CHAPTER V

ANALYSIS

It is apparent from previous chapter that performing vertical cost assignment provides useful information of how diversity and variation in products and customers creates product and customer cost structures including product unit cost. Gaining such useful information is only half of ABC's success. The real success is to use ABC information to improve business process. Therefore, this chapter will describe how to put ABC information to work to meet the goal of business process improvement.

In this chapter, the same activity costs will be oriented in the context of the time-based horizontal process view or the business process flowchart. The horizontal process view provides insights of what causes costs to exist and how much processes cost. This facilitates activity and process analysis and eventually allows management to identify opportunities for improvement. This chapter begins with analysis of activities to identify opportunities for improvements. The mechanisms for improvement will be determined, and the appropriate ones will be converted into action. Finally, it is about evaluation of this improvement.

5.1 Identifying Opportunities for Improvement

In order to identify the opportunities, it needs to analyze the activities to understand why they work and how well they do. However, there are about 45 activities in the company business process. It is simply not the time to analyze all of them. Thus, it is better to identify where the best areas are potentially focused. The key is to focus on significant activity cost. This is based on the assumption that the more activity cost, the greater opportunities for improvement. Identifying the focus areas can be done by Pareto Analysis.

Pareto analysis is a simple ranking tool to assist in the selection of the largest or smallest component of cost. The concept is based on the theory that eighty percent of the total cost is normally generated by twenty percent of the activities.

5.1.1 Identifying Target Areas

Regarding to table 4.30, manufacturing process cost is 17,954,066 Baht, which is about over 96% of overall costs. Thus, it is appropriate to start applying Pareto analysis at this process. The manufacturing process is constructed with A21, A22, A23, A24, and A25. Their costs are ranked in descending order of cost and calculated cumulative cost as shown in table and figure.

Act. ID	Activities	Activity Costs (Baht)	% of Total Cost	Cumulative Cost (%)
A23	Production Process	16,321,570	90.91	90.91
A25	Delivery Process	860,991	4.80	95.70
A24	Perform QA. Process	351,573	1.96	97.66
A22	Develop New Products	341,361	1.90	99.56
A21	Develop Production Plan	78,571	0.44	100.00
	Total	17,954,066	100.00	

Table 5.1 Pareto analysis of manufacturing process

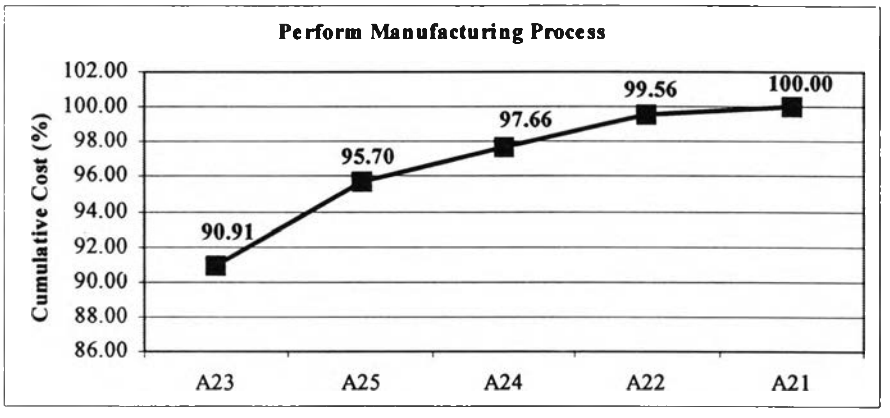

Figure 5.1 Pareto analysis of manufacturing process (A2)

The result indicates that production process A23 generates about 90 percents of the total cost. Thus, the next step is to apply Pareto analysis through A23, which is constructed by Melting process (A231), Moulding Process (A232), Pouring Process (A233), and Finishing Process (A234). These activity costs are ranked in descending in order of cost and calculated cumulative cost as shown in table 5.2 and figure 5.2.

Act. ID	Activities	Activity Costs (Baht)	% of Total Cost	Cumulative Cost (%)
A231	Melting Process	8,030,080	49.20	49.20
A233	AMF Moulding Process	3,804,324	23.31	72.51
A236	Finishing Process	2,727,866	16.71	89.22
A235	Pouring Process	902,417	5.53	94.75
A234	FD Moulding Process	475,483	2.91	97.66
A232	Make Core	381,401	2.34	100.00
	Total	14,575,969	100.00	

Table 5.2 Pareto analysis of production process (A23)

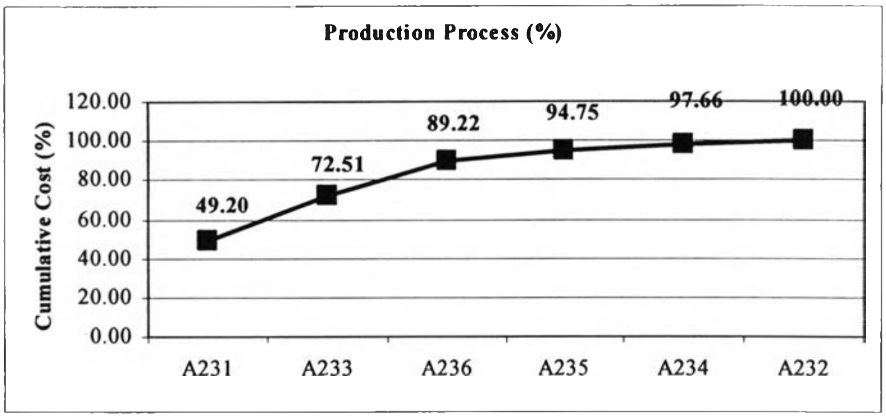

Figure 5.2 Pareto analysis of production process (A23)

The result indicates that Melting, AMF Moulding and Finishing process create about 89% of production process cost. Melting process is constructed with A2331, A2332, A2333, A2334, and A2335. Moulding process is constructed with A2321, A2322, A2323, A2324, and A2325. Finishing process is constructed with A2361, A2362, A2363, and A2364. Thus, the next step is to apply Pareto analysis through A231 and A233. Sub activity of melting and moulding process are ranked in descending in order of cost and calculated cumulative cost as shown in table and figure 5.3 and 5.4 respectively. Note that, Pareto analysis is not applied to finishing process even if its cumulative cost is over 80%. The reason is that there are over 100 different products produced from Jun – Nov 2005. Generally, in finishing process, different products require different activities to finish. The consequence is that this process is too complicated. Therefore, with limited time of this study, it is not appropriate to discover opportunities for improvement in finishing process.

