Chapter 4
Supplier Kanban and the Sequence Schedule Used by Suppliers

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CONTENTS

4.1 INFORMATION TO THE SUPPLIER

- Toyota provides two kinds of information to the supplier:

- ***Monthly information*** (monthly production plan)

- ***Daily information***

4.1 INFORMATION TO THE SUPPLIER

- Using a monthly production plan, the supplier will determine
  - Cycle time of each process
  - Standard operations routine (rearrangement of workers)
  - Quantities of parts and materials to be ordered to sub suppliers
  - Number of each kanban for sub suppliers (if any)

4.1 INFORMATION TO THE SUPPLIER

- Daily information: the actual number of units to be supplied

- later replenishment system → kanban
- sequenced withdrawal system → sequence schedule

4.1 INFORMATION TO THE SUPPLIER

❖ Sequenced withdrawal system

- Toyota provides a supplier with the sequence schedule for different parts.

$$A - B - A - C - A - B - A - C - \ldots$$

$$T_A - T_B - T_A - T_C - T_A - T_B - T_A - T_C - \ldots$$

T: transmission

4.2 LATER REPLENISHMENT SYSTEM

- Suppose an example with Toyota and a supplier.

- The parts produced by the supplier are withdrawn by Toyota twice a day:
  - 8 a.m.
  - 10 p.m.

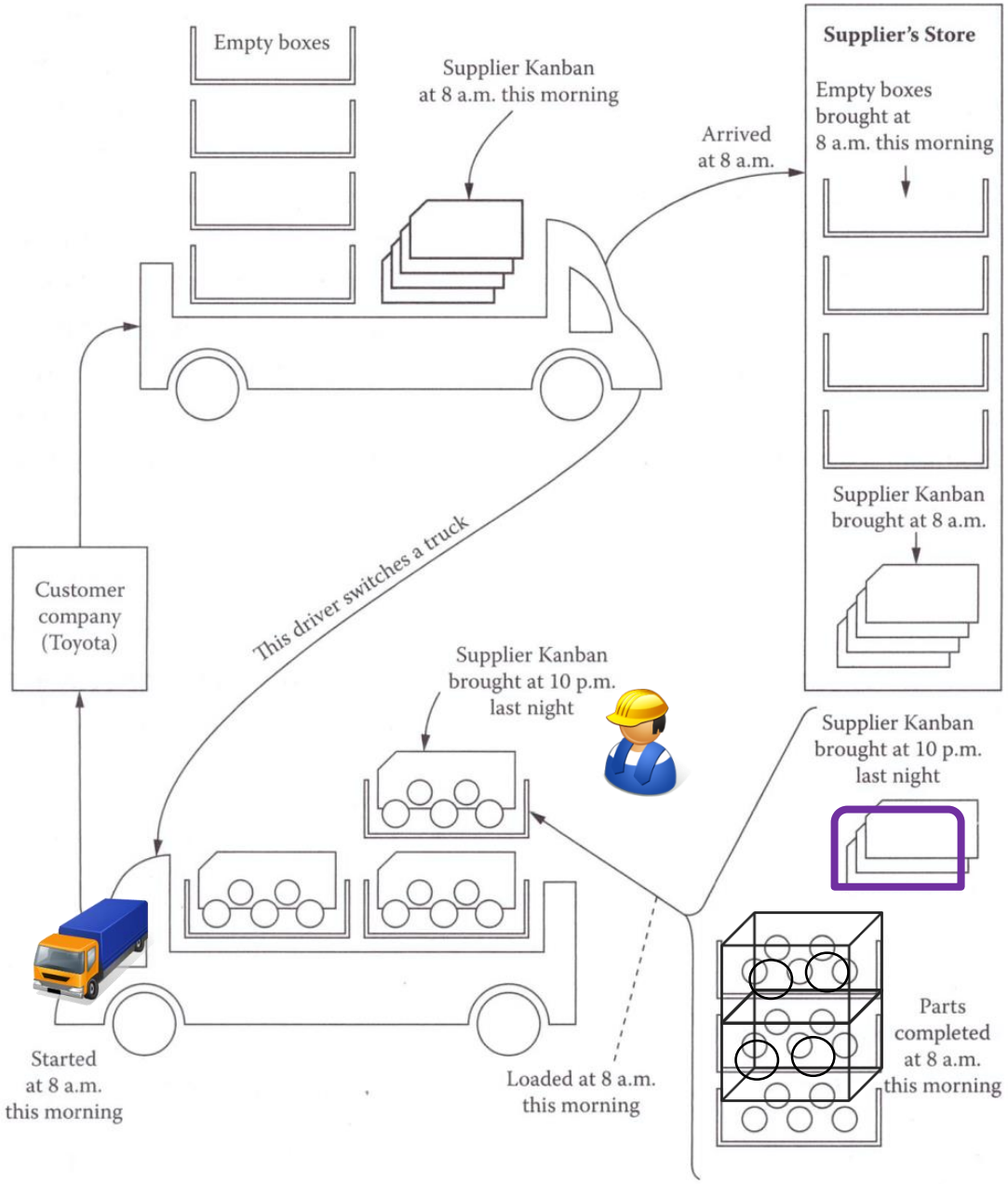


FIGURE 4.1
Flow of supplier kanban.

