

# Chapter 4

## Supplier Kanban and the Sequence Schedule Used by Suppliers



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# CONTENTS

4.1 Information to the supplier

4.2 Later replenishment system

4.3 Sequenced withdrawal system

4.4 Problems and countermeasures

4.5 How supplier Kanban should be circulated

4.6 Delivery system and cycle

# 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.

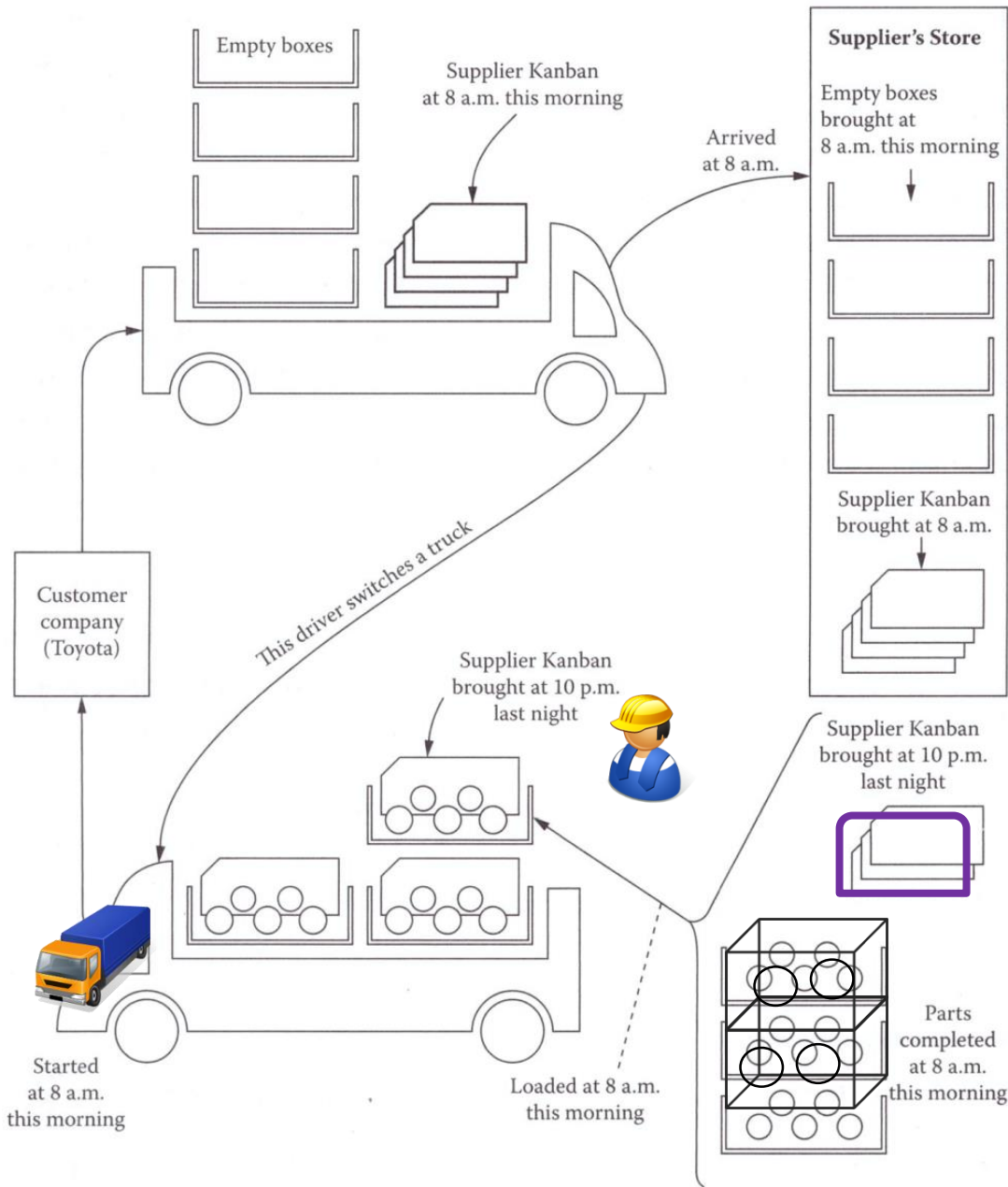
A – B – A – C – A – B – A – C – ...