In contrast, melting and AMF moulding process are more generic. Different products require the same melting process but slightly different moulding process (in term of number of sand mould per ladle). ***It could be said that if melting and AMF moulding process are improved, the company performance can improve as a whole.***

Act. ID	Activities	Activity Costs (Baht)	% of Total Cost	Cumulative Cost (%)
A2313	Melt metal	7,491,385	93.29	93.29
A2314	Check chemical compositions	251,634	3.13	96.43
A2315	Pour into Ladles	174,748	2.18	98.60
A2312	Prepare SS and RS	83,742	1.04	99.64
A2311	Prepare Chemical Composition	28,571	0.36	100.00
	Total	8,030,080	100.00	

Table 5.3 Pareto analysis of melting process (A231)

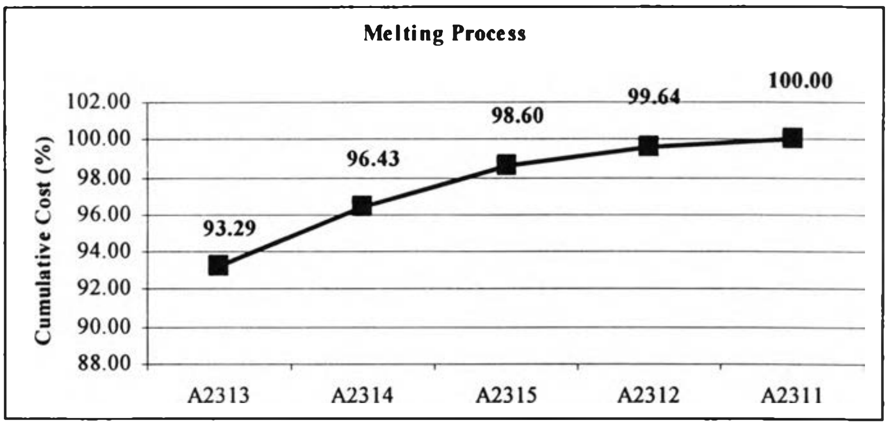

Figure 5.3 Pareto analysis of melting process (A231)

Act. ID	Activities	Activity Costs (Baht)	% of Total Cost	Cumulative Cost (%)
A2334	Make Sand Mould	3,004,956	78.99	78.99
A2333	Mix Sand	725,072	19.06	98.05
A2332	Prepare Pattern	46,691	1.23	99.27
A2331	Prepare Materials	27,606	0.73	100.00
	Total	3,804,324		

Table 5.4 Pareto analysis of moulding process (A233)

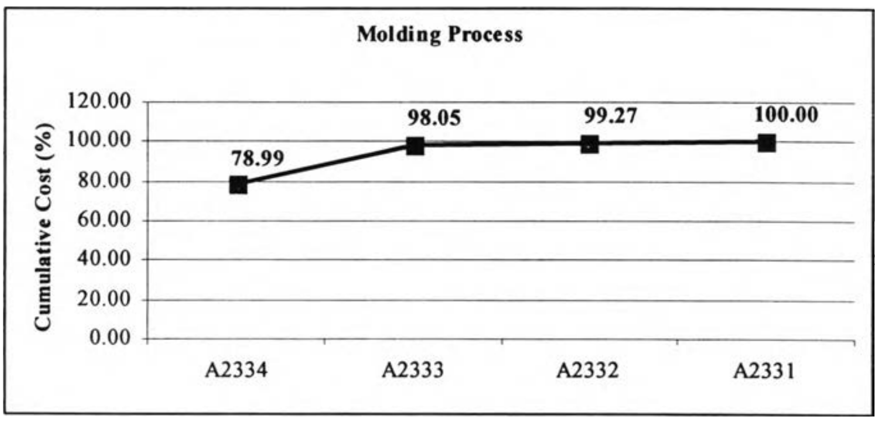

Figure 5.4 Pareto analysis of moulding process (A233)

The results indicate that A2313 creates about 93% of melting process cost, and A2334 creates about 79% of moulding process cost. A2313 and A2334 cost is 7,491,385 baht and 3,004,956 Baht, which is about 46% and 18% of production process cost and 42% and 17% of manufacturing process cost respectively. The summation of A2313 and A2334 is 10,496,341 Baht, which is about 64% and 59% of production and manufacturing process cost. ***It could be said that these two activities are significant to the company as a whole. Therefore, it is worthy to pay attention on these activities.***

5.1.2 Activity Analysis

A2313 (Melt Metal) and A2334 (Make AMF Sand Mould) have been selected to analyze. The key to meet the goal of process improvement will consider to firstly their cost driver. Understanding what causes require activities to perform is a critical success factor. Eliminating causes will eventually reduce activity cost. However, the cost driver of A2313 and A2334 is "daily production plan". This cost driver relates to customer demands. It is nonsense to reduce daily production plan because it will directly impact to customer demands. The other reason is that these activities are essential activities, which are ranked at high value added activity (1). There is no reason to reduce performing high value-added activity.

The other way, secondly, for process improvement is to optimize activity cost rate. Activity cost rate is calculated by total activity cost divided by output quantity (Activity Cost Rate = Total Activity Cost/Output quantity). From the equation, there are 2 different ways to reduce activity cost rate as shown in table 5.5. The first is to decrease activity cost. Decreasing activity cost means decreasing resource costs for instances man power, materials, etc. However, this will directly impact to product quality and eventually company performance and customer satisfaction. Thus, decreasing resource costs is not a right direction to meet target of process improvement. The second way is to increase the number of output quantity. This way will not affect to product quality because resources are consumed at the same level. The activity cost rate of A2313 and A2334 is 1,900.88 Baht/Charge and 13.83 Baht/Mould. The key to increase the number of charge and the number of mould can be done by reducing cycle time of both activities and the activities dealing with.

Activity Cost Rate	Total Activity Cost	Total Unit Output
↓	↓	-
↓	-	↑

Table 5.5 The way to decrease activity cost rate

To identify the activities that their cycle time impacts to the level of those output quantity, it is necessary to consider in the other perspective, which is time and cause-and-effect relationship. It is clear that A2313 and A2334 are performed in relation to the activities in melting, AMF moulding, and pouring process. To understand how they interrelate, it is better to simulate a situation of performing melting, moulding, and pouring process. The situation is to produce a product 1 cycle of performing melting process. The selected product is Flywheel ZE1 because its capacity shares about 35% of total capacity, which is the most.

