.00
2	Software	$ 200,000.00
3	Hardware	$ 150,000.00
4	Other consulting and interfaces	$ 200,000.00
5	Travel	$ 150,000.00
6	Training	$ 90,000.00
	TOTAL	$ 1,790,000.00

The explanation about the cost account is explained below:

- R/3 consulting cost is the amount of cash that has to be paid to R/3 consultant. The company that wants to implement R/3 has to hire consultant in to get success in the implementation process.
- Software cost is the amount that company has to pay for get R/3 license.
- Hardware cost is the amount of cash that company has to pay for buy the equipment for support the running of software.
- Other consulting and interface cost is the amount of cash that company has to pay for hire consulting for other requirement except R/3 such as interface of the application.
- Travel cost is the amount of cash that company has to pay for travelling the software installation and/or hardware.
- Training cost is the amount of cash that company has to pay for train the employee so the employee can operate R/3 well.

The total cost to implement SAP R/3 is estimated $1,790,000 or Rp 22,512,830,000.00 with exchanged rate $1 dollar equal to Rp 12,577 per January 2015.

2. Lightweight Directory Access Protocol (LDAP)

In developing implementation ERP R/3 plan, some assumptions is used, there are:

- PT PAL Indonesia (Persero) has ability to provide financial requirement of LDAP installation.

- All employee have good support about the plan to implement LDAP

According to Softerra, Ltd. (2014), the license for installing and maintaining the system investment cost are $220 for the initial investment and the company has to pay $85 for the investment in the following year. The calculation of investment planning for LDAP is shown below.

With exchanged rate $1 is equal to Rp 12.577 per January 2015

- Total investment in year 1 = 10 x $220 = $2,200 ≈ Rp 27,669,400

- Total investment in year 2 = 10 x $85 = $850 ≈ Rp 10,690,450

- Total investment in year 3 = 10 x $85 = $850 ≈ Rp 10,690,450

- And etc.

5.2.2.3 Benefit Analysis

There are some expected benefits when the company implemented the alternatives. The explanation of the benefits for each alternatives is explains below.

1. SAP R/3

By implementing SAP R/3 General Engineering Division of PT PAL Indonesia (Persero) is expected to achieve some benefits such as:

- Administrative costs of fax and telephone is going down

- Order processing will be simpler

- Support more integration between departments

By achieving those benefits, General Engineering Division PT PAL Indonesia (Persero) potentially to get savings about $125,000 in a year. The amount of savings is come from the assumption that those benefits

will reduce the "recover" cost which the amount is 5% of total cost of production in a project which has $1,250,000 in cost of production in a year. By achieving savings through implementing SAP R/3, the payback period of SAP R/3 investment can be calculated. Assumed that General Engineering Division get two project in a year, the calculation of SAP R/3 payback period is explained below.

Payback period = total investment/savings

$$= \$\ 1,790,000.00/ \$\ 125,000$$

$$= 14.32 \approx 14 \text{ years and 4 months}$$

Based on the payback period calculation, it can be conclude that General Engineering Division of PT PAL Indonesia (Persero) will get benefit after 14 years and 4 months implementation. One method to analyze the benefit that General Engineering Division of PT PAL Indonesia (Persero) can get is Benefit Cost Ratio (BCR). The steps to calculated BCR are explained below.

- Defines the time horizon. The time horizon that used to conducted BCR analysis is 10 years.
- Analyze the cash flow

Figure 5.5 SAP R/3 implementation cash flow

- Calculate the outflow Net Present Value (NPV)
  The outflow NPV is $1,790,000. It because in the next years there are no outflow.

63

- Calculate the inflow NPV

  The interest rate (i) that used to calculate the NPV is 3%. The calculation of inflow NPV is explained below.

  $$NPV = FV/(1+i)^1 + \ldots + FV/(1+i)^{10}$$
  $$= \$125,000/(1+0.03)^1 + \ldots\ldots + \$125,000/(1+0.03)^{10}$$
  $$= \$1,066,275.355$$

- Calculate the ratio by dividing inflow NPV with outflow NPV

  $$BCR = inflow\ NPV/outflow\ NPV$$
  $$= \$1,066,275.355/\$1,790,000.00$$
  $$= 0,60$$

Based on BCR calculation, the ratio is below 1. It means that the cost for investment is more than the benefit that General Engineering Division of PT PAL Indonesia (Persero) can get.

2. Lightweight Directory Access Protocol (LDAP)
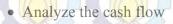
By implementing LDAP General Engineering Division of PT PAL Indonesia (Persero) is expected to achieve some benefits such as:
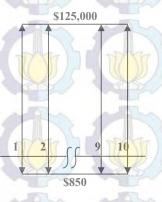
- Support good integration between department

- Data is more safe and secure

- Administrative costs of fax and telephone is going down

By achieving those benefits, General Engineering Division PT PAL Indonesia (Persero) potentially to get savings about $125,000 in a year. The amount of savings is come from the assumption that those benefits will reduce the "recover" cost which the amount is 5% of total cost of production in a project which $1,250,000 in cost of production in a year and it is assumed that General Engineering Division of PT PAL Indonesia (Persero) get two project in a year. One method to analyze the benefit that General Engineering Division of PT PAL Indonesia (Persero) can get is Benefit Cost Ratio (BCR). The steps to calculated BCR are explained below.

- Defines the time horizon. The time horizon that used to conducted BCR analysis is 10 years.

• Analyze the cash flow

Figure 5.6 LDAP implementation cash flow

• Calculate the outflow Net Present Value (NPV)

The interest rate (i) that used to calculate the NPV is 3%. The calculation of outflow NPV is explained below.

$NPV = FV/ (1+i)^0 + ... + FV/ (1+i)^{10}$

$= \$2,200/ (1+0.03)^0 + \$850/ (1+0.03)^1 + ... + \$850/ (1+0.03)^{10}$

$= \$9,450.67$

• Calculate the inflow NPV

The interest rate (i) that used to calculate the NPV is 3%. The calculation of inflow NPV is explained below.

$NPV = FV/ (1+i)^1 + ... + FV/ (1+i)^{10}$

$= \$125,000/ (1+0.03)^1 + ... + \$125,000/ (1+0.03)^{10}$

$= \$1,066,275.355$

• Calculate the ratio by dividing inflow NPV with outflow NPV

$BCR = $ inflow NPV/outflow NPV

$= \$1,066,275.355/\$9,450.67$

$= 112.83$

Based on BCR calculation, the ratio is more than 1. It means the benefit that can get is more than the cost that has to be paid.

5.2.2.5 Sensitivity Analysis

Companies are always deal with uncertainty. One method to analyze the change of benefit that produced by the improvement alternatives because uncertainty is conduct a sensitivity analysis. The sensitivity analysis is conduct to analyze the robustness of IT system improvement alternatives which are SAP R/3 and LDAP.

The first step to conduct sensitivity analysis is defining the critical factor or input variable. In this case, the input variables that will be change are cost of production, % savings and number of project. After defining the critical factors, the next step is calculate the benefit that produced with different value of those factors. The sensitivity analysis of SAP R/3 and LDAP is shown below.

1. SAP R/3

    The sensitivity analysis of SAP R/3 is conducted with changing the input variable or critical factor and analyze the benefit result. The sensitivity analysis of SAP R/3 by each factor is shown below.

    *   Cost of production

        The result of sensitivity analysis with change of cost of production is shown in table 5.2 and figure 5.7.

Table 1.2 SAP R/3 cost scenario sensitivity analysis

Initial Cost	Cost (Scenario Sensitivity)	Result	
		BCR	NPV
$ 1,250,000.00	$1,250,000.00	0.60	$ (723,724.65)
$ 1,250,000.00	$1,500,000.00	0.71	$ (510,469.57)
$ 1,250,000.00	$1,750,000.00	0.83	$ (297,214.50)
$ 1,250,000.00	$2,000,000.00	0.95	$ (83,959.43)
$ 1,250,000.00	$2,250,000.00	1.07	$ 129,295.64
$ 1,250,000.00	$1,000,000.00	0.48	$ (936,979.72)
$ 1,250,000.00	$950,000.00	0.45	$ (979,630.73)

Figure 5.7 Cost sensitivity result for SAP R/3

Based on table 5.2 and figure 5.7, it can be seen that majority of the results are negative NPV. SAP R/3 will produce benefit if cost of production is $2,250,000.

- % savings

The result of sensitivity analysis with change of % savings is shown in table 5.3 and figure 5.8

Table 5.3 SAP R/3 % savings scenario sensitivity analysis

Initial % savings	% savings (Scenario Sensitivity)	Result	
		BCR	NPV
5%	5.00%	0.60	$ (723,724.65)
5%	7.0%	0.83	$ (297,214.50)
5%	8.0%	0.95	$ (83,959.43)
5%	9.0%	1.07	$ 129,295.64
5%	10.0%	1.19	$ 342,550.71
5%	4.00%	0.48	$ (936,979.72)
5%	3.0%	0.36	$ (1,150,234.79)
5%	2.0%	0.24	$ (1,363,489.86)

Figure 5.8 percent (%) savings sensitivity result for SAP R/3

Based on table 5.3 and figure 5.8, it can be seen that SAP R/3 will produce benefit or positive NPV result if the savings is above 9%.

- Number of project

The result of sensitivity analysis with change of number of project is shown in figure 5.9 and table 5.4,

Table 5.4 SAP R/3 number of project scenario sensitivity analysis

Initial number of project	Number of project (Scenario Sensitivity)	Result	
		BCR	NPV
2.00	2.00	0.60	$ (723,724.65)
2.00	3.00	0.89	$ (190,586.97)
2.00	4.00	1.19	$ 342,550.71
2.00	1.00	0.30	$ (1,256,862.32)
2.00	0.00	0.00	$ (1,790,000.00)

NUMBER OF PROJECT SENSITIVITY

$342,550.71

$(190,586.97)

$(723,724.65)

$(1,256,862.32)

$(1,790,000.00)

—— NPV

Figure 5.9 Number of project sensitivity result for SAP R/3

Based on table 5.3 and figure 5.9, it can be seen that SAP R/3 will produce benefit or positive NPV result if the number of project is above 4. After all of the critical factors sensitivity analysis have been calculated, then plot the result in the one graph. The result of those three factors sensitivity analysis is shown in figure 5.10.

Cost, %savings and number of project Sensitivity

—— NPV for cost scenario sensitivity —— NPV for %savings scenario sensitivity —— NPV for number of project scenario sensitivity

Figure 5.10 Graph of sensitivity analysis for SAP R/3

- Integration

In integration scenario of sensitivity analysis is change the all factors in the same scenario. The result of integration scenario of sensitivity analysis is shown in table 5.5 and figure 5.11.

Table 5.5 Integration scenario of sensitivity analysis for SAP R/3

Scenario	Cost (Scenario Sensitivity)	% savings (Scenario Sensitivity)	Number of project (Scenario Sensitivity)	Result	
				BCR	NPV
1	$ 1,250,000.00	5.00%	2.00	0.60	$ (723,724.65)
2	$ 1,750,000.00	8.0%	3.00	2.00	$ 1,792,685.19
3	$ 2,250,000.00	4.0%	4.00	1.72	$ 1,280,873.02
4	$ 950,000.00	10.00%	1.00	0.45	$ (979,630.73)

Figure 5.11 Integration scenario of sensitivity analysis for SAP R/3

2. LDAP

The sensitivity analysis of LDAP is conducted with changing the input variable or critical factor and analyze the benefit result. The sensitivity analysis of LDAP by each factor is shown below.

- Cost of production

The result of sensitivity analysis with change of cost of production is shown in table 5.6 and figure 5.12.

Table 5.6 LDAP cost scenario sensitivity analysis

Initial Cost	Cost (Scenario Sensitivity)	Result	
		Ratio	NPV
$ 1,250,000.00	$1,250,000.00	112.83	$ 1,056,824.68
$ 1,250,000.00	$1,500,000.00	135.39	$ 1,270,079.75
$ 1,250,000.00	$1,750,000.00	157.96	$ 1,483,334.82
$ 1,250,000.00	$2,000,000.00	180.52	$ 1,696,589.89
$ 1,250,000.00	$2,250,000.00	203.09	$ 1,909,844.97
$ 1,250,000.00	$1,000,000.00	90.26	$ 843,569.61
$ 1,250,000.00	$950,000.00	85.75	$ 800,918.60

Figure 5.12 Cost sensitivity result for LDAP

Based on table 5.6 and figure 5.12, the result of LDAP NPV is positive in all scenario of cost.

71

- % savings

The result of sensitivity analysis with change of % savings is shown in table 5.7 and figure 5.13.

Table 5.7 LDAP % savings scenario sensitivity analysis

Initial % savings	% savings (Scenario Sensitivity)	Result	
		BCR	NPV
5%	5.00%	112.83	$ 1,056,824.68
5%	7.0%	157.96	$ 1,483,334.82
5%	8.0%	180.52	$ 1,696,589.89
5%	9.0%	203.09	$ 1,909,844.97
5%	10.0%	225.65	$ 2,123,100.04
5%	4.00%	90.26	$ 843,569.61
5%	3.0%	67.70	$ 630,314.54
5%	2.0%	45.13	$ 417,059.47

Figure 5.13 % savings sensitivity result for LDAP

Based on table 5.7 and figure 5.13, the result of LDAP NPV is positive in all scenario of % savings.

- Number of project

The result of sensitivity analysis with change of number of project is shown in table 5.8 and figure 5.14.

Table 5.8 LDAP number of project scenario sensitivity analysis

Initial number of project	Number of project (Scenario Sensitivity)	Result	
		Ratio	NPV
2.00	2.00	112.83	$ 1,056,824.68
2.00	3.00	169.24	$ 1,589,962.36
2.00	4.00	225.65	$ 2,123,100.04
2.00	1.00	56.41	$ 523,687.00
2.00	0.00	0.00	$ (9,450.67)

Figure 5.14 number of project sensitivity result for LDAP

Based on table 5.8 and figure 5.14, the result of LDAP NPV is positive in almost all scenario of number of project. The negative result is occurred when the number of project is 0. After all of the critical factors sensitivity analysis have been calculated, then plot the result in the one graph. The result of those three factors sensitivity analysis is shown in figure 5.15

Figure 5.15 Graph of sensitivity analysis for LDAP

- Integration

In integration scenario of sensitivity analysis is change the all factors in the same scenario. The result of integration scenario of sensitivity analysis is shown in table 5.9 and figure 5.16

Table 5.9 Integration scenario of sensitivity analysis for LDAP

Scenario	Cost (Scenario Sensitivity)	% savings (Scenario Sensitivity)	Number of project (Scenario Sensitivity)	Result	
				BCR	NPV
1	$ 1,250,000.00	5.00%	2.00	112.83	$ 1,056,824.68
2	$ 1,750,000.00	8.0%	3.00	379.09	$ 3,573,234.52
3	$ 2,250,000.00	4.0%	4.00	324.94	$ 3,061,422.35
4	$ 950,000.00	10.00%	1.00	85.75	$ 800,918.60
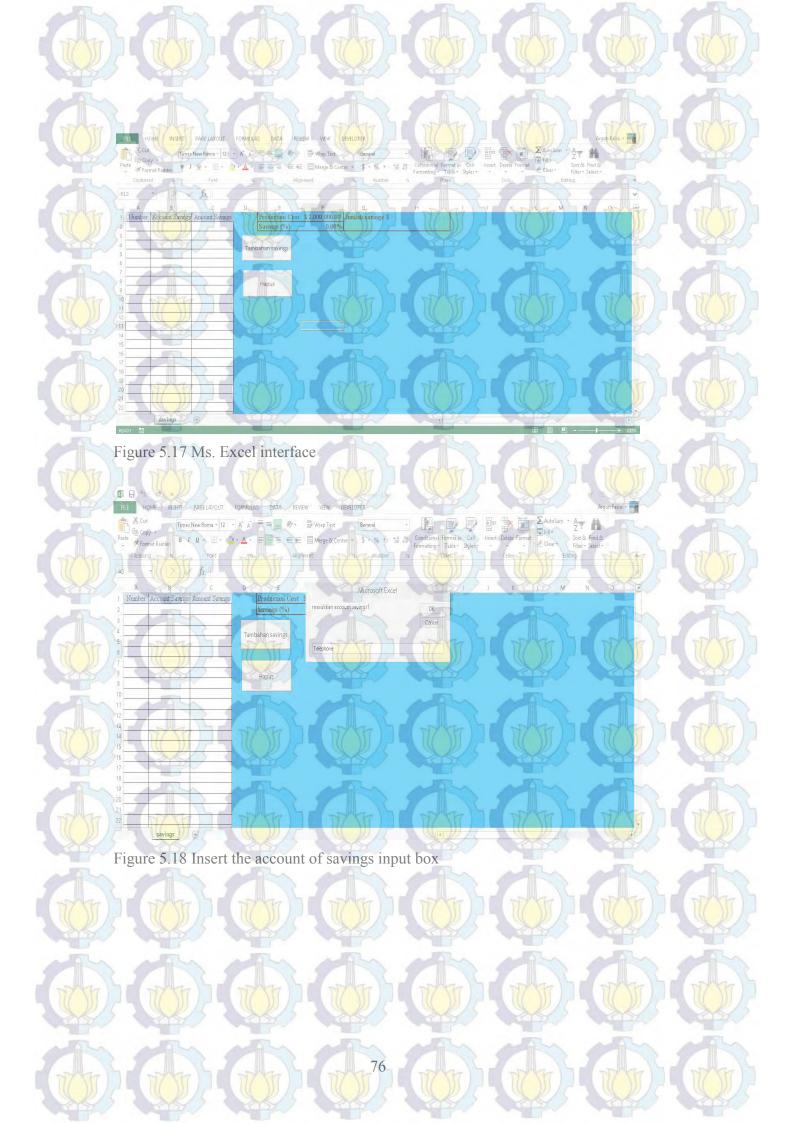
Figure 5.16 Integration scenario of sensitivity analysis for LDAP

Based on the sensitivity analysis, the critical factor that has highest sensitivity is number of project. It because number of project sensitivity analysis result has widest range than the other. LDAP is more robust to provide benefit than SAP R/3 in the change of those factors.