$T_A - T_B - T_A - T_C - T_A - T_B - T_A - T_C - \dots$

T: transmission

## 4.2 LATER REPLENISHMENT SYSTEM

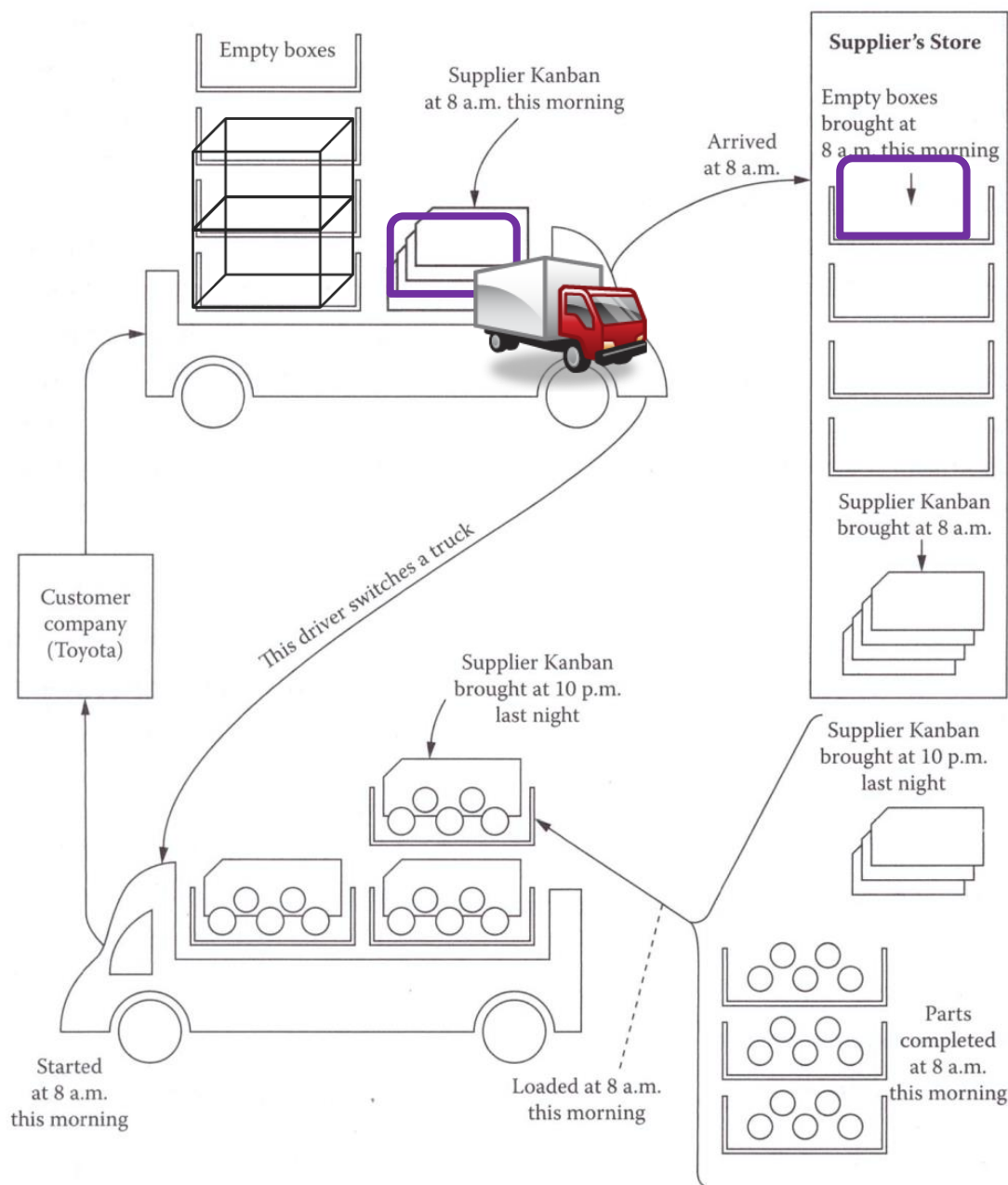
- ❖ Suppose an example with Toyota and a supplier.
- ❖ The parts produced by the supplier are withdrawn by Toyota twice a day:
  - 8 a.m.
  - 10 p.m.