Table 5.6 represents total cost and time required by each activity to perform one cycle of performing melting process. Note that, A2331 and A2332 are not included in the simulation due to they are not normally required by every charge, but they perform only 1 time per shift and 1 time per plan respectively.

Act. ID	Name	Activity Cost Driver	Activity Cost Rate (A) (Baht/Unit Output)	Cycle Time (Min/Cycle) (C)	Number of Activity Output (N)	Total Cost (A*N)	Total Time (C*N)	Start Time (Min)	Stop Time (Min)
A231	**Perform Melting Process**								
A2311	Prepare Chemical Composition	# of Charge	7.25	5.00	1	7.25	5	0	5
A2312	Prepare SS and RS	# of Charge	21.25	10.00	1	21.25	10	0	10
A2313	Melt metal	# of Charge	1,900.88	40.00	1	1,900.88	40	0	40
A2314	Check chemical compositions	# of Charge	63.85	7.00	1	63.85	7	40	47
A2315	Pour to 2 Ladles	# of Charge	44.34	8.00	1	44.34	9	47	56
A233	**Perform AMF Moulding Process**								
A2331	Prepare Sand Compositions			20.00					
A2332	Prepare Pattern			5.00					
A2333	Mix Sand	# of Mix (AMF)	33.00	4.00	7	231.02	28	0	28
A2334	Make AMF Sand Mould	# of AMF Sand Mould	13.83	0.63	56	774.49	35	0	35
A235	**Pouring Process**								
A2351	Pour into AMF Sand Mould	# of AMF Sand Mould	2.17	0.17	56	121.77	10	0	10
A2352	Remove Gating System (AMF)	# of AMF Sand Mould	1.06	0.63	56	59.26	35	0	35

Table 5.6 Time and cost built up for performing one charge

Figure 5.5 depicts how these activities are performed in relation to the time and their relationships in each cycle. It is apparent that A2315 is a key activity to initiate the next cycle of melting and moulding process. A2313 (Melt Metal), A2314 (Check Chemical Composition) and A2315 (Pour into Ladles) are critical activities to determine the cycle time of melting process, and A2334 (Make AMF Sand Mould) is a critical activities to determine the cycle time of moulding process. Interestingly, melting process operates about 56 min/cycle. However, moulding process operates about 35 min/cycle. It means that moulding process has to stop about 15 minutes in every cycle.

This indicates that the real factor impacting to level of number of charge and sand mould is the cycle time of melting process. The less cycle time of melting process, the more number of charge and number of sand mould.

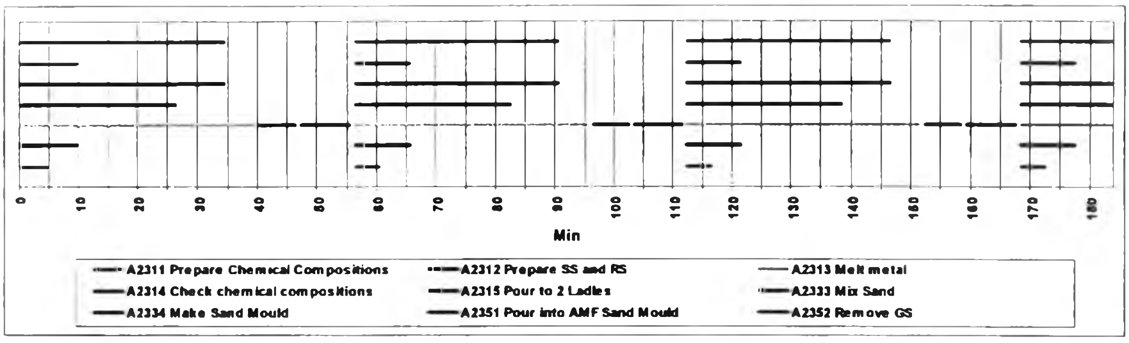

Figure 5.5 Cycle time of melting, moulding, and pouring process

The performance of melting and moulding process can be measured in term of molten metal weight per hour and number of mould per hour respectively. With such cycle time of both processes, the current performance is 900 kg/56 min or 964 kg/hr for melting process and 70 second/mould or 52 moulds/hr. In fact, the best practice is about 1,350 kg/hr for melting process and 110 moulds/hr for moulding process.

In sum, the objective of this improvement is to reduce activity cost rate of A2313 and A2334. Time-reduction of melting process is the key to meet such target. ***This is based on the assumption that reducing melting process cycle time can increase the number of charge and sand mould, and increasing number of those output quantity can eventually reduce activity cost rate of two significant activities.*** Next paragraph will discuss how to reduce melting process cycle time.

As mentioned, the activities determining the cycle time of melting process is A2313 (Melt metal), A2314 (Check Chemical Compositions), and A2315 (Pour into Ladle). Therefore, it is necessary to analyze the factors impacting to their cycle time and determine how the time can be reduced. Cause and effect diagram (Fishbone diagram) is appropriate to determine the root causes of this problem as shown in figure 5.6.

