CHAPTER IV

Solutions and Their Implementation

As a direct result from the problems as stated in the previous chapter, improvements to the key areas of the company were developed, and later applied to the MP Hotel project (Job No. P135/97) as a case study. The area of improvements proposed herewith cover 5 main topics as follows:-

1. Improvements of the existing functions
2. Reorganisation
3. Establishment of Project Planning System
4. Establishment of Project Costs Controlling System
5. Information System for Project Management

4.1 Improvements of the Existing Functions

After a study was conducted into the way many department were working, it was found that there were unnecessary work repetitions, many guessed works, and information were not shared and used efficiently. Critical areas that needed to be reformed were:-

4.1.1 Estimation Department

From the previous chapter, we know that the project cost estimation could produce a very different end result from the actual costs when the traditional estimation method is used. This is especially true for items that have to be manufactured by the factory. Although one could never expect zero cost variance, a more realistic and accurate cost estimation could put the company a better position for bidding. Several

key areas for improvements are:-

1) Updating and Using the same BoMs

Since it was given that, in the past, whenever changes were made to the Standard Equipment, necessary corrections to the BoMs were not carried out, it is, therefore, important to proceed with the improvement by, first of all, making that necessary corrections to all the Standard Equipment currently supplied to the projects. Table 4.1 shows a list of the Standard Equipment which had their BoMs updated.

NO.	Product ID	Description	Adjusted Costs in Baht
1	BCK07000	Char Broiler(Gas+Lava)	640
2	CRB18000	2-Door Refrigerated Base	1,110
3	EFK07000	Deep Fat Fryer	981
4	GCH15000	2-Chinese Range	681
5	GCH18000	3-Chinese Range	421
6	GGK07000	Griddle	1,110
7	GKH23000	2-Kwali Range	825
8	GOH08000	1-Soup Range	796
9	GPH07000	1-Stock Pot Stove	591
10	KO207000	Open Cabinet	271
11	KO212000	Open Cabinet	419
12	KO215000	Open Cabinet	320
13	KWO15000	Warming Cabinet	691
14	MGT06500	GN.Trolley	388
15	SP415000	Plain Shelf	253
16	TB115000	Work Table	199
17	TCD15000	Clean Dish Table W/Rack Shelf	624
18	TL007000	Low Table	313
19	VCS10080	Exhaust Hood	758
20	VCS10085	Exhaust Hood	916
21	VCS10090	Exhaust Hood	216
22	VCS20080	Exhaust Hood	393
23	WS115000	Single Sink Table	786
24	WS223000	Double Sink Table	217
25	WS224000	Double Sink Table	828

Table 4.1: The changes in the costs of standard equipment after their BoMs revision.

Another reason for the cost variances was attributed to the fact that the BoMs which were used during the project cost estimation were not committed to during the production stage. Instead, when the job order was sent into the factory, the person who was in-charge of the material take-offs would make another set of BoMs to determine what materials would be needed to fabricate the equipment. In order to rectify the problem with two different sets of BoMs, the creation of the Bill of Materials for all equipment, standards or non-standard alike, had been assigned to the Engineering Department. Should there be any needs to estimate the prices for a project bidding, the list of equipment to be manufactured locally must be sent to the factory so that their BoMs could be worked out. Afterwards, if the project was awarded to the company, the same BoMs must be used for the actual production, thus reducing and/or preventing the chance of the cost variances due to discrepancy in the BoMs.

2) Establish Purchasing Policy

In contrast to the finished goods bought for the project, the prices for the raw materials of equipment to be manufactured by the company have always been unreasonably jacked up by the Purchase Department for fear that they would not be able to buy the materials at the prices as promised to the Estimator. In order to ease up this exaggeration, the materials are classified into 3 groups, according on the frequency of their requirements as well as their influences on the total costs of the equipment. Agreements on the period of validity of the material prices are then worked out with their corresponding suppliers, so as to increase the certainty of the prices used in the cost estimation, and thereby reducing the need for price contingencies. The 3 groups of materials as classified above are:

1. Sheet metals -- As sheet metals, especially stainless steel, are the primary raw materials for foodservice equipment (contributing to more than 50 percent of the total equipment cost), the overestimation of their prices during the estimation stage could result in the major deviation from their probable costs. And, unlike other materials or parts the company uses, the prices of the stainless steel sheets can be affected by the uncontrollable external factors in the world markets, thus, particular attention must be given to their prices. A couple of ways the Purchase Department could be certain of the prices of stainless steel sheets they give to the Estimator are (1) Fixing the prices with the supplier on a quarterly basis. This technique should be effective for any small projects that could be completed within a few months time from the date of quotation. (2) For a project that is of substantial size, and could span over a year, the prices of the stainless steel sheets could be negotiated with the supplier on a project-by-project basis. Although some premium might be added on top of the normal cost of the materials, this technique provides a reasonably high degree of confident that the prices of the most important materials would not deviate from the commitment made to the Estimator.

2. Frequently used parts -- For frequently used parts, such as stainless steel footings, pipes, and gussets, etc., annual price lists, which guarantee the prices of these parts for a period of 1 year, are arranged with major suppliers, and used for the project cost estimation.

3. Consumables -- Miscellaneous consumables materials are relatively low in prices, such as drill bits, seal tapes, and welding rods, and therefore, do not have much effects on the final cost of each equipment when used cautiously. Hence, their prices need not be

fixed with the suppliers in a normal economic situation. However, since they are usually taken from the stock in quantity, their usage must be controlled, otherwise the problem with wasteful usage of them would occur.

3) Project Cost Estimation System

From chapter 3, it was shown that the existing method of estimating project costs could not provide a good costs estimation for a project due to many factors, such as incorrect BoM lists, incomplete cost contributors in the cost estimating formula, lack of comparisons between the actual and the estimated costs, and lack of mechanism for making the corrections to the estimation method if unacceptable variances are found. With the updating of the BoMs as mentioned above, the Project Cost Estimation System is introduced using a simple cycle as shown in the Figure 4.1.

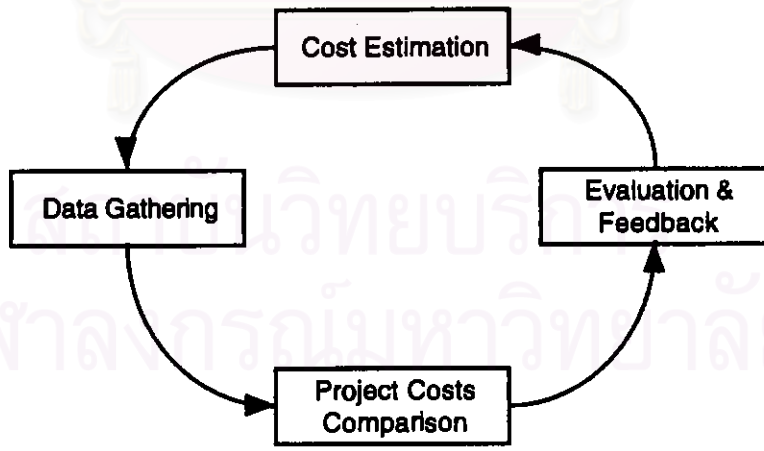

Figure 4.1: The Project Cost Estimation System

1. Cost Estimation

Firstly, in order to promote better cost estimation system, it is important that the formula used to estimate the cost price of each equipment represents as close to the actual costs that would occur as possible. Therefore, some modification to the previous cost estimating formula was made as shown below:-

Old Cost Estimation Method

Cost Price (CP) = Direct Material (DM) + Direct Labour (DL)

Where :

DM consists of 1. Estimated costs of production materials.

and DL consists of 1. Estimated labour cost for production.

2. Estimated costs of installation work

Modified Cost Estimation Method

$$\text{Cost Price (CP)} = DM_{(Production)} + DL_{(Production)} + FOH + DM_{(Installation)} + DL_{(Installation)}$$

Where:

$DM_{(Production)}$ = Estimated costs of production materials.

$DL_{(Production)}$ = Estimated costs of labour required for production.

FOH = Estimated factory overhead costs.

$DM_{(Installation)}$ = Estimated costs of installation materials.

$DL_{(Installation)}$ = Estimated costs of labour for installation works.

The sources for each cost elements are given below:-

DM (Production) - This is the cost of all direct materials (parts and components) according to the BoM of equipment, which are used to manufacture the product.

DM (Installation) - The type and quantity of direct materials which are needed for the installation of the kitchen equipment, as well as their costs, can be estimated from the tentative Utility Layout by the Project Manager (see Appendix H). This tentative utility drawing is used roughly to indicate the proposed positions of the utility outlets in the kitchen area, such as electrical, water, and gas supplies, as well as floor drainage points, against the positions of the foodservice equipment as given in the kitchen plan. The estimated material requirements are then based on the type and distances of the equipment to the corresponding utility outlets. The reason for using the tentative utility drawing instead of the more detailed actual Utility Layout is because of the uncertainties involved in the pre-bid stage. Also, because the actual Utility Layout would require great amount of resources to prepare, it is usually not done before the project has been awarded to the company.

DL (Production) - The estimated cost of direct labour associated with the production of each equipment is calculated by multiplying the estimated direct labour-hour required in each department by the corresponding direct labour-hour (DLH) rate, and adding them up as shown below.

$$\text{Estimated Direct Labour Costs (Baht)} = \text{No.of DLH Required} \times \text{DLH Rate}$$

The DLH rate of each production section, on the other hand, can be calculated by the formula:

$$\text{Direct Labour-Hour Rate (Baht/ Man-Hour)} = \frac{\text{Direct Labour Cost Paid}}{\text{Man-Hour Consumed}}$$

At the time of the study, the Direct Labour-Hour Rates of each department were determined using the data from the months between January to August 1997. To arrive at the DLH rate of each production section, first, the labour wages paid in each month were divided by the number of direct labour-hours used in that corresponding months. With the rates from January 1997 to August 1997 established for each section, the DLH rates which are to be used for the actual project cost estimation were derived by taking the average DLH rates section by section (see Table 4.2).

Month	Direct Labour-Hour Rate of Various Production Sections				
	Forming	Assembly	Finishing	Technics	Refrigeration
January '97	28.97	28.55	24.95	57.14	26.95
February	35.43	35.46	29.99	55.44	33.51
March	34.71	34.53	28.90	50.04	32.79
April	35.71	35.37	29.44	47.93	33.49
May	35.78	35.13	29.24	47.14	33.57
June	35.54	34.92	29.31	46.49	33.05
July	35.18	34.65	28.99	45.17	32.61
August	35.43	34.89	28.94	45.33	32.62
Average DLH Rate (Baht/Man-Hour)	34.59	34.19	28.72	49.34	32.32

Table 4.2: Direct Labour-Hours Rate for Each Section at the Factory.

DL (Installation) - The estimation of direct labour costs involve with the installation works are categorised into 2 groups:

1) Installation - The "installation" activities encompass the setting of the equipment in their proper locations as indicated in the kitchen plan, and hooking them up to appropriate utilities (gas, water, electricity, steam, drainage, etc.).

2) Test-run - The test-run of foodservice equipment that have mechanical, electrical, and/or gas combustion systems are conducted only when all the equipment in a given kitchen have been completely installed. The purpose of this activity is to make sure that equipment can function as they are designed to do. After satisfactorily tested the equipment, the test results are then compiled and submitted together with a Letter of Commissioning for customer's acceptance.

Similar to the various sections in the factory, the estimated DLH cost of installation are calculated by multiplying the amount of estimated direct labour-hours required for installation and test-run activities by the DLH rate as established in the Table 4.3 below.

Month	Direct Labour-Hours Rate
January '97	46.82
February	52.87
March	53.90
April	56.29
May	56.13
June	56.06
July	55.38
August	55.25
Average DLH Rate (Baht/Man-Hr.)	54.09

Table 4.3: DLH Rate for Installation Department.

Factory Overheads (FOH) - Besides having distinguished various direct costs of the production and installation activities from one another for easier monitoring and control, another improvement made over the previous method of calculating the project costs is to include the factory overheads in the calculation of the cost prices of equipment.

Since it is the cost due to project activities that are being interested in this case, only the variable overheads are calculated.

In order to estimate the overhead cost of the equipment, firstly, it must be aware that activities within each department vary from one to another, and therefore, exact figures can not be calculated. In order to assist in the determination of the estimated overhead cost for a project, it is necessary to establish some sort of multiplication factor which do have correlations with the past overhead spendings. This so called Overhead Application Rate, gives an indication of how much the overhead costs would be for each production activities. From Chapter 2, it is known that a job-shop, such as PFE, is not suitable for overhead application rate which is based on unit of production and direct material costs, due to the infinite number of product type. Furthermore, since the factory is very labour intensive, and the machines are mostly manually operated, the overhead application rate based on machine hour is also not suitable. Before attempting to base the overhead application rate on direct labour-hour, it is necessary to verify if there are any correlations between the overhead costs and the number of direct labour used. In order to do this, these two sets of data which represent the period between January to August 1997 are listed in Table 4.4 to 4.8, and then plotted against each other as shown in Figure 4.2 to 4.6. The Overhead Application Rate for each production section are calculated using the formula below.

$$\text{Overhead Application Rate (Baht/ Man-Hour)} = \frac{\text{Overhead Costs}}{\text{Direct Labour-Hour Consumed}}$$

The items that constitute overhead costs of each month include electricity charges, the costs of argon gas (for Assembly Section only), and the cost of miscellaneous consumable goods used.

Forming Section

Period (Month)	Overhead Consumption(Bht.)	Direct Labour-Hours	Overhead Appl. Rate (Baht/Man-Hr.)
January '97	29,433.67	4,243.20	6.94
February	65,221.18	7,779.20	8.38
March	104,022.78	11,532.80	9.02
April	147,210.25	14,524.80	10.14
May	172,365.44	17,666.40	9.76
June	207,906.93	20,950.80	9.92
July	242,656.13	24,214.60	10.02
August	274,775.17	27,057.20	10.16
		Standard Deviation	1.14
		Average =	9.29

Table 4.4: Overhead Application Rate for Forming Section

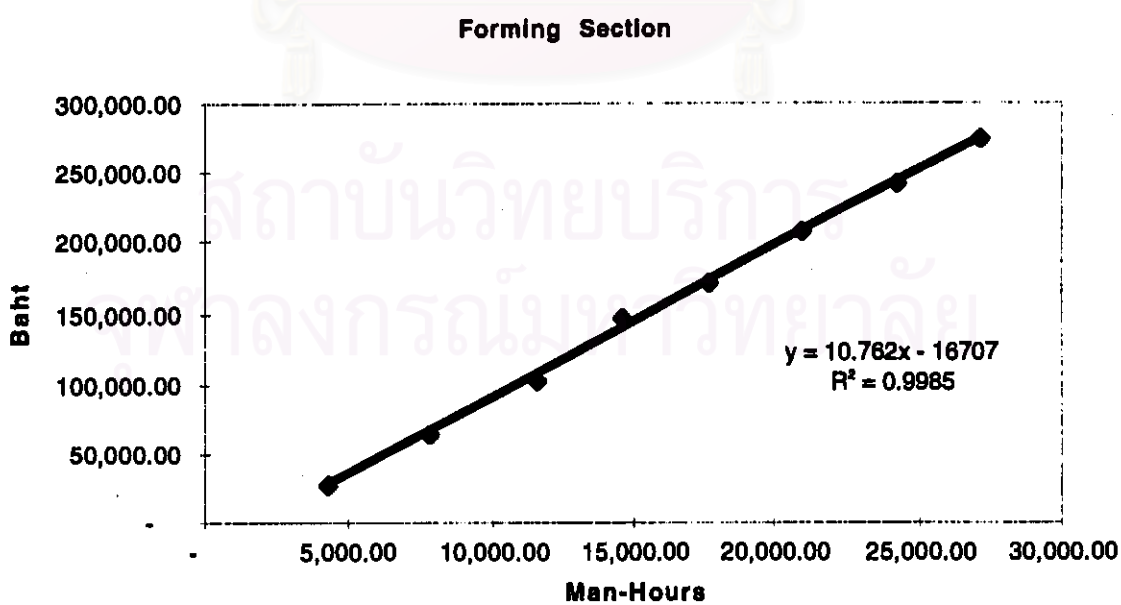

Figure 4.2: Overhead Costs VS Direct Labour-Hours of Forming Section

Assembly Section

Period (Month)	Consumables (Baht)	Direct Labour-Hours Consumed	Overhead Rate (Baht/Man-Hr.)
January '97	273,345.04	10,608.00	25.77
February	559,299.85	19,448.00	28.76
March	875,415.88	29,144.80	30.04
April	1,229,011.67	37,032.80	33.19
May	1,347,049.90	45,410.40	29.66
June	1,626,842.29	53,386.80	30.47
July	1,929,787.12	61,057.20	31.61
August	2,214,678.02	67,938.80	32.60
		Standard Deviation	2.35
		Average =	30.26