- 10 p.m. last night

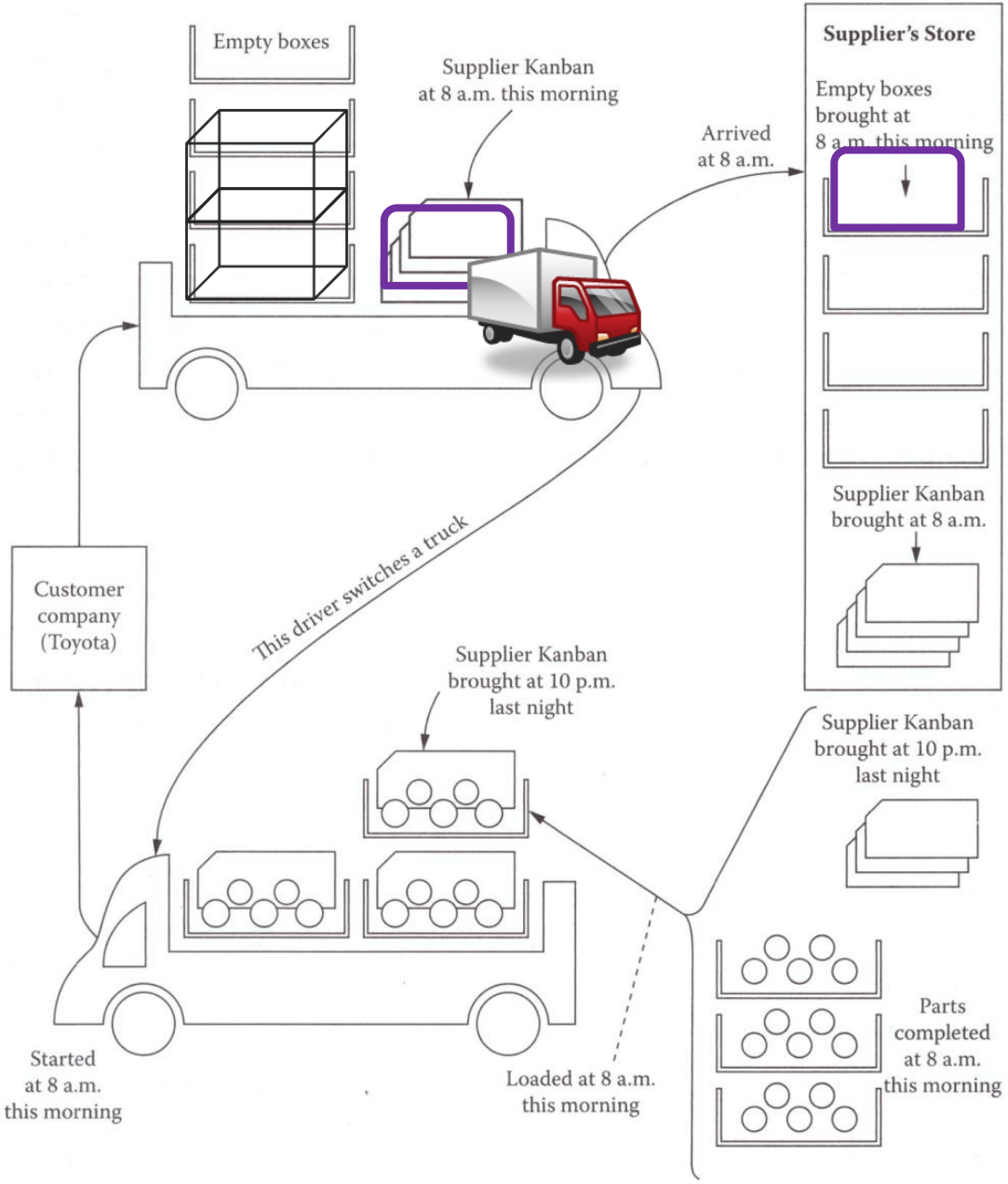


FIGURE 4.1
Flow of supplier kanban.

- at 8 a.m.
- one truck
- empty boxes
- supplier kanban

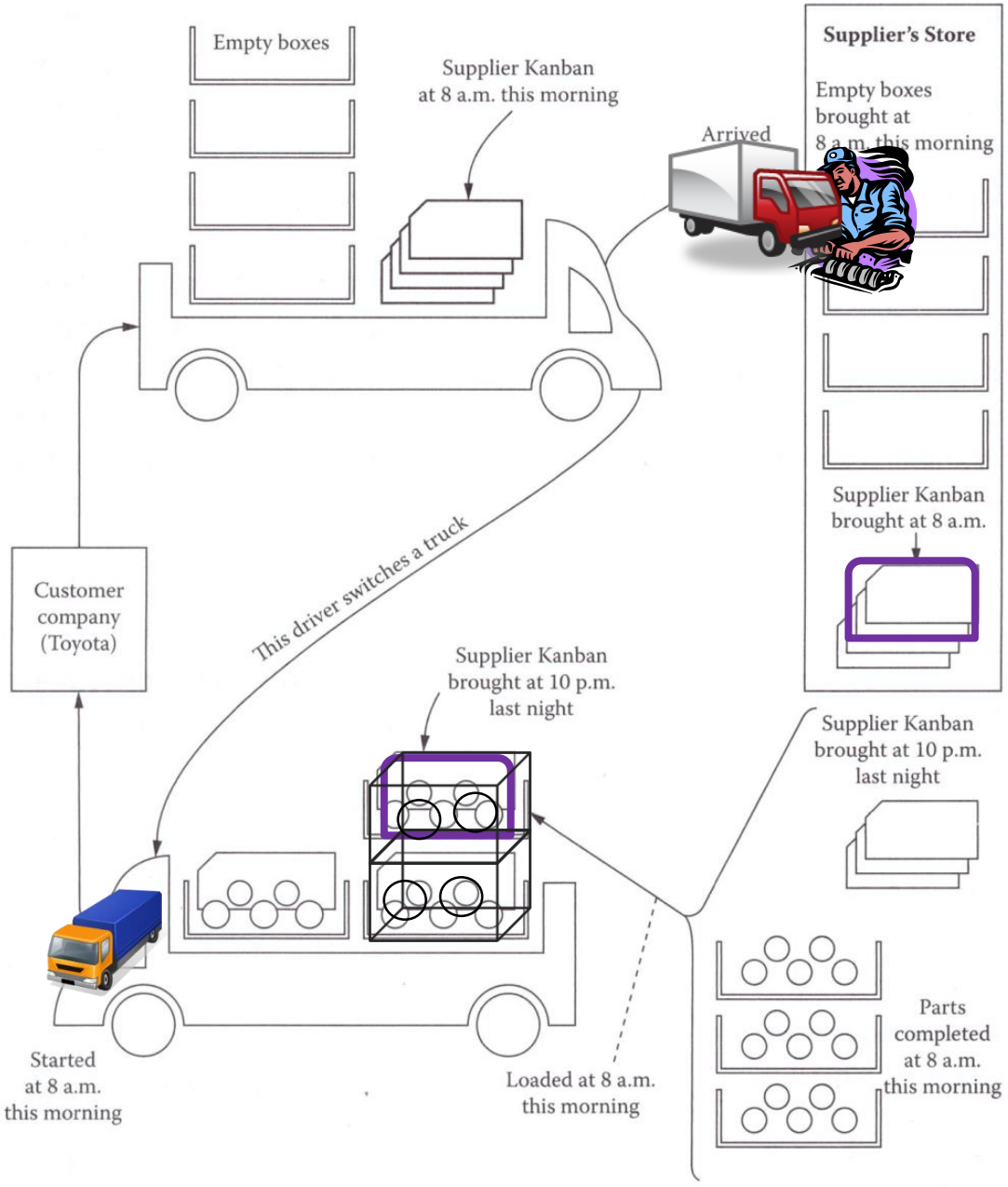


FIGURE 4.1
Flow of supplier kanban.

- at 8 a.m.
- one truck
- empty boxes
- supplier kanban

4.2 LATER REPLENISHMENT SYSTEM

- This system involves three trucks.