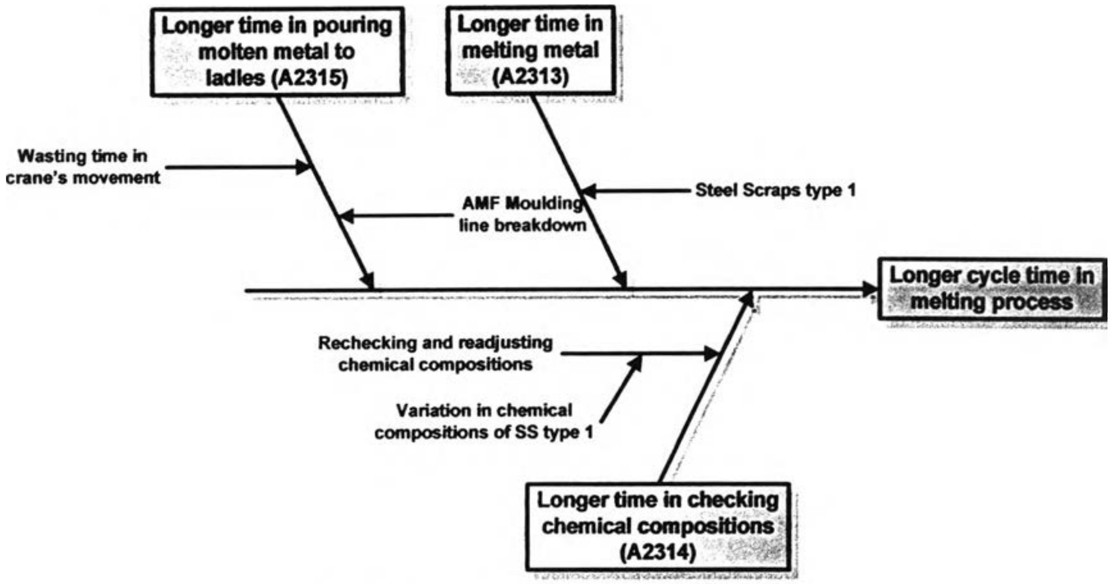

Figure 5.6 Cause and effect diagram

- A2313 (Melt Metal)

Generally, time for performing melting metal varies from 35 to 45 min/cycle. The major factor influencing to the melting time is types of steel scraps used. Steel scraps (SS) and return scraps (RS) are the major raw materials for producing molten metal. There are 2 different types of steel scraps. Type 1 can be molten faster, but its chemical composition is not stable. In contrast, type 2 is molten at slower speed, but its chemical composition is quite stable. Normally, these two types are used at the same ratio (50:50) every charge, 200 kg and 200 kg. From the analysis, the attention is time-reduction at melting process. Thus, the ratio should increase the first type. However, changing the ratio definitely has a consequence. The effect of chemical composition variation potentially increases. This will finally result to increasing of checking and adjusting chemical composition in A2314.

- A2314 (Check Chemical Compositions)

Normally, one charge of melting metal requires at least one time for checking chemical composition before molten metal is poured to ladles. But if the test result is not satisfied, molten metal needs to be adjusted and checked chemical compositions until the result is satisfied. Time required by this activity basically is about 4 minutes per time. In fact, regarding to table 5.6, it is 7 minutes by average. The major cause that drives this activity to perform more than 4 minutes or one time is the variation of chemical composition of steel scraps. This is the consequence of using steel scraps type 1.

- A2315 (Pour into Ladle)

Molten metal will be poured to ladles when the test result of checking chemical compositions is satisfied. Normally, this activity spends about 5 minutes per cycle. In reality, it takes about 9 minutes regarding to table 5.6. The factors affecting to the longer time are moulding line breakdown. It means that molten metal is unable to be poured to ladles, even if the result is satisfied, due to moulding line is not ready for pouring. However, this factor depends on how well the maintenance system, which is not the focus of this study. Rather, the attention is put more on how this activity can be reduced cycle time by itself.

By investigating, molten metal (1,000 kg) of one charge requires 2 ladles (450 kg/ladle) for pouring. As soon as the test result is ready, operator will move the first ladle by crane from warming ladle area to furnace for receiving molten metal (step 1). (Warming ladle area is a place for burning ladle to keep the temperature not below 700 C) Molten metal is poured from furnace to the first ladle (step2). The first ladle after pouring will be moved to moulding line by crane (step 3), and then operator will move crane to pick up the second ladle at warming area (step 4) and move to furnace for receiving molten metal again (step 5). Molten metal is poured from furnace to the second ladle (step 6). After pouring, the second ladle is moved to moulding line (step 7), and the next cycle of melting process can perform at the same time. These steps are graphically represented in figure 5.7.

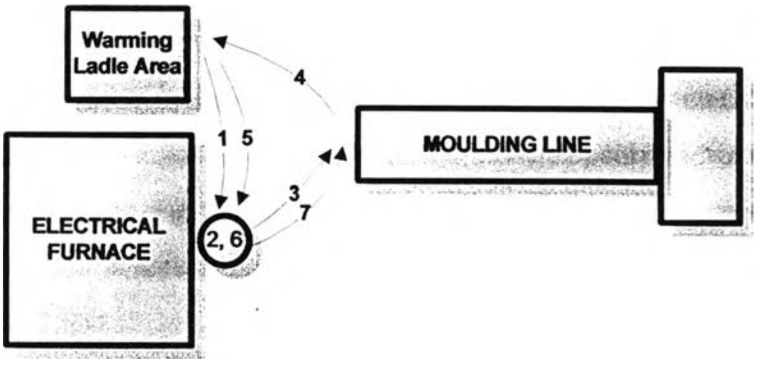

Figure 5.7 Step of movement of crane

It can conclude that most of the time is wasted to the movement of ladles not pouring molten metal to ladles.

5.2 Identifying the methods for improvement

From the analysis of those 3 activities, the factors influencing to the longer cycle time of melting process are summarize into 3 factors. The first is steel scraps type 2, the second is the variation of chemical compositions of steel scraps type 1, and the third is the movement of ladles. The solutions for these factors are described as follow:

- Changing steel scraps ratio

It is clear that the steel scraps type 2 takes longer time to melt. To reduce melting time, the ratio should be changed by increasing the proportion of type 1. As a result, the ratio is changed from 50:50 to 75:25 or 200:200 kg to 350:50 kg per charge.

- Adjusting receiving material activity (A113)

The impact of chemical composition variation in steel scraps type 1 can be reduced by adjusting receiving inspection activity. Generally, when raw materials deliver to the company, QA will inspect those by sampling. The specification of each is specified by inspection standard. For steel scraps, the frequency of sampling is specified as 1 piece / lot. To reduce this effect, the frequency is changed to at least 5 pieces / lot. In addition, QA will inform the result to melting team and assistant or general manager. This allows melting team to adjust the proportion among steel scrap type 1, type 2, and return scarps in “Prepare SS and RS” (A2312) before melting metal (A2313) is performed. In addition, assistant or general manager will inform to supplier to negotiate the action and request for improvement. The action can be “recheck” or “reject”.

In sum, increasing the frequency of sampling and informing the inspection result to concerned people provide opportunities to prevent the incident of chemical compositions in molten metal over standard that eventually result to waste the time for adjusting and rechecking chemical compositions.