Table 4.5: Overhead Application Rate for Assembly Section

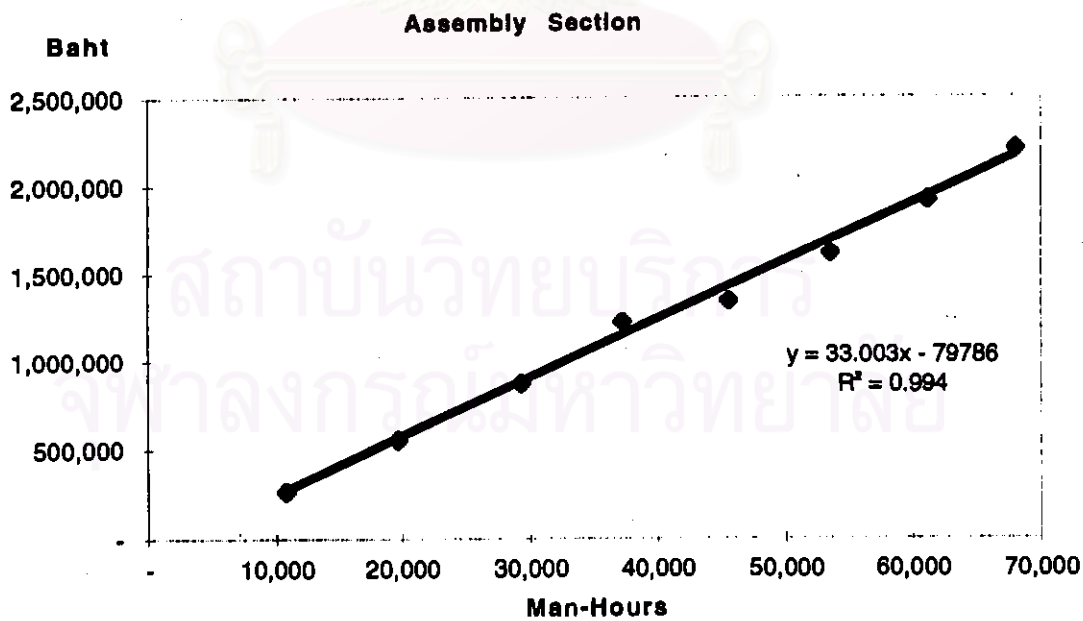

Figure 4.3: Overhead Costs VS Direct Labour-Hours of Assembly Section

Finishing

Period (Month)	Consumables (Baht)	Direct Labour-Hours Consumed	Overhead Rate (Baht/Man-Hr.)
January '97	73,100.21	2,284.80	31.99
February	173,077.21	4,188.80	41.32
March	269,226.51	6,378.40	42.21
April	398,908.29	8,282.40	48.16
May	449,349.15	10,376.80	43.30
June	541,845.71	12,410.00	43.66
July	641,702.60	14,531.60	44.16
August	728,573.95	16,478.40	44.22
		Standard Deviation	4.65
		Average =	42.38

Table 4.6: Overhead Application Rate for Finishing Section

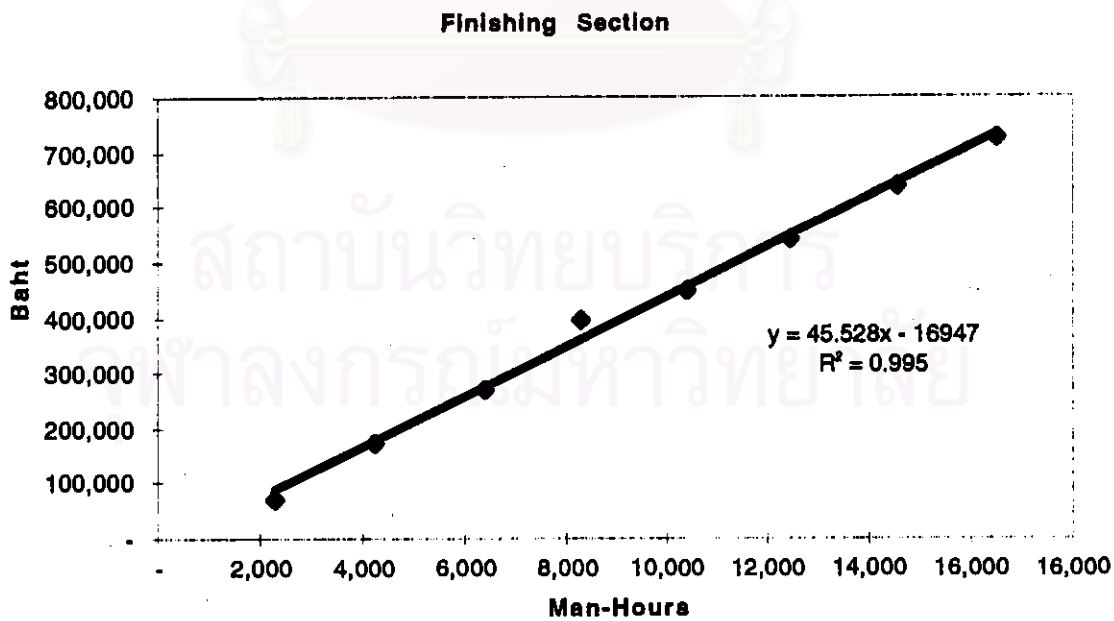

Figure 4.4: Overhead Costs VS Direct Labour-Hours of Finishing Section

Technics Section

Period (Month)	Consumables (Baht)	Direct Labour-Hours Consumed	Overhead Rate (Baht/Man-Hr.)
January '97	62,715.97	652.80	96.07
February	147,213.17	1,468.80	100.23
March	229,728.96	2,250.80	102.07
April	338,407.16	2,930.80	115.47
May	383,068.11	3,678.80	104.13
June	461,938.96	4,460.80	103.56
July	546,050.05	5,276.80	103.48
August	619,762.68	5,875.20	105.49
		Standard Deviation	5.54
		Average =	103.81

Table 4.7: Overhead Application Rate for Technics Section

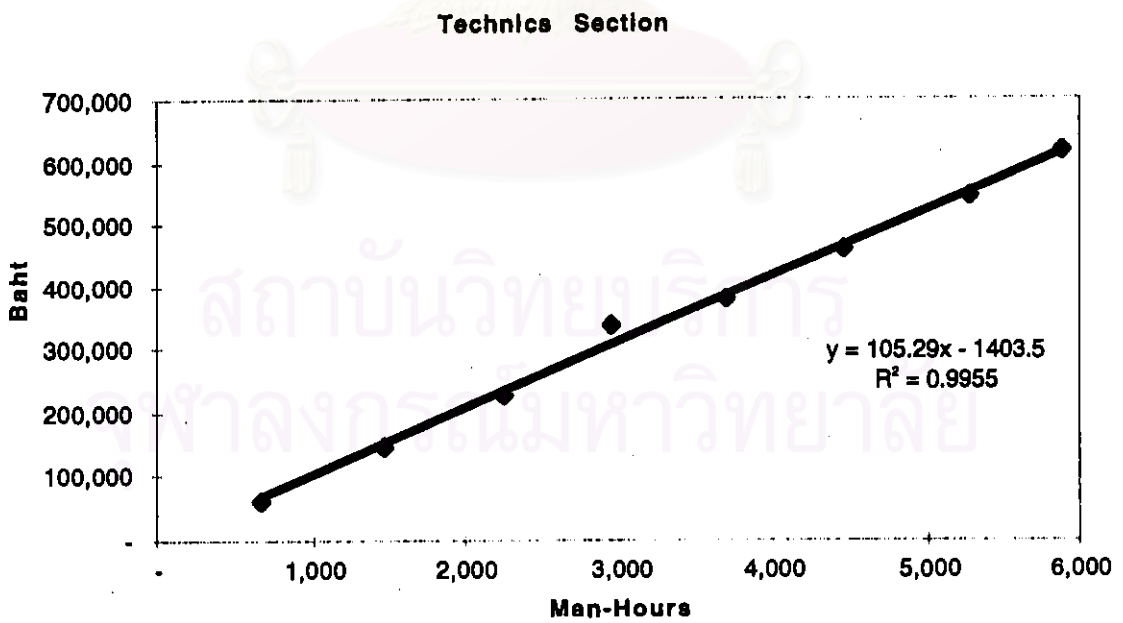

Figure 4.5: Overhead Costs VS Direct Labour-Hours of Technics Section

Refrigeration Section

Period (Month)	Consumables (Baht)	Direct Labour-Hours Consumed	Overhead Rate (Baht/Man-Hr.)
January '97	61,222.79	3,264.00	18.76
February	144,128.18	5,984.00	24.09
March	224,671.18	9,112.00	24.66
April	331,610.51	11,832.00	28.03
May	374,752.74	14,674.40	25.54
June	451,905.58	17,646.00	25.61
July	534,527.10	20,583.60	25.97
August	606,753.69	22,977.20	26.41
		Standard Deviation	2.74
		Average =	24.88

Table 4.8: Overhead Application Rate for Refrigeration Section

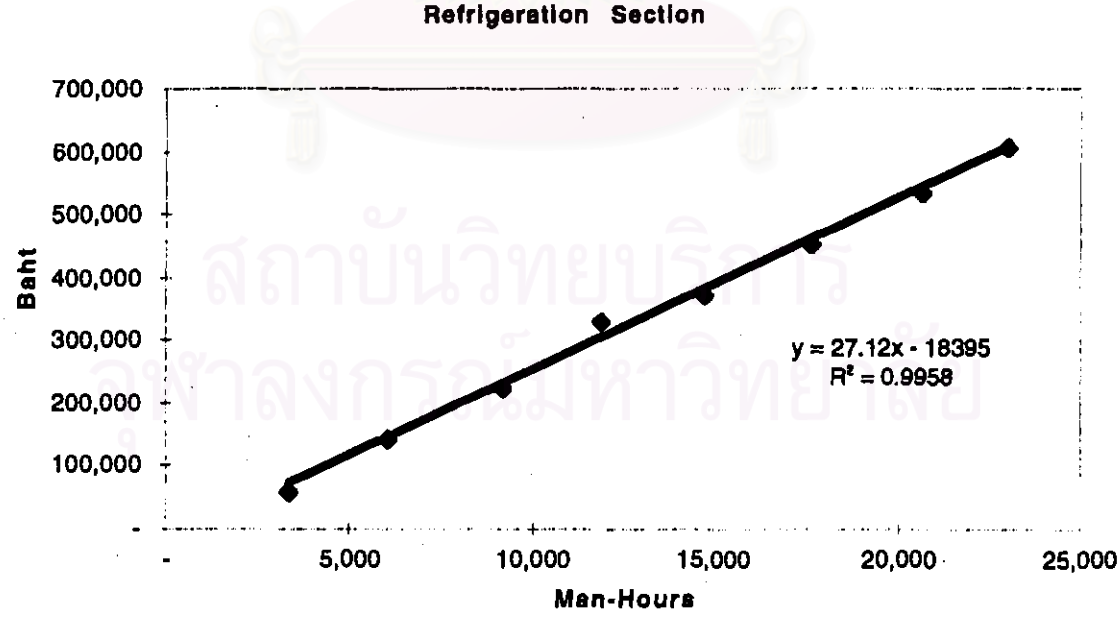

Figure 4.6: Overhead Costs VS Direct Labour-Hours of Refrigeration Section

From the relationships between the past overhead costs and the number of direct labour-hours consumed, as shown in figures above, there seems to be correlations between these two factors. Hence, the factory overhead costs for each equipment can be estimated by multiplying the number of direct labour-hour needed to manufacture the equipment at each section by the appropriate overhead application rate in corresponding section, and summing them up section by section.

$$\text{Estimated Overhead Costs (Baht)} = \text{DLH Required} \times \text{Overhead Application Rate}$$

With the use of the above cost estimation method, a sample cost price of an equipment is calculated as shown in Table 4.9 below.

Estimate Sheet

Project: MP Hotel — Job No. P135/97
Item No.: MK-56 — Description: Work Table

Manufacturing
DM

Description	Qty.	Unit	Unit Price	Total
SS. Sheet, 16 Ga.	1.5	Sq.M.	606	909
SS. Footing 1.1/2"	4	ea.	45	180
SS. Gusset, Type B	4	ea.	38	152
SS. Tube, d.1"	2.6	m.	115	299
SS. Tube, d.1.1/2"	4	m.	110	440
Total for DM (Production)				1,980

Section	DLH Rqd	DL Cost	FOH Cost
Forming	3.5	126	33
Assembly	10	340	300
Finishing	3	81	129
Technics	0	0	0
Refrigeration	0	0	0
Total (Baht)		547	462

Total Production Cost 2,989 Baht

Table 4.9: A Sample Cost Estimate of a Stainless Steel Work Table.

Estimate Sheet

Project: MP Hotel Job No. P135/97
Item No.: MK-56 Description: Work Table

Installation

DM

Description	Qty.	Unit	Unit Price	Total
Not Required	0		0	0
Total for DM (Installation)				0

Section	DLH Rqd	DL Cost
Installation & Testing	0.5	16

Total Installation Cost 18 Baht

Total Estimated Cost 3,007 Baht

Table 4.9: A Sample Cost Estimate of a Stainless Steel Work Table (Continued).

2. Data Gathering

The second stage of the Project Cost Estimation System occurs after the project is awarded to the company. This is when the actual project activities are being carried out, and information on the costs incurred are gathered for further analysis. At this stage, the estimated costs for each project activities can also be used as budgetary guideline by which the Project Manager must follow, and try not to exceed. Some of the documents which are used to collect data on the project cost during the implementation phase for the purpose of project cost control and analysis are:

i. Requisition from Stock Form

ii. Miscellaneous Consumables Request Form

iii. Acknowledgement of Buyouts and Imported Equipment Received

iv. Production Daily Report

v. Installation Daily Report

vi. Installation Material Request Form

Requisition From Stock

ID: 7-08-5023 Section: Assembly Ref.No.: 7-08-5023-5 Issued: 12/11/97

Job No.: P-136/97 Customer Name: MP Hotel Received:

ITEM NO.: MK-08 QTY: 1 Total Qty.: 1

DESCRIPTION: Work Table Size: 0.70 * 1.50 * (0.85 + 0.15)

Part ID	Part Name	Unit	Qty.
P-16-10-100-5	SS. Footing 1 1/2" (2")	ea.	4.0
P-16-11-100-5	SS. Gusset	ea.	4.0
R311120005	SS. Tube Ø 1.1/2" x 6 m. Thk. 1.2 mm (Polished)	m.	3.5

Approved By: Store Keeper: Received By:

Date: Date: Date:

Figure 4.7: A Requisition From Stock Form

Miscellaneous Consumables Request Form

Job No.: P-135/97 Item No.: MK-03 Date: 20/11/97

No.	Description	Part No.	Qty.	Remark
1	Sand Disc: No.100...Ø..5".....	U41020005	13	
2	Sand Paper: No.....			
3	Welding Rod			
4	Grinding Wheel: No...4".....	U44001020	2	
5	Saw Blade 1/2" x 12" 24 teeth	U51005020	2	
6	Drill Bit: No.....			
7	Gloves			
8	Sanding Knob	U44001005	3	
9				
10				

Approved By Received By

Figure 4.8: Miscellaneous Consumables Request form

ACKNOWLEDGEMENT OF BUYOUTS AND IMPORTED EQUIPMENT RECEIVED

☐ BUYOUTS ☐ IMPORTS Date:

NO.	DESCRIPTION	UNIT PRICE	QTY.	TOTAL (BAHT)	REMARK

Store Manager

Project Manager

Figure 4.9: Acknowledgement of Buyouts and Imported Equipment Received Form.

Professional Food Equipment, Ltd.

Production Daily Report

Section Assembly Date 26 / 11 / 97

Order ID	Job No.	Item No.	Description	Qty.	Labour-Hrs.	
					R.T.	O.T.
7-08-5030	P135/97	MK-17R	2-Door Refrigerated Base (180)	1	33.5	0
7-08-5034	P135/97	MK-24	SS.Filler Top (050)	1	2	0
7-08-5086	P135/97	MK-98	Mobile Table (180)			
			Soiled Dish Table W/Pre-Rinse&	2	18	0
7-08-5100	P135/97	MK-120	2-Poly Bin Size:3.00*3.10	1	84	0
7-08-5129	P135/97	MK-161	SS.Filler Top Size:0.60*(0.04+0.25)	1	2	0
7-08-5130	P135/97	MK-162	Tray Slide Size:0.35*2.70	1	5.25	0
7-08-5175	P135/97	SA-48	Clean Dish Table W/Rack Shelf (150)	1	17	0

Foreman | Supervisor | Department Manager

Figure 4.10 Production Daily Report Form

INSTALLATION MATERIAL REQUEST

Job No. P135/97 Project Name: MP Hotel Date: 12/12/97
ZONE: 1B (Hot Kitchen -- MK)

ITEM NO.	PART NO.	DESCRIPTION	REQUESTED	RETURN	USED
MK-25	R360012005	Pipe: BS ø1/2" 6m.	1	-	1
	R330012005	Pipe: GI ø1/2" 6m.	1	-	1
	R342000005	Pipe: PVC (th) ø2" x 4m.	1	-	1
	P25017010	Elbow90: BS ø1/2"	10	6	4
	P25012015	Elbow90: GI ø1/2"	10	6	4
	P25014017	Elbow90: PVC (tn) ø2"	10	5	5
	P25207025	Nipple: BS ø1/2"	5	2	3
	P25202015	Nipple: GI ø1/2"	5	2	3
	P25307005	Union: BS ø1/2"	5	4	1
	P25302010	Union: GI ø1/2"	5	4	1
	P25054020	PVC Conn. ø2" OT	5	3	2
	U11501055	Seal Tape	10	4	6

Site Foreman (Request) | Project Supervisor (Approve) | Store Manager (Dispatch)

Figure 4.11: Installation Material Request Form

INSTALLATION DAILY REPORT

Job No. P135/97 Project Name: MP Hotel Date: 12/12/97

ZONE: 1B (Hot Kitchen -- MK) ☑ INSTALLATION ☐ TEST-RUN

ITEM NO.	DESCRIPTION	QTY.	MAN-HRS. USED R.T.	O.T.	REMARK
MK-03	Double Sink Table (240)	1	4.8	-	
MK-07	3-Compartment Sink	1	6.7	-	
MK-25	2-Kwali Range (230)	1	7.8	-	
MK-29	1-Stock Pot Stove	1	3.5	-	
MK-30	3-Chinese Range (180)	1	7.2	-	
MK-32	1-Soup Range (80)	1	7	-	
MK-33	3-Chinese Range (180)	1	7.5	-	

Site Foreman Project Supervisor Project Manager

Figure 4.12: Installation Daily Report Form

3. Project Costs Comparison

In order to determine the performance of the Project Cost Estimation System, it is necessary to verify whether the estimated costs of the project activities are close to those of the actual ones or not. Traditionally, this process was carried out upon the request from the Top Management only. Even so, the costs comparison between the estimated and the actual values were done way after the completion of the project, and hence, it could only serve as a performance indication of the cost estimation practice. A form such as shown in Figure 4.13 can be use to calculate the cost variances if desired.