- One is on the way.
  -one driver

- One is stationed at Toyota's store for unloading the parts.
  -one worker

- One is stationed at the supplier for loading the parts.
  -one worker

4.2 LATER REPLENISHMENT SYSTEM

- Advantages of this system

- Shorten total lead time
- Decreased cost in the long run
- Reduced inventory

4.2 LATER REPLENISHMENT SYSTEM

- Production-ordering kanban in the supplier

- Kanban brought at 8 a.m.
- Should be finished before 10 p.m.

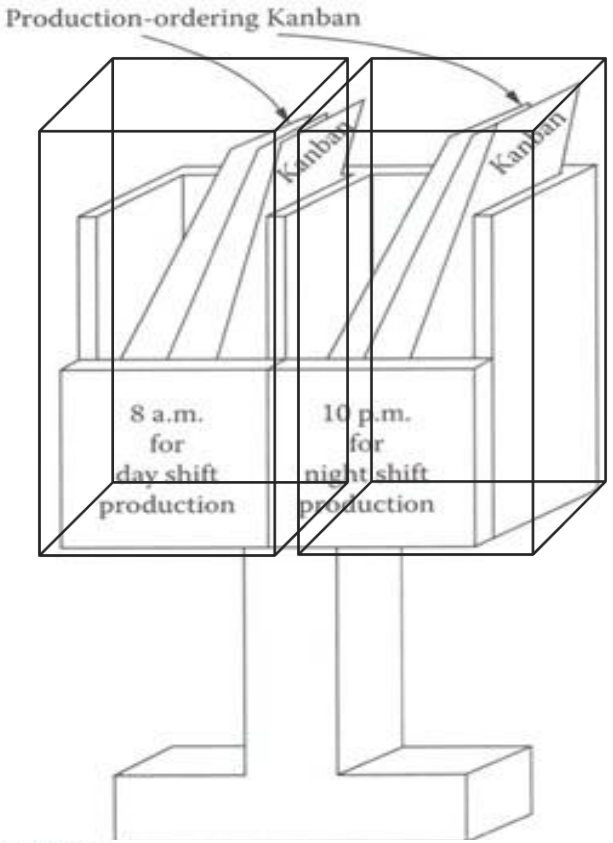


FIGURE 4.2
Production-ordering kanban post (dispatching post).

- Kanban brought at 10 p.m.
- Should be finished before 8 a.m. next morning

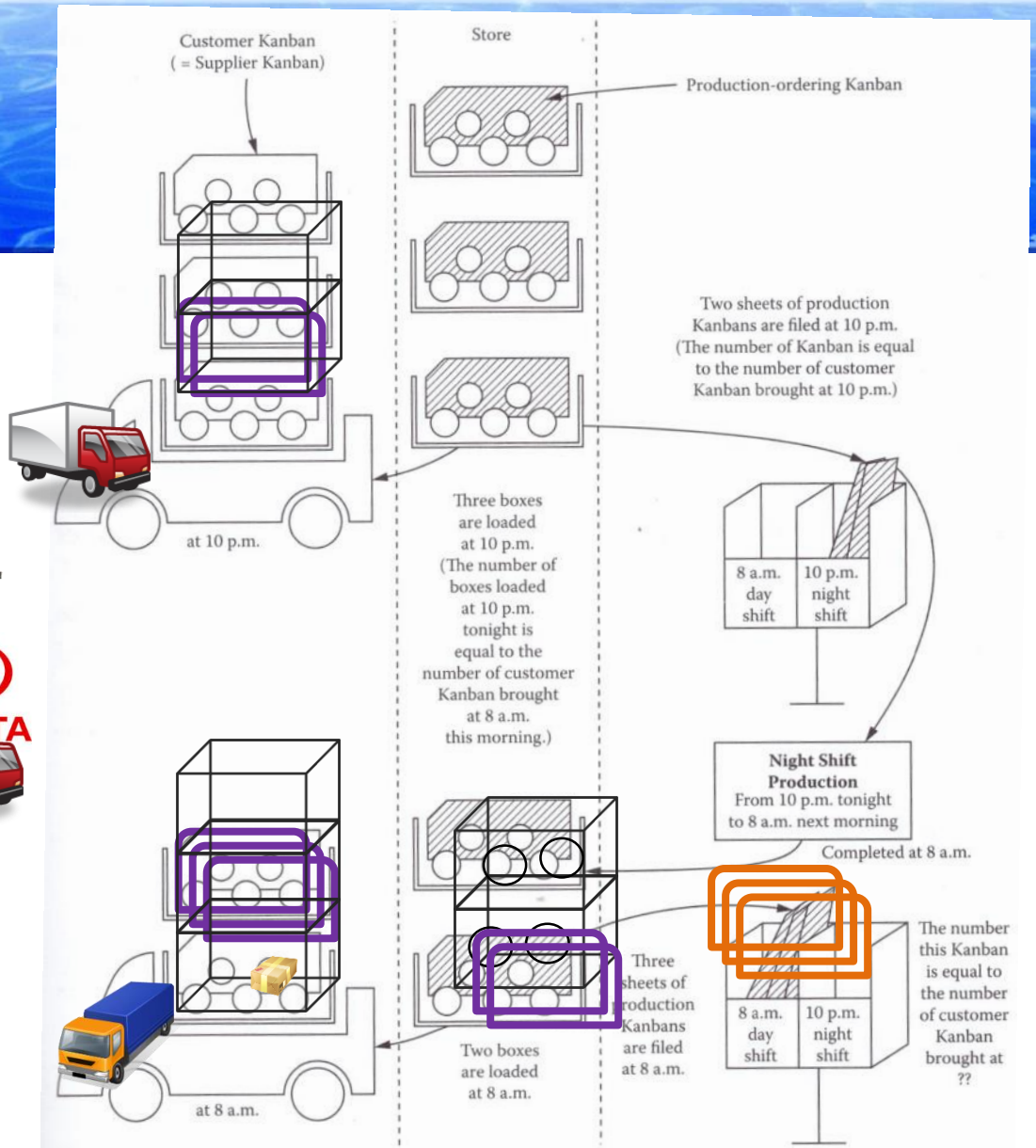
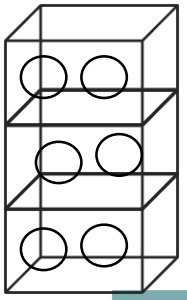
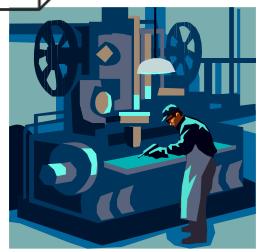


FIGURE 4.3
Flow of customer kanban and in-process kanban.