5.2.3   Ms. Excel template for savings calculation

In the previous subchapter, the amount of savings is come from assumption. In order to make General Engineering Division of PT PAL Indonesia (Persero) easier to calculate the amount of savings in a year (%), Ms. Excel template for savings calculation is developed. The interface of Ms. Excel template is shown in figure 5.17.

The Ms. Excel template contains of "Tambahan savings" button and "Hapus" button. "Tambahan savings" button has a function to add the kinds of savings and amount of savings (in number). After all of savings has been listed, the amount of savings will automatically calculate because in cell H1 the listed of savings is summarize with "SUM" formula and in cell F2 the "SUM" of listed of savings in H1 is divided by production cost (cell F1).

Figure 5.17 Ms. Excel interface

Figure 5.18 Insert the account of savings input box

Figure 5.19 Insert the amount of savings input box

Figure 5.20 Result of savings calculation

5.2.3 Discussion of alternatives improvement

This subchapter explains about the discussion of improvement alternatives that will be suggested and potential extra benefit of suggested improvement.

5.2.3.1 Reward improvement

Besides BCR analysis, it needs to analyze the intangible factor in every alternatives of reward improvement. One way to analyze the intangible factor is using Strength Weakness Opportunity Threat (SWOT).

1. Team member of the month

   The SWOT analysis of team member of the month reward is shown in table 5.10

Table 5.10 SWOT analysis of team member of the month reward

Strength	Weakness
1. Less cost	1. Potentially effect jelaousy between employee
2. Easy to implement	
3. Effect to personal recognition is high	

Table 5.10 SWOT analysis of team member of the month reward (con't)

Opportunity	Threat
1. Manager can be familiar with the employee who did job well	1. The reward is potentially become not prestige in the future

2. Thank you card

   The SWOT analysis of thank you card reward is shown in table 5.11

Table 5.11 SWOT analysis of thank you card reward

Strength	Weakness
1. easy to implement 2. effect to personal recognition is moderate 3. potentially can motivate employee better than other alternatives	1. it cost highest than other alternatives
Opportunity	Threat
1. Variation of reward is high 2. This reward potentially still prestige in the future	1. Employee not interested with the prizes

3.   Project team leader or manager personally congratulates

The SWOT analysis of the project team leader or manager personally congratulates reward is shown in table 5.12

Table 5.12 SWOT analysis of manager personally congratulates reward

Strength	Weakness
1. Less cost 2. Easy to implement	1. Effect to personal recognition is low
Opportunity	Threat
1. Potentially make better relationship between manager and employee	1. The reward is potentially become not prestige in the future

Based on the SWOT analysis, it can be seen that the alternatives that has highest number of Strength and Opportunity is "Thank you card" reward.

5.2.3.2   IT system improvement

Besides BCR analysis, it needs to analyze the intangible factor in every alternatives of reward improvement. One way to analyze the intangible factor is using Strength Weakness Opportunity Threat (SWOT).

1.   LDAP

The SWOT analysis of LDAP is shown in table 5.13.

Table 5.13 SWOT analysis of LDAP

Strength	Weakness
1. Less cost of investment 2. Easy to implement 3. Support moderate integration 4. time to implement is short	1. Not flexible 2. Takes longer in data processing 3. The directory need to be update if a company need additional process in future
Opportunity	Threat
1. Potentially make better relationship to IT Sub-Contractor company	1. Problem with IT sub-contractor effect to the performance of LDAP implementation

2. SAP R/3

The SWOT analysis of SAP R/3 is shown in table 5.14

Table 5.14 SWOT analysis of SAP R/3

Strength	Weakness
1. Support good integration	1. The investment cost is high
2. Decrease number of eror or redundant data entry	2. The time needed to implement is long
3. Data can be access fast even the number of data is high and complex	3. Need expert employee to operate
Opportunity	**Threat**
1. It can produce more savings when it used in larger scale	1. Repairing cost when software or hardware breakdown is high

Based on the SWOT analysis, it can be seen that the alternatives that has highest number of Strength and Opportunity is LDAP.

5.2.3.3 Suggested combination of improvement alternatives

Based on benefit cost ratio analysis and SWOT analysis the suggested combination of improvement alternatives are:

1. Thank you card and LDAP

By implementing these improvement suggestion, General Engineering Division of PT PAL Indonesia (Persero) is expected to increase the readiness level of team in organization part and integration support part. Thank you card is expected can increase motivation of worker higher than the other alternatives reward. But thank you card will cost this division higher than other alternatives. For IT system improvement, LDAP is expected can improve integration in General Engineering Division department. While SAP R/3 will provide this division more integration and employee can access data faster, in this case LDAP is enough to support the integration.

2. Team member of the month and LDAP

By implementing these improvement suggestion, General Engineering Division of PT PAL Indonesia (Persero) is expected to increase the readiness level of team in organization part and integration support part. Team member of the month is expected to increase employee's motivation, even the effect is still below from thank you card award, but team member of the month will cost lower than thank you card.

3. Thank you card and SAP R/3.

By implementing these improvement suggestion, General Engineering Division of PT PAL Indonesia (Persero) is expected to increase the readiness level of team in organization part and integration support part. This reward is expected to increase employee motivation highest than other alternatives. By implementing SAP R/3, General Engineering Division of PT PAL Indonesia (Persero) will get benefit if this division can increase the amount of savings in a year. The benefit or savings in a year is expected to increase on the following years. These rewards is very costly but these rewards is expected to increase those parts highest than other alternatives.

5.2.3.4 Potential extra benefit

By implementing the improvement suggestion, not only the parts that have lowest value will be increase but also other parts potentially will be increase. For IT system improvement, not only integration part will be increase but also communication support part, coordination support part, information sharing, and task support part are expected to be increase. For reward system improvement, team in organization part is expected to be increase and also improve discipline part which has average score 69%. It because when motivation of employee increase, employee will tend to be more discipline. The extra benefit that potentially to get when improvement in rewarding system implemented is shown in figure 5.21
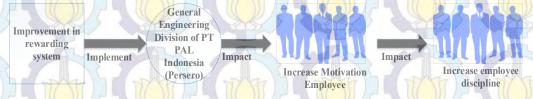
Figure 5.21 Expected extra benefit of reward system improvement suggestion

After all benefit of improvement suggestion known, new average score of Concurrent Engineering (CE) readiness level can be estimated. Assumed that every part that get the benefits of improvement increase 2%, the new average score of CE readiness level is shown in table 5.15

Table 5.15 Comparison of the existing score and the expected score of CE readiness level

Element	Part of element	Existing Perentage	Expected Percentage
Process	Management system	87%	87%
	Process focus	94%	94%
	Organizational framework	73%	73%
	Strategy deployment	68%	68%
	Agility	70%	70%
People	Team formation and development	80%	80%
	Team leadership and management	81%	81%
	Discipline	69%	71%
	Teams in organization	58%	60%
Project	Customer focus	64%	64%
	Quality assurance	94%	94%
	Project design	72%	72%
Technology	Communication support	78%	80%
	Coordination support	72%	74%
	Information sharing	75%	77%
	Integration on support	53%	60%
	Task support	81%	83%
AVERAGE		74.6%	75.7%

CHAPTER 6

CONCLUSSION AND SUGGESTION

This chapter is final chapter of this research. This chapter explains about conclusion and suggestion of this thesis.

6.1 Conclusion

1. To assess readiness of CE implementation in General Engineering Division PT. PAL Indonesia (Persero), the BEACON Model is used. Based on the questionnaire result, General Engineering Division PT PAL Indonesia (Persero) reached managed level and has total average score 74,65%. The average score for each element are 78% for process element, 72% for people element, 77% for project element and 72% for technology element. The parts that need to be improved is team in organization part in people element (58%) and integration support part in technology element (53%) which means both of them categorized to characterized level.

2. There are three alternatives to improve the readiness level of General Engineering division on team in organization part in people element. The first is implementing team member of the month. The second is implementing thank you card. The third is implementing a method that allow a top management or team leader congratulating directly to the team member who has best performance in a certain period. Those alternatives are expected to give some benefits such as motivation of all team will be increase and build a better work environment. To improve the readiness level of General Engineering division on integration support part in technology element, the alternatives are implement SAP R/3 and Lightweight Directory Access Protocol (LDAP). Implementing SAP R/3 will cost the company $ 1,790,000.00 in investment but it is expected to get savings about $200,000. Implementing LDAP will cost the company $2,200 in the first year

installment and $850 for the following year. By implementing LDAP the company is expected to get savings about $200,000. After conducted Benefit Cost Ratio (BCR) analysis and SWOT analysis, alternatives combination of improvement suggestion are thank you card and LDAP, team member of the month and LDAP, and Project team leader or manager personally congratulates and LDAP.

6.2 Suggestion

The suggestion of this research is divided into two, there are suggestion for PT PAL Indonesia (Persero) and suggestion for next research.

6.2.1 Suggestion for PT PAL Indonesia (Persero)

The suggestions for PT PAL Indonesia (Persero) through this research are:

1. Top Management keep increasing the understanding about Concurrent Engineering
2. Before implement CE, top management of General Engineering Division PT PAL Indonesia (Persero) has to increase the commitment to solve the part with lowest value from the result of BEACON Model by implementing the improvement recommendation before implementing Concurrent Engineering.
3. Top management also gives better understanding to the all employees about Concurrent Engineering.

6.2.2 Suggestion for Next Research

The suggestion for the next research in order to make the research better are:

1. Focus Group Discussion (FGD) with CE team is an important activity to do. It better conduct FGD more than one time if it possible in order to make better understanding about CE in CE team member.
2. Besides assess the company, it needs to assess the whole company supply chain. It because in running the business a company is not only

deal with the internal condition of the company but also another companies that related in the company supply chain. The implementation of CE will not effective if another companies in the company supply chain is not ready.

3. It needs to verify the analysis of improvement recommendation to the company in order to minimize the use of assumption and make the improvement recommendation analysis suitable with existing condition of the company.

REFERENCES

Alwi, S., Hampson, K., Mohamed, S. (2002). "*Non Value-Adding Activities: A Comparative Study of Indonesian and Australian Construction Projects.*" Proceedings of the 10th annual conference of the IGLC, Gramado, Brazil

Cleland, D. I. (1998). "*Field Guide to Project Management.*" John Wiley & Sons.

Connor, J., and Dodd, S.C. (2000). "*Achieving integration on capital Projects with enterprise Resource Planning Systems*" Automation in Construction, Vol. 9, issues 5-6 pp 5515-524

Crowley, A. (1996), 'Construction as a Manufacturing Process', in Kumar, B, and Retik, A. (eds), *Information Representation and Delivery in Civil Structural Engineering Design*, Civil-Comp Press, Edinburgh, Scotland, pp. 85-91

EconomyWatch. (2010, June 29). *Construction Industry*. Retrieved October 19, 2014, from Economy Watch: http://www.economywatch.com/world-industries/construction

Egan, J. (1998), 'Rethinking Construction', *Report of the Construction Task Force on the Scope for Improving the Quality and Efficiency of UK Construction*, Department of the Environment, Transport and the Regions, London.

Evbuomwan, N. F. O. and Anumba, C. J. (1998) "*an Integrated Framework for Concurrent Life-cycle Design and Construction*," Advances in Engineering Software, 1998, Vol. 5, No. 7-9, pp.587-597

Hatush, Z., Skitmor, & R., M. (1997). "*Criteria for contractor selection.*" Construction Management and Economics, 19-38.

INCOSE, International Council on Systems Engineering. (1998). "*Integrated Product and Process Development.*" Paper presented at the INCOSE System Engineering Handbook.

Kamara, M. J., Anumba, C. J., & Cutting-Decelle, A.-F. (2007). Introduction to Concurrent Engineering. In J. M. Kamara, C. J.Anumba, & A.-F. Cutting-Decelle, *Concurrent Engineering in Construction Projects* (p. 1). New York: Taylor & Francis.

Karningsih, P. D. (2007). "*Analisis Faktor-Faktor Penghambat pada Pengimplementasian Concurrent Engineering (CE).*" 1-7.

Khalfan, M. M., Anumba, C. J., & Carrilla, P. M. (2007). Readiness Assessment for Concurrent Engineering in Construction. In J. M. Kamara, C. J.Anumba, & A.-F. Cutting-Decelle, *Concurrent Engineering in Construction Projects* (pp. 31-43). New York: Taylor & Francis.

Khalfan, M M A, Anumba, C J and Carrillo, P M (2001) Concurrent engineering readiness assessment of sub-contractors within the UK construction industry. In: Akintoye, A (Ed.), 17th Annual ARCOM Conference, 5-7 September 2001, University of Salford. Association of Researchers in Construction Management, Vol. 1, 741-50

Lawson,M., and Karandikar, H. M. (1994). A survey of concurrent engineering. *Concurr. Eng. Res. Appl.* 2:1-6

Lee, S., Arif, A., and Halpin, D. (2002) "*Simulation Modeling by Enterprise Resource Planning implementation in Medium Sized Corporation*." Proceedings of First International Conference on Construction in the 21st Century (CITC-2002), Miami, Florida, pp 663-670.

Moges, A. (2007). *Concurrent Engineering and Implementation A Case Study in Addis Engineering Center*. Addis Ababa University.

Nelson, B. (1994). *1001 Ways to Reward Employees*. New York: Workman

O'Brien, James A (2005). *Introduction to Information System, 12th Edition*. McGraw Hill Companies Inc, New York.

P.Sumaedi, D. (2014, April 30). *PT PAL Incar Proyek Rekayasa Umum*. Retrieved September 09, 2014, from tempo.co: http://www.tempo.co/read/news/2014/04/30/093574556/pt-pal-incar-proyek-rekayasa-umum

PAL Indonesia. (2008). *Corporate Profile*. Retrieved September 09, 2014, from pal.co.id: http://www.pal.co.id/v5/company/index.php?page=E_3_7

Pawar, D. K., Driva, H., Thoben, D. K.-D., Oehlmann, D. R., & Weber, F. (1996). Concurrent Engineering: From Concept to Implementation. *International Conference on Agile Manufacturing*, (pp. 1-17). Banglore.

Prasad, B. (1995). Sequential versus Concurrent Engineering-An Analogy. *Concurrent Engineering*, 250-255.