- Buying from the best supplier

Buying from the best supplier can be a way to reduce the variation of chemical compositions. The company buys steel scraps type 1 from 3 suppliers, which are ILJ, CNK, and LSS. The criteria to select one is simply by interviewing melting team which suppliers have less problems. As a result, the best supplier is ILJ, and this supplier is selected for this improvement.

- Rearranging A2314 and A2315 to work simultaneously and Using two cranes

In A2315 (pour into ladles), it is clear that the time required by the movement of ladles is more than that by pouring molten metal to ladles. In sum, time required in this activity divided into 7 steps as follow:

Step 1: Move 1st ladle from warming ladle area to furnace
Step 2: Pour molten metal to 1st ladle
Step 3: Move 1st ladle from furnace to moulding line
Step 4: Move crane to pick up 2nd ladle from warming ladle area
Step 5: Move 2nd from warming ladle area to furnace
Step 6: Pour molten metal to 2nd ladle
Step 7: Move 2nd from furnace to moulding line

There are two improvement methods to reduce time wasted within this activity. The first method is to rearrange A2315 and A2314 to work simultaneously. It means checking chemical composition and pouring into ladles activity can start to perform at the same time. Both activities can start as soon as temperature of molten metal in furnace is 1450 C at least. This is different from the previous one that A2315 will perform after the test result of chemical compositions is OK. As a result, the consequence of rearranging the activities is that time required by step 1 is removed because step 1 has already done while checking chemical compositions is performing.

The second improvement method is to approach the other crane to handle the second ladle. Thus, each ladle is carried by its own crane. The result is that time required to pick up the second crane (step 4) and move to furnace (step 5) is removed.

Therefore, by rearranging the activities and using two cranes, time required by step 1, 4, and 5 is removed. The new steps is that as soon as the temperature in furnace reaches 1450 C, checking chemical compositions is performed in the same time that two cranes will move to pick up both ladles from warming area and then move to furnace to wait for pouring molten metal (step 0). After the test result of chemical compositions is satisfied, molten metal is poured to 1st ladle (step 1). 1st ladle is moved to moulding line in the same time that molten metal is poured to 2nd ladle. After pouring, 2nd ladle is moved to moulding line. The figure 5.8 illustrates the new steps.

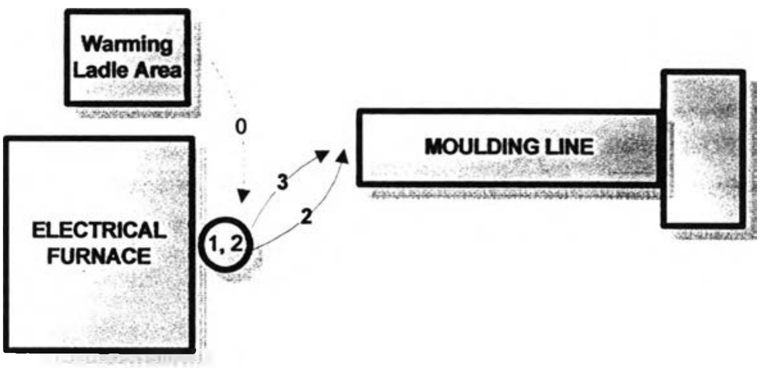

Figure 5.8 The new steps of crane movement

In sum, the way to reduce cycle time of melting process can be summarized into 4 methods as follow:

- Changing steel scraps ratio between type 1 and type 2 from 50:50 to 75:25 or 200:200 kg to 350:50 kg respectively.
- Increasing the frequency of sampling and informing the inspection result to concerned people.
- Buying steel scraps type 1 from the best supplier.
- Rearranging A2314 and A2315 to work simultaneously and Using two cranes

5.3 Implementation

As previously discussed, the key to meet the goal of improvement is time-reduction in melting process. Four methods have been analyzed to be mechanisms to archive that target. Now, the methods for improvement will be converted into action. There are several key points need to be clear and done to ensure the success of implementation.

- Purpose the improvement plan to General Manger and ensure the management commitment. In addition, time and scope need to be set. In this study, time required for the implementation is 1-31 December 2005, and the scope is within melting and moulding process.
- Educate concerned people especially melting, moulding, and QA team to understand the objective of the improvement and why the company needs to improve.
- Prepare what concerned people needs to encourage the improvement.
- Inform the performance results to the people everyday and have a meeting to determine and solve problems.

5.4 Evaluation

In this section, the results of implementation will be discussed. The criterion to evaluate is to test the potential financial impact by quantifying the cost saving in the activities. The evaluation will focus on where this improvement potentially impacts. In this study, the objective of the improvement is to reduce activity cost rate of A2313 and A2314. The key to meet the target is to reduce cycle time in melting process in order to increase the number of output quantity (number of charge and the number of sand moulds) and eventually to reduce cost rate of such activities. The evaluation will also consider how the improvement impacts to the financial term such as net profit of the company.

5.4.1 Organizing resource costs and reassigning resource costs to activities

At first step of evaluation, it requires to collect the cost data of December 2005. The cost data will be reassigned to the activities by vertical cost assignment as described in chapter 4. The 15 cost elements are collected and reorganized into 10 major groups as shown in table 5.7 and 5.8 respectively. These cost groups are reassigned to the activities as shown in table 5.9. In table 5.10, support activity costs are assigned to other activities.

Cost Elements	Baht
Direct Materials	4,732,715
Indirect Materials	571,833
Direct Labours	616,582
Salaries	177,979
Tools & Equipments	366,988
Maintenance	86,006
Electricity	1,545,833
Water	15,431
Fringe Benefits	51,271
Communication	5,439
Office Accessories	12,826
Miscellaneous Expenses	131,400
Traveling Expense	35,013
Fuel	74,726
Depreciation	329,011

Table 5.7 15 cost elements, Dec 2005

Cost Groups	Baht
Direct Materials	4,732,715
Indirect Mat.	571,833
Tools & Equips and Maintenance	452,994
Electricity	1,528,499
Water	10,140
Direct Labour	680,860
Salary	205,862
Transportation	109,739
Miscellaneous Expenses	131,400
Depreciation	329,011
Total	**8,753,054**