4.3 SEQUENCED WITHDRAWAL SYSTEM

- Toyota communicates the sequence schedule for various parts to the computer office of the supplier.

- This communication is in a real time manner, based on value-added network (VAN).

- This sequence schedule table is called the unit order table and is sent very hour, four hours before the delivery to Toyota.

4.3 SEQUENCED WITHDRAWAL SYSTEM

- To reduce the inventory level of a store, it is necessary to minimize the store's space size.
  - constant-quantity and inconstant-cycle withdrawal system
  - constant-cycle and inconstant-quantity withdrawal system
- In the JIT production system by kanban, some amount of inventory exists at the store of parts completed by the previous process.

4.3 SEQUENCED WITHDRAWAL SYSTEM

- The supplier faces productions of large variety and short runs.
- The assembly line is divided into two parts, main and sub.
- Storage for half-finished and finished transmissions are installed.

4.3 SEQUENCED WITHDRAWAL SYSTEM

- A label is fastened to ach transmission that sequences the 74 varieties.

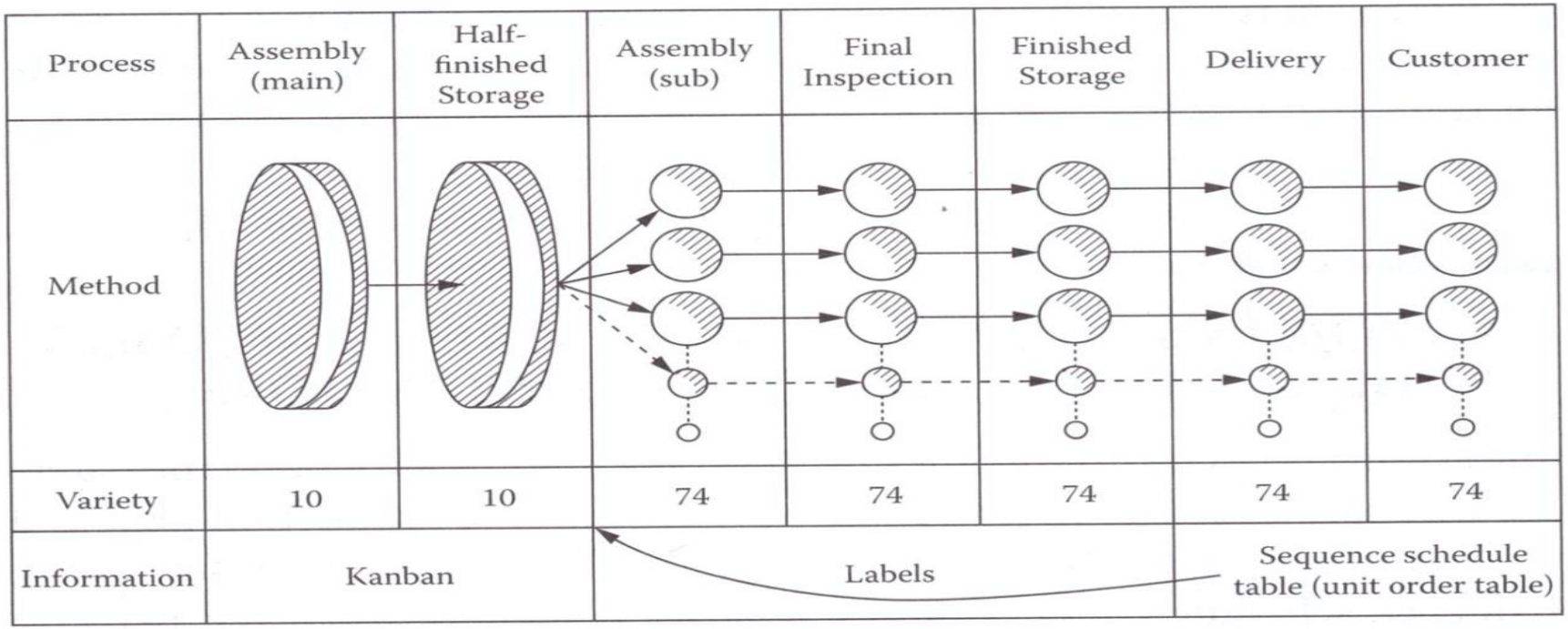


FIGURE 4.7
Information and production method on the assembly lines.

4.4 PROBLEMS AND COUNTERMEASURES

- Discrepancy exist between the quantities decided in the monthly production plan of Toyota and the actual order quantity in that month.
- For Toyota, this discrepancy is usually about 10%.

Japanese Communist Party
日本共産党

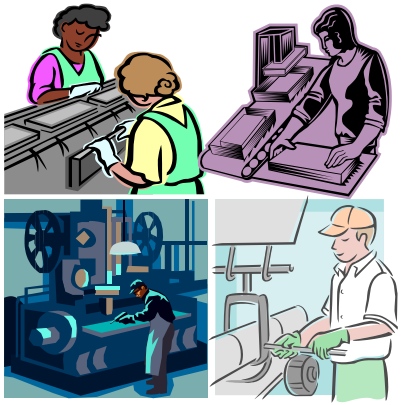
公正取引委員会
Japan Fair Trade Commission

TOYOTA

4.4 PROBLEMS AND COUNTERMEASURES

- In 1977, questions are revealed by Japanese Communist Party.

Profit of $1 billion



How about the suppliers' profits?

4.4 PROBLEMS AND COUNTERMEASURES

- There is no excessive parts inventory at Toyota.
- The suppliers have to engage in estimated production and undertake all of the loss.
- They need the contracts from Toyota.
- TPS is becoming popular in other industries.

4.4 PROBLEMS AND COUNTERMEASURES

- The Anti-Deferment-of-Payment-to-the-Subcontractor's Law (Subcontractor's Law, established in 1956).
- The Anti-Monopoly Law (established in1947).
- The Faire Trade Commission pointed out several questions about the Kanban system.

4.4 PROBLEMS AND COUNTERMEASURES

- 1. The ordering time is obscure.

monthly production plan

kanban and sequence schedule

4.4 PROBLEMS AND COUNTERMEASURES

- 2. Discrepancy exist between the quantities decided in the monthly production plan of Toyota and the actual order quantity in that month.

- 3. The Kanban delivery system should not be forced on the supplier.

4.4 PROBLEMS AND COUNTERMEASURES

- Toyota coped with criticism as follows.

- Hold the discrepancy down to less than 10%.
- Produce a model of an automobile for many months (usually 4 years).
- Promise to give advance notice when it is about to stop producing a model.

4.4 PROBLEMS AND COUNTERMEASURES

- Toyota coped with criticism as follows (continued).

  - Tell the suppliers not to start production until instructed by Kanban to avoid overproduction.