Project No.: Project Name:

Local Equipment			ESTIMATED					ACTUAL				
ITEM NO.	DESCRIPTION	QTY.	DM	DL	FOH	INSTALL	TOTAL	DM	DL	FOH	INSTALL	TOTAL

Total Estimated Cost for DM		Total Estimated Cost for DL	
Total Actual Cost for DM		Total Actual Cost for DL	
Variance		Variance	
% Variance		% Variance	
Total Estimated Cost for FOH		Total Estimated Cost for Install	
Total Actual Cost for FOH		Total Actual Cost for Install	
Variance		Variance	
% Variance		% Variance	

Total Estimated Cost for Local Equipment	
Total Actual Cost for Local Equipment	
Variance	
% Variance	

Figure 4.13: The Performance of the Cost Estimation System using Variance Analysis.

Project No.: Project Name:

Buyout and Imported Equipment			ESTIMATED			ACTUAL		
ITEM NO.	DESCRIPTION	QTY.	EQUIPMENT	INSTALL	TOTAL	EQUIPMENT	INSTALL	TOTAL

Total Estimated Cost for Equipment		Total Estimated Cost for Installation	
Total Actual Cost for Equipment		Total Actual Cost for Installation	
Variance		Variance	
% Variance		% Variance	

Total Estimated Cost for Buyout/Imported Equipment	
Total Actual Cost for Buyout/Imported Equipment	
Variance	
% Variance	

Total Estimated Cost for Project	
Total Actual Cost for Project	
Variance	
% Variance	

Figure 4.13: The Performance of the Cost Estimation System using Variance Analysis (Continued).

4. Evaluation and Feedback

To make the Project Cost Estimation System complete, and always up-to-date, it is also important to identify the source of cost variation, and make appropriate adjustments to the information used to make the cost estimates. From the comparison of the actual costs with the corresponding estimates, it is possible to determine whether the cost variance is in the material, labour, or overhead usage. And, in order to pinpoint the exact cause of the variation, further investigation can be made from individual document gathered during the project implementation phase, and the Estimate Sheets. Although small variations may be allowed, certain permanent changes, which result in the cost variances, must be corrected in order to keep the system usable for future projects. These changes includes:

1. Unit price of equipment and/or raw materials.
2. Content of BoMs, as a result of product redesign.
3. Wages
4. Overhead costs
5. New manufacturing technique
6. Material specifications

4.1.2 Installation Department

Since the installation work is one of the important tasks in a foodservice equipment project, the problems with rough schedule of works, and the inefficient use of resources as mentioned in previous chapter need to be corrected. Suggestions for improvements of the installation works are given below.

1) Setting of Working Priorities through the use of WBS

Since the installation work involves more than merely placing the equipment at the proper positions according to the kitchen plan, more details are needed. Also, because the installation work very much depends on the completion of the equipment production, it must be made as realistic as possible, so that the factory would have enough time to react to the requirements. In this connection, a kitchen project can be broken down into several tasks and subtasks according to their priorities, using the WBS technique (see Figure 4.14).

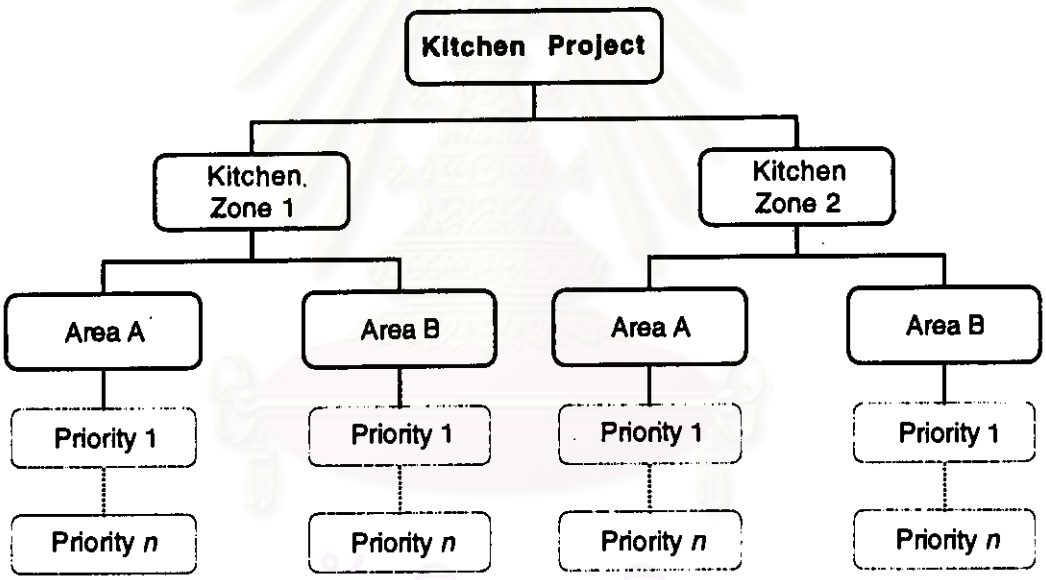

Figure 4.14: Sample of the WBS for a Kitchen Project.

i) Kitchen Zones and Areas -- Firstly, in a given foodservice equipment project, the kitchen is divided into zones and areas according to their functions. Each kitchen area often have different required date when compared to the others, although in many instances some of them may be needed to about the same time. The higher priority of work are given to the facilities which the customer needs to have become operational first, either to support their staffs who

are working at the job site, or as a way to make some money before the official opening of the entire facility. The kitchen that usually receive the first priority has typically been the Staff Canteen, followed by the Hot Kitchen. In the case of the MP Hotel, the project were divided into zones and areas as follows:-

Zone 1: Main Kitchen (see Appendix I)
- Area A: Staff Canteen
- Area B: Butchery, VegetablePreparation, Hot Kitchen, Production Kitchen
- Area C: Pastry, Bakery, Cold Kitchen, Dish Washing
- Area D: Stores, Room Services

Zone 2: Satellite Kitchen (see Appendix J)
- Area A: Hot Kitchen
- Area B: Pantry and Storage
- Area C: Dish Wash Up Area

So that the calling of kitchen areas are not confused between one another, their designations contain information on both the zone and area in which the equipment are located. From the grouping of priorities above, Zone 1A would mean Hot Kitchen area within the Main Kitchen, while Zone 2A means Hot Kitchen area within the Satellite Kitchen.

ii) Type of equipment -- Within every kitchen zone, the installation works could be further broken down into the types of equipment classified according to the difficulties involve in their

installation. When used in conjunction with the zoning priorities stated above, and with some assistance from the factory, it is possible to setup a project schedule which would serve the customer's need. A typical equipment priority, listed in the order of increasing difficulties of the installation work, are:-

1. Overhead Equipment, such as ventilators
2. Equipment with mechanical, electrical, gas, and/or plumbing systems
3. Equipment to be set in-line with others, such as cabinets, and tables
4. Equipment that need site verifications before production, such as wall shelves, fillers
5. Loose piece equipment, such as mobile table, GN. Trolleys, etc.

For the MP Hotel, the installation priorities of the equipment was grouped as follows:

Equipment Group	Installation Priority
1. Ventilators (Exhaust Hoods)	1
2. Sinks	2
3. Gas Heated Equipment	2
4. Electric Heated Equipment	2
5. Cooling Equipment	2
6. Cabinets	3
7. Shelves	3
8. Tables	3

9. Accessories	4
10. Mobile Equipment	5

2) Better Control of Installation Works

The lack of good controlling processes for the labour usage, as well as material requisitions in the Installation Department stated above had made it difficult to determine the project performance. Therefore, any problems, such as potential schedule delays, and/or cost overruns could not be spotted and avoided in advance. In this connection, the monitoring and controlling processes of these two areas of the Installation Department were developed and discussed below:-

i). Human Resources -- In order to gain proper control over the installation schedule, some sort of monitoring and controlling system must be implemented on installation works using a reporting system. To do this, the "Installation Daily Report" (Figure 4.15) was created for used in the monitoring of the work performed. This daily report is to be filled by the installation foreman responsible for that job site, and submitted to the Project Manager (PM) for information. The PM will then have to compare and evaluate the progress of work against the project plan, which would be discussed later in this chapter. Any deviation from the schedule must be noted, and if the problem is serious, corrective actions must be taken to prevent the possible delays.

INSTALLATION DAILY REPORT

Job No. P135/97 Project Name: MP Hotel Date: 12/12/97
ZONE: 1B (Hot Kitchen -- MK) ☑ INSTALLATION ☐ TEST-RUN

ITEM NO.	DESCRIPTION	QTY.	MAN-HRS. USED R.T.	O.T.	REMARK
MK-03	Double Sink Table (240)	1	4.8	-	
MK-07	3-Compartment Sink	1	6.7	-	
MK-25	2-Kwali Range (230)	1	7.8	-	
MK-29	1-Stock Pot Stove	1	3.5	-	
MK-30	3-Chinese Range (180)	1	7.2	-	
MK-32	1-Soup Range (80)	1	7	-	
MK-33	3-Chinese Range (180)	1	7.5	-	

Site Foreman Project Supervisor Project Manager

Figure 4.15: Installation Daily Report Form used to keep track of the project activities.

ii). Installation Materials -- Previously the requisition for the installation materials could not be properly controlled, due to the fact that the material requirement for each equipment was not worked out before hand during the cost estimation stage. Therefore, when the installation technician would like to requisition for such materials from the stock, the appropriate number of them were not available, and hence,extras had to be brought with the technicians to the job site, just in case they run out of parts. The problem here is not the bringing of the extras, but the fact that materials were taken without even knowing how much of them were actually needed. To improve the situation, the types and amount of the installation materials required for the installation work must first be known.

Normally, after a project is awarded to the company, the Installation Department would have to make a utility layout specifying the positions of the utility outlets required by the foodservice equipment. From this layout, the types and quantity of installation materials required to connect the equipment to the utility outlets could be summarised into a list. And, whenever the technicians need to obtain the materials for their installation works, the amount of parts to be given to them must based on the estimated figures from the said list, plus some percentage that would serve as contingency stock. A form, such as the one in Figure 4.16, could be used to keep track of the materials taken for installation works, so that the amount of the requisitioned parts could be controlled.

INSTALLATION MATERIAL REQUEST

Job No. P135/97 Project Name: MP Hotel Date: 12/12/97
ZONE: 1B (Hot Kitchen -- MK)

ITEM NO.	PART NO.	DESCRIPTION	REQUESTED	RETURN	USED
MK-25	R360012005	Pipe: BS ø1/2" 6m.	1	-	1
	R330012005	Pipe: GI ø1/2" 6m.	1	-	1
	R342000005	Pipe: PVC (th) ø2" x 4m.	1	-	1
	P25017010	Elbow90: BS ø1/2"	10	6	4
	P25012015	Elbow90: GI ø1/2"	10	6	4
	P25014017	Elbow90: PVC (th) ø2"	10	5	5
	P25207025	Nipple: BS ø1/2"	5	2	3
	P25202015	Nipple: GI ø1/2"	5	2	3
	P25307005	Union: BS ø1/2"	5	4	1
	P25302010	Union: GI ø1/2"	5	4	1
	P25054020	PVC Conn. ø2" OT	5	3	2
	U11501055	Seal Tape	10	4	6

Site Foreman (Request) | Project Supervisor (Approve) | Store Manager (Dispatch)

Figure 4.16: Installation Material Request Form

4.2 Reorganisation

As the functional organisation did not serve well to the needs of the project works; in that it did not provide a person who has direct responsibility over the project; there were many difficulties with the coordination, decision makings, and cost control aspects of the projects. Hence, in order to reduce, or possibly prevent, the problems from happening, a project management function was added to the current organisation structure (see Figure 4.17). The new project management team would substitute the function of the previous Installation Department, extend further authorities and controls over project-related activities at the job site, and serve to coordinate with the factory in order to meet with the project deadlines. The added functions and their related responsibilities are described below.

1) Project Manager

Title: Project Manager

Report To: Deputy Managing Director

Subordinates: Project Supervisors, Site Foremen, and installation personnel.

Direct Responsibilities:

1. Estimate the requirement for time, resources, and cost for the installation work of a project.
2. Make installation plans based on the delivery date.
3. Coordinate with Purchase Department to make sure the imported and buy-out equipment would arrive on time.
4. Coordinate with the Factory Manager on the acceptable delivery dates for equipment.
5. Monitor and control the project schedule and resources used.

6. Make decisions and solve project related problems which the Project Supervisor can not make or solve.
7. Set working priorities for the equipment in the project.
8. Revise and update project plan when necessary.

Authorities:

1. Approve the use of project plan.
2. Revise project plan when necessary.
3. Approve materials to be used in the project.
4. Approve subcontractor for the project.
5. Approve the purchase of tools and equipment needed.

2) Project Supervisor

Title: Project Supervisor

Report To: Project Manager

Subordinates: Site Foremen, and installation personnel.

Direct Responsibilities:

1. Monitor and control work progress at assigned job sites.
2. Solve immediate problems, and make non-policy decisions for assigned job sites.
3. Report progress of projects to the Project Manager.
4. Authorise the "Installation Material Request" form base on the works that need to be done daily.
5. Supervise Test-run and commissioning of all equipment.

Authorities:

1. Approve the request for overtime work.
2. Approve the site verification data.
3. Negotiate with other contractors on general difficulties.

3) Site Foreman

Title: Site Foreman

Report To: Project Supervisor

Subordinates: installation personnel.

Direct Responsibilities:

1. Carry out the daily installation project tasks as planned.
2. Request for installation materials on a "Installation Material Request" form.
3. Control the use of installation materials, and return the extras to the Store Manager.
4. Request for overtime work.
5. Take the site measurements for items that need to be custom-built to the job site.
6. Check all utility supplies before connecting equipment.
7. Control the amount of work need to be completed on each day.
8. Control quality of installation works.
9. Oversee preliminary test-run of equipment.
10. Record actual usages of direct labour on the "Installation Daily Report" form.
11. Report work progress to Project Supervisor on a daily basis.

Authorities:

1. Approve the hiring of outside labour for moving heavy equipment.
2. Evaluate the workers performance, and make appropriate recommendations.

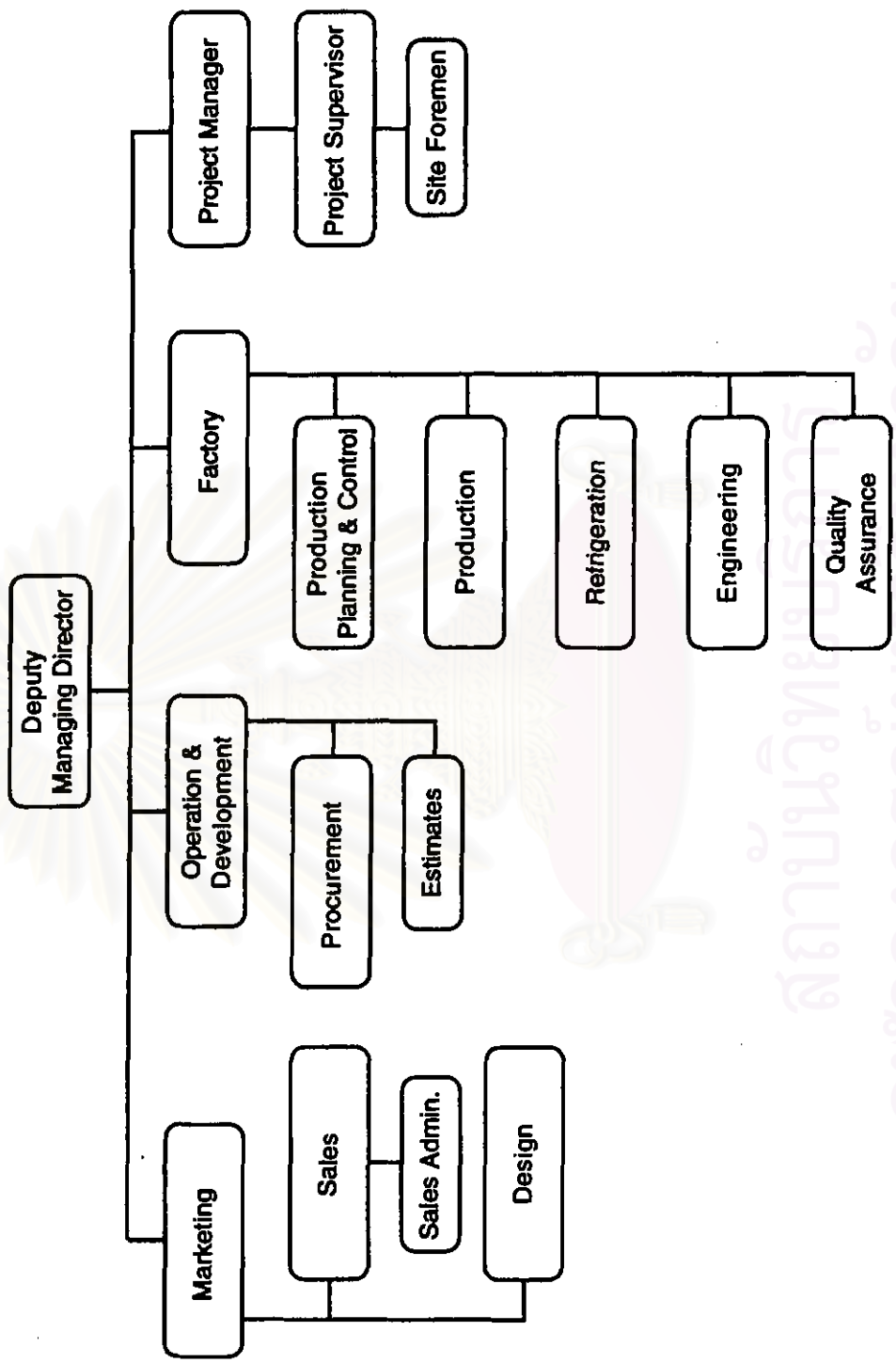

Figure 4.17: The Addition of Project Management Function to the Organisation

4.3 Establishment of Project Planning System

The problems with the late deliveries of equipment in a project that the company had been experiencing, and was confirmed during the investigation of the New Bangkok Hotel, were caused by many factors, one of which was the lack of project planning system in the organisation. It was known that during the project cost estimation phase, the lead time for all of the equipment were determined individually. For example, the lead times of the equipment to be manufactured locally were estimated according to the time it would take to fabricate them, while those of the imported and the buy-out (locally purchased) items were given by the suppliers. Although the information on the lead time of all equipment were available, one thing that was not considered in the process was the capacity of the production at the time when the equipment needed to be manufactured. The lack of a decent planning system, coupled with the problem with the BoMs as stated earlier, caused some critical raw materials to be in short supply, and the limited resources to be over capacity, all of which subsequently led to the delays in the project schedule. To improve the situation, certain project planning work must be done.