Schilling, D.R. (2013, March 08). "*Global Construction Expected to Increase by $4.8 Trillion by 2020*". Retrieved October 19, 2014, from Industry Tap: http://www.industrytap.com/global-construction-expected-to-increase-by-4-8-trillion-by-2020/1483\

Sanvindo, V. E. and Medeiros, D. J. (1990), "*Applying Computer-Integrated Manufacturing Concepts to Construction*", *Journal of Construction Engineering and Management*, Vol. 116 No. 2, pp. 365-379

Smith, Preston G. and Reinertsen, Donald G. "*Developing Products in Half*" the Time New York: Van Nostrand Reinhold, 1995

Stajkovic, A. D. & Luthans, F. (1997). "*A meta-analysis of the effects of organizational behaviour modification on task performance*". Academy of Management Journal, 1997

Susan M.Bogus, M., Keith R. Molenaar, A., & James E. Diekmann, M. (2005). "*Concurrent Engineering Approach to Reducing Design Delivery Time*". Journal of Construction Engineering and Management, 1179-1185.
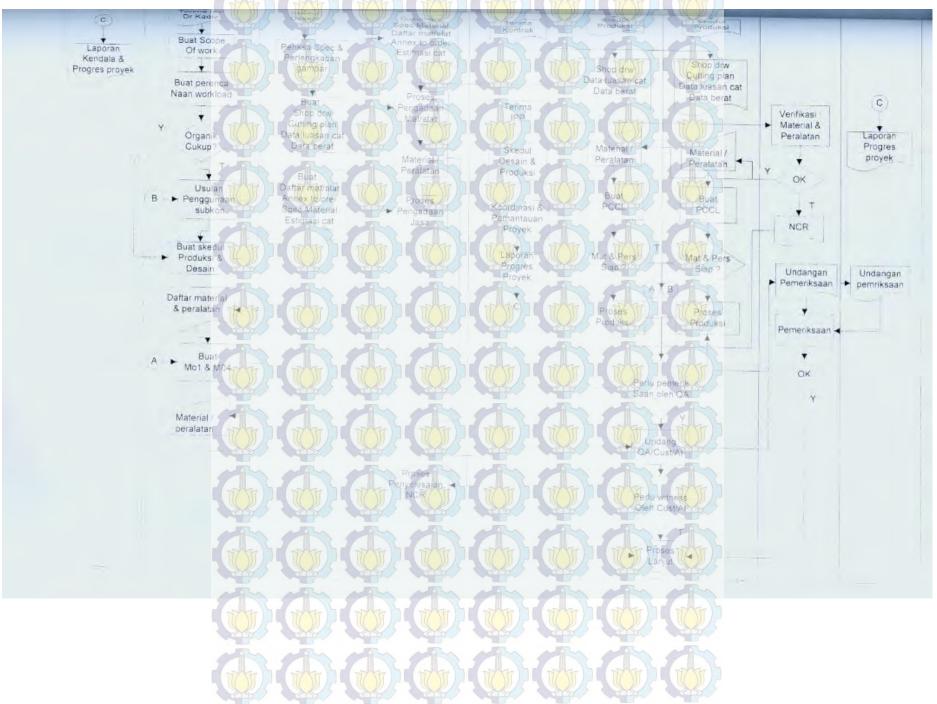
Syed M. Ahmed, M.S., Ahmad I., Azhar S., Mallikarjuna S. (2003). "*Implementation of Enterprise Resource Planning (Erp) Systems In The Construction Industry.*" Dept. of Construction Management, Florida International University
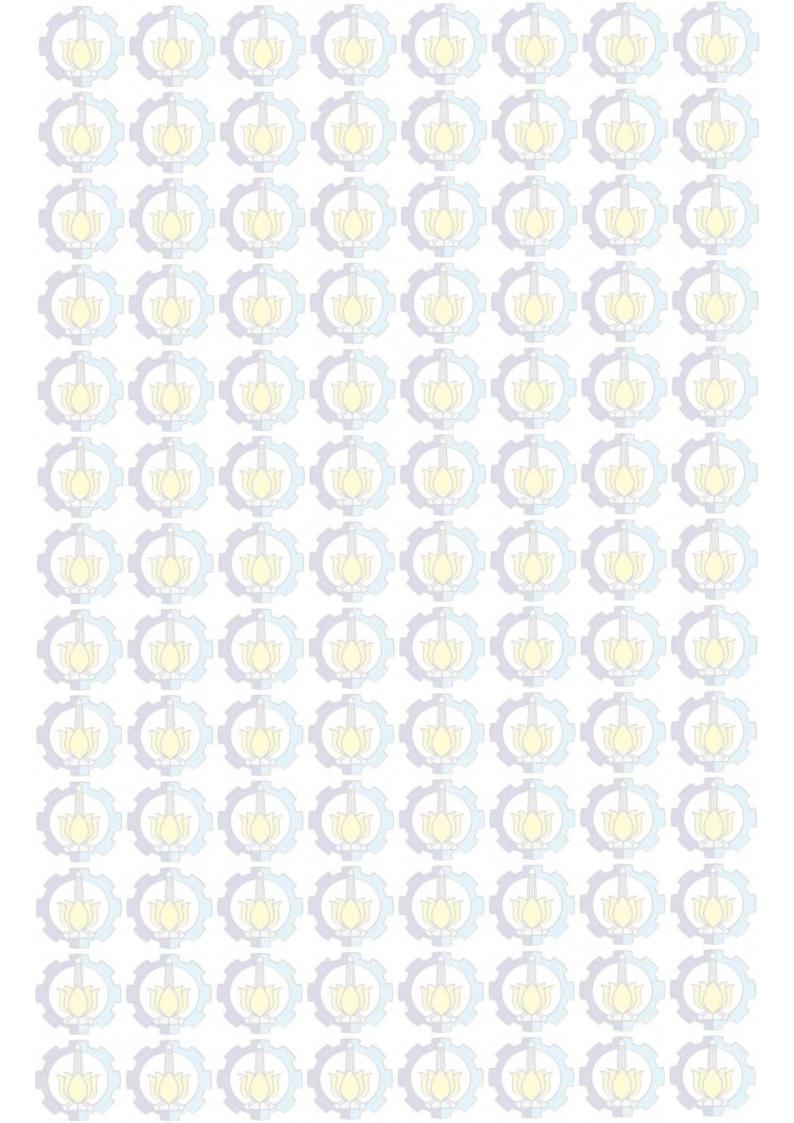
Towers Perrin (2003), "*Managing Performance and Rewards in a Challenging Business Environment*", New York: Towers Perrin.

Yeo, K. T, and Teo, K.K (1994), "*Perception and relevance of concurrent engineering in Singapore's Manufacturing Industry*", IEEE Region 10 (Asia) 9th Conference, 24-26 Aug 1994, Singapore

APPENDIX 1

GENERAL ENGINEERING DIVISION OF PT PAL INDONESIA

(PERSERO) BUSINESS PROCESS

C

Laporan Kendala & Progres proyek

Terima ... Dr Kadiv
Buat Scope Of work
Buat perencanaan workload
Y
Organik Cukup?
T
B → Usulan Penggunaan subkon
Buat skedul Produksi & Desain
Daftar material & peralatan
A → Buat Mo1 & M04
Material / peralatan

Desain
Periksa Spec & Perlengkapan gambar
Buat Shop drw Cutting plan Data luasan cat Data berat
Buat Daftar mat/alat Annex to order Spec Material Estimasi cat

Disahkan Spec Material Daftar mat/alat Annex to order Estimasi cat
Proses Pengadaan Mat/alat
Material / Peralatan
Proses Pengadaan Jasa
Proses Penyelesaian NCR

Terima Kontrak
Terima IPP
Skedul Desain & Produksi
Koordinasi & Pemantauan Proyek
Laporan Progres Proyek
C

Skedul Produksi
Shop drw Data luasan cat Data berat
Material / Peralatan
Buat PCCL
Mat & Pers Siap?
A

Skedul Produksi
Shop drw Cutting plan Data luasan cat Data berat
Material / Peralatan
Buat PCCL
T
Mat & Pers Siap?
B
Proses Produksi
Perlu pemeriksaan oleh QA
Y
Undang QA/Cust/AR
Perlu witness Oleh Cust/AR
Proses Lanjut

Verifikasi Material & Peralatan
Y
OK
T
NCR
Undangan Pemeriksaan
Pemeriksaan
OK
Y

C
Laporan Progres proyek
Undangan pemriksaan

APPENDIX 2
PROJECT ORGANIZATIONAL STRUCTURE

Deputy Project Manager — Bambang Setyawan

Fabrication Manager — Budiyono / Luciana Tjatur S

Project Secretary — Yayuk Sulasmi

Finance & Tax — Ari Dwi / Sampe Nainggolan

Engineering Coordinator — Hosni Tamrin
- **Structural Engineer** — Topside - Timbul Guntoro / Jacket - Beatrice Murtyta
- **Piping Engineer** — Ridwan
- **Mechanical Engineer** — Fendy Miranda
- **Elect & Instr Engineer** — Widijo Utomo / K. Yunata Kurniawan
- **Welding Engineer** — Choirul Basori
- **Loadout Engineer** — Agus Wibowo

Procurement Coordinator — M. Sholahuddin
- **Structural Purchaser & Expdt** — M. Sholahuddin
- **Piping Purchaser & Expdt** — Andry Prijoharjono
- **Mechanical Purchaser & Expdt** — Andry Prijoharjono
- **E & I Purchaser & Expdt** — Supramianto
- **Labour & Consumable Purchaser** — M. A Holik
- **Custom Clearance** — Ishaq Lumalunfur

HSE Coordinator — Sudi Utomo
- **HSE Officer** — Ika Marcelina
- **HSE Engineer** — A. M. Fiduddin
- **HSE Inspector** — Indita Eka Putra

Fabrication & Instalation Coordinator — Hendra Dwikangko
- **Fabrication Engineer** — Lutfi Taufik
- **Jacket / Pile Supervisor** — Jacket - Murjito
- **Top Side Supervisor** — Adji
- **Piping Supervisor** — Pujiono
- **Mechanical Supervisor** — Rudi Wahyudianto
- **E & I Supervisor** — Rapud Hananto

PPC Coordinator — Rudi Sugiarto
- **Planning & Reporting** — Suwadji
- **Document Control** — Ahmad Kholruddin
- **Material Expeditor** — Sugeng Hariono
- **Support Facility** — Suyono

QA / QC Coordinator — Imam Muttaqien
- **Structural QA/QC** — Fajar Nurcahyo
- **Piping QA / QC** — Eko Prasetyo
- **Mechanical QA/QC** — Dimas Pamungkas
- **Electrical & Instrument QA/QC** — M. Andri Lutfi
- **Pre-Commisioning** — Rusaeful Arief
- **Document (MDR)** — Novi Mayasari

APPENDIX 3
EXISTING CONDITION RESULT IN BEACON QUESTIONNAIRE

KUISIONER *BEACON MODEL*

Kuisioner BEACON *model* di esain oleh Malik M. A. Khalfan pada tahun 2000 untuk menilai tingkat kesiapan organisasi dalam implemetasi *concurrent engineering*. Dengan model kuisioner yang baru ini akan menilai organisasi dalam empat element utama (Proses, Manusia, Proyek, dan Teknologi).

Pada kuisioner ini akan terbagi menjadi lima bagian. Bagian pertama (bagian A) akan mengumpulkan informasi umum mengenai perusahaan dan responden. Untuk bagian selanjutnya (bagian B hingga bagian E) akan membahas tentang empat elemen dari model.

Mohon untuk menjawab seluruh pertanyaan dengan cara mencentang (√) hanya pada satu kotak untuk setiap pertanyaan. Jika terdapat pertanyaan, silahkan segera bertanya untuk penjelasan lebih lanjut. Terima kasih atas bantuan Anda dalam berpartisipasi pada kegiatan *assessment* ini.

Argon Faisal Marconi – 25 11 100 108
Jurusan Teknik Industri
Fakultas Teknologi Industri
Institut Teknologi Sepuluh Nopember

INFORMASI UMUM

Nama Perusahaan : PAL

Alamat : Ujung

Nama Responden : Bambng S

Jabatan Responden : WPM

Deskripsi Jabatan : Wakil Pemimpin Proyek.

Tanggal Pengisian : 23 Dec 2014

Nomor Telepon : 08123034143

Email : bbsetiawan@pal.co.id

Prioritas Elemen(*): [1] Proses [2] Manusia [3] Proyek [4] Teknologi

Silahkan isi dengan nilai 1-4

(1→ prioritas pertama ; 2→ prioritas kedua ; 3→prioritas ketiga ; 4→prioritas keempat)

B. ELEMEN PROSES

Bagian dari Elemen	Pertanyaan	Selalu	Sering	Terkadang	Jarang	Tidak Pernah
Sistem Manajemen	Estimasi dan penjadwalan proyek terdokumentasi dalam hal *controlling* dan *tracking* Project Development Process (PDP)	v				
	Resources cukup telah tersedia dalam perencanaan proyek (Contoh : pendanaan, pengalaman pada individu, dll.)		v			
	Tim Pengembangan Proyek (TPP) menetapkan *time margin* dalam jadwal untuk *contingencies*.	v				
	Terdapat peraturan pada perusahaan dalam hal pelaksanaan kontrak dan sub-kontrak untuk *supplier* atau *outsource*.	v				
	Aktivitas dan performansi dari kontraktor dan sub-kontraktor *supplier* dilakukan *review* baik secara periodik maupun secara *eventual*.		v			
	Prosedur alokasi *resource* yang sama dilakukan oleh perusahaan untuk setiap proyek (contoh: alokasi dilakukan pada tingkat kesulitan teknis pada setiap aktivitas untuk setiap proyek, dll.).		v			
	Analisa dampak dalam alokasi *resource* memungkinkan untuk dilakukan.	v				
	Sistem akuntansi & manajemen keuangan proyek yang terstandarisasi dan dapat dipercaya digunakan dalam seluruh proyek.		v			
	Sistem akuntansi & manajemen keuangan proyek terintegrasi dengan sistem manajemen proyek.		v			
	Rencana manajemen resiko dipersiapkan pada setiap proyek (dapat digunakan untuk memonitor proses pengembangan proyek dan kuantifikasi faktor resiko proyek).		v			

Bagian dari Elemen	Pertanyaan	Selalu	Sering	Terkadang	Jarang	Tidak Pernah
	Studi *Trade-off* telah dilakukan untuk mengidentifikasi resiko terkait dengan teknologi baru.		v			
	Tindakan korektif dilakukan saat kondisi aktual berbeda secara signifikan dari rencana proyek.	v				
	Senior management melakukan review pada aktivitas perencanaan proyek baik secara periodik maupun secara *eventual*.	v				
Process Focus	Proses Pengembangan Proyek (PPP) terdokumentasi.	v				
	Proses dokumentasi tersimpan dalam bentuk elektronik dan dapat diakses oleh anggota Tim Pengembangan Proyek (TPP).	v				
	Proses yang sama digunakan pada proyek yang berbeda (Contoh: proses *reuse)*.	v				
	Keputusan terdahulu dianalisa untuk membantu *improvement* dalam PPP secara kontinyu.	v				
	Prosedur digunakan untuk mengevaluasi dan meningkatkan PPP secara periodik.	v				
	Data dikumpulkan untuk mengukur efektivitas dari PPP.	v				
	Terdapat seseorang atau grup yang bertanggung jawab dalam *improvement* PPP.		v			
	PPP (Proses Pengembangan Proyek) fleksibel sehingga dapat beradaptasi pada perubahan (Contoh: perubahaan pada proyek, personal, dll.)			v		
	Aktivitas proses kritis teridentifikasi pada tahap awal PPP.	v				
	Parameter proses kritis teridentifikasi pada tahap awal PPP.	v				