  - Teach the suppliers how to shorten production lead time.

4.5 SUPPLIER KANBAN CIRCULATION IN TOYOTA

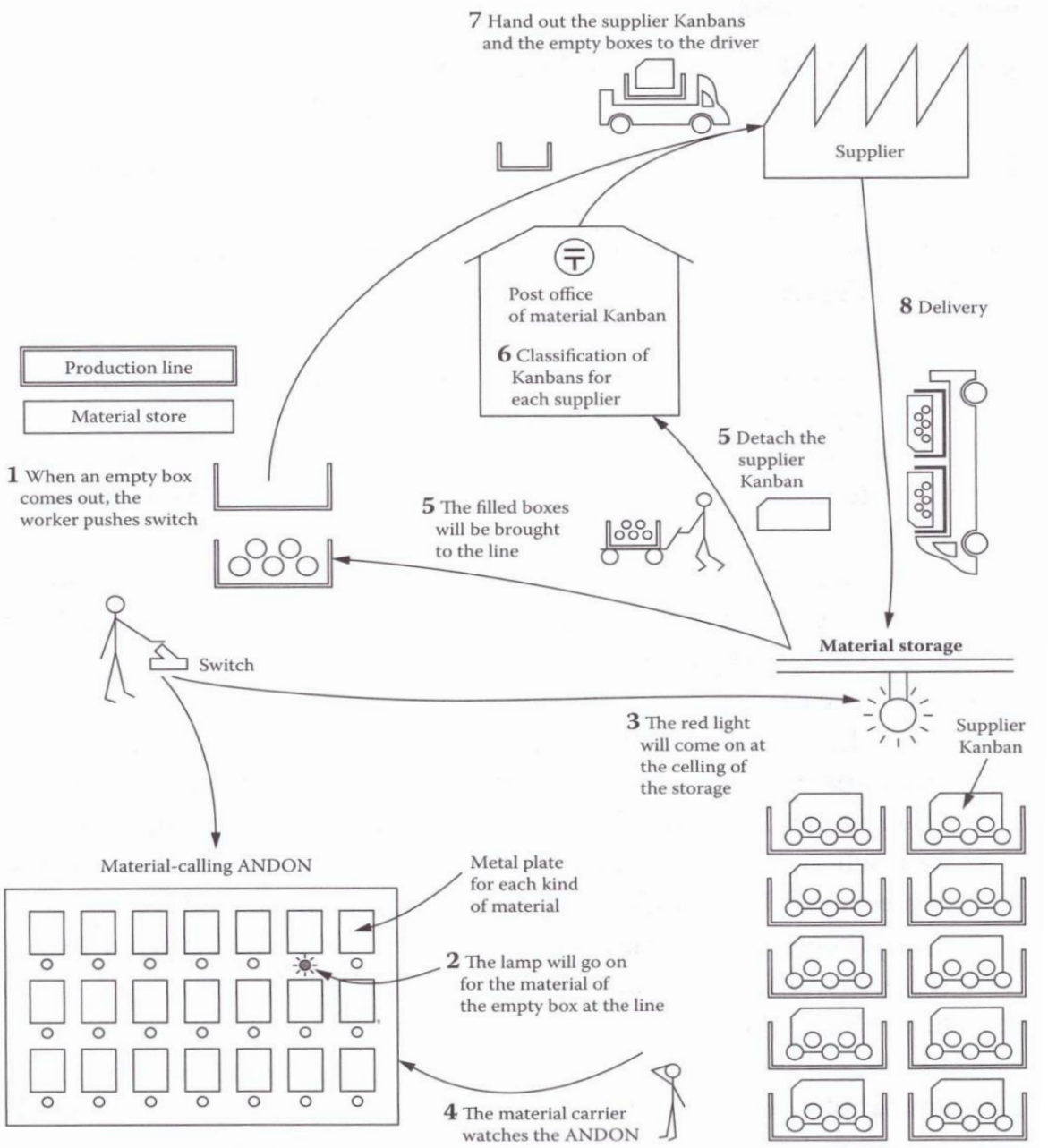


FIGURE 4.9
Material-calling andon for the later-replenishment system.

4.5 SUPPLIER KANBAN CIRCULATION IN TOYOTA

- Structure of the supplier Kanban sorting office

  - Step 1. When the part is picked from the box on the production line, the Kanbans are placed in the Kanban post.

  - Step 2. The Kanbans are brought to the Kanban sorting office.

4.5 SUPPLIER KANBAN CIRCULATION IN TOYOTA

- Structure of the supplier Kanban sorting office

- Step 3. The office sorts various supplier Kanbans by suppliers.

- Step 4. The sorted supplier Kanbans are shelved on the wall which is partitioned for each supplier.

4.6 DELIVERY SYSTEM AND CYCLE

- Materials are delivered to the five plants of Toyota.
- The total number of runs is 39 each day.

Number of Runs to each Toyota Plant/Day

1	to	Tsutsumi plant	16 runs (2 places)
2	to	Motomachi plant	10 runs (3 places)
3	to	Takaoka plant	6 runs (3 places)
4	to	Tahara plant	4 runs (4 places)
5	to	Hino plant	3 runs (1 place)

FIGURE 4.13
Number of delivery times to each plant.

4.6 DELIVERY SYSTEM AND CYCLE

- If these runs were done individually, the transportation cost would be high.
- An 11-ton truck's capacity is greater than one run.
- Runs are combined based on proximity, quantity, and load weight (with only 20 runs).

- "1-16" means there are 16 delivery runs to Tsutsumi each day.
- "-16" means the delivery issued by a supplier kanban is carried out 16 runs after the kanan arrives.

click.

Number of deliveries to each plant				Departure from Japan Sheet Glass Co., Ltd.	Arrival at Toyota	Arrival time of Kanban	* Delivery cycle of each plant
Tsutsumi	Motomachi	Takaoka	Tahara				
1	1			3:20	8:00	13:30	1 - Tsutsumi plant 1 - 16 - 16
2	2			5:10	9:10	15:20	
3		1		4:10	8:20	14:20	
4	3			7:40	11:30	17:30	2 - Motomachi plant 1 - 10 - 10
5		2		7:20	11:20	17:30	
6	4			11:10	14:10	23:20	
7	5			12:20	15:50	24:30	3 - Takaoka plant 1 - 6 - 6
8		3		11:50	15:20	1:00	
9	6			14:20	21:00	2:30	
10	7			16:10	22:10	4:20	4 - Tahara plant 1 - 4 - 5
11		4		15:10	21:20	3:20	
12	8			18:30	24:30	6:50	
13		5		18:20	24:20	6:30	5 - Hino 1 - 2 - 4
14	9			24:10	3:40	10:20	
15	10			1:20	4:50	11:30	
16		6		1:50	4:20	11:00	
			1	21:00	7:50	7:00	
			2	5:00	12:50	15:00	
			3	10:00	20:50	20:00	
			4	16:00	1:50	4:00	

Note: This delivery schedule is based on the cycle to the Tsutsumi plant. Delivery to Motomachi and Takaoka are set within it and to Hino is relayed in Toyoda City then delivered by Toyota's run.

