Business Process Improvement in Commercial Ship Division of PT. X: A Theory of Constraints Thinking Process Approach

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***Abstract*—PT. X as one of the biggest shipyard is facing a great challenge to keep its existence. One of its division which has the largest production capacity and expected contribution, is Commercial Ship Division. At 2011 it only fulfilled 23,1% of its target, which brought a huge loss to the corporate. That condition presses Commercial Ship Division to manage a continuous improvement in business process. Facing a constrained resources, all effort must be effectively and efficiently carried on. In this research, solution in business process improvement is approached using Theory of Constraints Thinking Process. From Current Reality Tree (CRT) diagram, the model of problem is acquired. Future Reality Tree (FRT) diagram is used to depict how injection influence the improvement. Transition Tree (TT) is assembled to arrange the necessary step for improvement or a road map.**

***Keywords*—business process, improvement, shipyard, theory of constraints, thinking process**

I. INTRODUCTION

To increase company's competitiveness, a need raises for business process improvement. There are several methods prior to this, such as: Lean Thinking, Total Quality Management (TQM), six Siqgma, and Theory of Constraints (TOC)[1]. Each has its own paradigm and process.

TOC which is introduced by Goldratt in 1984 has a different view to throw an improvement. It is begun with unwanted or undesired condition. Everything that seems not right in the business process. From that point, the whole system is analyzed to seek its weakest chain; the thing that takes effect significantly in the improvement effort.

PT. X, one of the strategic state owned company is facing a survival condition in 2011[2]. A lot of problems occured in the business process makes the company unable to achieve its goals. PT. X only achieved 39,26% of expected sales, meanwhile the expenses rocketed up to 142% from target[2].

One of its biggest division is Commercial Ship Division, because of the biggest production capacity. The comparison among division in PT. X is shown in Table 1. Unfortunately, it achieved the lowest sales realization. From Table 2 we know that the expected sales is 367,77 billion Rupiahs but the actual sales is only 88,4 billion Rupiahs or 23,91% from target.

Table 1 Production Capacity on 2011[3]

Divison	Capacity per month	Output
Warship	70 ton	1 unit/tahun (kelas FPB 38)
Maintenance and Repairment	27.375 DWT	328.500 DWT/tahun (72 kapal/tahun)
General Engineering	200 ton	1 unit *platform*/ tahun (800 ton) 1 unit *jacket* / tahun (400 ton)
Commercial Ship	700	1 unit *tanker* / tahun (30.000 DWT Pertamina)

Table 2 Actual Achievement at the End of 2011[3]

Division	Actual (in billion Rupiahs)	Expected (in billion Rupiahs)	(%)
Commercial Ship	88,4	369,77	23,1
Warship	80,53	178,07	45,22
General Engineering	69,16	146,11	47,34
Maintenance and Repairment	81,87	145,26	56,37
Other service (Palmars)	28,5	48,37	58,93

Total sales	348,46	887,58	32,26

In 2012 the Commercial Ship Division is targeted to contribute 33,21% of all sales or 482,55 billion Rupiahs (see Table 1.3). To operate well according to the plan, the division must improve its business process.

Table 3 Expected Sales in 2012[3]

Division	Sales (in billion Rupiahs)	Revenue Mix (%)
Commercial Ship	482,55	33,21
Warship	266,57	27,61
General Engineering	218,71	17,66
Maintenance and Repairment	231,36	18,68
Other service (Palmars)	35,22	2,84
Total sales	1.234,41	100

In this research, the formulation of improvement will be conducted. For detail, it contains: finding the things that must be improved, objective of improvement, and way to do the improvement. Besides, the theorical comparison with Lean Thinking will be discussed.

II. REVIEW ON THEORY OF CONSTRAINTS

This research is based on the approach of Theory of Constraints Thinking Process (TOC TP). First introduced by Goldratt in 1984[4], TOC TP views a company as a system. A system which has objective or goal and constraints which limit the company to achieve more[5-7]. A critical chain or weakest link is an entity that becomes constraint. Goal is denoted to be expected result by effort[8].