Bagian dari Elemen	Pertanyaan	Selalu	Sering	Terkadang	Jarang	Tidak Pernah
	Parameter proses kritis secara kontinyu dimodifikasi untuk mengoptimasi biaya, kualitas, dan waktu.	v				
	Proses dan sub-proses sebisa mungkin dilakukan secara *concurrent*	v				
	Proses *non-value-adding* dieliminasi dari PPP sebisa mungkin.	v				
Framework Organisasi	*Briefing* proyek terdokumentasi pada setiap awal proyek.	v				
	Aktivitas untuk mengelola dan memperbarui *briefing* objek ditujukan untuk review *quality assurance*.		v			
	Terdapat peraturan pada perusahaan yang dapat membantu dalam pengawasan dan pengaturan perbaikan secara kontinyu pada sistem dan teknologi manajemen.		v			
	Perusahaan menganalisa nilai tambah pada setiap aktivitas pengembangan proyek.		v			
	Terdapat peraturan yang dapat membantu tim untuk mengalokasikan *resource* dan *trade-off* (*resource* seperti dana, tenaga kerja, dll.).		v			
	Terdapat dukungan dari perusahaan yang cukup untuk menyelesaikan konflik dalam tim.		v			
	Lingkungan perusahaan mendukung setiap individu untuk melakukan pekerjaan yang berbeda.			v		
	Lingkungan perusahaan mendukung anggota tim pengembangan proyek dan sub tim untuk bekerja secara individu, grup, atau jenis pekerjaan transisi dari keduanya.			v		
	Lingkungan perusahaan mendukung cara kerja yang disukai setiap individu.			v		

Bagian dari Elemen	Pertanyaan	Selalu	Sering	Terkadang	Jarang	Tidak Pernah
	Struktur organisasi fleksibel dan mendukung untuk variasi dari kebutuhan proyek dan proses.		v			
	Senior management memiliki bisnis strategi yang jelas pada setiap proyek.		v			
	Strategi konsisten dengan peraturan bisnis perusahaan.		v			
	Strategi fokus pada *improvement* dari proses pengembangan proyek pada setiap proyek.		v			
	Strategi dapat mendorong tim untuk menyelesaikan isu pada tingkat struktur organisasi terendah.			v		
	Kebijakan SDM mendukung strategi dan dilakukan *improvement* secara kontinyu.			v		
Penyebaran Strategi	Tim menyertakan beberapa orang untuk mengidentifikasi dan mencegah permasalahan di masa depan terkait dengan proses pengembangan proyek.		v			
	Tim disiapkan untuk menangani permintaan *client* terkait dengan proses pengembangan proyek.		v			
	Senior management fokus pada *improvement* sistem manajemen dari setiap proyek dalam perusahaan.			v		
	Senior management memastikan bahwa setiap krisis tidak akan mengganggu jalannya proses pengembangan proyek.			v		
	Permasalahan yang dihadapi pada saat proses pengembangan proyek diawasi hingga terselesaikan.	v				
Kesigapan	Prosedur terdokumentasi digunakan untuk memastikan bahwa perusahaan dapat merespon perubahaan dalam proses pengembangan proyek.		v			

94

Bagian dari Elemen	Pertanyaan	Selalu	Sering	Terkadang	Jarang	Tidak Pernah
	Waktu respon untuk perubahan pada kebutuhan *client* ditingkatkan untuk proyek baru.			v		
	Setiap anggota tim secara *concurrent* membuat keputusan *trade-off* untuk merespon perubahan pada kebutuhan *client*.		v			
	Proses pengembangan proyek cukup fleksibel untuk menggabungkan perubahan pada kebutuhan *client*.		v			
	Dokumentasi proses pengembangan proyek dilakukan secara elektronik dan dapat diakses oleh seluruh anggota tim.		v			
	Dokumentasi proses pengembangan proyek menyertakan informasi pada keputusan yang diambil pada saat proses.		v			
	Memori perusahaan mengenai organisasi di-*maintain*.		v			
	Memori perusahaan tersedia untuk seluruh anggota tim pengembangan proyek.			v		
	Aset dan *resource* dapat digunakan ulang untuk proyek baru (Contoh: permesinan, rancangan fasilitas, material, dll.		v			
	Tim pengembangan proyek menggunakan informasi proyek terdahulu (Contoh: desain, konstrain, dll.) untuk merencanakan perubahan.		v			

C. ELEMEN MANUSIA

Bagian dari Elemen	Pertanyaan	Selalu	Sering	Terkadang	Jarang	Tidak Pernah
Pembentukan dan Pengembangan Tim	Tim Pengembangan Proyek (TPP) terbentuk sebagaimana mungkin merepresentasikan dari setiap divisi (Contoh: tim desain, tim Q/S, dll.)	v				
	TPP dan sub-tim terdiri dari individual yang antusias dan ahli dalam bidang masing-masing.		v			
	Seluruh anggota tim berinteraksi secara kontinyu.	v				
	Masing-masing anggota tim mengerti akan kewajibannya.	v				
	Terdapat tujuan bersama dalam tim untuk proyek tertentu.	v				
	Peraturan perusahaan mendorong tim untuk mencapai tujuan yang berbeda.			v		
	Terdapat peraturan perusahaan untuk mengatur program pelatihan untuk tim.	v				
	Resource cukup tersedia untuk mengimplementasikan program pelatihan (Contoh: pendanaan, fasilitas pelatihan, dll.).			v		
	Seluruh anggota tim menerima pelatihan secara rutin untuk meningkatkan kemampuan teknis dan kerjasama tim.		v			
	Pelatihan tim dievaluasi untuk efektivitasnya.			v		
***Leadership* dan Manajemen Tim**	Ketua tim dari tim pengembangan proyek (TPP) dan sub-tim terpilih berdasarkan kemampuan teknis dan manajerial.	v				
	Ketua tim bertanggung jawab dalam penyelesaian tugas dan aktivitas tepat waktu dan tidak melebihi *budget*.	v				
	Ketua tim memiliki kewenangan untuk mendapatkan anggota tim baru.	v				

Bagian dari Elemen	Pertanyaan	Selalu	Sering	Terkadang	Jarang	Tidak Pernah
	Ketua dari TPP bekerja sebagai manajer proyek dan bertanggung jawab untuk *controllingi,* mengatur, mengarahkan, dan merencanakan Proses Pengembangan Proyek (PPP).	v				
	Ketua tim mengambil keputusan final untuk semua proyek dan isu pada tim.	v				
	Ketua tim berkonsultasi kepada *senior management* sebelum mengambil keputusan tim.		v			
	Senior manager mengawasi *progress* dari PPP dan TPP.		v			
	Senior management mencoba untuk menyelesaikan isu pada level organisasi terbawah.					v
Kedisiplinan	Seluruh anggota tim berada dalam aturan kedisiplinan yang telah dirancang oleh perusahaan.	v				
	Seluruh anggota tim (termasuk ketua tim) berkomitmen pada peraturan tim.	v				
	Anggota mengesampingkan agenda individual dan bekerja untuk kepentingan tim.	v				
	Anggota tim tetap bersama meskipun terdapat isu yang tidak mudah.	v				
	Meeting tim mengikuti peraturan perilaku yang berlaku.	v				
	Terdapat komitmen dari perusahaan untuk mengatasi permasalahan kedisiplinan secara jelas.			v		
	Terdapat prosedur mengenai keluhan.					v
	Senior management memastikan bahwa tim proyek mengikuti peraturan yang berlaku saat menyampaikan *value* kepada *client*.	v				

97

Bagian dari Elemen	Pertanyaan	Selalu	Sering	Terkadang	Jarang	Tidak Pernah
Tim dalam Organisasi	Terdapat berbagai grup yang terspesialisasi dalam organisasi sehingga dapat bekerja dalam tim.	v				
	Anggota tim fokus pada tugas spesifik masing-masing dan menunjang tim pengembangan proyek.	v				
	Tim memiliki kewenangan dalam keputusan terkait hal teknis dan biaya.	v				
	Tim memiliki kewenangan dalam pemberian *reward* kepada anggota tim.					v
	Terdapat *reward* untuk bertindak sebagai anggota tim dibandingkan memenuhi kepentingan pribadi.					v
	Anggota tim mudah untuk ditempatkan.			v		
	Komunikasi dan *sharing* informasi antar anggota tim mudah untuk dilakukan.	v				
	Masing-masing anggota bertanggung jawab untuk mencapai kesuksesan dalam proyek yang spesifik.	v				
	Peraturan perusahaan dapat mengukur performansi tim dan mendorong *teamwork*.			v		
	Performansi tim krusial untuk kesuksesan karir individu.			v		
	Terdapat komitmen dari perusahaan untuk menyediakan pelatihan yang cukup dan terspesifikasi untuk setiap individu dalam menjalankan perannya di dalam tim.	v				
	Terdapat peraturan perusahaan untuk merencanakan dan mengadakan *peer review* di dalam tim untuk mengurangi *defect* dari aktivitas *output* pada awal dan secara efisien.			v		

D. ELEMEN PROYEK

Bagian dari Elemen	Pertanyaan	Selalu	Sering	Terkadang	Jarang	Tidak Pernah
Client Focus	*Client* terlibat dalam Proses Pengembangan Proyek (PPP) sebagai anggota dari Tim Pengembangan Proyek (TPP).			v		
	Prosedur dan panduan yang terdokumentasi dengan baik ada pada saat pengumpulan kebutuhan *client*.		v			
	Seluruh anggota Tim Pengembangan Proyek (TPP) paham dengan baik dalam kebutuhan *client*.		v			
	Sarana berbasis komputer digunakan dalam pemunculan dan penyebaran kebutuhan *client*.		v			
	Tim dapat mengakses kebutuhan *client* kapan pun selama proses pengembangan proyek.		v			
	Tim merespon dengan tepat dalam perubahan prioritas *client*.		v			
	Prosedur digunakan untuk mengevaluasi sebaik apa tim mengakomodasi prioritas baru *client*.			v		
	Prosedur digunakan untuk mengevaluasi apakah kebutuhan *client* telah terpenuhi.			v		
	Sarana berbasis komputer digunakan untuk membantu mengevaluasi apakah kebutuhan komputer telah terpenuhi.			v		
Quality Assurance	Pengembangan standar proyek secara internal yang digunakan pada saat fase desain dan proyeksi dari proyek telah berjalan dengan baik.		v			
	Standar proyek dapat diakses oleh seluruh anggota tim.		v			

Bagian dari Elemen	Pertanyaan	Selalu	Sering	Terkadang	Jarang	Tidak Pernah
	Aktivitas *Quality Assurance* (QA) yang dapat mengkonfirmasi proyek yang telah selesai dan proses sesuai dengan prosedur telah digunakan.	v				
	Segala perubahan dan variasi dari proyek ditujukan untuk *review* dan audit QA.	v				
	Terdapat peraturan perusahaan untuk memastikan kualitas proyek dengan mengimpelementasikan teknik manajemen kualitas.	v				
	Metode digunakan untuk memastikan qualitas yang dibutuhkan untuk material sebelum proyeksi pada setiap proyek.	v				
	Terdapat metode standar untuk mengumpulan dan analisa dari data proyek gagal untuk *feedback* bagi tim.	v				
	Terdapat prosedur untuk mengecek *progress* dari proses pengembangan proyek berdasarkan kualitas, biaya, waktu, dan spesifikasi baik secara periodik maupun *eventual*.	v				
Desain Proyek	*Interface* utama selama Proses Pengembangan Proyek (PPP) secara strategis didefinisikan pada tahap awal proyek.		v			
	Desain dan gambar pendahuluan dari proyek telah disiapkan sebelum memasuki desain final produk dan fase proyeksi dari sebuah proyek.		v			
	Seluruh anggota Tim Pengembangan Proyek (TPP) menganalisa gambar pendahuluan dan memberikan komen beserta saran dalam bagaimana cara mengatasi adanya masalah pada hilir selain itu juga mengkonfirmasi kebutuhan *client*.		v			
	Terdapat peraturan perusahaan yang memastikan bahwa *client* telah puas dengan desain pendahuluan dari proyek.			v		

Bagian dari Elemen	Pertanyaan	Selalu	Sering	Terkadang	Jarang	Tidak Pernah
	Desain terdahulu yang relevan dikonsultasikan dan diulas untuk mengembangkan desain dan gambar proyek saat ini.		v			
	Desain proyek cukup fleksibel untuk menerima perubahan dari kebutuhan *client*.		v			
	Pendekatan desain (seperti standarisasi, modularisasi, dll.) digunakan dalam desain proyek.		v			
	Desain proyek mendorong prosedur repetitif dan standar menimbulkan elemen untuk megurangi kompleksitas selama fase proyeksi.	v				
	Desain proyek tidak hanya ada dalam bentuk lembaran tetapi pada bentuk elektrik.			v		

E. ELEMEN TEKNOLOGI

Bagian dari Elemen	Pertanyaan	Selalu	Sering	Terkadang	Jarang	Tidak Pernah
	Seluruh anggota tim tersambung satu sama lain dalam sebuah *network* pada saat bekerja dalam proyek.		v			
	Email digunakan oleh masing-masing individu untuk berkomunikasi.	v				
Communication Support	Seluruh anggota Tim Pengembangan Proyek (TPP) bertukar data proyek pada sebuah *network*.		v			
	Anggota tim dapat berbagi program aplikasi melalui *network*.			v		
	Pertukaran grafik, suara, video, dan *file* terkait dengan proyek dapat dilakukan.		v			
	Komunikasi antar anggota menggunakan komputer.		v			
	Sarana komputer digunakan untuk interaksi yang lebih baik antar		v			

Bagian dari Elemen	Pertanyaan	Selalu	Sering	Terkadang	Jarang	Tidak Pernah
	anggota tim.					
	Sistem yang ada pada perusahaan mendukung adanya interaksi pada anggota dengan anggota, anggota dengan komputer, dan komputer dengan komputer.			v		
	Network yang digunakan untuk komunikasi sangat transparan.	v				
	Meeting berbasis komputer dan interaksi antar anggota TPP dilakukan seperti *meeting* secara *face-to-face*.	v				
Co-ordination Support	Data proyek tersedia secara elektronik dan dapat diakses oleh anggota tim pengembangan proyek.	v				
	Alur kerja proyek dikelola pada *network* (Contoh: perintah kerja secara elektronik, dll.).			v		
	Sarana dan metode digunakan yang dapat mendorong anggota tim membuat analisa *trade-off*.			v		
	Model proyek terpusat digunakan untuk memfasilitasi koordinasi dari seluruh anggota tim yang terlibat dalam proyek.		v			
	Sebuah sistem digunakan untuk setiap proyek yang secara otomatis dapat memperbarui alur kerja dan data proyek saat aktivitas telah terpenuhi.			v		
	Terdapat sistem yang tersedia pada perusahaan yang digunakan untuk men-*support* identifikasi konflik, resolusi, negosiasi, dan *trade-off* dari anggota tim.			v		
	Sarana berbasis komputer digunakan untuk men-*support* pengawasan proyek.	v				
	Sarana yang digunakan dalam pengawasan proyek dilakukan penilaian secara kontinyu.	v				

Bagian dari Elemen	Pertanyaan	Selalu	Sering	Terkadang	Jarang	Tidak Pernah
	Pengaturan versi pada setiap proyek dilakukan ketat untuk memastikan pertukaran dan akses alur kerja dan data proyek dengan mudah.		v			
Information Sharing	Informasi mengenai kebutuhan proses pengembangan proyek dapat diakses dalam bentuk elektronik untuk seluruh anggota tim pengembangan proyek.	v				
	Seluruh informasi dalam bentuk elektronik dikelola dalam Sistem Manajemen *Data Base*(SMDB) yang tepat.			v		
	Tersedia sistem IT yang dapat menyediakan *database* yang terintegrasi dan dapat dilihat oleh pengguna.	v				
	Layanan *information sharing* memanfaatkan teknologi multimedia.			v		
	Informasi proyek disimpan dalam bentuk *file* teks, grafik, gambar, video, dan suara.	v				
	Terdapat sebuah *master model* dari proses pengembangan proyek dan digunakan pada seluruh proyek.	v				
	Memori perusahaan terkait dengan informasi dan keputusan proyek telah di-*maintain*.			v		
	Intranet perusahaan yang dapat diakses oleh seluruh staf telah di-*maintain*.			v		
	Penggunaan internet untuk komunikasi proyek.	v				
	Sistem komunikasi yang tepat digunakan untuk menghubungkan antar divisi dan organisasi.	v				
Integration Support	Perusahaan menggunakan komputer dengan sistem operasi yang umum untuk seluruh proyek (Contoh: Macintosh, Windows, dll.)	v				