4.3.1. Pre-bid Project Planning

Previously unheard of by the company, the pre-bid and post bid project planning was introduced to the case study of the MP Hotel project, in order to make sure that the company could stay committed to its quotation with regards to the delivery date. As the name suggests, this is going to be done before the quotation for the project is submitted to the potential customer.

In the project conception phase (see Figure 4.18), the information on the customer requirements were translated into kitchen plans, perspective drawings, and specifications as shown in Appendices I to K. Then, a make-or-buy decisions were made to distinguish between the items to be locally manufactured, imported, and bought-out. While the availability of the latter two types of equipment were given by their suppliers, the locally made items need to have their BoMs worked out in order to determine the costs and the number of man-hours required to fabricate them.

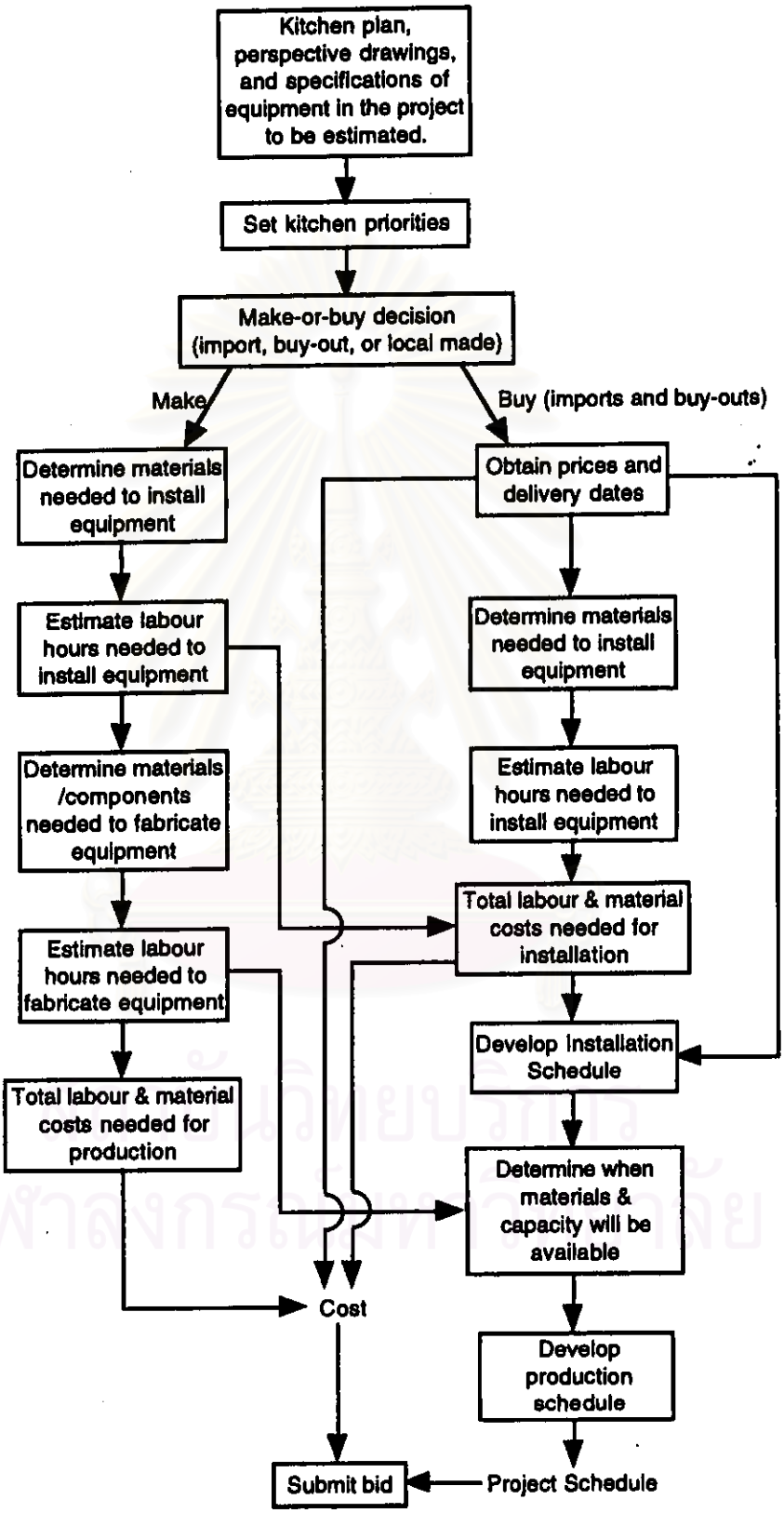

Figure 4.18: Schematic Diagram of the Pre-bid Estimating Procedure for a Job Shop

Because the installation and production activities consume much of the company's resources, and could lead to project delays due to capacity conflicts if not planned ahead, their schedules must be worked out to determine the possible working periods which would not cause clashes with the projects already on hand. The concept here was to use backward scheduling technique to determine when the major project activities could be performed, so that the project could be completed in time to meet the customer's required date. The project scheduling of the two department (installation and production) are discussed below.

1) Installation Schedule

After the priorities of the kitchen, and all of the equipment within them (locally made, buy-out, and imported) had been established as stated in section 4.1.2, the number of man-hours, and man-days, required for the installation work were calculated according to the set priorities. For the case study, the number of DLH required for each equipment in the MP Hotel project are shown in the Table 4.10.

Labour-Hours Requirement for Installation

P135/97 MP Hotel
Project ID Project Name
Zone 1A

Item No.	Description	Priority	Install (MHr.)	Test-Run (MHr.)
MK-153	Exhaust Hood	1	16.5	1
MK-154	1-Stock Pot Stove	2	4	1
MK-149	Double Sink Table	2	5	1
MK-53	Double Sink Table	2	5	1
MK-58	Single Sink Table	2	5	1
MK-59	Sink Unit	2	4.5	1

Table 4.10: DLH Requirements for Installation of Equipment

Labour-Hours Requirement for Installation

P135/97 MP Hotel
Project ID Project Name
Zone 1A

Item No.	Description	Priority	Install (MHr.)	Test-Run (MHr.)
MK-65	Fish Sink	2	4.5	1
MK-66	Double Sink Table	2	5	1
MK-158R	Soiled Dish Table W/3-Sink&Plastic Bin	2	7	0
MK-159	Open Cabinet	3	0.5	0
MK-160	Open Cabinet	3	0.5	0
MK-161	SS.Filler Top	4	0.5	0
MK-162	Tray Slide	4	1	0
MK-150	Single Wall Shelf	4	0.5	0
MK-52	Single Wall Shelf	4	0.5	0
MK-67	Single Wall Shelf	4	0.5	0
MK-157	Slatted Shelf	5	0.5	0
MK-62	Chopping Block W/Stand	5	0.3	0
MK-151	Low Table	5	0.5	0
MK-163	Condiment Table	5	0.5	0
MK-55	Work Table	5	0.5	0
MK-56	Work Table	5	0.5	0
MK-57	Work Table	5	0.5	0
MK-63	Work Table	5	0.5	0
MK-64	Work Table	5	0.5	0
MK-68R	Work Table	5	0.5	0
	Total Man-Hours		65.3	8
Zone 1B				
MK-09	Exhaust Hood	1	16	1
MK-13	Exhaust Hood	1	16	1
MK-26	Exhaust Hood	1	18	2
MK-95	Exhaust Hood	1	18	2
MK-97	Exhaust Hood	1	16	1
MK-44	Infrared Food Warner 1300W	2	2.5	0.5
MK-40	Warming Cabinet	2	1.5	1
MK-04	4-Door Upright Refrigerator	2	4.5	2
MK-05	4-Door Upright Freezer	2	4.5	2
MK-17R	2-Door Refrigerated Base	2	1.5	2
MK-22	Deep Fat Fryer	2	1.5	1
MK-39	Bain Marie Cabinet	2	4.5	1
MK-21	Griddle	2	2	1
MK-23	Char Broiler(Gas+Lava)	2	4	1

Table 4.10: DLH Requirements for Installation of Equipment. (Continued)

Labour-Hours Requirement for Installation

P135/97 MP Hotel
Project ID Project Name
Zone 1B

Item No.	Description	Priority	Install (MHr.)	Test-Run (MHr.)
MK-25	2-Kwali Range	2	9	2
MK-29	1-Stock Pot Stove	2	3.6	1
MK-30	3-Chinese Range	2	7	1
MK-32	1-Soup Range	2	7	1
MK-33	3-Chinese Range	2	7	1
MK-11	Combi Oven	2	6.5	1
MK-92	Tilting Kettle 40 L.	2	7	1
MK-93	Tilting Braising Pan 40 L.	2	7	1
MK-03	Double Sink Table	2	4.5	0.5
MK-07	3-Compartment Sink Table W/Pot Rail	2	7	0.5
MK-99	Hand Sink	2	4.5	0.3
MK-10	Pizza Oven (Counter Type)	2	5	1
MK-18	4-Open Burner W/Oven	2	5	1
MK-96	Combi Oven	2	7.5	1
MK-38	Open Cabinet	3	0.5	0
MK-43	Serving Cabinet	3	0.5	0
MK-08	Work Table	3	0.5	0
MK-15	Work Table	3	0.3	0
MK-24	SS.Filler Top	4	0.5	0
MK-31	SS.Filler Top	4	0.5	0
MK-14	Over Shelf	4	0.5	0
MK-16R	Over Shelf	4	0.5	0
MK-42	Double High Shelf	4	0.5	0
MK-54	Vegetable Preparation Machine w/ blades	5	1	0.5
MK-100	GN.Trolley	5	0.5	0
MK-98	Mobile Table	5	0.5	0
MK-02	Plain Shelf	5	0.5	0
MK-06	Slatted Shelf	5	0.5	0
MK-12	Equipment Stand (for Combi)	5	0.5	0
MK-34	Work Table	5	0.5	0
	Total Man-Hours		206.4	32.3
Zone 1C				
MK-73	Exhaust Hood	1	16	1
MK-75	Exhaust Hood	1	16	1
MK-84	2-Door Refrigerated Base W/Marble Top	2	2.5	2
MK-121	Dish Washing Machine	2	6	2

Table 4.10: DLH Requirements for Installation of Equipment. (Continued)

Labour-Hours Requirement for Installation

P135/97 **MP Hotel**
Project ID Project Name
Zone 1C

Item No.	Description	Priority	Install (MHr.)	Test-Run (MHr.)
MK-120	Soiled Dish Table W/Pre-Rinse&2-Poly Bin	2	5	1
MK-108	Open Cabinet	3	0.5	0
MK-113	Open Cabinet	3	0.5	0
MK-116AD	2-Door Upright Refrigerator	3	3.5	2
MK-115	Single Sink Table	3	4.5	1
MK-79	Sink Table W/Accessories Hanger	3	4.5	1
MK-123	Clean Dish Table W/Rack Shelf	3	0.5	0
MK-122	Condensate Canopy	3	4	0
MK-86	Open Cabinet W/Chocolate Drawers	4	1	0
MK-111	Single Wall Shelf	4	1	0
MK-85	Single Wall Shelf	4	1	0
MK-125	Mobile Sorting Table	5	0.5	0
MK-83	Mobile Flour Bin	5	0.5	0
MK-109R	Plain Shelf	5	0.5	0
MK-124	Slatted Shelf	5	0.5	0
MK-126.1	Plain Shelf L1	5	0.5	0
MK-126.2	Plain Shelf L2	5	0.5	0
MK-80	Work Table	5	0.5	0
MK-82	Wooden Top Table	5	0.5	0
	Total Man-Hours		72.5	11
Zone 1D				
MK-137	Sink Cabinet	2	4.5	1
MK-135	Open Cabinet	3	0.5	0
MK-140	Open Cabinet	3	0.5	0
MK-134	2-Door Upright Refrigerator	3	3.5	2
MK-141	Single Wall Shelf	3	1	0
MK-136	SS.Filler Top	5	0.5	0
MK-152	Automatic Rice Cooker 9 Litres	5	2.5	0
	Total Man-Hours		13	3
Zone 2A				
SA-19	Exhaust Hood	1	18	2
SA-09	1-Stock Pot Stove	2	3.5	1
SA-11	Char Broiler(Gas+Lava)	2	4	1
SA-12	1-Soup Range	2	7	1
SA-14	3-Chinese Range	2	8	1
SA-15R	2-Chinese Range	2	8	1

Table 4.10: DLH Requirements for Installation of Equipment. (Continued)

Labour-Hours Requirement for Installation

P135/97 MP Hotel
Project ID Project Name
Zone 2A

Item No.	Description	Priority	Install (MHr.)	Test-Run (MHr.)
SA-17	Soup Range	2	7	1
SA-18	1-Stock Pot Stove	2	4	1
SA-03	Double Sink Table	2	5	1
SA-24	Double Sink Table	2	5	1
SA-25	Double Sink Table	2	5	1
SA-26	2-Door Upright Freezer	3	4.5	4
SA-27	4-Door Upright Refrigerator	3	4.5	4
SA-04R	Work Table	3	1	0
SA-08	Low Table	3	1	0
SA-10	Work Table	3	1	0
SA-13	Work Table	3	1	0
SA-22	Double High Shelf	4	1	0
SA-23	Slatted Shelf	4	0.5	0
SA-16R	SS.Filler Top	5	1	0
SA-08.1	Plain Shelf L1	5	1	0
SA-08.2	Plain Shelf L2	5	1	0
SA-07	Work Table	5	1	0
SA-20	Work Table	5	1	0
SA-21	Work Table	5	1	0
	Total Man-Hours		95	20
Zone 2B				
SA-36	Open Cabinet	3	1	0
SA-33	2-Door Upright Refrigerator	3	4.5	1
SA-34	Sink Cabinet	3	4.5	1
SA-40	Plain Shelf	5	1	0
	Total Man-Hours		11	2
Zone 2C				
SA-47	Condensate Canopy	1	4	0
SA-46	Dish Washing Machine	2	11	4
SA-45	Soiled Dish Table&Pre-Rinse W/Poly Bin	2	8	1
SA-48	Clean Dish Table W/Rack Shelf	4	0.5	0
SA-49	Slatted Shelf	5	1	0
SA-50	Plain Shelf	5	1	0
	Total Man-Hours		25.5	5

Table 4.10: DLH Requirements for Installation of Equipment. (Continued)

Using the date required of MP Hotel as the reference, and the data from Table 4.11, as well as the current resources allocations for the projects already on hand as the supporting information, the Project Manager, then, made the installation schedule by backward scheduling technique to obtain the installation schedule for this project. To ease the trouble involves with this process, a project management software, in this case Microsoft Project 2.0, was used to construct the Gnatt chart as shown in Figure 4.19.

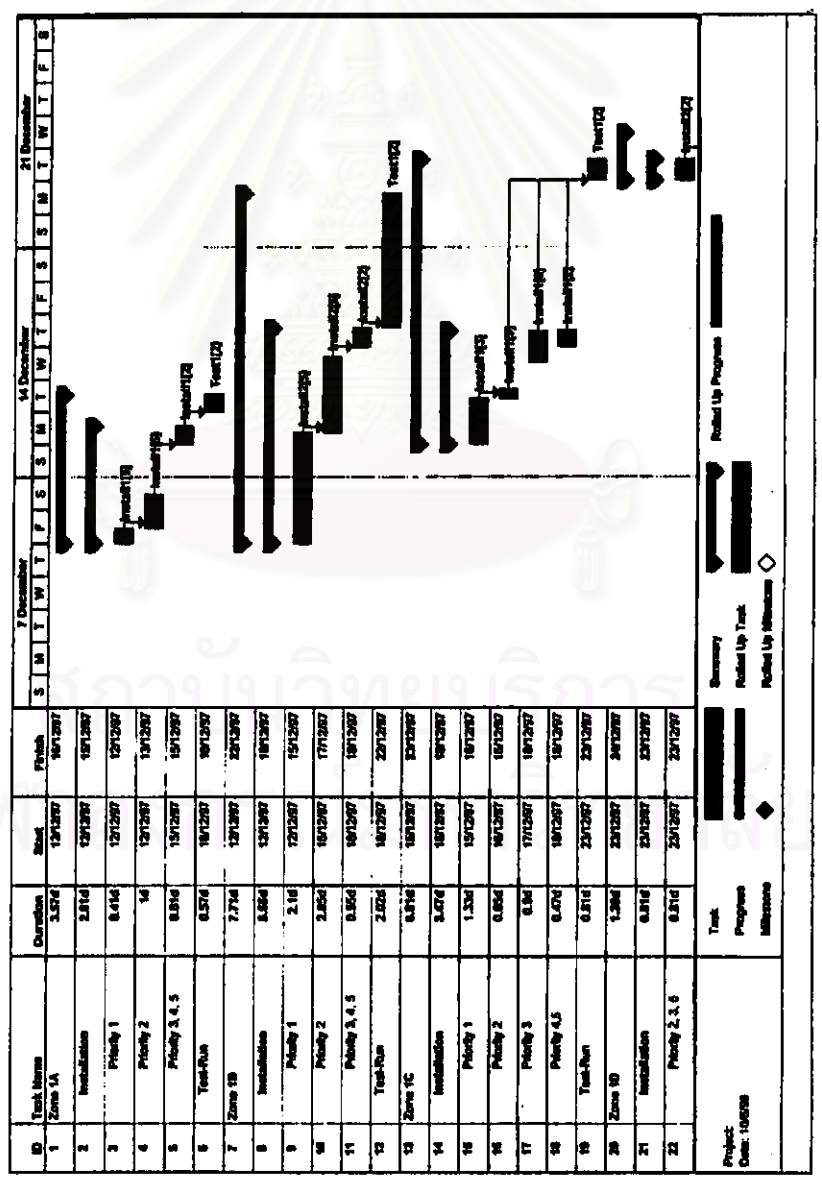

Figure 4.19: Installation Schedule for MP Hotel Project.