FIGURE 4.14
Delivery schedule for Toyota.

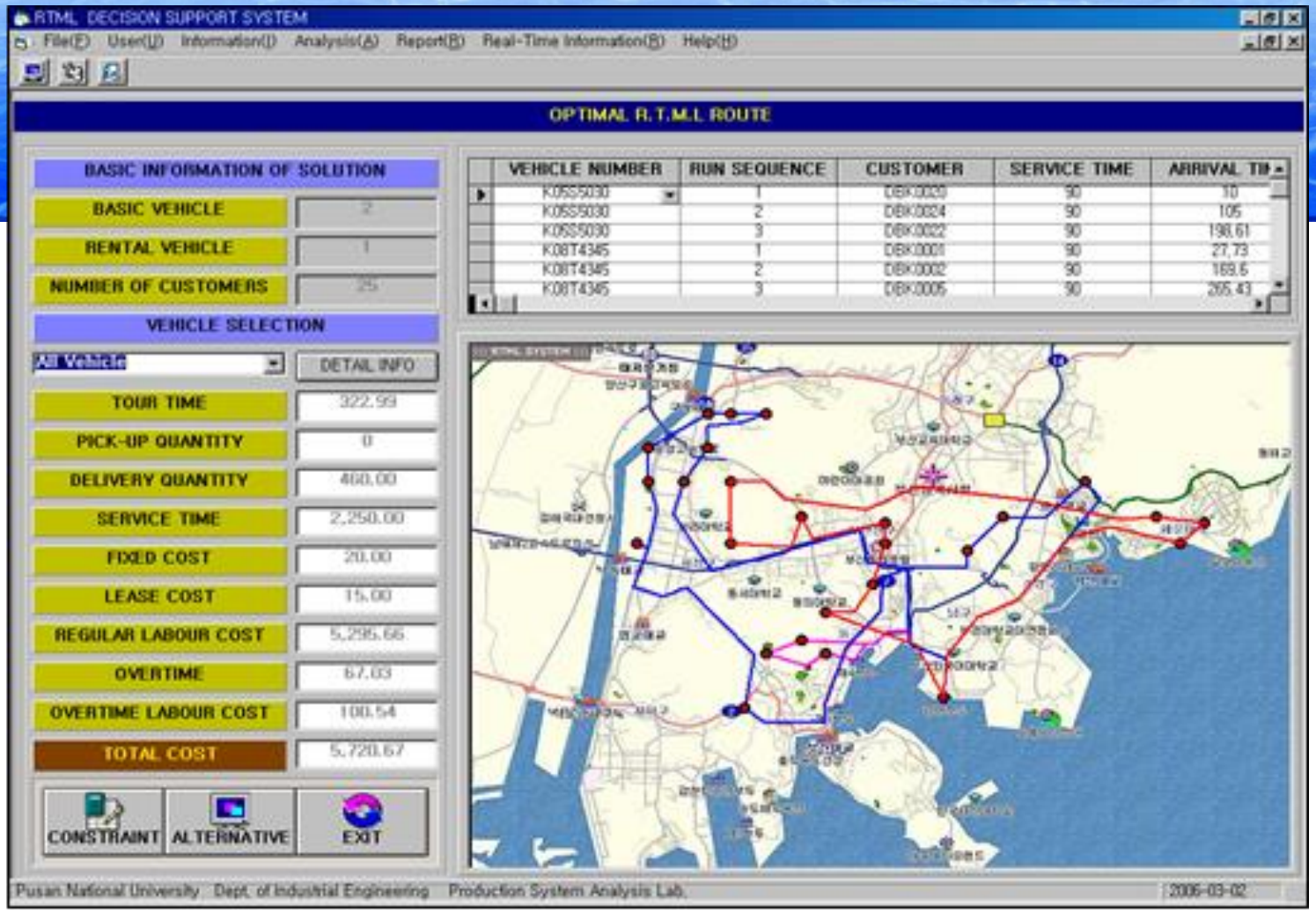
4.6 DELIVERY SYSTEM AND CYCLE

- The JIT supply may be impossible due to the complication in transportation.
  - traffic congestion
- Toyota's plants have storage areas (called station) 30 minutes away from the plant.
  - safety inventory

