

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

Argon Faisal Marconi, Putu Dana Karningsih, S.T., M.Eng.Sc., Ph.D

Industrial Engineering Department, Faculty of Industrial Technology, Institut Teknologi Sepuluh Nopember (ITS)

Jl. Arief Rahman Hakim, Surabaya 60111 Indonesia

e-mail: argonfaisal@gmail.com

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. 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 Ref.[1] 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.

I. INTRODUCTION

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. Ref.[2] 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.

PT. PAL Indonesia (Persero) has divisions, one of them is General Engineering Division which has business process in engineering construction sector. Production director of PT. PAL Indonesia (Persero), Edi Widiarto in Ref.[3] declared that engineering project, procurement, construction and installation (EPCO) from General Engineering Division contributed 30% of company.

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 Ref.[4] 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 [1]. According Ref.[5] 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

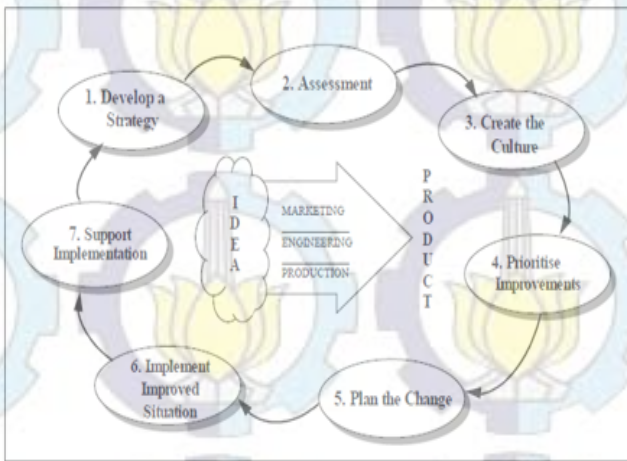


Figure 1 CE implementation framework[6]

There is a framework in implementing CE as figure 1 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.

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 [1].

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.

II. LITERATURE REVIEW

A. Concurrent Engineering

Concurrent Engineering by Winner et al. (1988) in Ref.[7] 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 [8]. The real implementation of CE result in company is shown in the table 1.

Table 1. 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
Rolls-Royce	44% improvement in manufacturing cost
	a trouble-free product introduction
Rolls-Royce	reduce the lead-time to develop a new aircraft engine by 30%
McDonnell Douglas	Reduce production costs by 40%
ITT (waste treatment and water service)	reduced design cycle time by 33%

B. Readiness Assessment of Concurrent Engineering

According to Ref.[7] 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.
- Make the 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.

C. BEACON MODEL

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 organization. Model BEACON shown in figure 2 below.

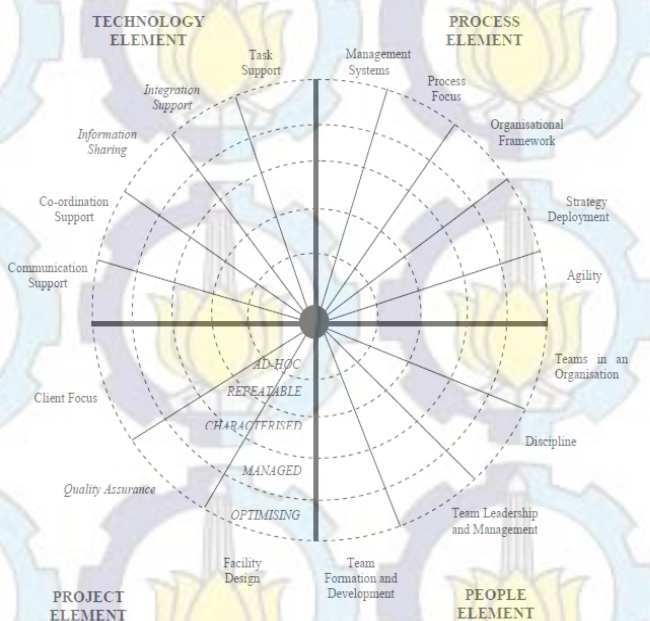


Figure 2. BEACON Model [1]

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’.

There are five maturity level in BEACON model that adopted from RACE Model. The five maturity level are explained in table 2.

Table 2.

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.

III. RESEARCH METHODOLOGY

A. Problem Identification and Formulation Phase

This phase is the first phase of this research. This phase contains steps to identify and formulate the problem, there are problem formulation, defining research objective, and literature review and field study.

B. Readiness Assessment Phase

The steps in this phase are data gathering and development of CE team. Data that need to be collected in this research are organizational structure of the project, new project of General Engineering Division of PT PAL Indonesia (Persero), and new project development phase. CE team will be developed as pilot project team and consist of people from various departments in this phase.

C. Assessment of CE Readiness Phase

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

questionnaire filling and measuring of CE implementation readiness. BEACON questionnaire will be divided into two, the first is to assess the existing condition and the second is to assess the desired condition. BEACON questionnaire for assess the existing condition is filled by CE team representative and for assess the desired condition is filled by a top management. 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.

D. Analysis and Improvement Phase

Analysis of all research activities that have been conducted and improvement recommendation suggestion are conduct in this phase. The steps are gap analysis and developing improvement suggestion.

E. 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.

IV. DATA GATHERING AND PROCESSING

A. Existing Condition Questionnaire Recap and Mapping

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 3 and table 4.