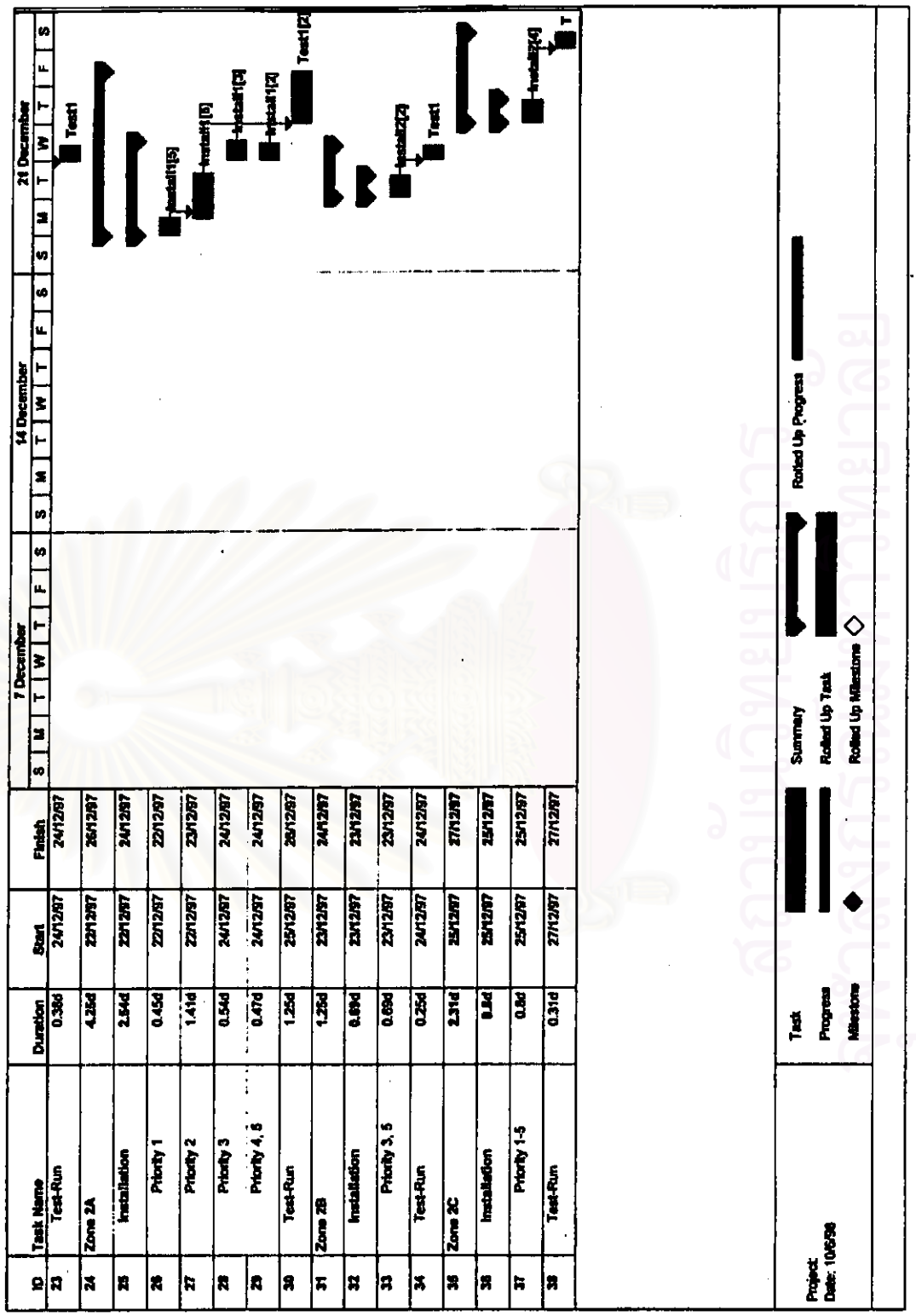

Figure 4.19: Installation Schedule for MP Hotel Project (Continued).

2) Production Schedule

After the installation schedule for the project was finalised, a production schedule must also be made for the same reason; to prevent possible schedule and resources conflicts with the existing projects. Unlike the previous way of production scheduling which used the project due date as the reference, this time the Factory immediate "customer" was considered to be the Installation Department, and not the external customer. Hence, the date required of the equipment for the Factory would be the starting dates of the installation activities of those equipment. Before further production planning could be done, the amount of direct labour-hours needed for each equipment to be fabricated by the Factory must be summarised.

Incidentally, the requirement of the installation was very zone-specific, meaning that the equipment they want to have delivered to the job site must be in the same kitchen area, as opposed to the same type. However, to manufacture the equipment exactly according to the installation zoning priorities would not be a very good use of the Factory's resources. To get out of this dilemma, an assumption was made that the production of the equipment would have the priority over the installation works, so as to prevent erratic production schedule. Although the factory would not be able to make equipment to satisfy the need kitchen by kitchen, one thing it could do was to fabricate them according to the group priorities. This meant the same type of equipment were produced together around the same period of time to reduce the set up times, as well as to reduce the actual fabrication time through batch production, and learning curve. For the MP Hotel project, the equipment can be grouped as follows:

1. Ventilators (Exhaust Hoods)
2. Sinks
3. Gas Heated Equipment
4. Electric Heated Equipment
5. Cooling Equipment
6. Cabinets
7. Shelves
8. Tables
9. Accessories
10. Mobile Equipment

As with other equipment, these 10 groups of products also underwent the same production processes, some more than the other, depending on their requirements. The 5 main processes include: Forming, Assembly, Finishing, Technics, and Refrigeration. All of the equipment must go through the first 2 processes (Forming and Assembly), as these are the key processes in transforming sheet metals into actual products. After that, if there was any requirement for technical components (gas, plumbing, or electrical systems, etc.), and/or refrigeration system, the equipment would be passed on to the appropriate department for further works. With the information at hand, the summary of the direct-labour required for each equipment and its group are shown in the Table 4.11. These data, can then be input into the Microsoft Project 2.0 to obtain the proposed production schedule for the project (see Figure 4.20).

Production DLH Requirement Summary

P135/97 MP Hotel
Project ID Project Name

Item No.	Description	Qty.	Zone	Forming Man-Hr.	Assy. Man-Hr.	Finish Man-Hr.	Tech. Man-Hr.	Refrig. Man-Hr.
Accessories								
MK-161	SS.Filler Top	1	1A	2.5	4	2	0	0
MK-162	Tray Slide	1	1A	3.5	6	2	0	0
MK-24	SS.Filler Top	1	1B	4	4	2	0	0
MK-31	SS.Filler Top	2	1B	8	12	4	0	0
MK-136	SS.Filler Top	1	1D	2.5	4	2	0	0
SA-16R	SS.Filler Top	1	2A	4	8	2	0	0
	Total Man-Hours			24.5	40.0	14.0	0.0	0.0
Cabinets								
MK-159	Open Cabinet	1	1A	7.5	30	6	0	0
MK-160	Open Cabinet	1	1A	7.5	30	6	0	0
MK-36	Open Cabinet	1	1B	7.5	30	6	0	0
MK-40	Warming Cabinet	1	1B	6.5	58	10	6	0
MK-43	Serving Cabinet	1	1B	8	24	4	0	0
MK-108	Open Cabinet	1	1C	11.5	30	6	0	0
MK-113	Open Cabinet	1	1C	11.5	30	6	0	0
MK-86	Open Cabinet W/Chocolate	1	1C	11.5	30	6	0	0
MK-135	Open Cabinet	1	1D	7.5	30	6	0	0
MK-140	Open Cabinet	1	1D	7.5	30	6	0	0
SA-36	Open Cabinet	1	2B	7.5	30	6	0	0
	Total Man-Hours			96.0	352.0	68.0	6.0	0.0
Cooling Equipment								
MK-17R	2-Door Refrigerated Base	1	1B	13.5	35	2.5	0	22
MK-84	2-Door Refrigerated Base	1	1C	15.5	35	2.5	0	22
	Total Man-Hours			29.0	70.0	5.0	0.0	44.0
Electric Heated Equipment								
MK-22	Deep Fat Fryer	1	1B	6	40	4.5	8	0
MK-39	Bain Marie Cabinet	1	1B	12	46	8	16	0
	Total Man-Hours			18.0	86.0	12.5	24.0	0.0
Gas Heated Equipment								
MK-154	1-Stock Pot Stove	1	1A	6	16	4	8	0
MK-21	Griddle	1	1B	6.5	32	4	12	0
MK-23	Char Broiler(Gas+Lava)	1	1B	5.5	52	3.5	16	0
MK-25	2-Kwali Range	1	1B	11	75	11	30	0
MK-29	1-Stock Pot Stove	1	1B	6	16	4	8	0
MK-30	3-Chinese Range	1	1B	10	40	8	10	0

Table 4.11: DLH Requirements for Production of Equipment.

Production DLH Requirement Summary

P135/97 MP Hotel
Project ID Project Name
Gas Heated Equipment (Cont.)

Item No.	Description	Qty.	Zone	Forming Man-Hr.	Assy. Man-Hr.	Finish Man-Hr.	Tech. Man-Hr.	Refrig. Man-Hr.
MK-32	1-Soup Range	1	1B	6	18	4	8	0
MK-33	3-Chinese Range	1	1B	6	20	6	6	0
SA-09	1-Stock Pot Stove	1	2A	6	16	4	8	0
SA-11	Char Broiler(Gas+Lava)	1	2A	6.5	52	3.5	16	0
SA-12	1-Soup Range	1	2A	6	18	4	8	0
SA-14	3-Chinese Range	1	2A	8	20	6	8	0
SA-15R	2-Chinese Range	1	2A	6	40	8	10	0
SA-17	Soup Range	1	2A	6	18	4	6	0
SA-18	1-Stock Pot Stove	1	2A	6	16	4	8	0
	Total Man-Hours			105.5	449.0	78.0	166.0	0.0
Mobile Equipment								
MK-100	GN.Trolley	2	1B	5	32	12	0	0
MK-98	Mobile Table	2	1B	6.5	20	6	0	0
MK-125	Mobile Sorting Table	1	1C	6.5	10	3	0	0
MK-83	Mobile Flour Bin	2	1C	14	64	10	0	0
	Total Man-Hours			34.0	126.0	31.0	0.0	0.0
Shelves								
MK-150	Single Wall Shelf	1	1A	2.5	16	6	0	0
MK-52	Single Wall Shelf	1	1A	7	24	6	0	0
MK-62	Chopping Block W/Stand	1	1A	6	16	4	0	0
MK-67	Single Wall Shelf	1	1A	7	24	6	0	0
MK-14	Over Shelf	1	1B	4.5	8	2	0	0
MK-16R	Over Shelf	1	1B	4.5	8	2	0	0
MK-42	Double High Shelf	1	1B	3	20	3	0	0
MK-109R	Plain Shelf	1	1C	1.5	8	4	0	0
MK-111	Single Wall Shelf	1	1C	7	24	6	0	0
MK-65	Single Wall Shelf	1	1C	2.5	16	6	0	0
MK-141	Single Wall Shelf	1	1D	2.5	16	6	0	0
SA-22	Double High Shelf	1	2A	3	20	3	0	0
	Total Man-Hours			51.0	200.0	54.0	0.0	0.0
Sinks								
MK-149	Double Sink Table	1	1A	7	46	9	2	0
MK-53	Double Sink Table	1	1A	7	46	9	2	0
MK-56	Single Sink Table	1	1A	6	24	6	1	0
MK-59	Sink Unit	1	1A	7	24	6	1	0

Table 4.11: DLH Requirements for Production of Equipment (Continued).

Production DLH Requirement Summary

P135/97 MP Hotel
Project ID Project Name
Sinks (Cont.)

Item No.	Description	Qty.	Zone	Forming Man-Hr.	Assy. Man-Hr.	Finish Man-Hr.	Tech. Man-Hr.	Refrig. Man-Hr.
MK-65	Fish Sink	1	1A	6	20	8	1	0
MK-66	Double Sink Table	1	1A	7	48	9	2	0
MK-03	Double Sink Table	1	1B	7	48	9	2	0
MK-07	3-Compartment Sink	1	1B	9.5	72	13	3	0
MK-99	Hand Sink	1	1B	3.5	16	4	2	0
MK-115	Single Sink Table	1	1C	6	24	6	1	0
MK-79	Sink Table W/Accessories	1	1C	7	24	8	1	0
MK-137	Sink Cabinet	1	1D	9.75	42	4	1	0
SA-03	Double Sink Table	1	2A	7	48	9	2	0
SA-24	Double Sink Table	1	2A	7	48	9	2	0
SA-25	Double Sink Table	1	2A	8.75	48	9	2	0
SA-34	Sink Cabinet	1	2B	7	24	6	1	0
	Total Man-Hours			112.5	606.0	122.0	26.0	0.0
Tables								
MK-151	Low Table	1	1A	2.25	16	2	0	0
MK-158R	Soiled Dish Table	1	1A	11	47	11	2	0
MK-163	Condiment Table	2	1A	13	20	6	0	0
MK-55	Work Table	1	1A	3.25	10	3	0	0
MK-56	Work Table	2	1A	6.5	20	6	0	0
MK-57	Work Table	1	1A	3.25	10	3	0	0
MK-63	Work Table	1	1A	4.25	10	3	0	0
MK-64	Work Table	1	1A	4.25	10	3	0	0
MK-68R	Work Table	1	1A	4.25	10	3	0	0
MK-08	Work Table	1	1B	3.25	10	3	0	0
MK-12	Equipment Stand	1	1B	4.75	16	3	0	0
MK-15	Work Table	1	1B	4.25	10	3	0	0
MK-34	Work Table	2	1B	8.5	20	6	0	0
MK-120	Soiled Dish Table	1	1C	11	47	11	2	0
MK-123	Clean Dish Table W/Rack	1	1C	3.5	20	4	0	0
MK-60	Work Table	1	1C	4.25	10	3	0	0
MK-82	Wooden Top Table	1	1C	4.25	10	3	0	0
SA-04R	Work Table	1	2A	4.25	10	3	0	0
SA-06	Low Table	1	2A	3.25	16	2	0	0
SA-07	Work Table	1	2A	4.25	10	3	0	0
SA-10	Work Table	1	2A	4.25	10	3	0	0

Table 4.11: DLH Requirements for Production of Equipment (Continued).

Production DLH Requirement Summary

P135/97 MP Hotel
Project ID Project Name
Sinks (Cont.)

Item No.	Description	Qty.	Zone	Forming Man-Hr.	Assy. Man-Hr.	Finish Man-Hr.	Tech. Man-Hr.	Refrig. Man-Hr.
SA-13	Work Table	1	2A	4.25	10	3	0	0
SA-20	Work Table	2	2A	8.5	20	6	0	0
SA-21	Work Table	2	2A	8.5	20	6	0	0
SA-45	Soiled Dish	1	2C	11	47	11	2	0
SA-48	Clean Dish Table W/Rack	1	2C	3.5	20	4	0	0
	Total Man-Hours			147.5	459.0	117.0	6.0	0.0
Ventilators								
MK-153	Exhaust Hood	1	1A	8	16	8	2	0
MK-09	Exhaust Hood	1	1B	10	16	8	4	0
MK-13	Exhaust Hood	1	1B	10	16	8	4	0
MK-26	Exhaust Hood	1	1B	8	16	8	2	0
MK-95	Exhaust Hood	1	1B	8	16	8	2	0
MK-97	Exhaust Hood	1	1B	10	16	8	4	0
MK-122	Condensate Canopy	1	1C	4	8	4	2	0
MK-73	Exhaust Hood	1	1C	6	16	6	2	0
MK-75	Exhaust Hood	1	1C	10	16	8	4	0
SA-19	Exhaust Hood	1	2A	8	16	8	2	0
SA-47	Condensate Canopy	1	2C	4	8	4	1	0
	Total Man-Hours			66.0	160.0	80.0	29.0	0.0

Table 4.11: DLH Requirements for Production of Equipment (Continued).