4.6 DELIVERY SYSTEM AND CYCLE

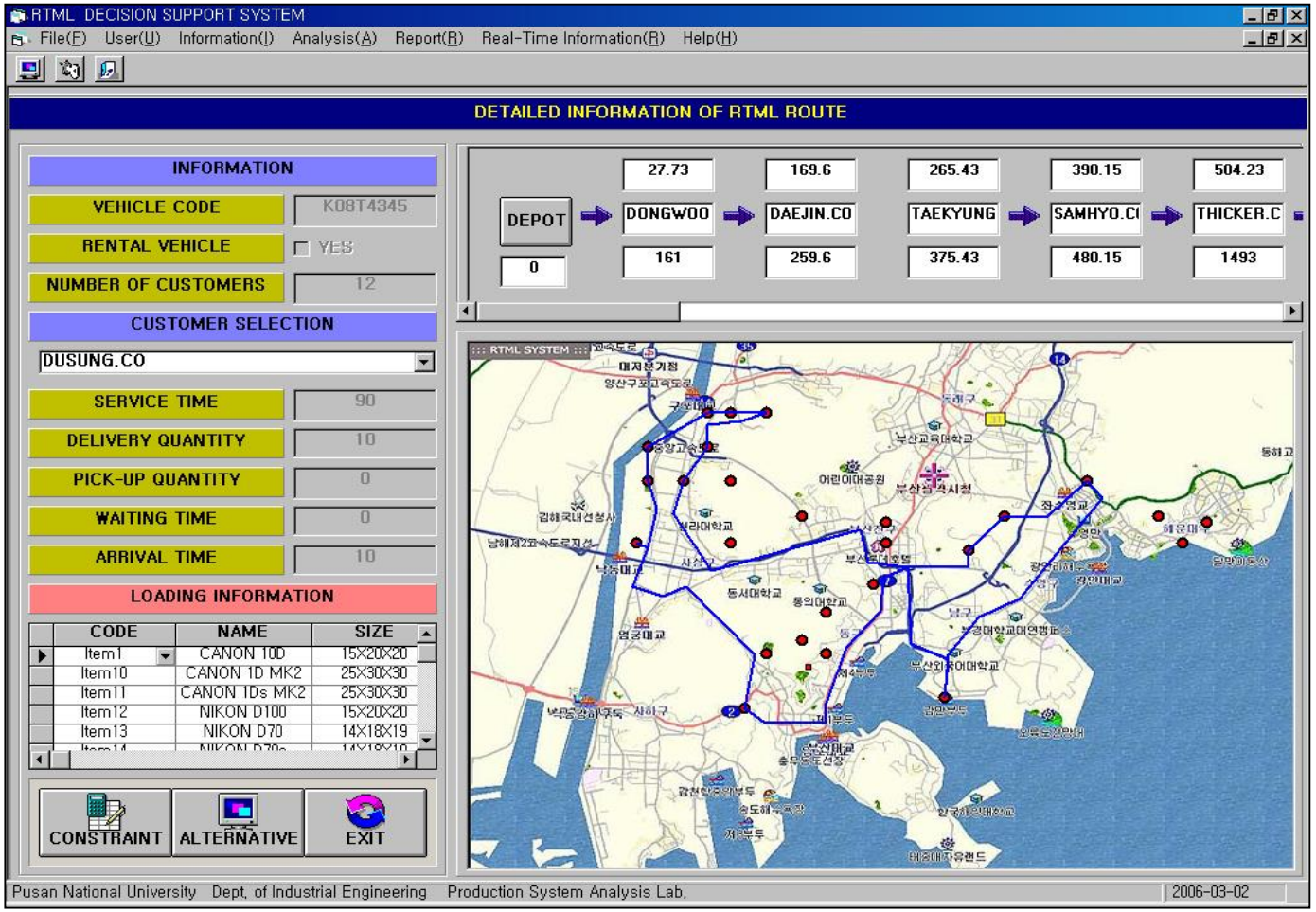
❖ Kanban system to emergency

➢ Step 1. Caution	Less than two-hour delay Transportation company
➢ Step 2. Warning	More than two-hour delay The plant takes action
➢ Step 3. Emergency	More than three-hour delay Emergency headquarters Inventory on the station

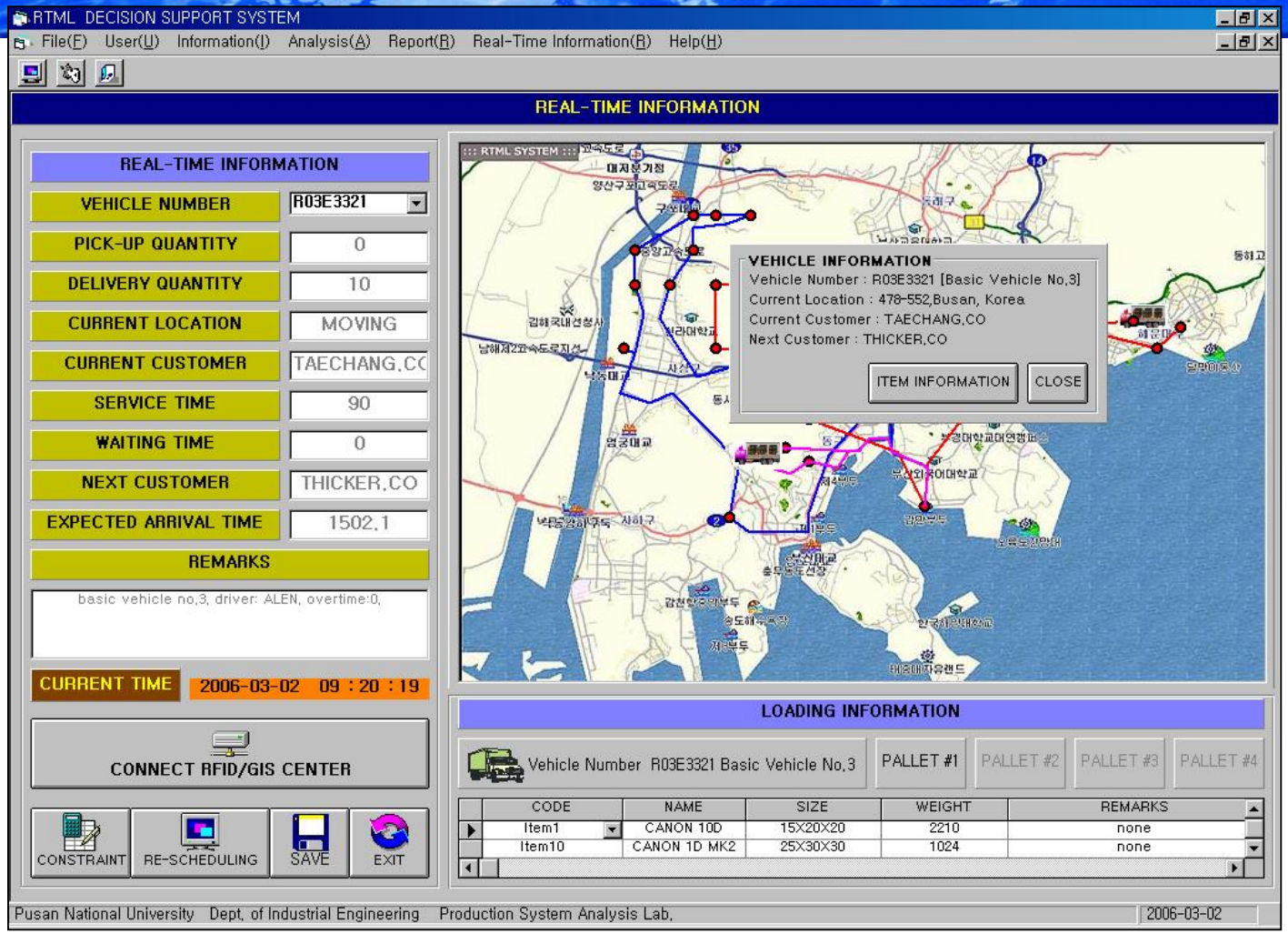


Screen of optimal vehicle routes.

