

CHAPTER V

WAREHOUSE DESIGN

5.1 Layout planning and physical design

5.1.1 Layout planning and physical design

The layout is planned base on maximum SKU to be store in the warehouse. To design the warehouse, the existing warehouse is separated into 3 zones by the types of part operation, pull card, internal sequencing and call for material tool part. Therefore the physical design for each zone is described below.

5.1.1.1 Zone 1 - Pull card zone

The existing design of pull card zone storage is flow rack. Because of the packaging characteristic of this part is box and the weight is not higher than 15 kg. In this case, the existing design of flow rack is suitable so, only add the number of flow racks to support the material proliferation instead of the inspection area which is removed. And other functions are used in the existing design such as top shelf and name plates.

The existing mobile equipment which is used in this area is reach trucks and they require the aisle width to be at least 2.5 m.

The detail of this pull card zone design is below.

- 1) 3 Layers rack design to increase efficiency in presenting parts for storing and picking. Flow Rack systems are adjustable and flexible in the warehouse.
- 2) Top shelves are installing on the top of the flow rack's top shelf to store material with the guards and wire net to protect against

the material falling. In case there are no top shelves on existing flow racks, new installations are required.

- 3) Plastic name plates in proper design are required for the front of every flow rack beds.
- 4) ABC Company requested rack's color in blue to match with the current racks.

For the inspection area which empty in the existing layout is applied for zone 1 store area and install flow rack to serve the pull card part in this area.

5.1.1.2 Zone 2 - Internal sequencing zone

The existing pattern for internal sequencing part is floor storage. All materials are placed on the floor to support the picking process. So, the existing condition is lack of utilization in the overhead area.

After analyzing the racking system, the design of multi-propose high rack is designed with 3 alternatives supporting the warehouse condition in this zone and they can be combined together. The result is the high rack with free roller, in order to support the operation of picking process on the first floor and in the second floor is the regular type of high rack. The depth of high rack could not be the same for all because warehouse columns may obstruct so, the depth are both double and triple deep depending on the warehouse grid. Therefore, terms of rack design are type A and type B, indicating double deep and triple deep, respectively. In this case, single deep high rack leads to a loss of space due to it requiring many aisle ways.

The operation in this area required fork lift for supplying material in pallet. Single and double deep racks with free roller are applied into this area in a suitable design for this warehouse blueprint.

The roller or pallet flow:

- Loading modules related to design and proper slope and double deep reach truck can operate in that area. Adjustable and provide for 2 sets of roller-track per one bay (one bay or beam length is 2.8 m.).
- Support the flow products and the materials to be handled pallets and containers on the pallet which pallet load range between 200 to 500 kg.
- Including safety equipments which are breaks, safety separators, guided and speed controllers.

Figure 5.1 and 5.2 show Rack design-type A for zone 2 and Rack design-type B for zone 2, respectively.