Table 3. Existing condition recap value in each part of element

Element	Part of element	Score	Total Score	Percentage
Processes	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%

Table 3. Existing condition recap value in each part of element (con't)

Element	Part of element	Score	Total Score	Percentage
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%

Table 4. 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 3.

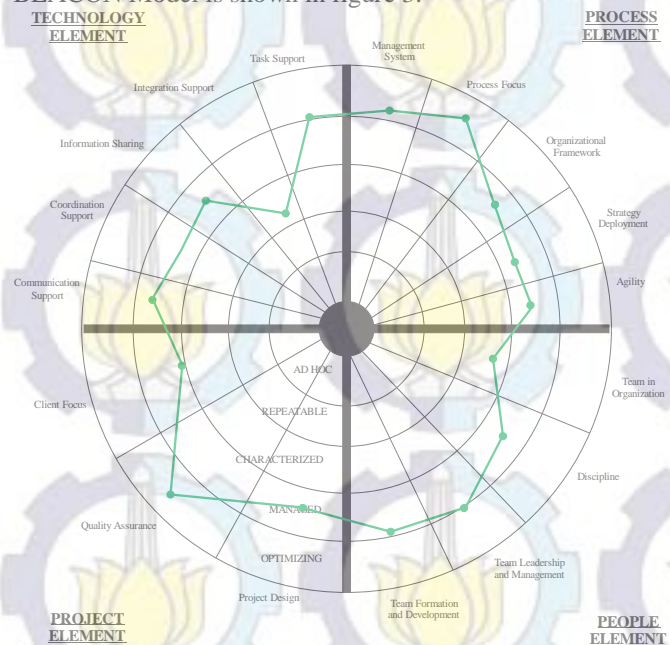


Figure 3. Existing condition mapping in BEACON Model

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.

B. Desired Condition Questionnaire Recap and Mapping

This questionnaire is also filled by a top management of General Engineering Division PT PAL Indonesia (Persero). The recap of score in each part of element is shown in table 5 and table 6.

Table 5. 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%

Table 6. 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%		

Desired condition result in BEACON Model is shown in figure 4

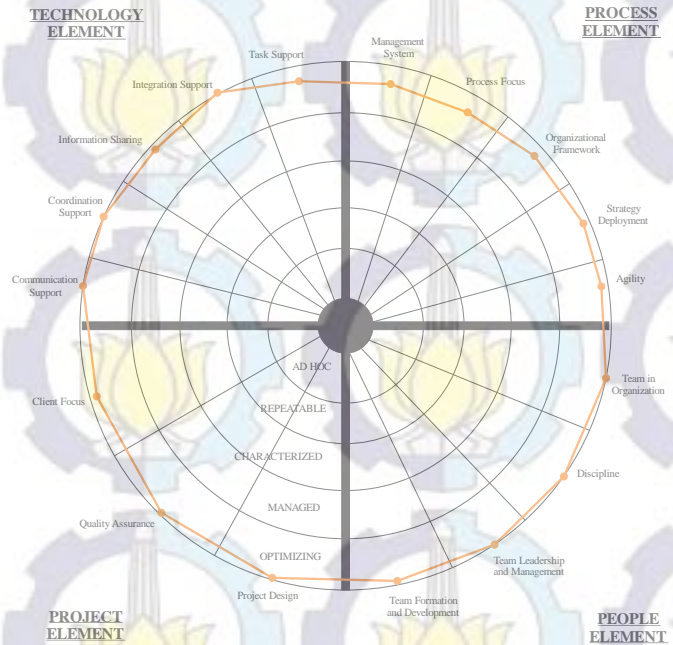
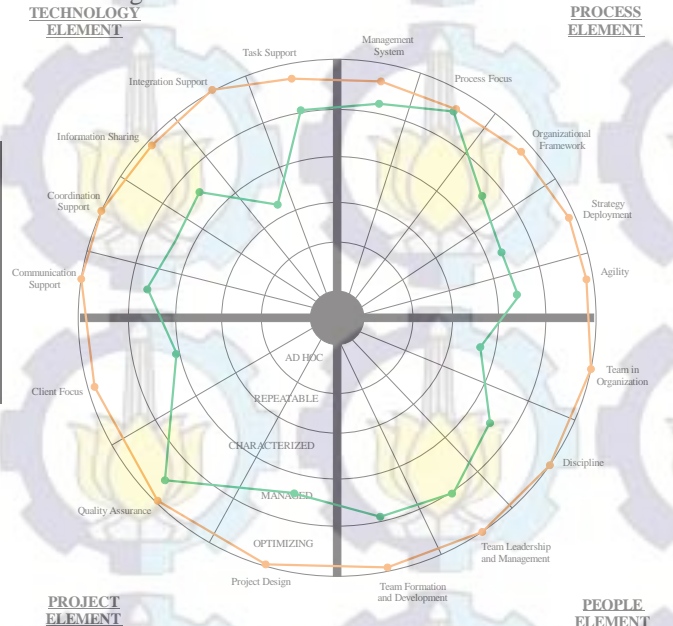


Figure 4. Desired condition mapping in BEACON Model

V. CE READINESS ASSESSMENT ANALYSIS

1. 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



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.

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.

2. Improvement

• Improvement Recommendation for Reward System

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. The alternatives of personal recognition reward that the project team can implement are:

1. Team member of the month
2. Thank you card
3. The project team leader or manager personally congratulates their employee for doing the job well.

• Improvement Recommendation for IT System

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 or Lightweight Directory Access Protocol (LDAP)

THANK YOU EXPRESSION

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