A. 5 Focusing Steps

To turn TOC's practice into a continuous imporvement, Goldratt throw an idea called 5 Focusing Steps (5FS). Each is a part of circular action which directs the way we improve[4, 9]. Those five steps are:

- Find the constraint, the critical chain
- Find a way to exploit the constraint. Some author point this step as finding creative way to overcome problem without doing major change or big cost[7, 10]
- Suboordinate with everything else. Remember that a slight change to one entity in a system may cause change in other entity or everal performance
- Elevate the constraint. Elevate mean appl;ying all necessary change, including the one that costly too.
- If things go well as expected, go back to step one and watch for inertia.

B. Thinking Process

While 5FS is more like a philosophy, Thinking process is a set of tool. Thinking Process (TP) is used to illuminate and solve unstructural problem. The tools are logic based. There are 5 logical tree in TP[10-11]:

- Current Reality Tree (CRT)
- Conflict Resolution Diagram (CRD)
- Future Reality Tree (FRT)
- Prequisite Tree (PRT)
- Transition Tree (TT)

Contrary to popular belief, even they come from one set, but we according to other experts we could use them as separate tools[12-13] . Later we use the opinion in this research.

C. Current Reality Tree

The generic question to start TOC case are these threee question[10]:

- What to change?
- What to change to?
- How to cause the change?

CRT is used to answer the first question. What to change is the weakest link in the system. The process of searching is begun with finding Undesired Effects (UDE). UDE is a negative thing that really happen[10]. It is the main cause of unability to achieve the goal.

After UDEs are identified, then we pull Root Causes (RC) with causality logic. We stop pulling causes on the boundary of span of controlIf there are one or more RC that become the major cause of all UDE (approximately 70%) it is called Core Problem (CP) (see Figure 1).

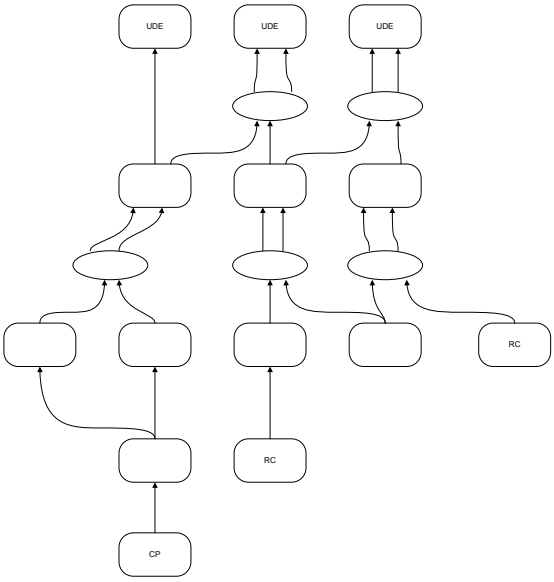

Figure 1 Current Reality Tree

D. Conflict Resolution Diagram (CRD)

It is obviously clear that to eliminate problem we just have to negate all the RC in CRT (see Figure 1). But one does not simply eliminate it. Some even evoke new problem, in this case conflicts.

A negated RC is a new objective. Then the necessary condition to fulfill the objective may cause conflict. CRD comes to finish the dispute.

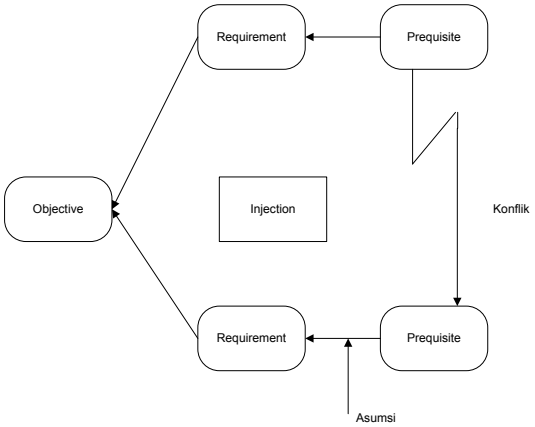

Figure 2 Conflict Resolution Diagram

The necessary condition could possibly requirement or prerequisite. In this tool we illuminate how the conflict arises and how genuine breakthrough (injection) proposed works.