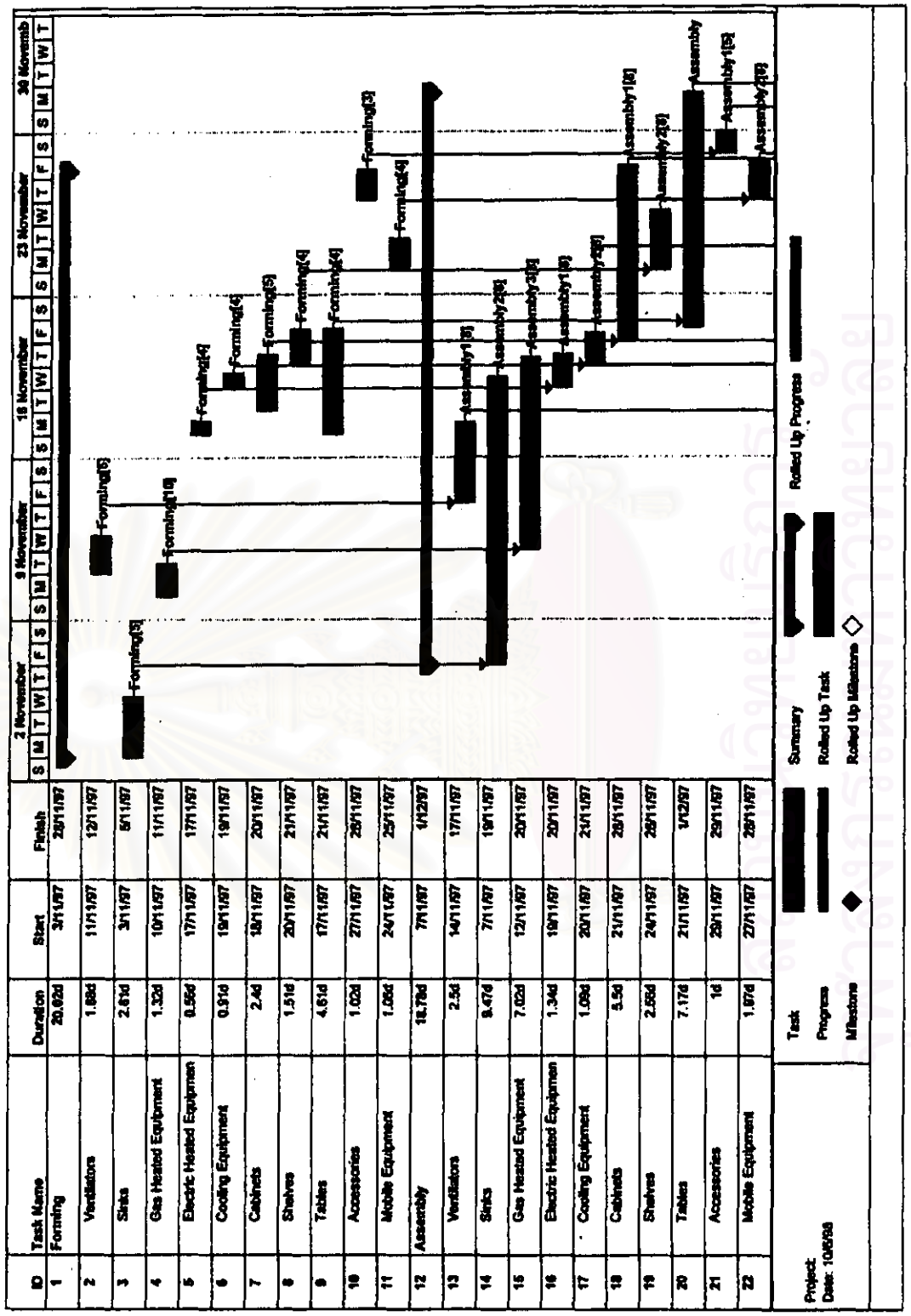

Figure 4.20: Production Schedule for MP Hotel Project.

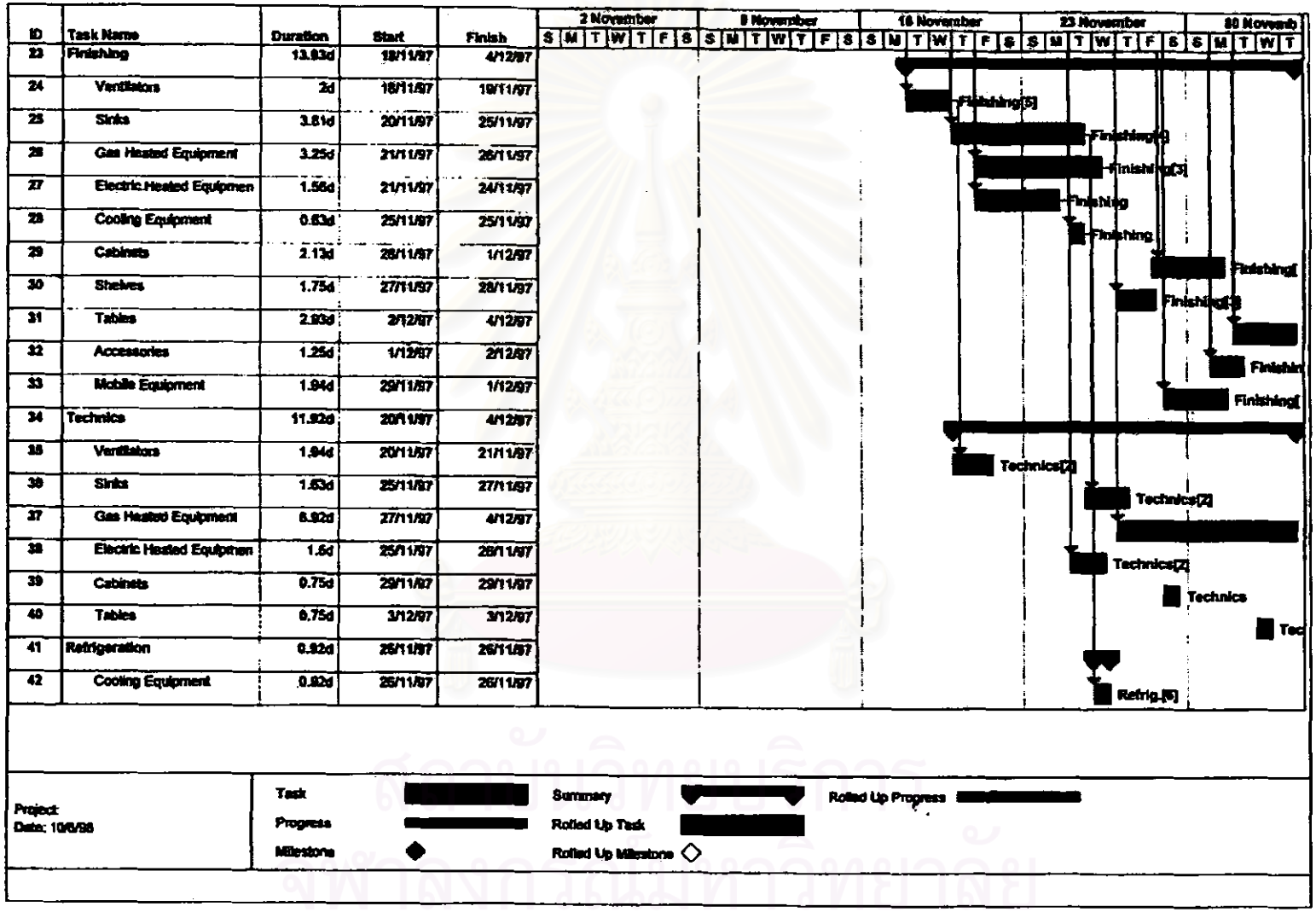

Figure 4.20: Production Schedule for MP Hotel Project (Continued).

By making the project schedule before bidding, the company could be quite certain that the quotation they were about to offer, if awarded, would not be faced with schedule conflicts due to limited amount of available resources. Also, since requirements for the finished goods (imported and buy-outs), as well as the materials needed for the production were known in advance, their availability could be prepared, and thus reducing the chance of shortages, which could cause the project delays, from happening.

4.3.2. Post-bid Project Planning

After the quotation for the project had been met with satisfaction, and the customer awarded the contract for the supply and install of foodservice equipment, first thing that needed to be done was to check for any variations from the original requirements and plans which could have been made during the negotiation with the customer. If not much changes were made, especially the project due date, the pre-bid plan could be slightly altered to suit the slight modifications and used as the actual project plan. However, should the date required of the project be changed so that it would cause competition for the limited resources among projects on hand, then, replanning of the project must be carried out. The Project Manager must use his or her own discretion in this matter for the best interest of the company.

When the go-ahead was given to proceed with the project, the Sales Administrative staffs would issue a copy of the Job Order to the factory, another copy to the Project Manager, while the Purchase Department would receive the "Purchase Request" form (Appendix L) for the buy-out items, and a list of imported equipment that needed to be procured for the project. The planning and implementation of the

project to ensure timely delivery were classified into 3 categories in the ascending order of difficulties in obtaining the equipment.

1) Stocked Items

After receiving the Job Order, the PM, then, had to reconfirm the reservation of the stocked items, which were reserved in the design stage, using the "Equipment Reservation and Confirmation" form (Appendix M). This was to prevent the store keeper from sending the reserved equipment to other jobs.

2) Buy-out and Imported Equipment

The equipment to be purchased from external suppliers, meaning all the buy-outs and imports, are handled by the Purchasing Department. From the installation dates as given by the Project Manager, the Purchase Manager must schedule the acquisitions of these equipment, so that they would arrive in time for the installation works, and not too early, or too late.

3) Items to be Locally Manufactured

After summarising what equipment are needed to be fabricated, the Project Manager must inform the Production Planning and Control Manager (PPC) of the project schedule so that the production plan for the equipment could be worked out, and integrated into the Master Production Schedule. Figure 4.21 shows the work flow of the project after the Job Order is issued.

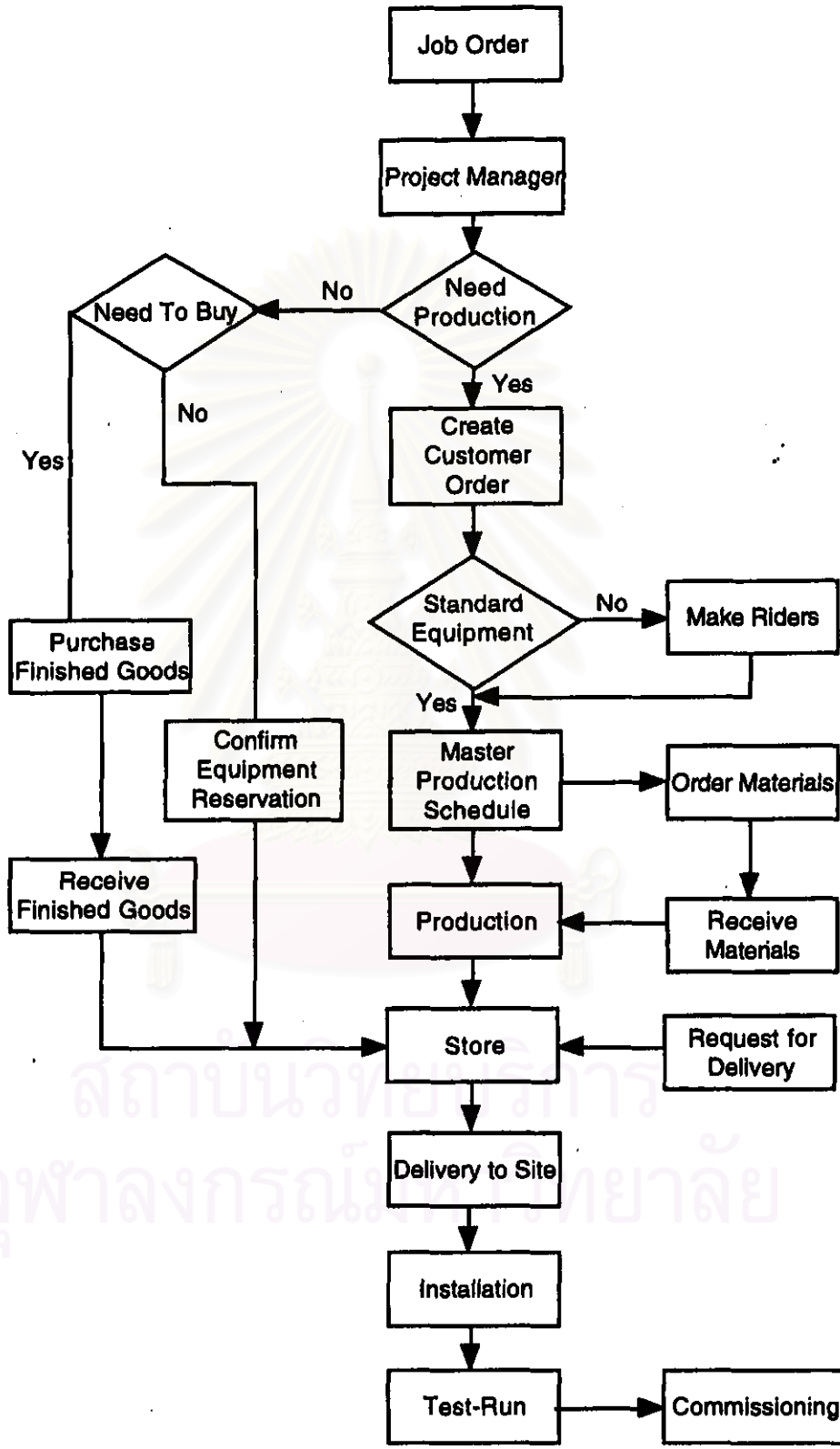

Figure 4.21: The Project Work Flow -- After Awarded.

Whether they be stocked items, buy-out and imported equipment, or locally fabricated products, the correct timing and quantity of their availabilities are most crucial to the success of the project. Unlike the already-finished products which do not require complicated planning for their availability, each locally fabricated equipment, on the other hand, may consist of a few parts, all the way to hundreds of parts, that are required at various stages throughout its production cycle. Hence, the availability of the production materials must be carefully planned in order to avoid shortages during production run. This can be done by using a Material Requirements Planning (MRP) technique. The materials required to manufacture the locally fabricated equipment for a project can be determined using the following steps:-

1. Identify items to be produced.
2. Determine the gross material requirements from their BoMs.
3. Check the availability of materials already in stock, as well as those that are scheduled to receive.
4. Determine the net material requirements for the project by subtracting (3) from (2).
5. Determine the dates which materials must be ordered from the Master Production Schedule and their lead times, in order for them to arrive in time to meet the production schedule.
6. Order materials as planned.

4.4 Establishment of Project Controlling System

As the main result for not having a person who is directly responsible for the project, works were performed, but not controlled. Likewise, the cost controlling aspects of the project, was not carried out. As previously mentioned, the only time the management knew about the financial performance of the project was when the entire project had been completed. With the reorganisation of the company, as mentioned in section 4.2, the newly established Project Management team was given the task of monitoring and controlling of the project schedule and costs, so as to achieve the two main objectives of on-time delivery and at the costs no more than estimated. These activities are done in 2 key areas as discussed below:-

4.4.1) Production

Although the production control is generally, the responsibility of the Production Planning and Control Manager, because the factory does not only manufacture on a project-by-project basis, but also make equipment for unit sales, as well as producing them to stock. But since a foodservice equipment project must involve the fabrication of some products, the Project Manager must be aware of the production status, in order to be able to make necessary corrections, if needed. Hence, in order to avoid the overlapping of authorities with the PPC, the Project Manager would only be monitoring the status of the project he is responsible for, and consult with the PPC should the production of the equipment shows a possibility of overspending or the likelihood of causing project delays. The monitoring and controlling of the production schedule and costs could be done in the following manners:-

1) Production Schedule Control

The monitoring and controlling of production schedule can be done using a graphical representation of the work progress, such as the gantt chart. Before using the chart to display the production status with respect to the project plan, enough information must be collected and summarised using reports such as the "Actual Production DLH Consumption" (see Appendix N). With these information, a project tracking chart can be created for monitoring the progress of the production work (see Figure 4.22).