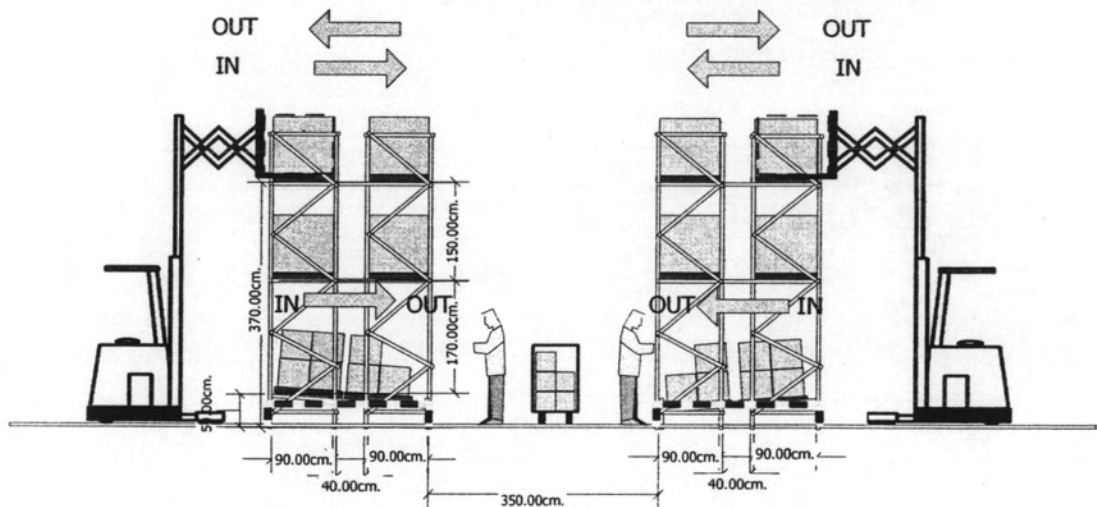


Figure 5.1: Rack design-type A for zone 2

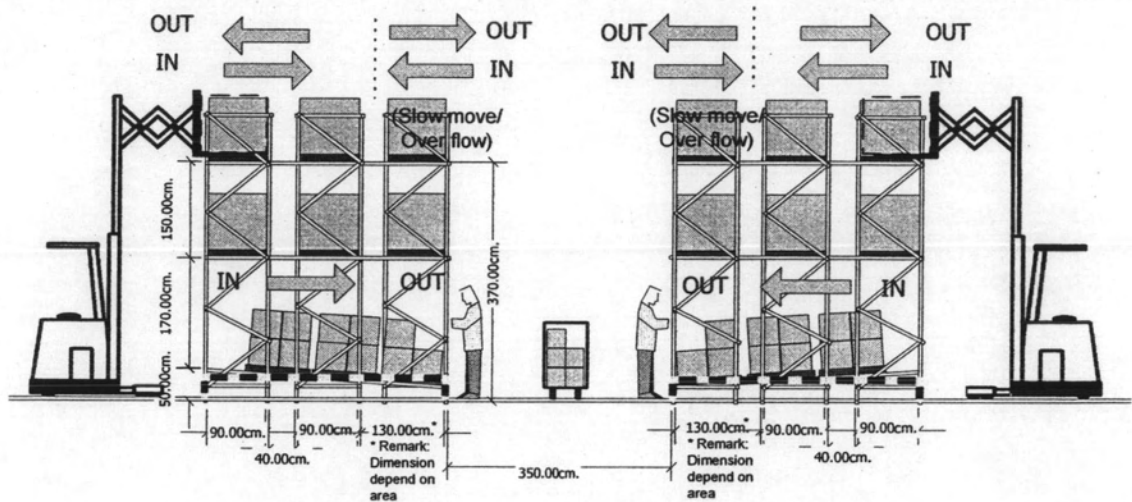


Figure 5.2: Rack design-type B for zone 2

5.1.1.3 Zone 3 - Call for material tool zone

New installation of additional rack and relocation of existing racks are the operations assigned. For Zone 3, only high racks without rollers are desired to install and relocate the current racks for optimizing the layout.

High rack:

- Double C beam with adjustable length related to design (current beam length is 2.8 m.). The maximum load capacity information is required to display in the front of every beams.
- Upright height profiles support the levels height depending on the design 3 levels.
- Diagonal braces and horizontal braces are adjustable. Recommendation color is blue.
- Front-to-back pallet support (cross beam) provide for 6 pieces per bed on every upright positions.
- Spacer beam to brace rack-to-rack are required (4 pieces per bed and on every upright positions).
- Load Capacity (kg.) = 2,000 kg. (2 tons) per level.

- Plastic name plates in proper design are required 2 plates per bed in every high rack beams.