E. Future Reality Tree (FRT)

Based on CRT, we put injections to negate each CP or RC to engineered the desired effect. The conceptual idea is depicted in FRT. So basically FRT is a conceptual drawing to describe how the injections change the existing condition[10].

The simbology of FRT is same as CRT and CRD.

F. Prerequisite Tree (PRT)

If the objective (negated Core Problem) is too complicated to achieved, PRT comes to depict any necessary steps and obstacle faced. In here obstacle is not solved but rather neutralized. That is why an Intermediate Objective is needed.

The simbology and general structure of PRT is shown on Figure 3.

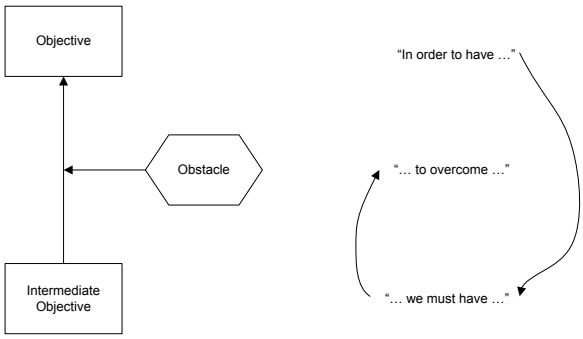

Figure 3 Prerequisite Tree

G. Transition Tree (TT)

Last tool of the set, TT is used to depict detailed action to kick out an improvement project based on findings from previous tools[10]. While FRT is a conceptual work, TT emphasizes on steps. In this research, TT is used to build a road map to achieve objective. And this tools can also point out which step could be done paralleled.

The relation between PRT and TT is shown on Figure 4.

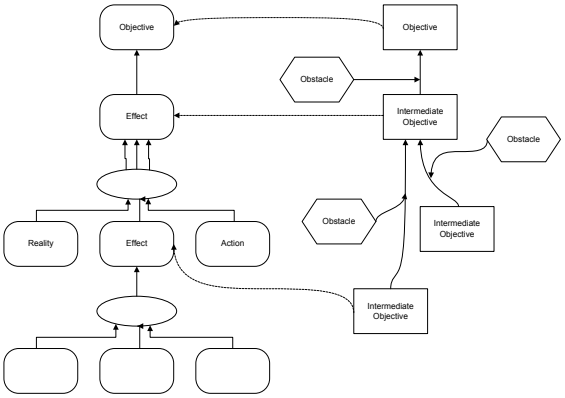

Figure 4 Relation betweeen PRT and TT

III. THEORICAL COMPARISON BETWEEN THEORY OF CONSTRAINTS AND LEAN THINKING

TOC and Lean Thinking are interesting to compared because the two shared the same goal, making improvement[6]. Some works can be found on books and academic journals[1, 6-7, 11, 14-17]. Some works touch only theorical aspect and the others research for practice.

Some author try to combine the two philosophy called TOC Lean Six Sigma[16-17]. Even doing integration, both approach from different concept.

Both TOC or Lean Thinking has philosophy base. The general comparison is shown on Table 4.

Table 4 Comparison

Philosophy	*Lean Thinking*	*Theory of Constraints*
Theory	Eliminate waste	Manage constraint
Steps	Identify value	Identify constraint
	Identify value stream	Exploit constraint
	Flow	Suboordinate processes
	Pull	Elevate constraint
	Perfection	
Focus	Flow time	Constraint in system
Main objective[6]	Eliminate *muda* or waste	Increase throughput

In Lean thinking, main objective is to reduce waste. So the expected results are decreasing flow time, variation, and inventory. In TOC, main objective is to manage constraints. The expected results is a leverage in throughput volume.

When working on TOC case, we start with identifying UDEs. Meanwhile in Lean Thinking, it is started with checking *muda*[6].