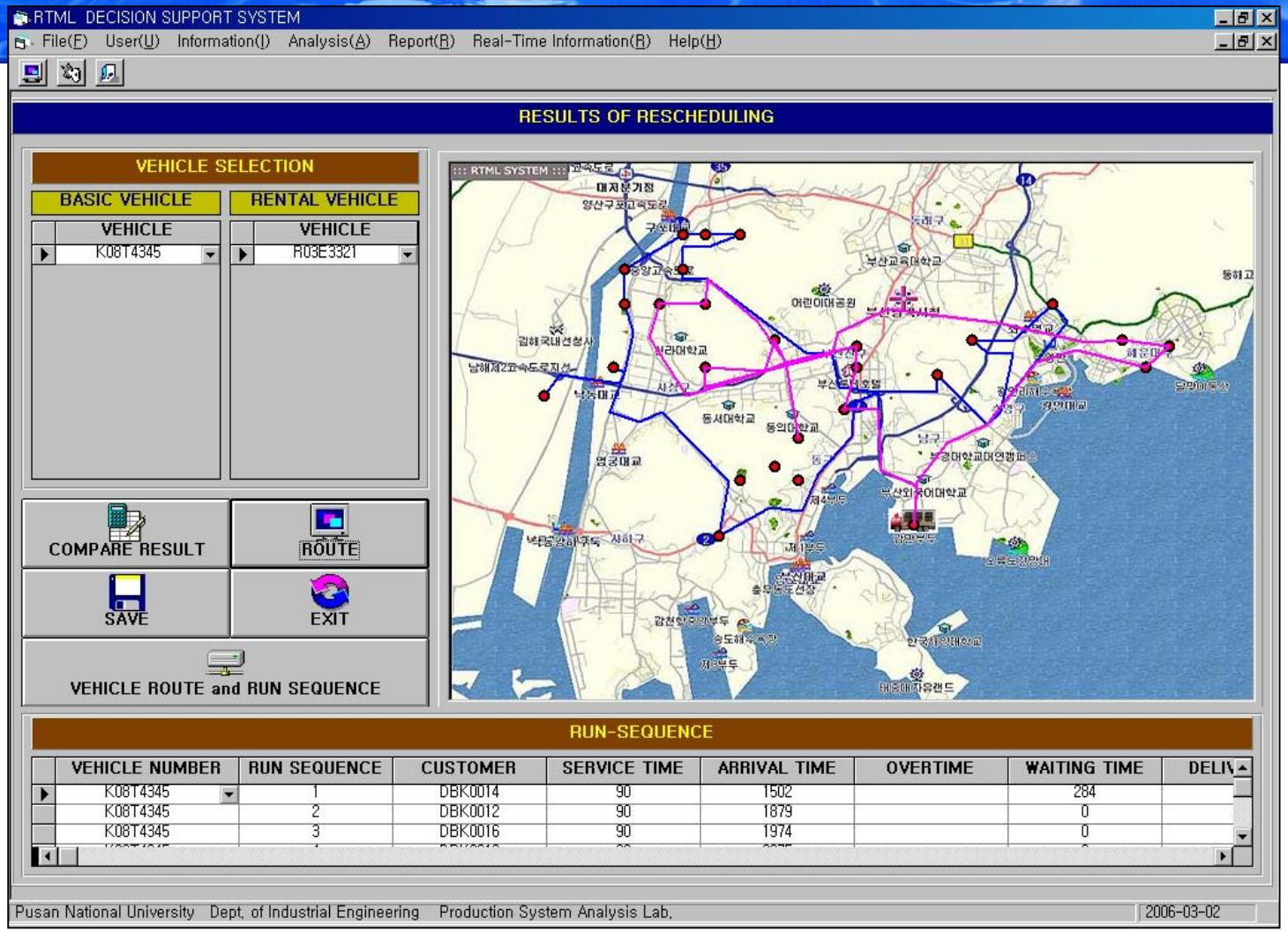
Moon, I.K., Lee, J.H., and Seong, J., 2012, Vehicle Routing Problem with Time Windows considering Overtime and Outsourcing Vehicles. *Expert Systems with Applications*, 39(18), 13202–13213.



Detailed information screen for a vehicle route.



Real-time information screen.



Vehicle route rescheduling screen.

4.5 SUPPLIER KANBAN CIRCULATION IN TOYOTA

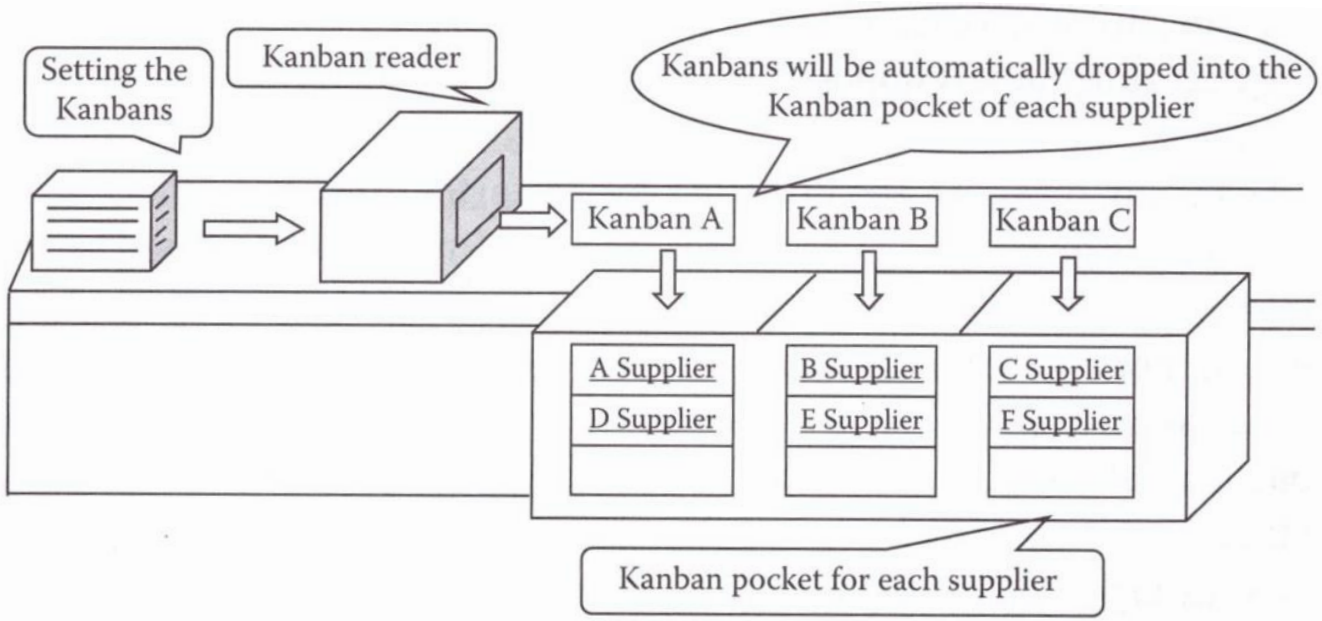


FIGURE 4.11
Post office for supplier kanban. (Adapted from Aoki, M. 2007. *Full Illustration of the Systems of Toyota Production Plants*, Nihon-Jitsugyou Shuppansha, p. 66.)