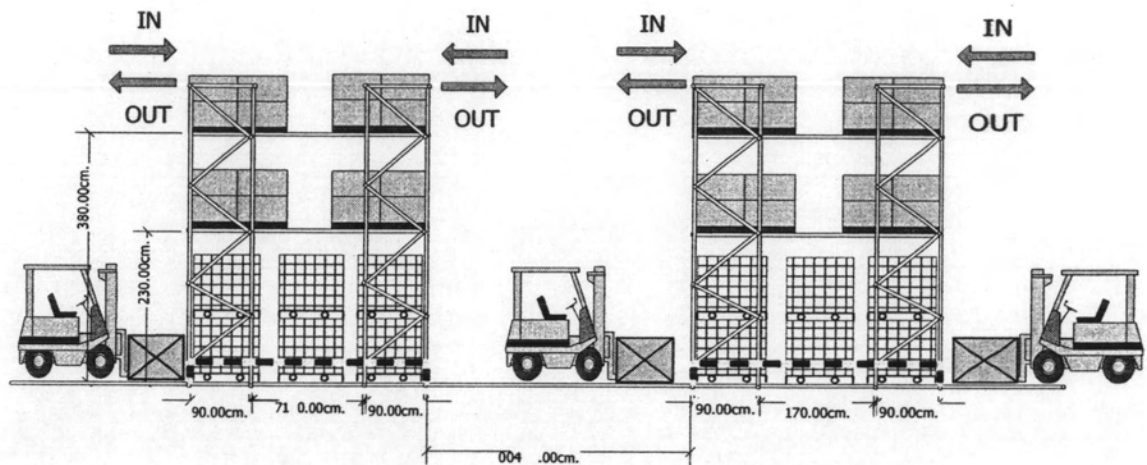


Figure 5.3: Rack design for zone 3

In summarize the physical design for these 3 zones are following.

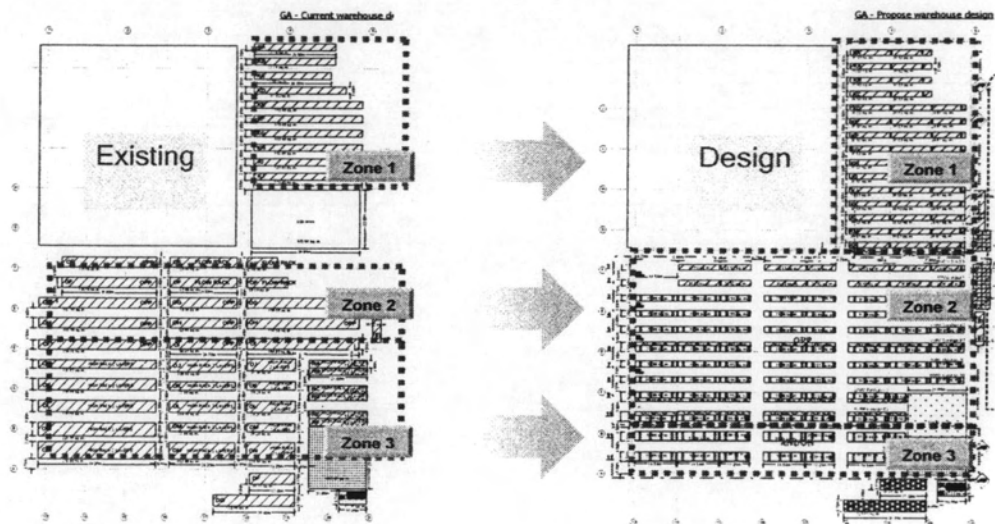
- Zone 1 : Flow rack (FIFO rack) with top self
- Zone 2 : 2+1 layers High rack with free roller (Selective flow rack)
- Zone 3 : 2+1 layers High rack

In the triple bays rack of internal sequencing part – zone2, the front row of material out in the 2nd and the 3rd floor of rack are designed to utilize the air space and invest in one package. This slow moving zone is totally 324 sq.m. (or 270 pallets for standard pallet 1x1.2 m.). By the way, this zone is reserved for slow moving parts and over flow area which have to control traffic when using the reach truck. The traffic system for fork lift and reach truck shall be declared by visual sign or system to block the picking operation when using the trucks. The overall layout is shown in **Figure 5.4:** Layout design.