Table 5.8 10 cost groups, December 2005

Act. ID	Indirect Materials	Tools & Equips and Maintenance	Electricity	Water	Direct Labour	Salary	Transportation	Activity Cost
A1								**41,144**
A11	0	0	0	0	0	0	0	9,564
A111	0	0	0	0	0	1,084	0	1,084
A112	0	0	0	0	0	849	0	849
A113	0	0	0	0	4,000	1,084	0	5,084
A114	0	0	0	0	0	2,547	0	2,547
A12	0	0	0	0	0	0	0	6,791
A121	0	0	0	0	0	3,395	0	3,395
A122	0	0	0	0	0	2,547	0	2,547
A123	0	0	0	0	0	849	0	849
A13	0	0	0	0	0	0	0	16,297
A131	0	0	0	0	0	5,311	0	5,311
A132	0	0	0	0	0	3,395	0	3,395
A133	0	0	0	0	0	7,591	0	7,591
A14	0	0	0	0	0	8,492	0	8,492
A2	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3,129,465**
A21	0	0	0	0	0	13,095	0	13,095

A22	304	25,846	0	0	0	30,791	0	56,940
A23	0	0	0	0	0	0	0	2,867,187
A231	0	0	0	0	0	0	0	1,446,422
A2311	0	0	0	0	2,299	0	0	2,299
A2312	0	0	0	0	11,494	0	0	11,494
A2313	63,641	65,742	1,159,915	7,098	57,470	3,979	0	1,357,845
A2314	20,066	2,116	2,598	0	20,597	0	0	45,378
A2315	1,820	0	0	0	27,586	0	0	29,406
A232	31,887	0	5,852	0	28,220	0	0	65,959
A233	0	0	0	0	0	0	0	668,343
A2331	0	0	0	0	2,138	0	0	2,138
A2332	6,675	0	0	0	2,138	0	0	8,813
A2333	0	19,797	88,246	1,014	13,541	0	0	122,598
A2334	157,450	134,258	198,398	1,927	42,761	0	0	534,794
A234	0	0	0	0	0	0	0	77,095
A2341	296	0	2,471	101	7,597	0	0	10,466
A2342	0	0	4,097	0	49,381	0	0	53,478
A2343	0	0	1,756	0	11,396	0	0	13,151
A235	0	0	0	0	0	0	0	150,731
A2351	81,845	1,495	0	0	8,046	0	0	91,385
A2352	0	6,367	0	0	29,489	0	0	35,855
A2353	0	0	0	0	8,747	0	0	8,747
A2354	0	0	0	0	14,744	0	0	14,744
A236	0	0	0	0	0	0	0	458,637
A2361	75,929	9,356	28,471	0	44,233	0	0	157,989
A2362	0	0	0	0	12,037	0	0	12,037
A2363	0	0	0	0	0	0	0	257,598
A23631	41,779	5,021	11,863	0	36,861	0	0	95,524
A23632	4,738	7,532	9,490	0	51,605	0	0	73,365
A23633	7,052	0	9,490	0	29,489	0	0	46,031
A23634	431	0	0	0	7,372	0	0	7,803
A23635	6,907	0	5,852	0	22,116	0	0	34,876
A2364	0	6,939	0	0	24,074	0	0	31,014
A24	0	0	0	0	0	0	0	58,596
A241	0	5,333	0	0	22,018	0	0	27,351
A242	0	0	0	0	4,000	1,300	0	5,300
A243	0	0	0	0	0	20,746	0	20,746
A244	0	0	0	0	0	5,199	0	5,199
A25	0	12,623	0	0	23,460	10,242	87,322	133,647
A3	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**71,880**
A3.1	0	0	0	0	0	12,965	0	12,965
A3.2	0	0	0	0	0	17,252	0	17,252
A3.3	0	0	0	0	0	14,748	0	14,748
A3.4	0	0	0	0	0	8,582	0	8,582
A3.5	0	0	0	0	0	18,333	0	18,333
A4	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**266,742**
A4.1	57,338	0	0	0	2,299	1,990	0	61,626
A4.2	3,293	0	0	0	20,688	9,495	0	33,476
A4.3	0	0	0	0	13,330	0	0	13,330
A4.4	1,078	147,235	0	0	9,997	0	0	158,310
A5	**9,306**	**3,333**	**0**	**0**	**15,640**	**0**	**22,418**	**50,697**
	571,833	**452,994**	**1,528,499**	**10,140**	**680,860**	**205,862**	**109,739**	**3,559,928**

Table 5.9 Assigning resource costs to activities

Act. ID	Act. Type	Activity Cost	Support Costs	Total Activity Cost
A1		**41,144**		**49,071**
A11		9,564	0	17,491
A111	Sustaining	1,084	0	1,084
A112	Sustaining	849	0	849
A113	Sustaining	5,084	7,927	13,011
A114	Sustaining	2,547	0	2,547
A12		6,791	0	6,791
A121	Customer	3,395	0	3,395
A122	Customer	2,547	0	2,547
A123	Customer	849	0	849
A13		16,297	0	16,297
A131	Sustaining	5,311	0	5,311
A132	Sustaining	3,395	0	3,395
A133	Sustaining	7,591	0	7,591
A14	Sustaining	8,492	0	8,492
A2		**3,129,465**	**0**	**3,280,667**
A21	Customer	13,095	0	13,095
A22	Product	56,940	0	56,940
A23		2,867,187	0	3,007,820
A231		1,446,422	0	1,508,319
A2311	Product	2,299	2,642	4,941
A2312	Product	11,494	2,642	14,136
A2313	Product	1,357,845	56,612	1,414,458
A2314	Product	45,378	0	45,378
A2315	Product	29,406	0	29,406
A232	Product	65,959	3,537	69,496
A233		668,343	0	699,280
A2331	Product	2,138	2,642	4,780
A2332	Product	8,813	0	8,813
A2333	Product	122,598	10,611	133,208
A2334	Product	534,794	17,684	552,478
A234		77,095	0	80,632
A2341	Product	10,466	3,537	14,002
A2342	Product	53,478	0	53,478
A2343	Product	13,151	0	13,151
A235		150,731	0	163,943
A2351	Product	91,385	0	91,385
A2352	Product	35,855	2,642	38,498
A2353	Product	8,747	7,927	16,674
A2354	Product	14,744	2,642	17,387
A236		458,637	0	486,150
A2361	Product	157,989	9,793	167,781
A2362	Product	12,037	0	12,037
A2363		257,598	0	272,675
A23631	Product	95,524	4,446	99,969
A23632	Product	73,365	4,446	77,811
A23633	Product	46,031	3,015	49,046
A23634	Product	7,803	1,585	9,388
A23635	Product	34,876	1,585	36,461
A2364	Product	31,014	2,642	33,656
A24		58,596	0	58,596
A241	Product	27,351	0	27,351
A242	Customer	5,300	0	5,300
A243	Customer	20,746	0	20,746
A244	Sustaining	5,199	0	5,199
A25	Customer	133,647	10,569	144,216
A3	Sustaining	**71,880**		**71,880**
Total		**3,242,490**	**159,129**	**3,401,618**