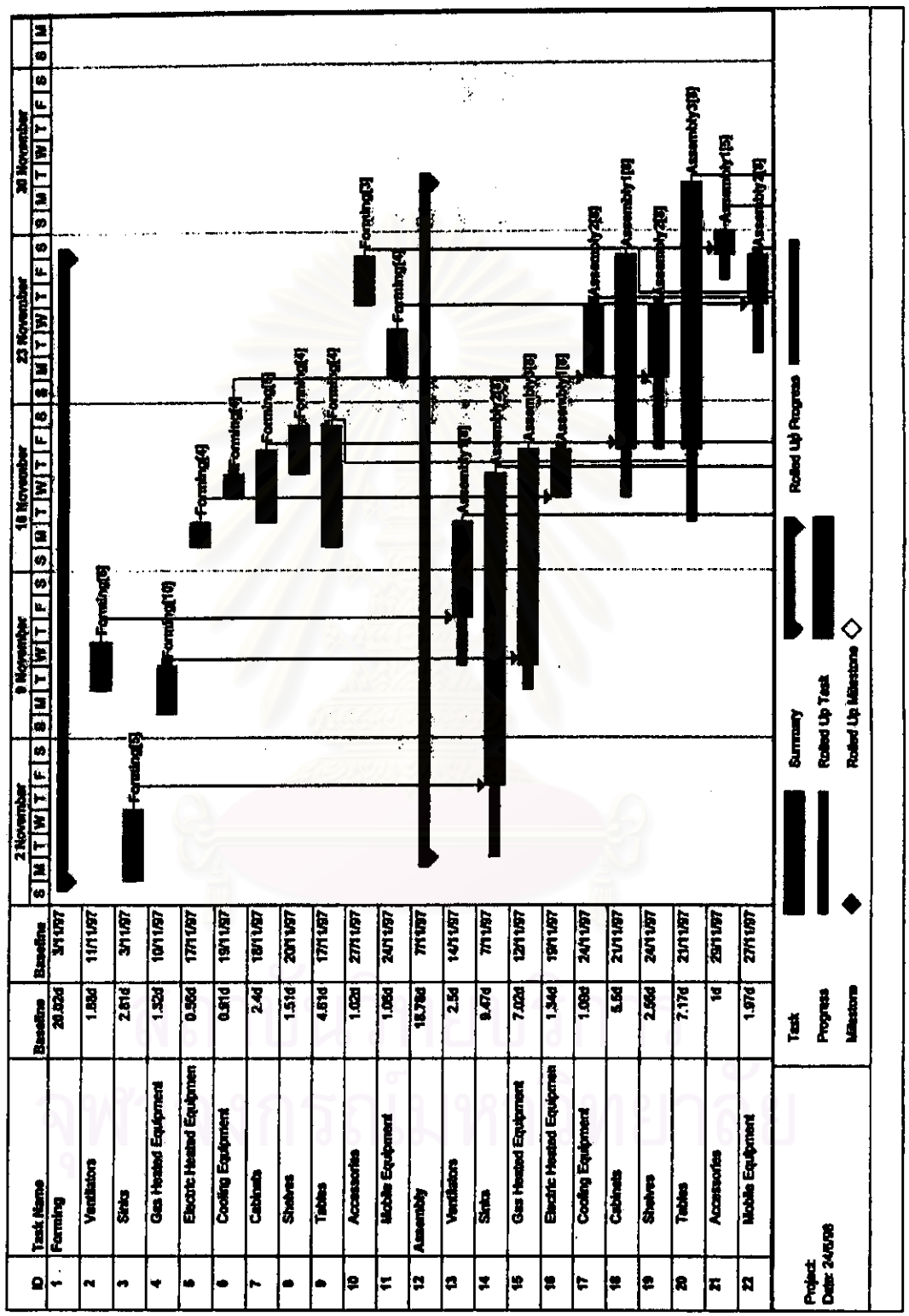

Figure 4.22: Production Tracking Chart

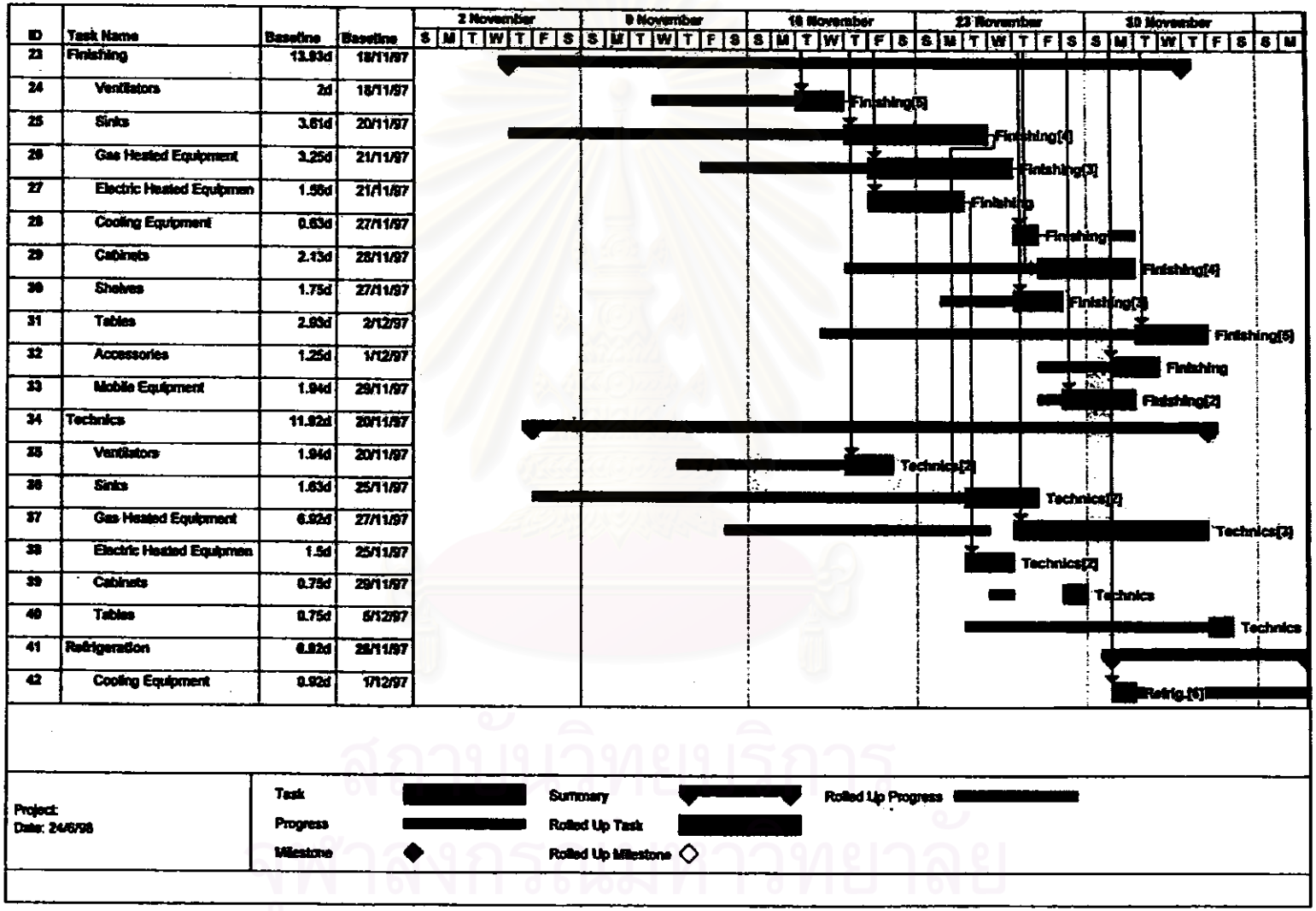

Figure 4.22: Production Tracking Chart (Continued)

2) Production Cost Control

In order to monitor the production cost of the project, raw data on the consumption of resources must be accurately gathered. The cost of each product, broken down into 3 distinct cost elements; DM, DL, and FOH, can be obtained from the following calculations:

DM -- The total actual cost of direct materials of each equipment is the summation of all costs incurred by the materials as listed in the "Requisition from Stock" form, because this is the actual amount of materials taken from the inventory. For Standard Equipment, this basically has the same content as the BoM of the equipment. However, for Non-Standard (or Customised) Equipment, some changes to the BoM might be needed, especially in the more technically involved equipment, and hence, the content of the two could be slightly different. A sample of the "Requisition from Stock" form can be seen in Figure 4.23.

DL -- The actual amount of direct labour cost involve in the manufacturing of the equipment can be calculated from the number of man-hours actually consumed, as recorded in the "Production Daily Report" form (such as the one in Figure 4.24). The amount of man-hours used by each department during the production are multiplied by the DLH rates of corresponding department to obtain the direct labour cost of each department. When summed together, this would yield the total amount of direct labour cost of the equipment.

FOH -- The actual variable overhead costs of each equipment can be obtained by the summation of the costs due to the consumption of miscellaneous parts, and electricity. While the former

can be calculated from the "Miscellaneous Consumables Request" form (Figure 4.25), the latter can be computed from the monthly electric bill.

Requisition From Stock

ID: 7-08-5023 Section: Assembly Ref.No.: 7-08-5023-5 Issued: 12/11/97

Job No.: P-136/97 Customer Name: MP Hotel Received:

ITEM NO.: MK-08 QTY: 1 Total Qty.: 1

DESCRIPTION: Work Table Size: 0.70 * 1.50 * (0.85 + 0.15)

Part ID	Part Name	Unit	Qty.
P-16-10-100-5	SS. Footing 1 1/2" (2")	ea.	4.0
P-16-11-100-5	SS. Gusset	ea.	4.0
R311120005	SS. Tube Ø 1.1/2" x 6 m. Thk. 1.2 mm (Polished)	m.	3.5

Approved By: Store Keeper: Received By:

Date: Date: Date:

Figure 4.23: Sample of Requisition From Stock Form

Professional Food Equipment, Ltd.

Production Daily Report

Section Assembly Date 26 / 11 / 97

Order ID	Job No.	Item No.	Description	Qty.	Labour-Hrs.	
					R.T.	O.T.
7-08-5030	P135/97	MK-17R	2-Door Refrigerated Base (180)	1	33.5	0
7-08-5034	P135/97	MK-24	SS.Filler Top (050)	1	2	0
7-08-5086	P135/97	MK-98	Mobile Table (180)			
			Soiled Dish Table W/Pre-Rinse&	2	18	0
7-08-5100	P135/97	MK-120	2-Poly Bin Size:3.00*3.10	1	84	0
7-08-5129	P135/97	MK-161	SS.Filler Top Size:0.60*(0.04+0.25)	1	2	0
7-08-5130	P135/97	MK-162	Tray Slide Size:0.35*2.70	1	5.25	0
7-08-5175	P135/97	SA-48	Clean Dish Table W/Rack Shelf (150)	1	17	0

Foreman | Supervisor | Department Manager

Figure 4.24: Production Daily Report Form

Miscellaneous Consumables Request Form

Job No.: P-135/97 Item No.: MK-03 Date: 20/11/97

No.	Description	Part No.	Qty.	Remark
1	Sand Disc: No.100...Ø..5".....	U41020005	13	
2	Sand Paper: No.....			
3	Welding Rod			
4	Grinding Wheel: No....4".....	U44001020	2	
5	Saw Blade 1/2" x 12" 24 teeth	U51005020	2	
6	Drill Bit: No.....			
7	Gloves			
8	Sanding Knob	U44001005	3	
9				
10				

Approved By Received By

Figure 4.25: Miscellaneous Consumables Request form

As the production of the locally made items is one of the two most important tasks in a kitchen project, the constant monitoring and control of the manufacturing costs of these equipment is, in itself, the monitoring and control of the project costs. In order to do so, the costs of these equipment are summarised using the Earned Value Analysis technique. Table 4.12 shows the values of "Budgeted Cost of Work Performed" (BCWP), "Actual Cost of Work Performed" (ACWP), the Cost Variances, and the "Cost Performance Index" (CPI) of the MP Hotel project. The two former values are plotted against each other on a graph as shown in Figure 4.26 for easy visualisation.

As of Date	BCWP	ACWP	Cost Variance	CPI
1/11/97	0.00	0.00	0.00	- -
15/11/97	334,856.74	302,799.56	32,057.18	1.11
1/12/97	917,967.36	807,809.52	110,157.84	1.14
15/12/97	965,735.36	854,540.26	111,195.10	1.13

Table 4.12: The Production Cost of Equipment.

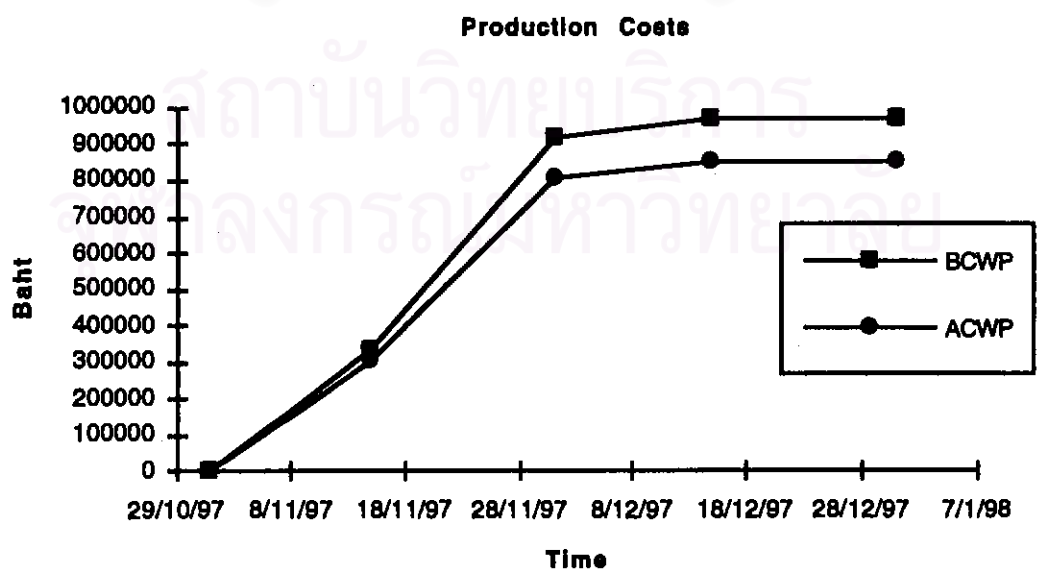

Figure 4.26: The Production Costs of Equipment VS Time

4.4.2 Installation

1) Installation Schedule Control

Unlike the production works in the factory, the installation activities are under direct supervision from the Project Manager and his team, and therefore, can be more directly controlled. In monitoring and controlling of the installation schedule, the "Installation Daily Report" form, as previously shown in Figure 4.16, is used to record the installation data, which in turn, can be summarised and translated into a gantt chart showing the performance of the work with respect to the plan. Figure 4.27 shows the performance of the installation and test-run activities of the MP Hotel project.

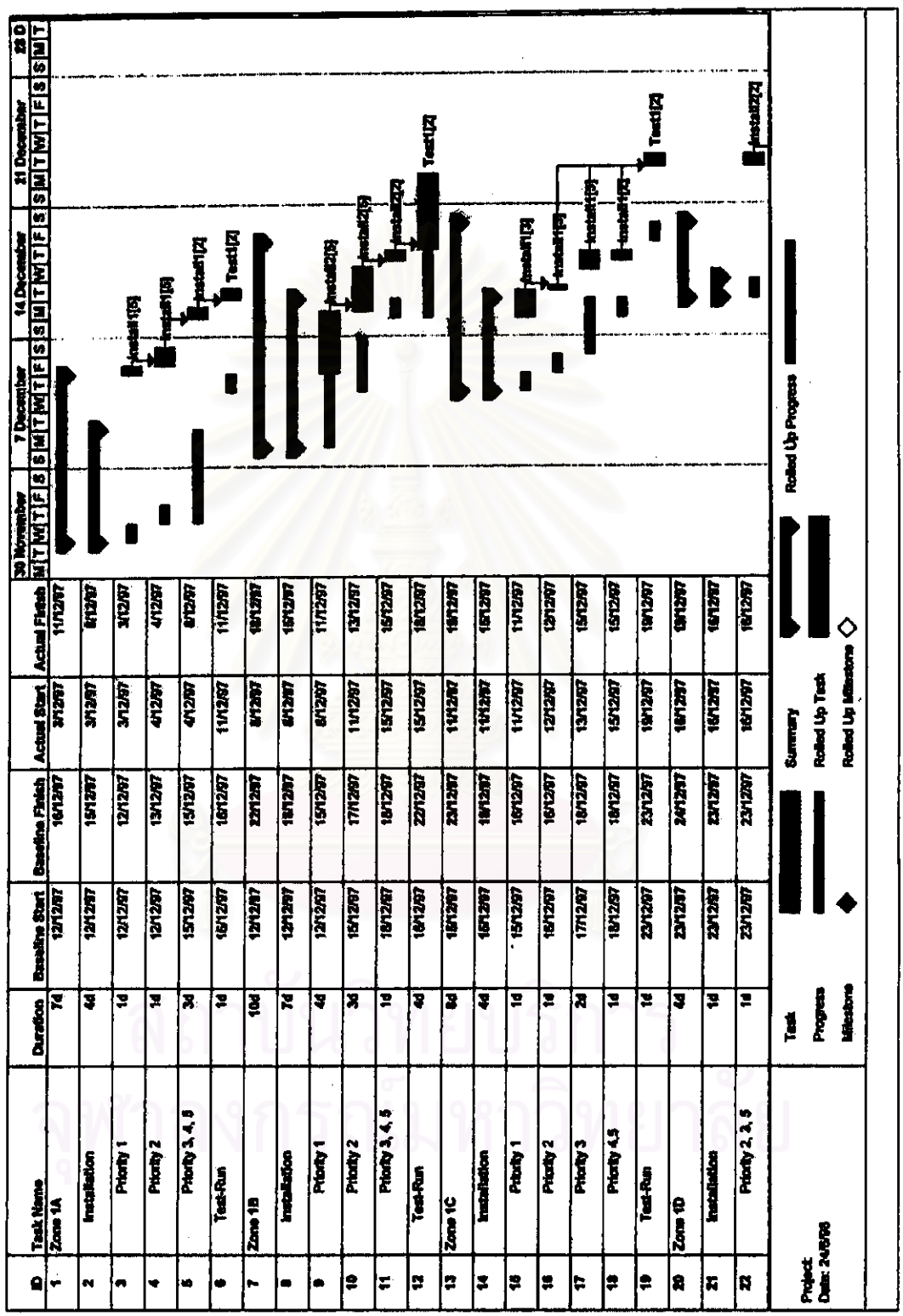

Figure 4.27: Installation Tracking Chart

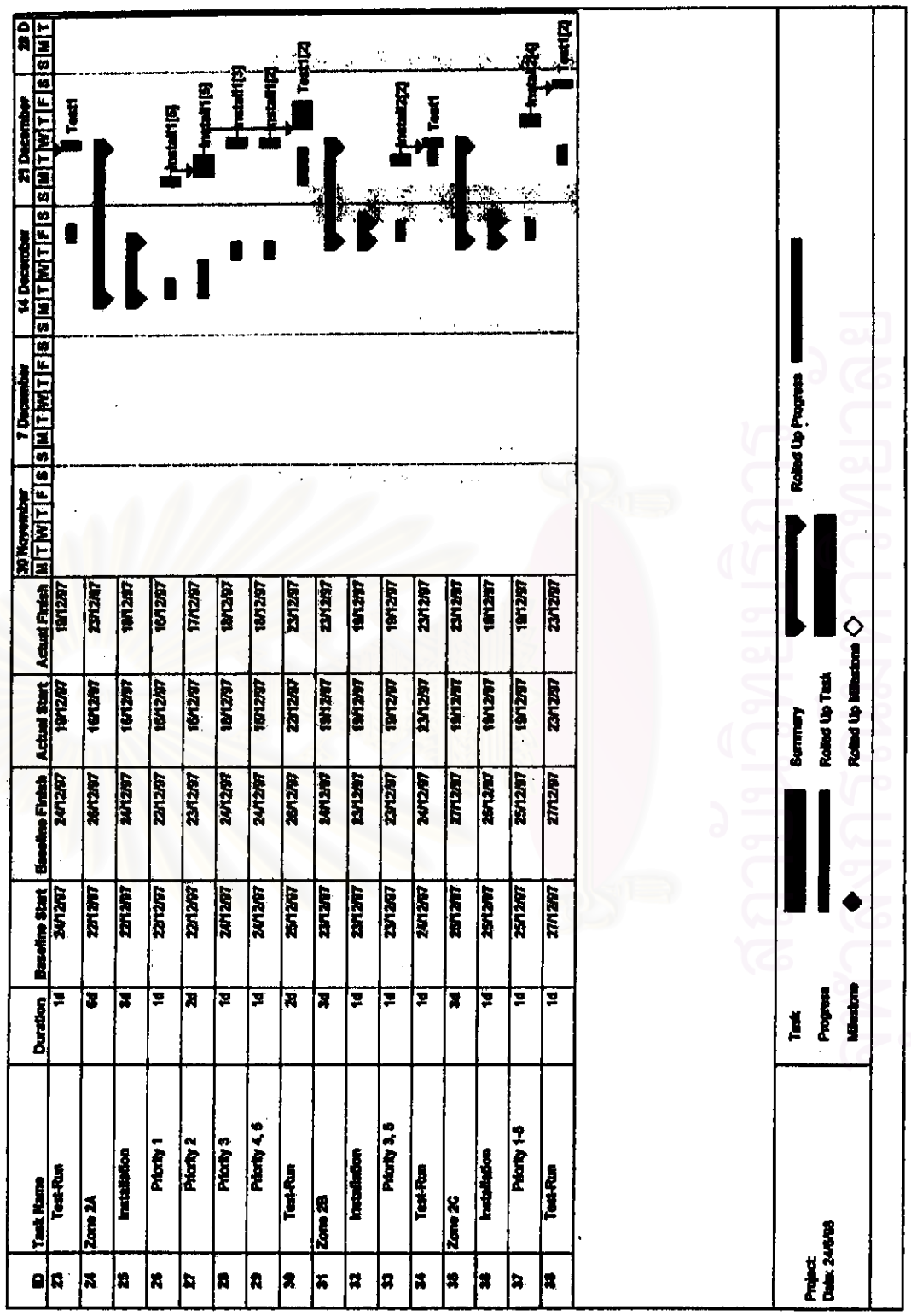

Figure 4.27: Installation Tracking Chart (Continued)

2) Installation Cost Control

As for the cost control aspect of the installation activities, the variance analysis technique, as used during the production stage, could also be implemented here to determine the cost performance of the Installation Department. Similar to the above, the cost elements of the installation work are calculated in the following manner:

DM -- The actual cost of direct materials of each equipment is calculated from their usage as recorded by the "Installation Materials Request" form previously shown in Figure 4.16.