Bagian dari Elemen	Pertanyaan	Selalu	Sering	Terkadang	Jarang	Tidak Pernah
	Anggota Tim Pengembangan Proyek (TPP) dan sub-tim terintegrasi secara vritual melalui model informasi yang terintegrasi dan telah ter-*update* selama Proses Pengembangan Proyek (PPP).		v			
	Sistem komputer perusahaan menghubungkan satu sama lain agar meminimasi pemasukan ulang data dan error.		v			
	Perusahaan memiliki pendekatan untuk men-*support* standarisasi pertukaran data.			v		
	Seluruh anggota TPP mengakses data melalui model informasi yang terintegrasi.			v		
	Teknik penerjemahan data digunakan saat mengakses data melalui model informasi yang terintegrasi.			v		
	Terdapat sistem untuk membantu menerjemahkan data pada perusahaan juga pada saat memunculkan data dari sumber luar.				v	
	Sistem IT yang digunakan oleh anggota tim dapat disambungkan dengan *partner* bisnis perusahaan yang sering berhubungan.					v
Task Support	Sistem yang ada pada perusahaan yang memiliki informasi desain historis berlaku pada proyek yang sedang berjalan saat fase desain.			v		
	Computer Aided Design (CAD) dan sarana simulasi digunakan untuk mengecek manufakturabilitas dan *assembly* dari proyek.	v				
	Sarana CAD dan visualisasi digunakan untuk menyiapkan desain dari proyek berdasarkan kebutuhan *client*.	v				
	Sarana CAD digunakan untuk membuat desain dari proyek interaktif dan optimal.	v				

Bagian dari Elemen	Pertanyaan	Selalu	Sering	Terkadang	Jarang	Tidak Pernah
	Sarana berbasis komputer digunakan untuk kerja secara kolaboratif saat Proses Pengembangan Proyek (PPP).	v				
	Terdapat peraturan perusahaan ntuk membuat dan mengikuti rencana pengelolaan teknologi.	v				
	Senior management fokus pada perbaikan dari teknologi (Contoh: komputer, perlengkapan, dll.).		v			
	Terdapat metode pada perusahaan dalam penilaian teknologi baru untuk membantu pemilihan teknologi saat PPP.			v		
	Saran *task support* digunakan selama PPP (seperti peralatan, komputer, *software*, dll.) merupakan jenis terbaru dalam tingkat teknologinya.		v			
	Terdapat sistem pada perusahaan (seperti *Intelligent Agents*), yang menginformasikan secara otomatis kepada seluruh anggota TPP jika terdapat perubahan pada PPP (Contoh: perubahan desain proyek, kebutuhan, dll.).			v		
	Terdapat saran yang menggunakan metode kuantitatif selayaknya seperti metode kualitatif untuk membantu dalam pembuatan keputusan.		v			
	Sarana *task support* dievaluasi untuk menentukan efeknya pada proyek (contoh: kualitas, proyektifitas, reduksi pada biaya dan waktu, dll.).	v				
	Perusahaan menggunakan standar pada pertukaran data internal untuk setiap proyek.		v			

Komentar:

Diisi Oleh,

(Bintng S.   )

106

APPENDIX 4
DESIRED CONDITION RESULT IN BEACON QUESTIONNAIRE

KUISIONER *BEACON* MODEL

Kuisioner BEACON *model* di desain oleh Malik M. A. Khalfan pada tahun 2000 untuk menilai tingkat kesiapan organisasi dalam implemetasi *concurrent engineering*. Dengan model kuisioner yang baru ini akan menilai organisasi dalam empat element utama (Proses, Manusia, Proyek, dan Teknologi).

Pada kuisioner ini akan terbagi menjadi lima bagian. Bagian pertama (bagian A) akan mengumpulkan informasi umum mengenai perusahaan dan responden. Untuk bagian selanjutnya (bagian B hingga bagian E) akan membahas tentang empat elemen dari model.

Mohon untuk menjawab seluruh pertanyaan dengan cara mencentang (√) hanya pada satu kotak untuk setiap pertanyaan. Jika terdapat pertanyaan, silahkan segera bertanya untuk penjelasan lebih lanjut. Terima kasih atas bantuan Anda dalam berpartisipasi pada kegiatan *assessment* ini.

Argon Faisal Marconi – 25 11 100 108
Jurusan Teknik Industri
Fakultas Teknologi Industri
Institut Teknologi Sepuluh Nopember

INFORMASI UMUM

Nama Perusahaan : PT. PAL INDONESIA.

Alamat : Ujung - Surabaya

Nama Responden : M. Agus B

Jabatan Responden : Manajemen

Deskripsi Jabatan :

Tanggal Pengisian :
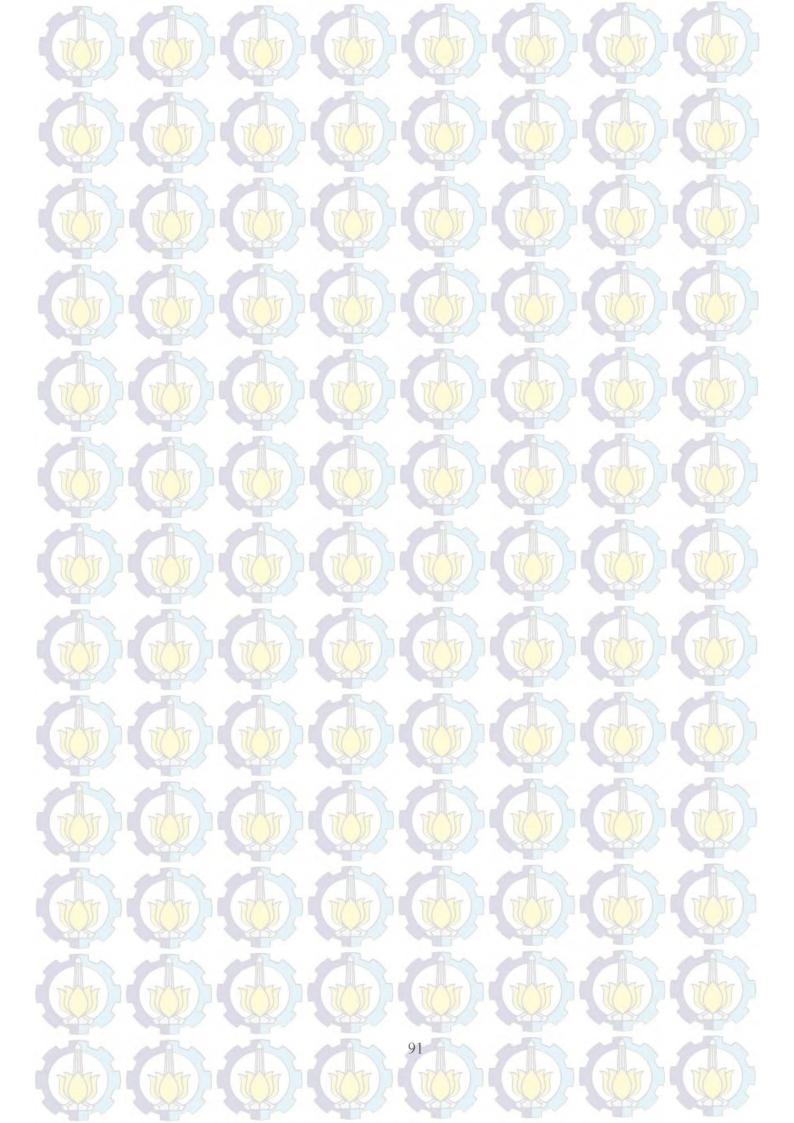
Nomor Telepon : +62 815529 4007

Email :

Prioritas Elemen(*): [1] Proses [2] Manusia [4] Proyek [3] Teknologi

*Silahkan isi dengan nilai 1-4

*(1→ prioritas pertama ; 2→ prioritas kedua ; 3→prioritas ketiga ; 4→prioritas keempat)

91

B. ELEMEN PROSES

Bagian dari Elemen	Pertanyaan	Selalu	Sering	Terkadang	Jarang	Tidak Pernah
Sistem Manajemen	Estimasi dan penjadwalan proyek terdokumentasi dalam hal *controlling* dan *tracking* Project Development Process (PDP)	v				
	Resources cukup telah tersedia dalam perencanaan proyek (Contoh : pendanaan, pengalaman pada individu, dll.)	v				
	Tim Pengembangan Proyek (TPP) menetapkan *time margin* dalam jadwal untuk *contingencies*.	v				
	Terdapat peraturan pada perusahaan dalam hal pelaksanaan kontrak dan sub-kontrak untuk *supplier* atau *outsource*.	v				
	Aktivitas dan performansi dari kontraktor dan sub-kontraktor *supplier* dilakukan *review* baik secara periodik maupun secara *eventual*.	v				
	Prosedur alokasi *resource* yang sama dilakukan oleh perusahaan untuk setiap proyek (contoh: alokasi dilakukan pada tingkat kesulitan teknis pada setiap aktivitas untuk setiap proyek, dll.).	v				
	Analisa dampak dalam alokasi *resource* memungkinkan untuk dilakukan.		v			
	Sistem akuntansi & manajemen keuangan proyek yang terstandarisasi dan dapat dipercaya digunakan dalam seluruh proyek.	v				
	Sistem akuntansi & manajemen keuangan proyek terintegrasi dengan sistem manajemen proyek.	v				
	Rencana manajemen resiko dipersiapkan pada setiap proyek (dapat digunakan untuk memonitor proses pengembangan proyek dan kuantifikasi faktor resiko proyek).	v				

91

Bagian dari Elemen	Pertanyaan	Selalu	Sering	Terkadang	Jarang	Tidak Pernah
	Studi *Trade-off* telah dilakukan untuk mengidentifikasi resiko terkait dengan teknologi baru.		v			
	Tindakan korektif dilakukan saat kondisi aktual berbeda secara signifikan dari rencana proyek.	v				
	Senior management melakukan review pada aktivitas perencanaan proyek baik secara periodik maupun secara *eventual*.	v				
Process Focus	Proses Pengembangan Proyek (PPP) terdokumentasi.	v				
	Proses dokumentasi tersimpan dalam bentuk elektronik dan dapat diakses oleh anggota Tim Pengembangan Proyek (TPP).	v				
	Proses yang sama digunakan pada proyek yang berbeda (Contoh: proses *reuse)*.	v				
	Keputusan terdahulu dianalisa untuk membantu *improvement* dalam PPP secara kontinyu.		v			
	Prosedur digunakan untuk mengevaluasi dan meningkatkan PPP secara periodik.	v				
	Data dikumpulkan untuk mengukur efektivitas dari PPP.	v				
	Terdapat seseorang atau grup yang bertanggung jawab dalam *improvement* PPP.	v				
	PPP (Proses Pengembangan Proyek) fleksibel sehingga dapat beradaptasi pada perubahan (Contoh: perubahaan pada proyek, personal, dll.)	v				
	Aktivitas proses kritis teridentifikasi pada tahap awal PPP.		v			
	Parameter proses kritis teridentifikasi pada tahap awal PPP.		v			

Bagian dari Elemen	Pertanyaan	Selalu	Sering	Terkadang	Jarang	Tidak Pernah
	Parameter proses kritis secara kontinyu dimodifikasi untuk mengoptimasi biaya, kualitas, dan waktu.	v				
	Proses dan sub-proses sebisa mungkin dilakukan secara *concurrent*	v				
	Proses *non-value-adding* dieliminasi dari PPP sebisa mungkin.	v				
Framework Organisasi	*Briefing* proyek terdokumentasi pada setiap awal proyek.		v			
	Aktivitas untuk mengelola dan memperbarui *briefing* objek ditujukan untuk review *quality assurance*.	v				
	Terdapat peraturan pada perusahaan yang dapat membantu dalam pengawasan dan pengaturan perbaikan secara kontinyu pada sistem dan teknologi manajemen.	v				
	Perusahaan menganalisa nilai tambah pada setiap aktivitas pengembangan proyek.	v				
	Terdapat peraturan yang dapat membantu tim untuk mengalokasikan *resource* dan *trade-off* (*resource* seperti dana, tenaga kerja, dll.).		v			
	Terdapat dukungan dari perusahaan yang cukup untuk menyelesaikan konflik dalam tim.	v				
	Lingkungan perusahaan mendukung setiap individu untuk melakukan pekerjaan yang berbeda.	v				
	Lingkungan perusahaan mendukung anggota tim pengembangan proyek dan sub tim untuk bekerja secara individu, grup, atau jenis pekerjaan transisi dari keduanya.	v				
	Lingkungan perusahaan mendukung cara kerja yang disukai setiap individu.	v				

Bagian dari Elemen	Pertanyaan	Selalu	Sering	Terkadang	Jarang	Tidak Pernah
	Struktur organisasi fleksibel dan mendukung untuk variasi dari kebutuhan proyek dan proses.	v				
Penyebaran Strategi	*Senior management* memiliki bisnis strategi yang jelas pada setiap proyek.	v				
	Strategi konsisten dengan peraturan bisnis perusahaan.	v				
	Strategi fokus pada *improvement* dari proses pengembangan proyek pada setiap proyek.	v				
	Strategi dapat mendorong tim untuk menyelesaikan isu pada tingkat struktur organisasi terendah.	v				
	Kebijakan SDM mendukung strategi dan dilakukan *improvement* secara kontinyu.	v				
	Tim menyertakan beberapa orang untuk mengidentifikasi dan mencegah permasalahan di masa depan terkait dengan proses pengembangan proyek.	v				
	Tim disiapkan untuk menangani permintaan *client* terkait dengan proses pengembangan proyek.	v				
	Senior management fokus pada *improvement* sistem manajemen dari setiap proyek dalam perusahaan.	v				
	Senior management memastikan bahwa setiap krisis tidak akan mengganggu jalannya proses pengembangan proyek.	v				
	Permasalahan yang dihadapi pada saat proses pengembangan proyek diawasi hingga terselesaikan.		v			
Kesigapan	Prosedur terdokumentasi digunakan untuk memastikan bahwa perusahaan dapat merespon perubahaan dalam proses pengembangan proyek.	v				

Bagian dari Elemen	Pertanyaan	Selalu	Sering	Terkadang	Jarang	Tidak Pernah
	Waktu respon untuk perubahan pada kebutuhan *client* ditingkatkan untuk proyek baru.	v				
	Setiap anggota tim secara *concurrent* membuat keputusan *trade-off* untuk merespon perubahan pada kebutuhan *client*.	v				
	Proses pengembangan proyek cukup fleksibel untuk menggabungkan perubahan pada kebutuhan *client*.	v				
	Dokumentasi proses pengembangan proyek dilakukan secara elektronik dan dapat diakses oleh seluruh anggota tim.	v				
	Dokumentasi proses pengembangan proyek menyertakan informasi pada keputusan yang diambil pada saat proses.	v				
	Memori perusahaan mengenai organisasi di-*maintain*.	v				
	Memori perusahaan tersedia untuk seluruh anggota tim pengembangan proyek.	v				
	Aset dan *resource* dapat digunakan ulang untuk proyek baru (Contoh: permesinan, rancangan fasilitas, material, dll.		v			
	Tim pengembangan proyek menggunakan informasi proyek terdahulu (Contoh: desain, konstrain, dll.) untuk merencanakan perubahan.	v				

C. ELEMEN MANUSIA

Bagian dari Elemen	Pertanyaan	Selalu	Sering	Terkadang	Jarang	Tidak Pernah
Pembentukan dan Pengembangan Tim	Tim Pengembangan Proyek (TPP) terbentuk sebagaimana mungkin merepresentasikan dari setiap divisi (Contoh: tim desain, tim Q/S, dll.)	v				
	TPP dan sub-tim terdiri dari individual yang antusias dan ahli dalam bidang masing-masing.	v				
	Seluruh anggota tim berinteraksi secara kontinyu.	v				
	Masing-masing anggota tim mengerti akan kewajibannya.	v				
	Terdapat tujuan bersama dalam tim untuk proyek tertentu.	v				
	Peraturan perusahaan mendorong tim untuk mencapai tujuan yang berbeda.	v				
	Terdapat peraturan perusahaan untuk mengatur program pelatihan untuk tim.	v				
	Resource cukup tersedia untuk mengimplementasikan program pelatihan (Contoh: pendanaan, fasilitas pelatihan, dll.).	v				
	Seluruh anggota tim menerima pelatihan secara rutin untuk meningkatkan kemampuan teknis dan kerjasama tim.	v				
	Pelatihan tim dievaluasi untuk efektivitasnya.		v			
***Leadership* dan Manajemen Tim**	Ketua tim dari tim pengembangan proyek (TPP) dan sub-tim terpilih berdasarkan kemampuan teknis dan manajerial.	v				
	Ketua tim bertanggung jawab dalam penyelesaian tugas dan aktivitas tepat waktu dan tidak melebihi *budget*.	v				
	Ketua tim memiliki kewenangan untuk mendapatkan anggota tim baru.	v				