Table 5.10 Assigning support activity costs to other activities

The total product, customer, infrastructure sustaining activity costs are 190,147 Baht, 3,092,111 Baht, and 738,080 Baht. Note that, infrastructure activity costs will include maintaining infrastructure activity cost (A4.4) (158,310 Baht), miscellaneous cost (131,400 Baht), and depreciation cost (329,011 Baht). As a result, the summary of product, customer, and infrastructure sustaining activity costs are shown in table 5.11. The summation between total activity costs (4,020,339 Baht) and direct materials (4,732,715 Baht) is 8,134,333 Baht, which is the same number of total 10 cost groups in table 5.8.

Activities	Baht
Product Activity Cost	3,092,111
Customer Activity Cost	190,147
Infrastructure Sustaining Cost	738,080
Total	4,020,339

Table 5.11 Summary of activity costs

5.4.2 Measuring Performance

Considering the activities dealing with this improvement, the output quantity and cost rate of these activities after the improvement are shown in table 5.12. Table 5.13 represents their cycle time, start time, and finish time after implementation. In addition, table 5.14 represents the comparison of cost rate and cycle time between before and after implementation.

Act. ID	Activity	Activity Cost Driver	Output Quantity (Unit)	Activity Cost (Baht)	Activity Cost Rate (Baht/Unit)
A231	**Perform Melting Process**				
A2311	Prepare Chemical Composition	# of Charge	777	4,941	6.36
A2312	Prepare SS and RS	# of Charge	777	14,136	18.20
A2313	Melt metal	# of Charge	777	1,414,458	1,820.79
A2314	Check chemical compositions	# of Charge	777	45,378	58.41
A2315	Pour to 2 Ladles	# of Charge	777	29,406	37.85
A233	**Perform AMF Molding Process**				
A2331	Prepare Sand Compositions	# of Mix (AMF)	*	*	*
A2332	Prepare Pattern	# of Plan	*	*	*
A2333	Mix Sand	# of Mix (AMF)	4,330	133,208	30.76
A2334	Make AMF Sand Mould	# of AMF Sand Mould	42828	552,478	12.90
A235	**Pouring Process**				
A2351	Pour into AMF Sand Mould	# of AMF Sand Mould	42,828	91,385	2.13
A2352	Remove Gating System (AMF)	# of AMF Sand Mould	42,828	38,498	0.90

Table 5.12 Cost rate after improvement

Act ID	Activity	Cycle Time (Min)	Start Time (Min)	Finish Time (Min)
A231	**Perform Melting Process**			
A2311	Prepare Chemical Composition	5	0	5
A2312	Prepare SS and RS	10	0	10
A2313	Melt metal	38	0	38
A2314	Check chemical compositions	5	38	43
A2315	Pour to 2 Ladles	5	43	48
A233	**Perform AMF Molding Process**			
A2331	Prepare Sand Compositions	•	•	•
A2332	Prepare Pattern	•	•	•
A2333	Mix Sand	28	0	28
A2334	Make AMF Sand Mould	35	0	35
A235	**Pouring Process**			
A2351	Pour into AMF Sand Mould	10	48	58
A2352	Remove Gating System (AMF)	35	0	35

Table 5.13 Time required by the activities after improvement

	Cycle Time				Activity Cost Rate			
Act. ID	BEFORE Cycle Time (Min)	AFTER Cycle Time (Min)	Diff (Min)	Diff (%)	BEFORE Cost Rate (Baht/Unit)	AFTER Cost Rate (Baht/Unit)	Diff (Min)	Diff (%)
A231								
A2311	5	5	0	0.00	7.25	6.36	0.89	12.28
A2312	10	10	0	0.00	21.25	18.20	3.05	14.35
A2313	40	38	2	5.00	1,900.88	1,820.79	80.09	4.21
A2314	7	5	2	28.57	63.85	58.41	5.44	8.52
A2315	9	5	4	44.44	44.34	37.85	6.49	14.64
A233								
A2331	•	•	•	•	•	•	•	•
A2332	•	•	•	•	•	•	•	•
A2333	28	28	0	0.00	33.00	30.76	2.24	6.79
A2334	35	35	0	0.00	13.83	12.90	0.93	6.72
A235								
A2351	10	10	0	0.00	2.17	2.13	0.04	1.84
A2352	35	35	0	0.00	1.06	0.90	0.16	15.09

Table 5.14 Cost rate comparison between before and after improvement

In table 5.14 (left side), by summing the cycle time of critical activities (A2313, A2314, A2315), it indicates that cycle time of melting process can be reduced from 55 min to 48 min after 4 improvement methods were implemented. On the other hand, ***the melting process cycle time is improved about 7 min or 12.7%.*** As previously mentioned, time-reduction of melting process will result to increase the number of output quantity in term of the number of charge and the number of sand mould. Increasing the number of output quantity will finally reduce activity cost rate. The activity cost rate between before and after improvement are shown in table 5.13 (right side). Considering to significant activities (A2313 and A2334), ***their activity cost rate are reduced by 4.21% and 6.72% respectively.*** Moreover, any activity cost rate having the number of charge and sand mould as cost driver will be also reduced. The performance measurement of melting and moulding process before and after implementation is shown in table 5.15.

It indicates that after the improvement molten metal weight/hour, number of charge/day, number of sand mould/hour, and machine utilization increases 161 kg/hr, 4.53 charges/day, 11 moulds/hr, and 11% respectively. Furthermore, table 5.16 represents the comparison of performance measurement in financial term between Jun – Nov 2005 and Dec 2005. The result indicates that the company gains 23.08% net profit in Dec 2005, which is more than 6.68% net profit in Jun – Nov 2005.