Wilson point out that Lean Thinking works best at make to stock copany, while TOC in make to order[1]. Besides, by the nature of its process TOC is weaker at handling waste and quality, but stronger at tackle unusual problem. Something that depends heavily on logical thinking. And also the concept of Throughput, Inventory, and Operating Expenses makes a simplified financial indicator.

IV. METHODS AND ANALYSIS

We conducted a several interviews with the manager. A person who knows well the business process and pays responsible with it. It is agreed that the main goal of the division are the shipbuilding project. The company monitors each project based on finished works valued by money. This is called sales.

Each project has target sales per month. And the manager makes monthly report on the progress, including causes of delay.

By understanding that. We defines the goals are delivering the seven project as expected target in the end of the year. UDE is the delay that happen.

As shown on Table 5, 4 of 7 projects didn't make it. At this point, we get UDEs for CRT.

Table 5 The Expected And Actual Sales

No.	Kode Proyek	Penjelasan	RKAP 2011 (%)	Realisasi 2011 (%)
1	M241	*Chemical Tanker* 24000 DWT	100	100
2	M242		100	86,192
3	M259	*Chemical Tanker* 6200 DWT	100	92,876
4	M264	*Escort Tug*	100	100
5	M265		100	100
6	M271	Tanker Pertamina 17500 DWT	26,6	18,301
7	M272		9,3	7,806

Then we scratch on any information about causes of the delay. We collect information from interview with managers and staffs. Also a written report becomes our source.The collected information arranged in CRT (see attachment 1).

From CRT, RCs are founded. In the atttachment, it is marked with red shade. We learnt that RC number 2.2.1 and 6.4.1 are the most significant cause (see Table 6).

Table 6 Core Problems

Number	RC Number	UDEs affected
1	2.2.1	16
2	6.4.1	4

Both affect 20 out of 28 UDEs. It means 71,4% UDEs are caused by these two. This fact makes both RC to be CP.

From the previous theory, it is considered enough if only CPs affected by injections. Then we can begin to build FRT (see attachment 4). The injecteion marked with green shade, while the causes affected ini brown shade.

There is no conflict nor complicated obstacles could happen with the proposed injection, so we can skip to build TT.

TT is build not as part of the series. But it is specificallly intended to response the upcoming events. While gathering the data, an important update comes from the top management that PT. X will be granted financial aid from government. In this case TT is designed to be a road map to facilitate that financial aid.

Fortuitously, the biggest CP (number 2.2.1) is "the lack of funds". So the TT will be focused in this CP. The roadmap is not only intended to be a road map to overcome CPP 2.2.1, but also to increaase readiness of the company prior to get financial aid. That means the allocation and necessary action. The result of TT can be seen on attahcment 5.

V. DISCUSSION

From CRT (see attachment 1), it is clearly seen that even complex, the CRT can be "divided" into two sections. Project M242 and M259 share a lot of similar causes, same with M271 and M252. The two groups don't share much similar causes. It is understandable because M242 and M259 is the same class of ship, and M271 and M252 are too. The project kick start of the same class ship doesn't separate too long. This fact makes quite similar progress, also same problem faced.

From the FRT it is agreed that minimum effort to make improvements is targeting the CP only. But that is not the end of solution, the company still can pay attention to other RC as secondary mission. It will be effective and efficient if we begin to solve problem from the biggest trouble maker than scratch randomly and hoping for a good result.

From the TT we can see 12 parallel steps that must be done to overcome "lack-of-fund-problem".

VI. CONCLUSION

From the research conducted we find the things that have to be improved inside the business process.

- Design is only estimation
- Pay guarantee is weak
- *Lead time* inbound material is longer than deadline
- Lack of funds
- Unskilled labor
- Weak contract
- Waiting for incoming spare part
- Human error
- Long design time
- Time is a mandatory demand
- Maintenance is in monthly
- Delayed shipment
- Operational hours of machine is not consistent
- IHSC doesn't update certificate

The objective of improvement are to overcome lacks of funds problem and delayed shipment. Corresponding to financial aid from government, then the objective focused on overcome problem created from lack of funds.

The way to make it done is described in Transiton Tree.

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