Bagian dari Elemen	Pertanyaan	Selalu	Sering	Terkadang	Jarang	Tidak Pernah
	Ketua dari TPP bekerja sebagai manajer proyek dan bertanggung jawab untuk *controllingi,* mengatur, mengarahkan, dan merencanakan Proses Pengembangan Proyek (PPP).	v				
	Ketua tim mengambil keputusan final untuk semua proyek dan isu pada tim.	v				
	Ketua tim berkonsultasi kepada *senior management* sebelum mengambil keputusan tim.	v				
	Senior manager mengawasi *progress* dari PPP dan TPP.	v				
	Senior management mencoba untuk menyelesaikan isu pada level organisasi terbawah.	v				
Kedisiplinan	Seluruh anggota tim berada dalam aturan kedisiplinan yang telah dirancang oleh perusahaan.	v				
	Seluruh anggota tim (termasuk ketua tim) berkomitmen pada peraturan tim.	v				
	Anggota mengesampingkan agenda individual dan bekerja untuk kepentingan tim.	v				
	Anggota tim tetap bersama meskipun terdapat isu yang tidak mudah.	v				
	Meeting tim mengikuti peraturan perilaku yang berlaku.	v				
	Terdapat komitmen dari perusahaan untuk mengatasi permasalahan kedisiplinan secara jelas.	v				
	Terdapat prosedur mengenai keluhan.	v				
	Senior management memastikan bahwa tim proyek mengikuti peraturan yang berlaku saat menyampaikan *value* kepada *client*.	v				

Bagian dari Elemen	Pertanyaan	Selalu	Sering	Terkadang	Jarang	Tidak Pernah
Tim dalam Organisasi	Terdapat berbagai grup yang terspesialisasi dalam organisasi sehingga dapat bekerja dalam tim.	v				
	Anggota tim fokus pada tugas spesifik masing-masing dan menunjang tim pengembangan proyek.	v				
	Tim memiliki kewenangan dalam keputusan terkait hal teknis dan biaya.	v				
	Tim memiliki kewenangan dalam pemberian *reward* kepada anggota tim.	v				
	Terdapat *reward* untuk bertindak sebagai anggota tim dibandingkan memenuhi kepentingan pribadi.	v				
	Anggota tim mudah untuk ditempatkan.	v				
	Komunikasi dan *sharing* informasi antar anggota tim mudah untuk dilakukan.	v				
	Masing-masing anggota bertanggung jawab untuk mencapai kesuksesan dalam proyek yang spesifik.	v				
	Peraturan perusahaan dapat mengukur performansi tim dan mendorong *teamwork*.	v				
	Performansi tim krusial untuk kesuksesan karir individu.	v				
	Terdapat komitmen dari perusahaan untuk menyediakan pelatihan yang cukup dan terspesifikasi untuk setiap individu dalam menjalankan perannya di dalam tim.	v				
	Terdapat peraturan perusahaan untuk merencanakan dan mengadakan *peer review* di dalam tim untuk mengurangi *defect* dari aktivitas *output* pada awal dan secara efisien.	v				

D. ELEMEN PROYEK

Bagian dari Elemen	Pertanyaan	Selalu	Sering	Terkadang	Jarang	Tidak Pernah
Client Focus	*Client* terlibat dalam Proses Pengembangan Proyek (PPP) sebagai anggota dari Tim Pengembangan Proyek (TPP).		v			
	Prosedur dan panduan yang terdokumentasi dengan baik ada pada saat pengumpulan kebutuhan *client*.	v				
	Seluruh anggota Tim Pengembangan Proyek (TPP) paham dengan baik dalam kebutuhan *client*.	v				
	Sarana berbasis komputer digunakan dalam pemunculan dan penyebaran kebutuhan *client*.	v				
	Tim dapat mengakses kebutuhan *client* kapan pun selama proses pengembangan proyek.	v				
	Tim merespon dengan tepat dalam perubahan prioritas *client*.	v				
	Prosedur digunakan untuk mengevaluasi sebaik apa tim mengakomodasi prioritas baru *client*.	v				
	Prosedur digunakan untuk mengevaluasi apakah kebutuhan *client* telah terpenuhi.	v				
	Sarana berbasis komputer digunakan untuk membantu mengevaluasi apakah kebutuhan komputer telah terpenuhi.	v				
Quality Assurance	Pengembangan standar proyek secara internal yang digunakan pada saat fase desain dan proyeksi dari proyek telah berjalan dengan baik.	v				
	Standar proyek dapat diakses oleh seluruh anggota tim.	v				

Bagian dari Elemen	Pertanyaan	Selalu	Sering	Terkadang	Jarang	Tidak Pernah
	Aktivitas *Quality Assurance* (QA) yang dapat mengkonfirmasi proyek yang telah selesai dan proses sesuai dengan prosedur telah digunakan.	v				
	Segala perubahan dan variasi dari proyek ditujukan untuk *review* dan audit QA.	v				
	Terdapat peraturan perusahaan untuk memastikan kualitas proyek dengan mengimpelementasikan teknik manajemen kualitas.	v				
	Metode digunakan untuk memastikan qualitas yang dibutuhkan untuk material sebelum proyeksi pada setiap proyek.	v				
	Terdapat metode standar untuk mengumpulan dan analisa dari data proyek gagal untuk *feedback* bagi tim.	v				
	Terdapat prosedur untuk mengecek *progress* dari proses pengembangan proyek berdasarkan kualitas, biaya, waktu, dan spesifikasi baik secara periodik maupun *eventual*.	v				
Desain Proyek	*Interface* utama selama Proses Pengembangan Proyek (PPP) secara strategis didefinisikan pada tahap awal proyek.	v				
	Desain dan gambar pendahuluan dari proyek telah disiapkan sebelum memasuki desain final produk dan fase proyeksi dari sebuah proyek.	v				
	Seluruh anggota Tim Pengembangan Proyek (TPP) menganalisa gambar pendahuluan dan memberikan komen beserta saran dalam bagaimana cara mengatasi adanya masalah pada hilir selain itu juga mengkonfirmasi kebutuhan *client*.	v				
	Terdapat peraturan perusahaan yang memastikan bahwa *client* telah puas dengan desain pendahuluan dari proyek.	v				

Bagian dari Elemen	Pertanyaan	Selalu	Sering	Terkadang	Jarang	Tidak Pernah
	Desain terdahulu yang relevan dikonsultasikan dan diulas untuk mengembangkan desain dan gambar proyek saat ini.	v				
	Desain proyek cukup fleksibel untuk menerima perubahan dari kebutuhan *client*.	v				
	Pendekatan desain (seperti standarisasi, modularisasi, dll.) digunakan dalam desain proyek.	v				
	Desain proyek mendorong prosedur repetitif dan standar menimbulkan elemen untuk megurangi kompleksitas selama fase proyeksi.	v				
	Desain proyek tidak hanya ada dalam bentuk lembaran tetapi pada bentuk elektrik.	v				

E. ELEMEN TEKNOLOGI

Bagian dari Elemen	Pertanyaan	Selalu	Sering	Terkadang	Jarang	Tidak Pernah
	Seluruh anggota tim tersambung satu sama lain dalam sebuah *network* pada saat bekerja dalam proyek.	v				
	Email digunakan oleh masing-masing individu untuk berkomunikasi.	v				
Communication Support	Seluruh anggota Tim Pengembangan Proyek (TPP) bertukar data proyek pada sebuah *network*.	v				
	Anggota tim dapat berbagi program aplikasi melalui *network*.	v				
	Pertukaran grafik, suara, video, dan *file* terkait dengan proyek dapat dilakukan.	v				
	Komunikasi antar anggota menggunakan komputer.	v				
	Sarana komputer digunakan untuk interaksi yang lebih baik antar	v				

Bagian dari Elemen	Pertanyaan	Selalu	Sering	Terkadang	Jarang	Tidak Pernah
	anggota tim.					
	Sistem yang ada pada perusahaan mendukung adanya interaksi pada anggota dengan anggota, anggota dengan komputer, dan komputer dengan komputer.	v				
	Network yang digunakan untuk komunikasi sangat transparan.	v				
	Meeting berbasis komputer dan interaksi antar anggota TPP dilakukan seperti *meeting* secara *face-to-face.*	v				
Co-ordination Support	Data proyek tersedia secara elektronik dan dapat diakses oleh anggota tim pengembangan proyek.	v				
	Alur kerja proyek dikelola pada *network* (Contoh: perintah kerja secara elektronik, dll.).	v				
	Sarana dan metode digunakan yang dapat mendorong anggota tim membuat analisa *trade-off*.	v				
	Model proyek terpusat digunakan untuk memfasilitasi koordinasi dari seluruh anggota tim yang terlibat dalam proyek.	v				
	Sebuah sistem digunakan untuk setiap proyek yang secara otomatis dapat memperbarui alur kerja dan data proyek saat aktivitas telah terpenuhi.	v				
	Terdapat sistem yang tersedia pada perusahaan yang digunakan untuk men-*support* identifikasi konflik, resolusi, negosiasi, dan *trade-off* dari anggota tim.	v				
	Sarana berbasis komputer digunakan untuk men-*support* pengawasan proyek.	v				
	Sarana yang digunakan dalam pengawasan proyek dilakukan penilaian secara kontinyu.	v				

Bagian dari Elemen	Pertanyaan	Selalu	Sering	Terkadang	Jarang	Tidak Pernah
	Pengaturan versi pada setiap proyek dilakukan ketat untuk memastikan pertukaran dan akses alur kerja dan data proyek dengan mudah.	v				
Information Sharing	Informasi mengenai kebutuhan proses pengembangan proyek dapat diakses dalam bentuk elektronik untuk seluruh anggota tim pengembangan proyek.	v				
	Seluruh informasi dalam bentuk elektronik dikelola dalam Sistem Manajemen *Data Base*(SMDB) yang tepat.	v				
	Tersedia sistem IT yang dapat menyediakan *database* yang terintegrasi dan dapat dilihat oleh pengguna.	v				
	Layanan *information sharing* memanfaatkan teknologi multimedia.	v				
	Informasi proyek disimpan dalam bentuk *file* teks, grafik, gambar, video, dan suara.	v				
	Terdapat sebuah *master model* dari proses pengembangan proyek dan digunakan pada seluruh proyek.	v				
	Memori perusahaan terkait dengan informasi dan keputusan proyek telah di-*maintain*.	v				
	Intranet perusahaan yang dapat diakses oleh seluruh staf telah di-*maintain*.		v			
	Penggunaan internet untuk komunikasi proyek.	v				
	Sistem komunikasi yang tepat digunakan untuk menghubungkan antar divisi dan organisasi.	v				
Integration Support	Perusahaan menggunakan komputer dengan sistem operasi yang umum untuk seluruh proyek (Contoh: Macintosh, Windows, dll.)	v				

Bagian dari Elemen	Pertanyaan	Selalu	Sering	Terkadang	Jarang	Tidak Pernah
	Anggota Tim Pengembangan Proyek (TPP) dan sub-tim terintegrasi secara vritual melalui model informasi yang terintegrasi dan telah ter-*update* selama Proses Pengembangan Proyek (PPP).	v				
	Sistem komputer perusahaan menghubungkan satu sama lain agar meminimasi pemasukan ulang data dan error.	v				
	Perusahaan memiliki pendekatan untuk men-*support* standarisasi pertukaran data.	v				
	Seluruh anggota TPP mengakses data melalui model informasi yang terintegrasi.	v				
	Teknik penerjemahan data digunakan saat mengakses data melalui model informasi yang terintegrasi.	v				
	Terdapat sistem untuk membantu menerjemahkan data pada perusahaan juga pada saat memunculkan data dari sumber luar.	v				
	Sistem IT yang digunakan oleh anggota tim dapat disambungkan dengan *partner* bisnis perusahaan yang sering berhubungan.	v				
Task Support	Sistem yang ada pada perusahaan yang memiliki informasi desain historis berlaku pada proyek yang sedang berjalan saat fase desain.	v				
	Computer Aided Design (CAD) dan sarana simulasi digunakan untuk mengecek manufakturabilitas dan *assembly* dari proyek.	v				
	Sarana CAD dan visualisasi digunakan untuk menyiapkan desain dari proyek berdasarkan kebutuhan *client*.	v				
	Sarana CAD digunakan untuk membuat desain dari proyek interaktif dan optimal.	v				

Bagian dari Elemen	Pertanyaan	Selalu	Sering	Terkadang	Jarang	Tidak Pernah
	Sarana berbasis komputer digunakan untuk kerja secara kolaboratif saat Proses Pengembangan Proyek (PPP).	v				
	Terdapat peraturan perusahaan ntuk membuat dan mengikuti rencana pengelolaan teknologi.	v				
	Senior management fokus pada perbaikan dari teknologi (Contoh: komputer, perlengkapan, dll.).			v		
	Terdapat metode pada perusahaan dalam penilaian teknologi baru untuk membantu pemilihan teknologi saat PPP.	v				
	Saran *task support* digunakan selama PPP (seperti peralatan, komputer, *software*, dll.) merupakan jenis terbaru dalam tingkat teknologinya.	v				
	Terdapat sistem pada perusahaan (seperti *Intelligent Agents*), yang menginformasikan secara otomatis kepada seluruh anggota TPP jika terdapat perubahan pada PPP (Contoh: perubahan desain proyek, kebutuhan, dll.).	v				
	Terdapat saran yang menggunakan metode kuantitatif selayaknya seperti metode kualitatif untuk membantu dalam pembuatan keputusan.	v				
	Sarana *task support* dievaluasi untuk menentukan efeknya pada proyek (contoh: kualitas, proyektifitas, reduksi pada biaya dan waktu, dll.).	v				
	Perusahaan menggunakan standar pada pertukaran data internal untuk setiap proyek.	v				

Komentar:

Diisi Oleh,

(M. Agus Budiyanto)

APPENDIX 5
NPV CALCULATION FOR SENSITIVITY ANALYSIS
SCENARIO

Initial calculation is used $1,250,000 in cost of production, amount of savings is 5% and the number of project is 2.