Table 5.1: Warehouse available area from design warehouse

Operation	Existing warehouse		Designed warehouse		Number of changing	
	Rack Q'ty (Pallet/bay)	Available (sq.m.)	Rack Q'ty (Pallet/Bay)	Available (Sq.m.)	Rack Q'ty (Pallet/Bay)	Available (Sq.m.)
Zone 1	189 Bay	937.56	275 Bay	981.75	+86 Bay	+44.19
Zone 2	442 Pallet 42 Bay	1,580.04	3,759 Pallet 97 Bay	4,857.09	+3,317 Pallet +55 Bay	+3,277.05
Zone 3	904 Pallet	2,299.86	790 Pallet	1,692.10	-114 Pallet	-607.76
TOTAL	1,346 Pallet 231 Bay	4,817.46	4,549 Pallet 372 Bay	7,530.94	+3,203 Pallet +141 Bay	+2,713.48

The comparison of the existing warehouse and design warehouse is shown in **Figure 5.5: Design layout comparison**, zone arrangement style is similar to the existing one for convenient relocation and material flow out suitable for the production line or usage base.

**Figure 5.5:** Design layout comparison

5.2 Warehouse operation and information flow

The main activity are Unloading/Receiving and inspecting, inspecting and put-away. **Table 5.2** shows the result, **Table 5.2: Data from process steps and element times in design operation**. By use the same existing number of 6 receiving operators.

Table 5.2: Data from process steps and element times in design operation

	Process steps and element times	Time per item (min)	Repetition per shift (x times)	Old Time per step/ action (min)	Time per item (min)	Design Time per step/ action (min)
	Process start point: Truck / Trailer arrived for unloading					
1	Check paperwork on correctness	1.00	24	24.00	1.00	24.00
2	Visual check of trailer, seals, safety	1.00	30	30.00	1.00	30.00
3	Open truck/trailer					
3.1	Open truck	0.00	21	-	0.00	-
3.2	Open trailer	0.00	9	-	0.00	-
4	Unload material and place it to "check off area" for checking Check area could be shop floor, dolly, fork truck, etc.					
4.1	Unload Trailer	15.00	5.25	78.75	15.00	78.75
4.2	Unload Milk run	8.00	11.8125	94.50	8.00	94.50
4.3	Unload Direct Route	8.00	3.9375	31.50	8.00	31.50
5	Check material vs. Documents (Pick-up sheets, delivery note).			-		-
5.1	Box	0.01	2601	30.00	0.003845	10
5.2	Pallet	0.01	2342	30.00	0.004270	10
6	Handle additional labeling	20.00	2	40.00	20.00	40.00
7	Sign/stamp Pick-up sheets/delivery note	1.00	6.67	6.67	1.00	6.67
8	Hand over documents for Booking	10.00	24	240.00	10.00	240.00
9	Separation of mixed pallets, if applicable	45.00	48	2,160.00	45.00	2,160.00
10	Loading empties, if applicable					
10.1	Truck	10.00	20	200.00	10.00	200.00
10.2	Trailer	0.00	0	-	0.00	-
11	Close truck/trailer					
11.1	Close truck	0.00	21	-	0.00	-
11.2	Close trailer	0.00	9	-	0.00	-
12	Update unloading schedule (board)	5.00	21	105.00	5.00	105.00
13	Call next truck/trailer	5.00	24	120.00	5.00	120.00
	Required time for regular Receiving activities per			2,960.42		2,920.42
	Exceptions					
a)	handling of deviations (Mislabeling/wrong content)	20.00	16.67	333.40	20.00	333.40
b)	handling of transport damages/damaged containers	30.00	3	90.00	30.00	90.00
c)	perform quality spot checks	20.00	4.55	91.00	20.00	91.00
d)	perform quantity spot checks	20.00	8.89	177.80	20.00	177.80
e)	dangerous / hazardous material	10.00		-	10.00	-
f)	Report of discrepancies found on labeling, Report different error codes.	10.00	0	-	10.00	-
g)	repack material in original containers	20.00	87.3	1,746.00	20.00	1,746.00
h)	move material to marshalling area	10.00	0	-	10.00	-
	Required time for exceptional Receiving activities			2,438.20		2,438.20
	One time actions					
a)	Battery changes / fuel trucks	5.00	1	5.00	5.00	5.00
b)	Safety Checks	5.00	1	5.00	5.00	5.00
c)	Prepare unloading schedule (effort per shift)	5.00		5.00	5.00	5.00
	Total Receiving process time per shift (min)			5,413.62		5,373.62
	Heads Required to Run			11.37		11.28
	Utilization/efficiency in %			186%		185%
(*)	value pro shift varies excessively and does not give an accurate image of the effort/shift (1 route/shift can be equal to 3 trucks/shift in early and late shift and 1 truck during night shift only)					