Process	Performance Measurement	BEFORE	AFTER
Melting	A2313 Cost Rate	1,900.88 Baht/Charge	1,820.79 Baht/Charge
	Molten metal Weight / Hour	964 kg/hr	1,125 kg/hr
	Number of Charge / day	24.35 Charge/Day	28.82 Charge/Day
Moulding	A2334 Cost Rate	13.83 Baht/Mould	12.90 Baht/Mould
	Number of Sand Mould / Hour	52 Mould/Hr	63 Mould/Hr
	Machine Utilization	63%	74%

Table 5.15 Performance measurement of melting and moulding process

	Jun - Nov 05	Dec-05
Sales	**55,562,766**	**10,952,347**
Total Costs	**46,448,268**	**8,424,044**
Direct Materials	24,060,400	4,732,715
Indirect Materials	2,900,988	571,833
Direct Labours	3,699,493	616,582
Salaries	1,067,876	177,979
Tools & Equipments	2,201,928	366,988
Maintenance	516,035	86,006
Electricity	8,078,782	1,545,833
Water	84,650	15,431
Fringe Benefits	307,624	51,271
Communication	32,636	5,439
Office Accessories	76,956	12,826
Miscellaneous Expenses	788,401	131,400
Traveling Expense	210,081	35,013
Fuel	448,354	74,726
Depreciation	1,974,064	329,011
Net Profit	**9,114,498**	**2,528,304**
Net Profit (%)	**16.40**	**23.08**

Table 5.16 Comparison Net profit between before and after improvement

As a consequence, it can conclude that after improvement the company can reduce two significant activity cost rate, reduce melting process cycle time, increase molten weight per hour, increase number of sand mould per hour, and finally increase net profit. ***On the other hand, it could be said that the company can achieve the goal of business process improvement.***

Measuring performance goes further to measure cumulative activity cost between before and after improvement to gain insights of cost built up by the time or along with the processes. Cumulative cost is calculated by rearranging activity cost in ascending order of finish time. Figure 5.9 shows both cumulative activity cost in graphic presentation.

	Before			After		
Act. ID	Stop Time	Activity Cost	Cumulative Cost	Stop Time	Activity Cost	Cumulative Cost
A2311	5	7.25	7.25	5	6.36	6.36
A2312	10	21.25	28.50	10	18.20	24.56
A2333	28	231.02	259.52	28	231.02	255.58
A2352	35	59.26	318.77	35	722.40	977.97
A2334	35	774.49	1,093.27	35	50.34	1,028.31
A2313	40	1900.88	2,994.15	38	1,820.79	2,849.10
A2314	47	63.85	3,058.00	43	58.41	2,907.52
A2315	56	44.34	3,102.34	48	37.85	2,945.37
A2351	66	121.77	3,224.11	58	119.49	3,064.86

Table 5.17 Cumulative cost of before and after implementation

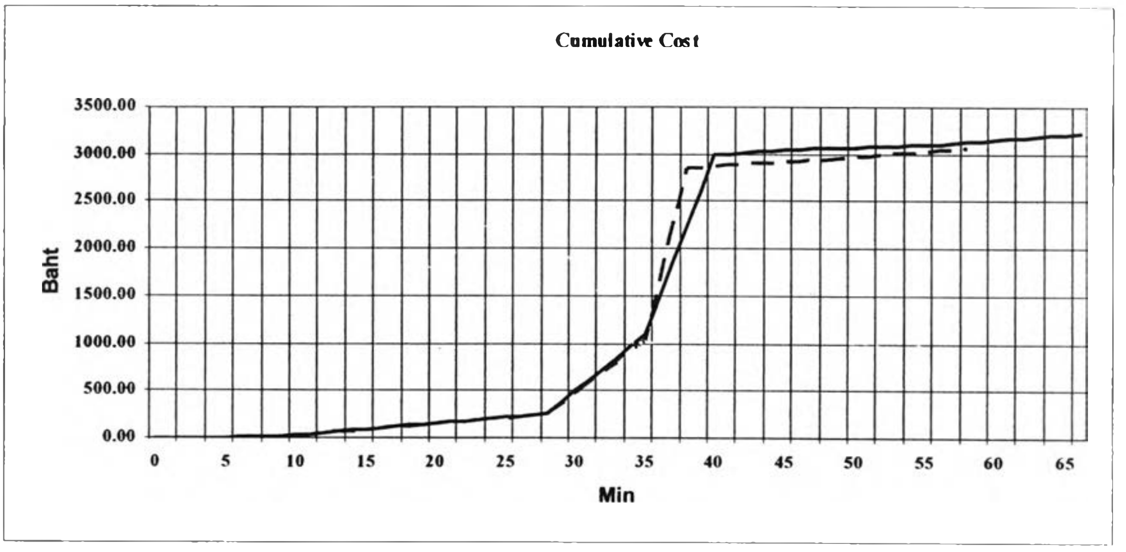

Figure 5.9 Cumulative cost between before and after implementation

The vertical axis of the graph represents the cumulative cost build up of the melting, moulding, and pouring process. The horizontal axis represents the cumulative cycle time moving through the processes from start to finish. The blue curve represents cumulative activity cost before improvement, and the red curve (dash curve) represents cumulative activity cost after improvement. The attention is at the slope of the curve between any two points. A steep slope is potentially good because cost is rapidly being added. A flat slope is potentially bad because it implies time is passing while little or no costs are being added after the investment or capital has already begun. A flat slope indicates potentially low financial payback or rate of return. It can conclude that by reducing activity cost rate of A2313 and A2334, cost built up by time is faster. It means the company has better financial payback.

In conclusion, this chapter explains how to use ABC information from previous chapter to identify opportunities for improvement and finally make an improvement. The activity analysis indicates that A2313 and A2334 are significant to the company. Thus, it is worthy to make an improvement in these activities. The key to improve is to reduce their activity cost rate, and the way to reduce activity cost rate is to increase their output quantity. This can be done by reducing cycle time of melting process. 4 methods have been analyzed to be mechanisms for time-reduction in melting process. These methods are implemented and evaluated. The results indicate that the company can meet the target both operational and financial term. In operational term, melting process cycle time can be reduced by 12.7%. This leads to reduce the activity cost rate of A2313 and A2334 by 4.21% and 6.72% respectively. In addition, the molten metal weight per hour and the number of sand mould per hour are also increased by 161 kg/hr and 11 mould/hr. In financial term, the result indicates that the company improves in net profit from 16.40% in Jun – Nov 05 to 23.08% in Dec 05.