The value is in ($1000)
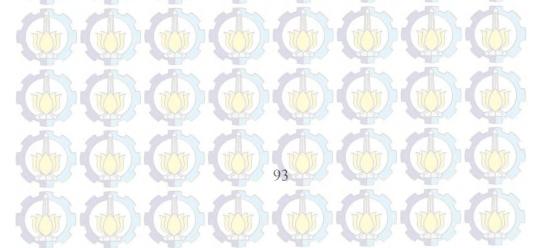
I. SAP R/3

1. Cost of Production Scenario

- $950,000

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$95.00	$95.00	$95.00	$95.00	$95.00	$95.00	$95.00	$95.00	$95.00	$95.00		
Cost	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00		
NPV Savings (1)	$0.00	$92.23	$89.55	$86.94	$84.41	$81.95	$79.56	$77.24	$74.99	$72.81	$70.69	$810.37	
NPV Cost (2)	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,790.00	
NPV (1-2)	-$1,790.00	$92.23	$89.55	$86.94	$84.41	$81.95	$79.56	$77.24	$74.99	$72.81	$70.69	-$979.63	0.45

- $1,000,000

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$100.00	$100.00	$100.00	$100.00	$100.00	$100.00	$100.00	$100.00	$100.00	$100.00		
Cost	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00		
NPV Savings (1)	$0.00	$97.09	$94.26	$91.51	$88.85	$86.26	$83.75	$81.31	$78.94	$76.64	$74.41	$853.02	
NPV Cost (2)	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,790.00	
NPV (1-2)	-$1,790.00	$97.09	$94.26	$91.51	$88.85	$86.26	$83.75	$81.31	$78.94	$76.64	$74.41	-$936.98	0.48

- $1,250,000
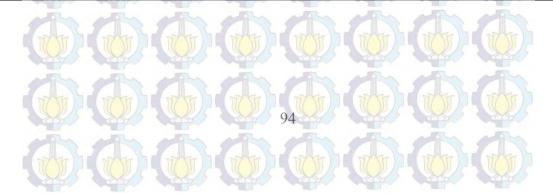
Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00		
Cost	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00		
NPV Savings (1)	$0.00	$121.36	$117.82	$114.39	$111.06	$107.83	$104.69	$101.64	$98.68	$95.80	$93.01	$1,066.28	
NPV Cost (2)	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,790.00	
NPV (1-2)	-$1,790.00	$121.36	$117.82	$114.39	$111.06	$107.83	$104.69	$101.64	$98.68	$95.80	$93.01	-$723.72	0.60

- $1,500,000

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$150.00	$150.00	$150.00	$150.00	$150.00	$150.00	$150.00	$150.00	$150.00	$150.00		
Cost	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00		
NPV Savings (1)	$0.00	$145.63	$141.39	$137.27	$133.27	$129.39	$125.62	$121.96	$118.41	$114.96	$111.61	$1,279.53	
NPV Cost (2)	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,790.00	
NPV (1-2)	-$1,790.00	$145.63	$141.39	$137.27	$133.27	$129.39	$125.62	$121.96	$118.41	$114.96	$111.61	-$510.47	0.71

- $1,750,000

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00		
Cost	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00		
NPV Savings (1)	$0.00	$169.90	$164.95	$160.15	$155.49	$150.96	$146.56	$142.29	$138.15	$134.12	$130.22	$1,492.79	
NPV Cost (2)	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,790.00	
NPV (1-2)	-$1,790.00	$169.90	$164.95	$160.15	$155.49	$150.96	$146.56	$142.29	$138.15	$134.12	$130.22	-$297.21	0.83

- $2,000,000

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$200.00	$200.00	$200.00	$200.00	$200.00	$200.00	$200.00	$200.00	$200.00	$200.00		
Cost	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00		
NPV Savings (1)	$0.00	$194.17	$188.52	$183.03	$177.70	$172.52	$167.50	$162.62	$157.88	$153.28	$148.82	$1,706.04	
NPV Cost (2)	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,790.00	
NPV (1-2)	-$1,790.00	$194.17	$188.52	$183.03	$177.70	$172.52	$167.50	$162.62	$157.88	$153.28	$148.82	-$83.96	0.95

- $2,500,000

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$225.00	$225.00	$225.00	$225.00	$225.00	$225.00	$225.00	$225.00	$225.00	$225.00		
Cost	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00		
NPV Savings (1)	$0.00	$218.45	$212.08	$205.91	$199.91	$194.09	$188.43	$182.95	$177.62	$172.44	$167.42	$1,919.30	
NPV Cost (2)	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,790.00	
NPV (1-2)	-$1,790.00	$218.45	$212.08	$205.91	$199.91	$194.09	$188.43	$182.95	$177.62	$172.44	$167.42	$129.30	1.07

2. Percent (%) Savings Scenario

- 2%

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$50.00	$50.00	$50.00	$50.00	$50.00	$50.00	$50.00	$50.00	$50.00	$50.00		
Cost	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00		
NPV Savings (1)	$0.00	$48.54	$47.13	$45.76	$44.42	$43.13	$41.87	$40.65	$39.47	$38.32	$37.20	$426.51	
NPV Cost (2)	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,790.00	
NPV (1-2)	-$1,790.00	$48.54	$47.13	$45.76	$44.42	$43.13	$41.87	$40.65	$39.47	$38.32	$37.20	-$1,363.49	0.24

- 3%
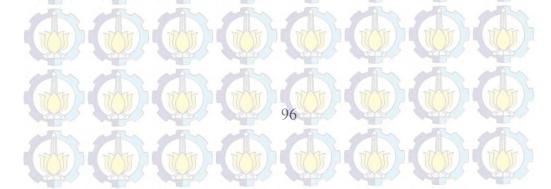
Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$75.00	$75.00	$75.00	$75.00	$75.00	$75.00	$75.00	$75.00	$75.00	$75.00		
Cost	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00		
NPV Savings (1)	$0.00	$72.82	$70.69	$68.64	$66.64	$64.70	$62.81	$60.98	$59.21	$57.48	$55.81	$639.77	
NPV Cost (2)	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,790.00	
NPV (1-2)	-$1,790.00	$72.82	$70.69	$68.64	$66.64	$64.70	$62.81	$60.98	$59.21	$57.48	$55.81	-$1,150.23	0.36

- 4%

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$100.00	$100.00	$100.00	$100.00	$100.00	$100.00	$100.00	$100.00	$100.00	$100.00		
Cost	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00		
NPV Savings (1)	$0.00	$97.09	$94.26	$91.51	$88.85	$86.26	$83.75	$81.31	$78.94	$76.64	$74.41	$853.02	
NPV Cost (2)	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,790.00	
NPV (1-2)	-$1,790.00	$97.09	$94.26	$91.51	$88.85	$86.26	$83.75	$81.31	$78.94	$76.64	$74.41	-$936.98	0.48

- 5&

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00		
Cost	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00		
NPV Savings (1)	$0.00	$121.36	$117.82	$114.39	$111.06	$107.83	$104.69	$101.64	$98.68	$95.80	$93.01	$1,066.28	
NPV Cost (2)	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,790.00	
NPV (1-2)	-$1,790.00	$121.36	$117.82	$114.39	$111.06	$107.83	$104.69	$101.64	$98.68	$95.80	$93.01	-$723.72	0.60

- 7%

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00		
Cost	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00		
NPV Savings (1)	$0.00	$169.90	$164.95	$160.15	$155.49	$150.96	$146.56	$142.29	$138.15	$134.12	$130.22	$1,492.79	
NPV Cost (2)	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,790.00	
NPV (1-2)	-$1,790.00	$169.90	$164.95	$160.15	$155.49	$150.96	$146.56	$142.29	$138.15	$134.12	$130.22	-$297.21	0.83

- 8%

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$200.00	$200.00	$200.00	$200.00	$200.00	$200.00	$200.00	$200.00	$200.00	$200.00		
Cost	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00		
NPV Savings (1)	$0.00	$194.17	$188.52	$183.03	$177.70	$172.52	$167.50	$162.62	$157.88	$153.28	$148.82	$1,706.04	
NPV Cost (2)	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,790.00	
NPV (1-2)	-$1,790.00	$194.17	$188.52	$183.03	$177.70	$172.52	$167.50	$162.62	$157.88	$153.28	$148.82	-$83.96	0.95

- 9%

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$225.00	$225.00	$225.00	$225.00	$225.00	$225.00	$225.00	$225.00	$225.00	$225.00		
Cost	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00		
NPV Savings (1)	$0.00	$218.45	$212.08	$205.91	$199.91	$194.09	$188.43	$182.95	$177.62	$172.44	$167.42	$1,919.30	
NPV Cost (2)	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,790.00	
NPV (1-2)	-$1,790.00	$218.45	$212.08	$205.91	$199.91	$194.09	$188.43	$182.95	$177.62	$172.44	$167.42	$129.30	1.07

- 10%

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$250.00	$250.00	$250.00	$250.00	$250.00	$250.00	$250.00	$250.00	$250.00	$250.00		
Cost	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00		
NPV Savings (1)	$0.00	$242.72	$235.65	$228.79	$222.12	$215.65	$209.37	$203.27	$197.35	$191.60	$186.02	$2,132.55	
NPV Cost (2)	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,790.00	
NPV (1-2)	-$1,790.00	$242.72	$235.65	$228.79	$222.12	$215.65	$209.37	$203.27	$197.35	$191.60	$186.02	$342.55	1.19

3. Number of Project Scenario

- 0

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00		
Cost	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00		
NPV Savings (1)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	
NPV Cost (2)	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,790.00	
NPV (1-2)	-$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	-$1,790.00	0.00

- 1

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$62.50	$62.50	$62.50	$62.50	$62.50	$62.50	$62.50	$62.50	$62.50	$62.50		
Cost	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00		
NPV Savings (1)	$0.00	$60.68	$58.91	$57.20	$55.53	$53.91	$52.34	$50.82	$49.34	$47.90	$46.51	$533.14	
NPV Cost (2)	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,790.00	
NPV (1-2)	-$1,790.00	$60.68	$58.91	$57.20	$55.53	$53.91	$52.34	$50.82	$49.34	$47.90	$46.51	-$1,256.86	0.30

- 2

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00		
Cost	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00		
NPV Savings (1)	$0.00	$121.36	$117.82	$114.39	$111.06	$107.83	$104.69	$101.64	$98.68	$95.80	$93.01	$1,066.28	
NPV Cost (2)	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,790.00	
NPV (1-2)	-$1,790.00	$121.36	$117.82	$114.39	$111.06	$107.83	$104.69	$101.64	$98.68	$95.80	$93.01	-$723.72	0.60

- 3

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$187.50	$187.50	$187.50	$187.50	$187.50	$187.50	$187.50	$187.50	$187.50	$187.50		
Cost	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00		
NPV Savings (1)	$0.00	$182.04	$176.74	$171.59	$166.59	$161.74	$157.03	$152.45	$148.01	$143.70	$139.52	$1,599.41	
NPV Cost (2)	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,790.00	
NPV (1-2)	-$1,790.00	$182.04	$176.74	$171.59	$166.59	$161.74	$157.03	$152.45	$148.01	$143.70	$139.52	-$190.59	0.89

- 4

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$250.00	$250.00	$250.00	$250.00	$250.00	$250.00	$250.00	$250.00	$250.00	$250.00		
Cost	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00		
NPV Savings (1)	$0.00	$242.72	$235.65	$228.79	$222.12	$215.65	$209.37	$203.27	$197.35	$191.60	$186.02	$2,132.55	
NPV Cost (2)	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,790.00	
NPV (1-2)	-$1,790.00	$242.72	$235.65	$228.79	$222.12	$215.65	$209.37	$203.27	$197.35	$191.60	$186.02	$342.55	1.19

4. Integration
   - $1,250,000; 5%;2
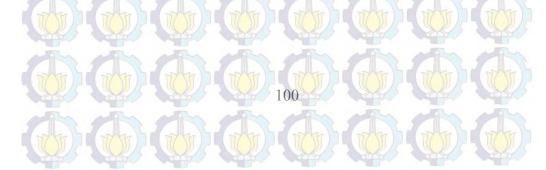
Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00		
Cost	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00		
NPV Savings (1)	$0.00	$121.36	$117.82	$114.39	$111.06	$107.83	$104.69	$101.64	$98.68	$95.80	$93.01	$1,066.28	
NPV Cost (2)	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,790.00	
NPV (1-2)	-$1,790.00	$121.36	$117.82	$114.39	$111.06	$107.83	$104.69	$101.64	$98.68	$95.80	$93.01	-$723.72	0.60

   - $1,750,000;8%;3

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$420.00	$420.00	$420.00	$420.00	$420.00	$420.00	$420.00	$420.00	$420.00	$420.00		
Cost	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00		
NPV Savings (1)	$0.00	$407.77	$395.89	$384.36	$373.16	$362.30	$351.74	$341.50	$331.55	$321.90	$312.52	$3,582.69	
NPV Cost (2)	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,790.00	
NPV (1-2)	-$1,790.00	$407.77	$395.89	$384.36	$373.16	$362.30	$351.74	$341.50	$331.55	$321.90	$312.52	$1,792.69	2.00

   - $2,250,000;4%;4

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$360.00	$360.00	$360.00	$360.00	$360.00	$360.00	$360.00	$360.00	$360.00	$360.00		
Cost	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00		
NPV Savings (1)	$0.00	$349.51	$339.33	$329.45	$319.86	$310.54	$301.49	$292.71	$284.19	$275.91	$267.87	$3,070.87	
NPV Cost (2)	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,790.00	
NPV (1-2)	-$1,790.00	$349.51	$339.33	$329.45	$319.86	$310.54	$301.49	$292.71	$284.19	$275.91	$267.87	$1,280.87	1.72

- $950,000;10%;1

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$95.00	$95.00	$95.00	$95.00	$95.00	$95.00	$95.00	$95.00	$95.00	$95.00		
Cost	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00		
NPV Savings (1)	$0.00	$92.23	$89.55	$86.94	$84.41	$81.95	$79.56	$77.24	$74.99	$72.81	$70.69	$810.37	
NPV Cost (2)	$1,790.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,790.00	
NPV (1-2)	-$1,790.00	$92.23	$89.55	$86.94	$84.41	$81.95	$79.56	$77.24	$74.99	$72.81	$70.69	-$979.63	0.45
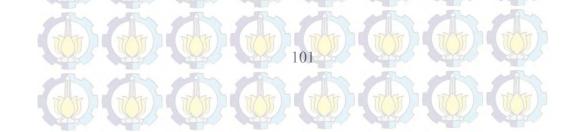
II. LDAP
1. Cost of Production Scenario
   - $950,000

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$95.00	$95.00	$95.00	$95.00	$95.00	$95.00	$95.00	$95.00	$95.00	$95.00		
Cost	$2.20	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85		
NPV Savings (1)	$0.00	$92.23	$89.55	$86.94	$84.41	$81.95	$79.56	$77.24	$74.99	$72.81	$70.69	$810.37	
NPV Cost (2)	$2.20	$0.83	$0.80	$0.78	$0.76	$0.73	$0.71	$0.69	$0.67	$0.65	$0.63	$9.45	
NPV (1-2)	-$2.20	$91.41	$88.75	$86.16	$83.65	$81.21	$78.85	$76.55	$74.32	$72.16	$70.06	$800.92	85.75

- $1,000,000

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$100.00	$100.00	$100.00	$100.00	$100.00	$100.00	$100.00	$100.00	$100.00	$100.00		
Cost	$2.20	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85		
NPV Savings (1)	$0.00	$97.09	$94.26	$91.51	$88.85	$86.26	$83.75	$81.31	$78.94	$76.64	$74.41	$853.02	
NPV Cost (2)	$2.20	$0.83	$0.80	$0.78	$0.76	$0.73	$0.71	$0.69	$0.67	$0.65	$0.63	$9.45	
NPV (1-2)	-$2.20	$96.26	$93.46	$90.74	$88.09	$85.53	$83.04	$80.62	$78.27	$75.99	$73.78	$843.57	90.26

- $1,250,000
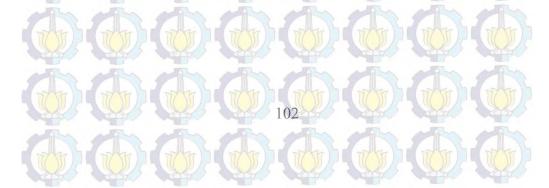
Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00		
Cost	$2.20	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85		
NPV Savings (1)	$0.00	$121.36	$117.82	$114.39	$111.06	$107.83	$104.69	$101.64	$98.68	$95.80	$93.01	$1,066.28	
NPV Cost (2)	$2.20	$0.83	$0.80	$0.78	$0.76	$0.73	$0.71	$0.69	$0.67	$0.65	$0.63	$9.45	
NPV (1-2)	-$2.20	$120.53	$117.02	$113.61	$110.31	$107.09	$103.97	$100.95	$98.01	$95.15	$92.38	$1,056.82	112.83

- $1,500,000

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$150.00	$150.00	$150.00	$150.00	$150.00	$150.00	$150.00	$150.00	$150.00	$150.00		
Cost	$2.20	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85		
NPV Savings (1)	$0.00	$145.63	$141.39	$137.27	$133.27	$129.39	$125.62	$121.96	$118.41	$114.96	$111.61	$1,279.53	
NPV Cost (2)	$2.20	$0.83	$0.80	$0.78	$0.76	$0.73	$0.71	$0.69	$0.67	$0.65	$0.63	$9.45	
NPV (1-2)	-$2.20	$144.81	$140.59	$136.49	$132.52	$128.66	$124.91	$121.27	$117.74	$114.31	$110.98	$1,270.08	135.39

- $1,750,000

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00		
Cost	$2.20	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85		
NPV Savings (1)	$0.00	$169.90	$164.95	$160.15	$155.49	$150.96	$146.56	$142.29	$138.15	$134.12	$130.22	$1,492.79	
NPV Cost (2)	$2.20	$0.83	$0.80	$0.78	$0.76	$0.73	$0.71	$0.69	$0.67	$0.65	$0.63	$9.45	
NPV (1-2)	-$2.20	$169.08	$164.15	$159.37	$154.73	$150.22	$145.85	$141.60	$137.48	$133.47	$129.58	$1,483.33	157.96