From the data in warehouse operation/information flow time consumption and the comparison analysis, information technology could be applied in checking via the barcode on the packaging label which can reduce the checking time. Regarding to the manually operation **Figure 4.1** and from the **Table 4.8** and **Table 5.2**, the process is trialed in terms of using barcode reader. It shows the operation time consumption for check actual number and material documentation from 60 minute to 20 minute so, it effects to the first 3 processes accumulation per day is $24 + 20 + 6.67 = 50.67$ minutes. It does not require data capture, because it automatically updates through the system. Then, the overall processes only 50.67 minutes per day. Therefore, this can increase volume by utilizing the existing resources. The information flow is better 54.22%.

Most of the warehouse operation activity is coming from overseas containers because local truck numbers are lower ratio and loading/unloading operations are done by driver. Therefore, the oversea container is focused. The highest time consuming factor from the time study data is separating the mix pallet into one part no. per pallet and the next one is checking process.

The material sorting or separating in the mix pallet activity depends on the container size and amount of mixing per pallet. Therefore, the assist device could help and support the manual operation by reducing work load and improving ergonomic such as turn tables and belt conveyors.

5.3 Resource planning

Base on the number of workforce and mobile equipments related to production rate so, the number of workforce and mobile equipment could be the same. By the way, the improvement points are introduced by grouping the workforce as material zoning and the part no. per head ratio into 3 zones from the existing is 2 zones (Zone 1 and Zone 2&3). And change the admin members to direct reporting with supervisor, in this case the information for these 3 groups could be collected and supported by admin easily. This shows in **Figure 5.6: Design organization**.