DL -- The actual cost of direct labour is calculated by multiplying the number of man-hour used by the DLH rate of the Installation Department in that particular month of activity.

Since all the materials used for installation of foodservice equipment are taken as the direct materials, the rest of the Installation Department overhead costs, such as electricity costs, petrol costs, and per diem, do not vary according to the project activities. Hence, they can not be calculated as a function of direct labour-hours consumption. Also, because the installation team work at the Job Site most of the time, the electrical consumption for this department is rather low. Since the variable overheads of the installation work represent a very small portion of product cost and are typically shared among many other works in the department, it becomes very tedious to try to allocate them to specific job, and therefore, they are not included in the cost of equipment at this stage.

The cost of installation activities of the MP Hotel, which consist of direct materials and direct labour, are compared to their respective estimated values using the Earned Value Analysis technique, and the results are shown in Table 4.13. These figures are then plotted for comparison in Figure 4.28.

As of Date	BCWP	ACWP	Cost Variance	CPI
1/12/97	0.00	0.00	0.00	- -
8/12/97	10,508.20	9,984.17	524.03	1.05
15/12/97	33,673.09	31,327.52	2,345.57	1.07
22/12/97	50,699.02	46,476.66	4,222.36	1.09
29/12/97	51,510.37	46,855.88	4,654.49	1.10

Table 4.13: The Installation Cost of Equipment.

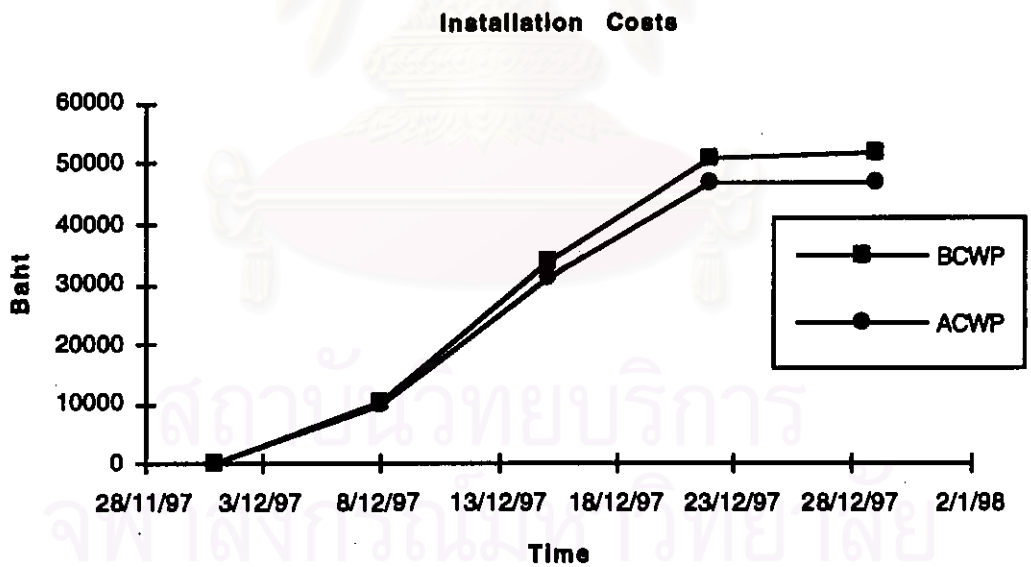

Figure 4.28: The Project Installation Costs VS Time

With information on the production costs, as well as installation costs worked out, the project cost itself could be derived by adding these two costs together. In this connection, the costs of the MP Hotel project are tabulated in the Table 4.14 below. The estimated costs and the actual costs are also plotted for comparison in Figure 4.29.

As of Date	BCWP	ACWP	Cost Variance	CPI
1/10/97	1,225,481.39	1,225,481.39	0.00	- -
15/10/97	1,355,581.39	1,376,161.42	-20,580.03	0.99
1/11/97	1,384,304.34	1,406,859.68	-22,555.34	0.98
15/11/97	2,075,061.08	2,165,640.32	-90,579.24	0.96
1/12/97	2,667,381.70	2,679,730.77	-12,349.07	1.00
15/12/97	2,748,822.79	2,757,789.03	-8,966.24	1.00
31/12/97	2,766,660.07	2,773,317.39	-6,657.32	1.00

Table 4.14: The Costs of MP Hotel Project Compared.

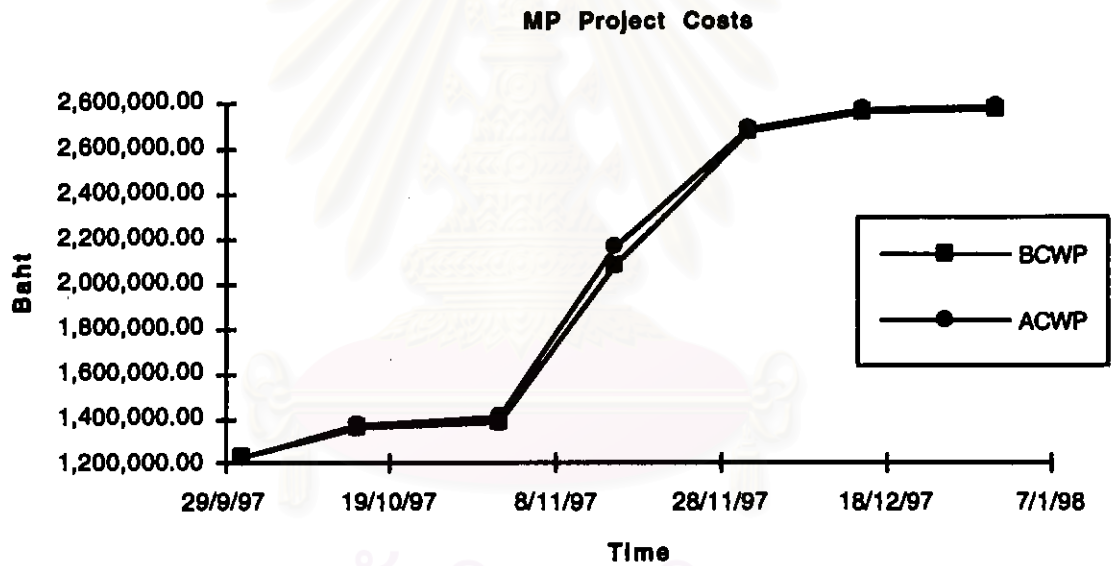

Figure 4.29: The Project Costs VS Time

Besides the coordination with PPC on the production schedule and resources used, the PM must also make sure that correct equipment are dispatched to the job site, and there will not be shortages of equipment and/or parts as a result of errors in logistics or quality problems. Hence, a close cooperation with the Dispatch Section and Quality Assurance Department are also required of the Project Manager.

4.5 Project Management Information System (PMIS)

The handling of project tasks, from the cost estimation stage all the way to the planning, monitoring, and controlling of installation and production works, so that they stay within the set schedule and budgets, do involve with a large amount of data which requires many cross referencing and calculations. Often times, these tasks have to be carried out repeatedly and regularly in order to produce meaningful reports for efficient management of the project. Since great processing power is required for fast and accurate ways to handle such data, a computerised database system was constructed, using "FileMaker Pro 3.0" programme, to serve as a project management information system (see Appendix O for more details). The main functions of the system are:

1) Project Cost Estimation

The Project Cost Estimation system consist of 2 main parts, i.e. the project data processing module, and the supporting databases.

1.1 The project data processing module has only one part to it, namely, the "*Equipment Records*" database. It is used to call relevant data from other supporting databases, process them, and, among other functions, issue the estimated cost of the production for the project.

1.2 The supporting databases are those that supply product related information, such as unit cost of material, labour requirement, etc., to the *Equipment Records* module for data processing, and summary. There are altogether 9 supporting databases, and their functions are described below.

i) Standard BoM - Used to store data on the Bill of Materials of the Standard Equipment that are frequently manufactured by the company.

ii) Standard Time - Stores information on the average time it takes to produce a Standard Equipment at each production stage (Forming, Assembly, Finishing, Technics, and Refrigeration).

iii) Customised BoM - This database stores information on the Bill of Materials which are estimated to be needed for each custom-made equipment in the project. Each BoM can be derived in two way, namely, by using the BoM of similar Standard Equipment as a template, and modify from then on, or completely worked out of the material requirement by the Engineering Department.

iv) Non-Standard Product -- DLH - The production time estimated for the custom-made equipment at each production stages are stored in this database. Similar to the Customised BoMs, the direct labour-hour required for each equipment can be worked out in two ways. First, for the custom-made product which differs from any one of the Standard Equipment only in the physical sizes, and some options, the direct labours requirement are based on those of the similar standard product. However, some appropriate modifications to the DLH requirement must be made to incorporate the differences between them. For the totally custom-made product which is not similar to any known standard equipment, the Production Department would have to estimate the time required to fabricate it.

v) Buy and Import Estimate - stores the unit costs of the equipment in the project which will have to be bought locally, and/or imported from abroad. For items to be bought locally, the prices come from the quotations obtained from the suppliers. In case of imported equipment, the landed costs are given by the Purchase Department basing on the CIF Bangkok prices, as quoted by the overseas suppliers, plus import duties, and other charges.

vi) Parts Inventory - This database stores all the manufacturing parts together with their prices. It serves as an information database for the calculation of the product costs when the material requirements are known. As defined in this database; the "Estimated Prices" are the prices which were obtained from the suppliers, and are used to estimate the cost of equipment in a project. On the other hand, the "Stock Prices" are calculated from the actual costs of parts as received by the store, using moving average method. The summation of the costs of the manufacturing parts of each equipment determines the product actual price.

vii) Finished Goods Inventory - stores the name and prices of all finished goods kept in stock, including locally purchased items, imported equipment, as well as some standard equipment manufactured to stock. The equipment prices given here are used in the cost estimation of the items which are to be sold from the stock.

viii) Installation Requirements - Used by the estimator to calculate the costs of materials and labour requirement for the installation work of the project. This database will also issue a summary on the installation cost, which can be combined with the

earlier production cost summary to form the total estimated cost of the project.

ix) Resources Info - This database provides information on the number of labour hour consumed in each month, as well as the monthly wages paid to each production section. The DLH rates established in this database are multiplied to appropriate number of direct labour consumption in the *Equipment Records* database to obtain the actual labour costs of each production activities. Also, the two important costs of factory overheads, namely the monthly electric bills, and liquid argon usages, are recorded here. When adding to the costs of miscellaneous consumable items as summarised in the *MiscConsumable Request* database, they can also be used to calculate the actual factory overhead costs of each department.

2) Project Planning, Monitoring and Control System

Besides using the Project Management Information System for the project costs estimation, this computer-based system can also be used to plan, monitor, and control the project in. This system consists of 6 interdependent, but related databases as follows:-

i) Equipment Data Entry - Uses by the management to monitor the overview of the production status of the equipment in the project. It also contains other information on the project, such as the name of the Project Manager, the project due date, and the actual production costs of the equipment and their variances from the estimated values.

ii) Equipment Records - Besides being able to determine the estimated project costs by processing the data retrieved from the supporting databases, this module can also calculate the actual product costs, as well as the variances from their estimated values. This is done during the project implementation phase through the entering of raw data, which were collected on various kind of forms in the shop floor, into this database for processing.

iii) Miscellaneous Consumables - Similar to the *Part Inventory*, the "*Miscellaneous Consumables*" database is used to store information on the consumable materials and parts which will be used in the actual production of equipment.

iv) MiscConsumables Request - This database records the actual usage of the miscellaneous consumable materials and parts of each manufacturing section, in order to determine this portion of actual variable overhead costs of each equipment. Every time when the Production Department issues a "Miscellaneous Consumables Request" form (Figure 4.26), the store keeper would make a record of the request using this database.

v) Requisition from Stock - The actual direct materials consumption of each equipment are recorded using this database. The data is obtained from the "Requisition from Stock" form (Figure 4.24), and are input here for the record.

vi) Buy and Import Estimates - Besides storing the estimated costs of the buy-out and imported equipment, this database is also used to store the actual cost of these equipment. When these

equipment arrive, the store would key-in the actual cost of each equipment, as given by the Purchase Department, into appropriate fields of the database. The information from this database are used by the "*Equipment Records*" database to compare the estimated and the actual prices of these equipment.

Figure 4.30 below shows how these databases are linked together to form the Project Management Information System.

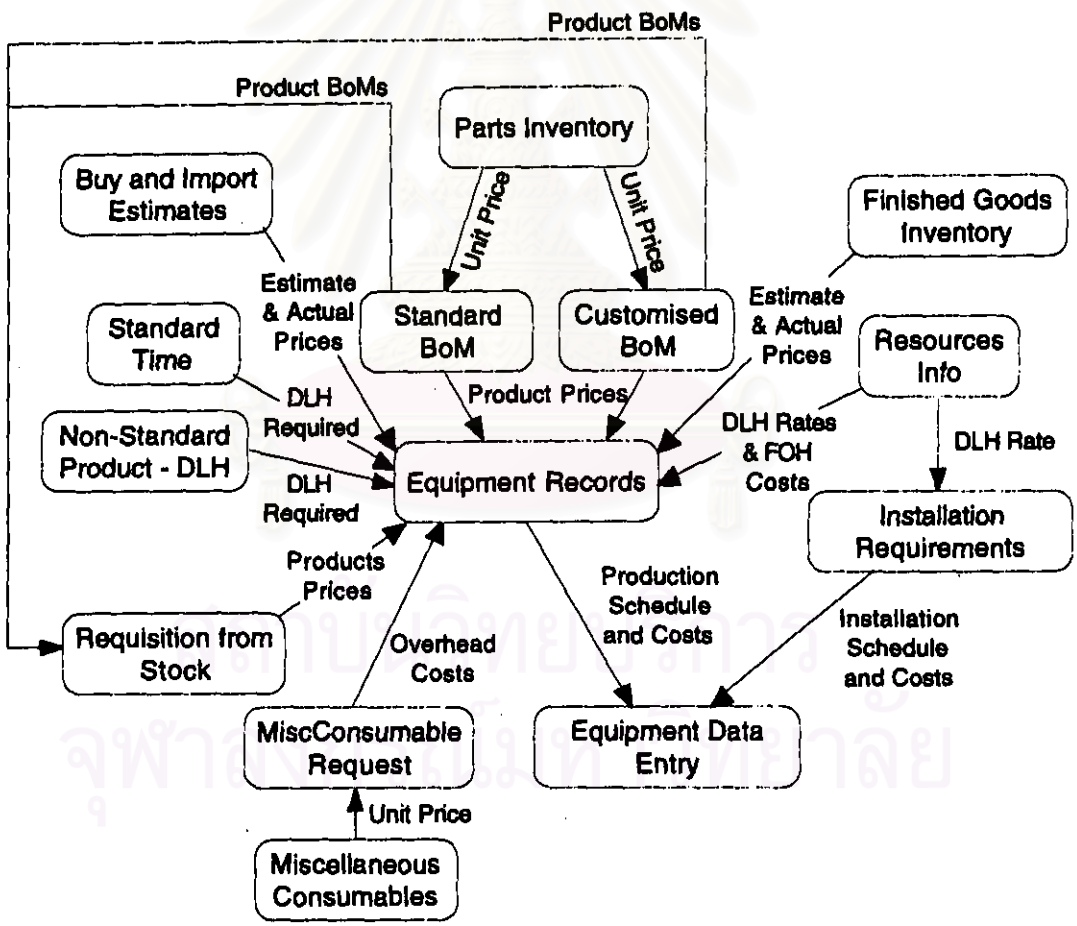

Figure 4.30: Schematic Diagram of the PMIS