- $2,000,000

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$200.00	$200.00	$200.00	$200.00	$200.00	$200.00	$200.00	$200.00	$200.00	$200.00		
Cost	$2.20	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85		
NPV Savings (1)	$0.00	$194.17	$188.52	$183.03	$177.70	$172.52	$167.50	$162.62	$157.88	$153.28	$148.82	$1,706.04	
NPV Cost (2)	$2.20	$0.83	$0.80	$0.78	$0.76	$0.73	$0.71	$0.69	$0.67	$0.65	$0.63	$9.45	
NPV (1-2)	-$2.20	$193.35	$187.72	$182.25	$176.94	$171.79	$166.78	$161.93	$157.21	$152.63	$148.19	$1,696.59	180.52

- $2,500,000

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$250.00	$250.00	$250.00	$250.00	$250.00	$250.00	$250.00	$250.00	$250.00	$250.00		
Cost	$2.20	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85		
NPV Savings (1)	$0.00	$242.72	$235.65	$228.79	$222.12	$215.65	$209.37	$203.27	$197.35	$191.60	$186.02	$2,132.55	
NPV Cost (2)	$2.20	$0.83	$0.80	$0.78	$0.76	$0.73	$0.71	$0.69	$0.67	$0.65	$0.63	$9.45	
NPV (1-2)	-$2.20	$241.89	$234.85	$228.01	$221.37	$214.92	$208.66	$202.58	$196.68	$190.95	$185.39	$2,123.10	225.65

2. Percent (%) Savings Scenario

- 2%

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$50.00	$50.00	$50.00	$50.00	$50.00	$50.00	$50.00	$50.00	$50.00	$50.00		
Cost	$2.20	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85		
NPV Savings (1)	$0.00	$48.54	$47.13	$45.76	$44.42	$43.13	$41.87	$40.65	$39.47	$38.32	$37.20	$426.51	
NPV Cost (2)	$2.20	$0.83	$0.80	$0.78	$0.76	$0.73	$0.71	$0.69	$0.67	$0.65	$0.63	$9.45	
NPV (1-2)	-$2.20	$47.72	$46.33	$44.98	$43.67	$42.40	$41.16	$39.96	$38.80	$37.67	$36.57	$417.06	45.13
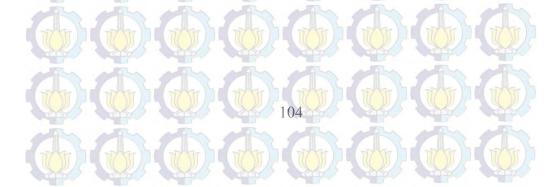
- 3%

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$75.00	$75.00	$75.00	$75.00	$75.00	$75.00	$75.00	$75.00	$75.00	$75.00		
Cost	$2.20	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85		
NPV Savings (1)	$0.00	$72.82	$70.69	$68.64	$66.64	$64.70	$62.81	$60.98	$59.21	$57.48	$55.81	$639.77	
NPV Cost (2)	$2.20	$0.83	$0.80	$0.78	$0.76	$0.73	$0.71	$0.69	$0.67	$0.65	$0.63	$9.45	
NPV (1-2)	-$2.20	$71.99	$69.89	$67.86	$65.88	$63.96	$62.10	$60.29	$58.53	$56.83	$55.17	$630.31	67.70

- 4%

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$100.00	$100.00	$100.00	$100.00	$100.00	$100.00	$100.00	$100.00	$100.00	$100.00		
Cost	$2.20	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85		
NPV Savings (1)	$0.00	$97.09	$94.26	$91.51	$88.85	$86.26	$83.75	$81.31	$78.94	$76.64	$74.41	$853.02	
NPV Cost (2)	$2.20	$0.83	$0.80	$0.78	$0.76	$0.73	$0.71	$0.69	$0.67	$0.65	$0.63	$9.45	
NPV (1-2)	-$2.20	$96.26	$93.46	$90.74	$88.09	$85.53	$83.04	$80.62	$78.27	$75.99	$73.78	$843.57	90.26

- 5%

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00		
Cost	$2.20	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85		
NPV Savings (1)	$0.00	$121.36	$117.82	$114.39	$111.06	$107.83	$104.69	$101.64	$98.68	$95.80	$93.01	$1,066.28	
NPV Cost (2)	$2.20	$0.83	$0.80	$0.78	$0.76	$0.73	$0.71	$0.69	$0.67	$0.65	$0.63	$9.45	
NPV (1-2)	-$2.20	$120.53	$117.02	$113.61	$110.31	$107.09	$103.97	$100.95	$98.01	$95.15	$92.38	$1,056.82	112.83

- 7%

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00		
Cost	$2.20	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85		
NPV Savings (1)	$0.00	$169.90	$164.95	$160.15	$155.49	$150.96	$146.56	$142.29	$138.15	$134.12	$130.22	$1,492.79	
NPV Cost (2)	$2.20	$0.83	$0.80	$0.78	$0.76	$0.73	$0.71	$0.69	$0.67	$0.65	$0.63	$9.45	
NPV (1-2)	-$2.20	$169.08	$164.15	$159.37	$154.73	$150.22	$145.85	$141.60	$137.48	$133.47	$129.58	$1,483.33	157.96

- 8%

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$200.00	$200.00	$200.00	$200.00	$200.00	$200.00	$200.00	$200.00	$200.00	$200.00		
Cost	$2.20	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85		
NPV Savings (1)	$0.00	$194.17	$188.52	$183.03	$177.70	$172.52	$167.50	$162.62	$157.88	$153.28	$148.82	$1,706.04	
NPV Cost (2)	$2.20	$0.83	$0.80	$0.78	$0.76	$0.73	$0.71	$0.69	$0.67	$0.65	$0.63	$9.45	
NPV (1-2)	-$2.20	$193.35	$187.72	$182.25	$176.94	$171.79	$166.78	$161.93	$157.21	$152.63	$148.19	$1,696.59	180.52

- 9%

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$225.00	$225.00	$225.00	$225.00	$225.00	$225.00	$225.00	$225.00	$225.00	$225.00		
Cost	$2.20	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85		
NPV Savings (1)	$0.00	$218.45	$212.08	$205.91	$199.91	$194.09	$188.43	$182.95	$177.62	$172.44	$167.42	$1,919.30	
NPV Cost (2)	$2.20	$0.83	$0.80	$0.78	$0.76	$0.73	$0.71	$0.69	$0.67	$0.65	$0.63	$9.45	
NPV (1-2)	-$2.20	$217.62	$211.28	$205.13	$199.15	$193.35	$187.72	$182.25	$176.95	$171.79	$166.79	$1,909.84	203.09

- 10%
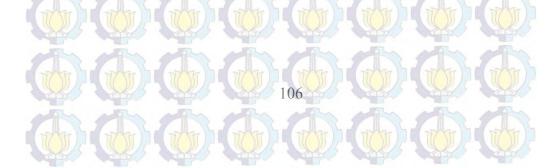
Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$250.00	$250.00	$250.00	$250.00	$250.00	$250.00	$250.00	$250.00	$250.00	$250.00		
Cost	$2.20	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85		
NPV Savings (1)	$0.00	$242.72	$235.65	$228.79	$222.12	$215.65	$209.37	$203.27	$197.35	$191.60	$186.02	$2,132.55	
NPV Cost (2)	$2.20	$0.83	$0.80	$0.78	$0.76	$0.73	$0.71	$0.69	$0.67	$0.65	$0.63	$9.45	
NPV (1-2)	-$2.20	$241.89	$234.85	$228.01	$221.37	$214.92	$208.66	$202.58	$196.68	$190.95	$185.39	$2,123.10	225.65

3. Number of Project Scenario

- 0

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00		
Cost	$2.20	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85		
NPV Savings (1)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	
NPV Cost (2)	$2.20	$0.83	$0.80	$0.78	$0.76	$0.73	$0.71	$0.69	$0.67	$0.65	$0.63	$9.45	
NPV (1-2)	-$2.20	-$0.83	-$0.80	-$0.78	-$0.76	-$0.73	-$0.71	-$0.69	-$0.67	-$0.65	-$0.63	-$9.45	0.00

- 1

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$62.50	$62.50	$62.50	$62.50	$62.50	$62.50	$62.50	$62.50	$62.50	$62.50		
Cost	$2.20	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85		
NPV Savings (1)	$0.00	$60.68	$58.91	$57.20	$55.53	$53.91	$52.34	$50.82	$49.34	$47.90	$46.51	$533.14	
NPV Cost (2)	$2.20	$0.83	$0.80	$0.78	$0.76	$0.73	$0.71	$0.69	$0.67	$0.65	$0.63	$9.45	
NPV (1-2)	-$2.20	$59.85	$58.11	$56.42	$54.78	$53.18	$51.63	$50.13	$48.67	$47.25	$45.87	$523.69	56.41

- 2

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00		
Cost	$2.20	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85		
NPV Savings (1)	$0.00	$121.36	$117.82	$114.39	$111.06	$107.83	$104.69	$101.64	$98.68	$95.80	$93.01	$1,066.28	
NPV Cost (2)	$2.20	$0.83	$0.80	$0.78	$0.76	$0.73	$0.71	$0.69	$0.67	$0.65	$0.63	$9.45	
NPV (1-2)	-$2.20	$120.53	$117.02	$113.61	$110.31	$107.09	$103.97	$100.95	$98.01	$95.15	$92.38	$1,056.82	112.83

- 3

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$187.50	$187.50	$187.50	$187.50	$187.50	$187.50	$187.50	$187.50	$187.50	$187.50		
Cost	$2.20	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85		
NPV Savings (1)	$0.00	$182.04	$176.74	$171.59	$166.59	$161.74	$157.03	$152.45	$148.01	$143.70	$139.52	$1,599.41	
NPV Cost (2)	$2.20	$0.83	$0.80	$0.78	$0.76	$0.73	$0.71	$0.69	$0.67	$0.65	$0.63	$9.45	
NPV (1-2)	-$2.20	$181.21	$175.94	$170.81	$165.84	$161.01	$156.32	$151.76	$147.34	$143.05	$138.89	$1,589.96	169.24

- 4

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$250.00	$250.00	$250.00	$250.00	$250.00	$250.00	$250.00	$250.00	$250.00	$250.00		
Cost	$2.20	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85		
NPV Savings (1)	$0.00	$242.72	$235.65	$228.79	$222.12	$215.65	$209.37	$203.27	$197.35	$191.60	$186.02	$2,132.55	
NPV Cost (2)	$2.20	$0.83	$0.80	$0.78	$0.76	$0.73	$0.71	$0.69	$0.67	$0.65	$0.63	$9.45	
NPV (1-2)	-$2.20	$241.89	$234.85	$228.01	$221.37	$214.92	$208.66	$202.58	$196.68	$190.95	$185.39	$2,123.10	225.65

4. Integration
   - $1,250,000; 5%;2
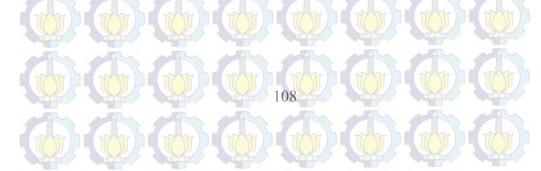
Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00	$125.00		
Cost	$2.20	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85		
NPV Savings (1)	$0.00	$121.36	$117.82	$114.39	$111.06	$107.83	$104.69	$101.64	$98.68	$95.80	$93.01	$1,066.28	
NPV Cost (2)	$2.20	$0.83	$0.80	$0.78	$0.76	$0.73	$0.71	$0.69	$0.67	$0.65	$0.63	$9.45	
NPV (1-2)	-$2.20	$120.53	$117.02	$113.61	$110.31	$107.09	$103.97	$100.95	$98.01	$95.15	$92.38	$1,056.82	112.83

   - $1,750,000;8%;3

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$420.00	$420.00	$420.00	$420.00	$420.00	$420.00	$420.00	$420.00	$420.00	$420.00		
Cost	$2.20	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85		
NPV Savings (1)	$0.00	$407.77	$395.89	$384.36	$373.16	$362.30	$351.74	$341.50	$331.55	$321.90	$312.52	$3,582.69	
NPV Cost (2)	$2.20	$0.83	$0.80	$0.78	$0.76	$0.73	$0.71	$0.69	$0.67	$0.65	$0.63	$9.45	
NPV (1-2)	-$2.20	$406.94	$395.09	$383.58	$372.41	$361.56	$351.03	$340.81	$330.88	$321.24	$311.89	$3,573.23	379.09

   - $2,250,000;4%;4
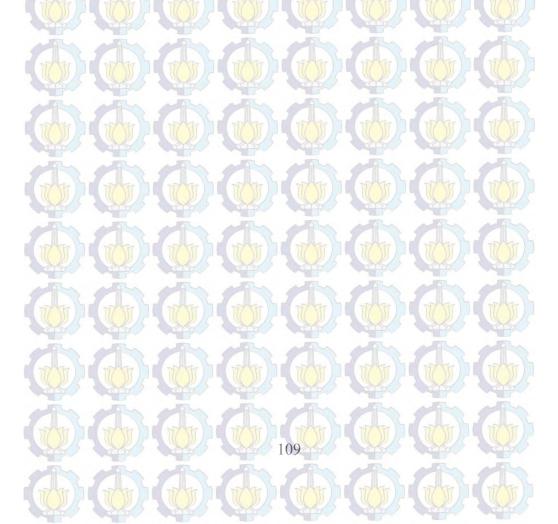
Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$360.00	$360.00	$360.00	$360.00	$360.00	$360.00	$360.00	$360.00	$360.00	$360.00		
Cost	$2.20	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85		
NPV Savings (1)	$0.00	$349.51	$339.33	$329.45	$319.86	$310.54	$301.49	$292.71	$284.19	$275.91	$267.87	$3,070.87	
NPV Cost (2)	$2.20	$0.83	$0.80	$0.78	$0.76	$0.73	$0.71	$0.69	$0.67	$0.65	$0.63	$9.45	
NPV (1-2)	-$2.20	$348.69	$338.53	$328.67	$319.10	$309.81	$300.78	$292.02	$283.52	$275.26	$267.24	$3,061.42	324.94

- $950,000;10%;1

Year	0	1	2	3	4	5	6	7	8	9	10	SUM	Ratio (1)/(2)
Savings	$0.00	$95.00	$95.00	$95.00	$95.00	$95.00	$95.00	$95.00	$95.00	$95.00	$95.00		
Cost	$2.20	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85		
NPV Savings (1)	$0.00	$92.23	$89.55	$86.94	$84.41	$81.95	$79.56	$77.24	$74.99	$72.81	$70.69	$810.37	
NPV Cost (2)	$2.20	$0.83	$0.80	$0.78	$0.76	$0.73	$0.71	$0.69	$0.67	$0.65	$0.63	$9.45	
NPV (1-2)	-$2.20	$91.41	$88.75	$86.16	$83.65	$81.21	$78.85	$76.55	$74.32	$72.16	$70.06	$800.92	85.75

(This page is intentionally left blank)

111

BIOGRAPHY

Author was born in Sukoharjo, 06th December 1993. Author's hobbies are reading, writing, playing game and play any kind of sport. Author has past education formal process, there are SDN No. 94 Palembang and SDN No.2 Centre Curup Bengkulu for elementary school, SMPN 09 Bekasi for junior high school and SMAN 05 Bekasi for senior high school. After past 12 years of education, author continue his study in Industrial Engineering Department Faculty of Industrial Technology Institut Teknologi Sepuluh Nopember Surabaya in 2011.

During study in his campus, author was active in several organizations and events committee. Organization experience of author during study in campus are Social Society Department of HMTI ITS 2012/2013 as staff, Social Politic Ministry of BEM ITS 2012/2013 as staff, Volley Sport Club TI 2012/2013 as manager, Social Society Department of HMTI ITS 2013/2014 as head of department and member of Senat Mahasiswa Teknik Industri (SMTI) ITS 2014/2015. Author was active in more than 15 events as committee such as IE Talk 2013, Industrial Engineering Social Project and P3MTI.

Author followed more than 10 trainings during his study in ITS, such as LKMM TM, LKMM TL and Social Development Community School. Author also got some achievement such as 3rd winner of Data Analysis Competition (DAC) 2013 and finalist of ISMEC's UB 2014.

Author can be contacted through email: argonfaisal@gmail.com, Facebook: Argon Faisal Marconi and phone number: 085733985224.