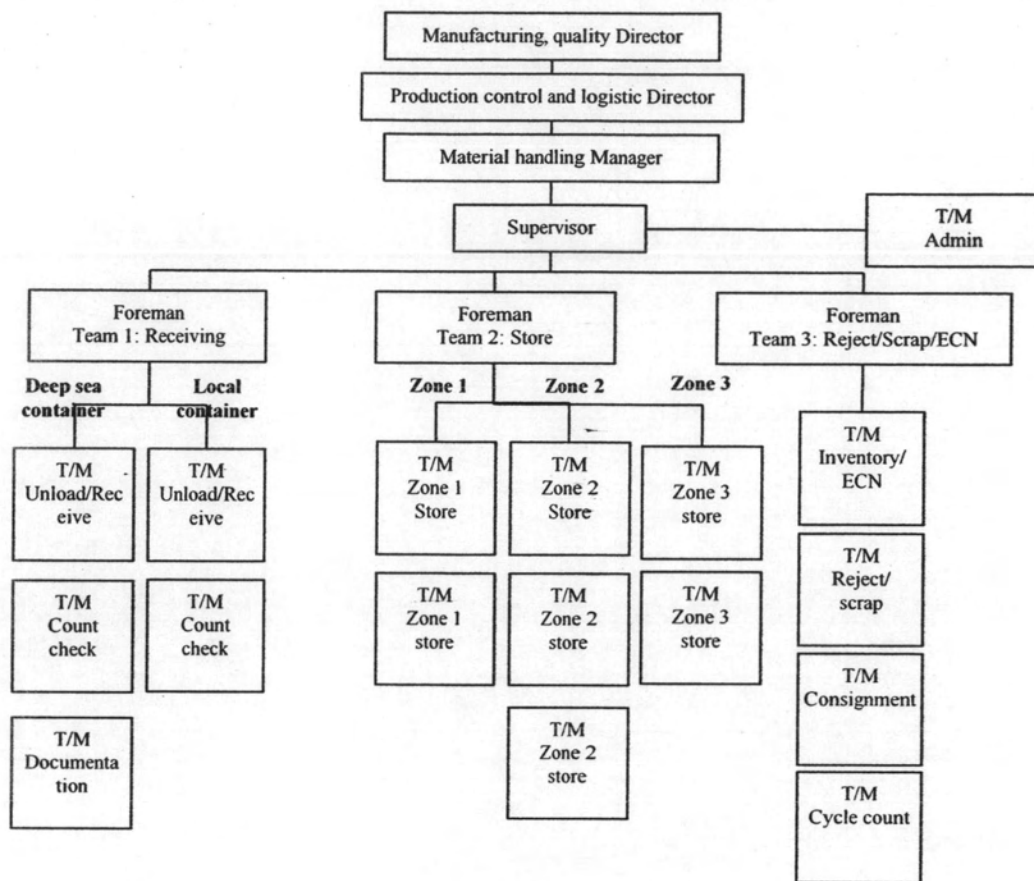


Figure 5.6: Design organization

In term of mobile equipment, due to the change in physical and layout design, the mobile equipment shall support the layout. The effect of changing the layout is in zone 2 which is double deep and triple deep racks, so they requires double deep reach truck to operate. Therefore, the number of the LPG fork lift could be reduced and use double deep reach truck 2 units to use in this zone instead and the total number of mobile equipment is the still the same as shows in **Table 5.3: Design for mobile equipment rental.**

Table 5.3: Design for mobile equipment rental

Description	Amount	Units	Baht/month
LPG Fork Lift Truck 1.5 ton	14,200.00	2.00	28,400.00
Double deep reach Truck 1.5 ton	34,900.00	2.00	69,800.00
LPG Fork Lift Truck 3.0 ton	17,900.00	1.00	17,900.00
Electric Tow Tractor	17,200.00	3.00	51,600.00
Full Electric Pedestrian Pallet Truck	20,800.00	1.00	20,800.00
Total		9.00	188,500.00

5.4 Design result

The result of the warehouse space is shown that the new design is increase storage space by installing the racking system from 4,817.46 sq.m. to 7,530.94 sq.m. which increasing 56.32%. The warehouse operation is improved by an improvement of the information flow of 54.22%. The space utilization for new design is 95.04% with 6,849.72 sq.m. occupied from totally 7,206.94 sq.m. (excludes the reserve for slow move area 324 sq.m. due to it is not in the regular working operation). In **Table 5.4** is the comparison result on the old and new design, **Table 5.4: The old and new design result comparison**. And the changing items of hardware are summarized in **Table 5.5, Table 5.5: Hardware changing summary**. The mobile equipment cost is higher 41,000 Baht per month (old design 147,000 Baht and new design 188,500 Baht) in the same total 9 units since, the cost of double deep reach truck is higher. This number is acceptable in budget request because it worth for racking system, compare with the extra building with more mobiles. Also, it can be exchange the mobile type with supplier with the same total quantity.

The utilization in workforce is close between old and new design since the company plans to utilize the existing workforce. This resource usage still effective, although the number of parts and documents are increased but the operations are supported by applying the information technology, altogether with the racking system supports the working operation by the gravity flow rollers as recommended in new design.

Table 5.4: The old and new design result comparison

Item	Criteria	Old design	New design	Improve
1.Physical layout	Storage space	4,817.46	7,530.94	56.32%
2.Space utilization	Space occupied	91.36%	95.04%	4.03%
3.Information flow	Time consumption	110.67	50.67	54.22%

Table 5.5: Hardware changing summary

Item	Zone	Old design	New design
1. Rack	Zone 1	Flow rack	Flow rack
	Zone 2	Floor space	High rack 2+1 with free roller
	Zone 3	High rack 2+1	High rack 2+1
2. Mobile equipment	Zone 1	Reach truck ,Tow motor	Reach truck ,Tow motor
	Zone 2	Fork lift truck	Double deep reach truck
	Zone 3	Fork lift truck	Fork lift truck

Traffic flow under high rack shall be developed with safe working conditions. Man and mobile equipment should separate in fork lift truck area and visual sign is recommend for both mobile equipment driver and pedestrian.

Safety guard or barrier is very important for protecting the material fall and some accident such double deep rack, because visibility in double deep racks zone may not be clear. So, the guard is useful for protecting. Also a barrier is the tool to protect the post of the rack which is recommended to be installed beside the rack's upright post. All of these are included in racking installation package as they result in safety, good visuals, and morale.