➤ 10 p.m. last night

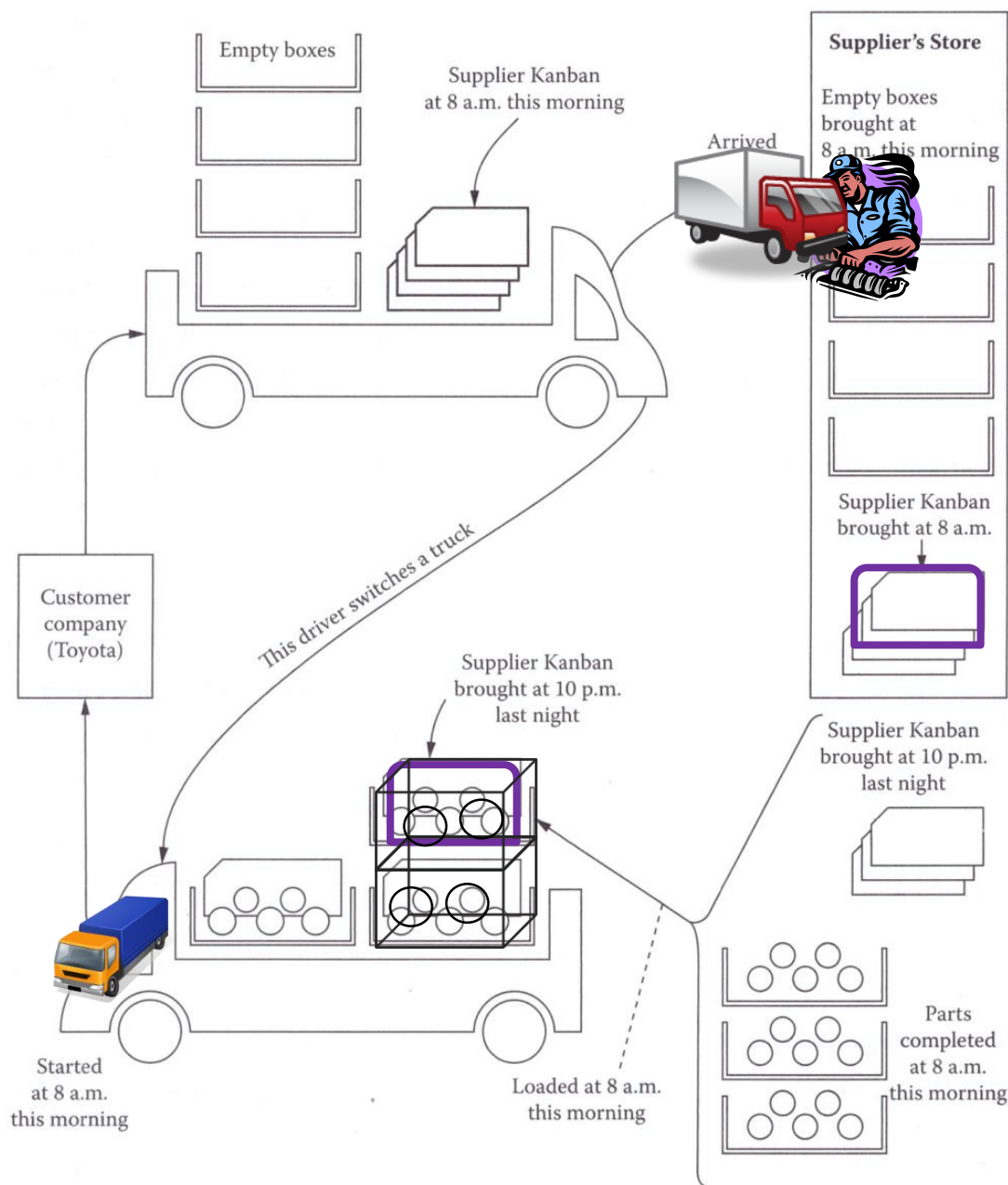
FIGURE 4.1  
Flow of supplier kanban.





- 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

**FIGURE 4.1**  
Flow of 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

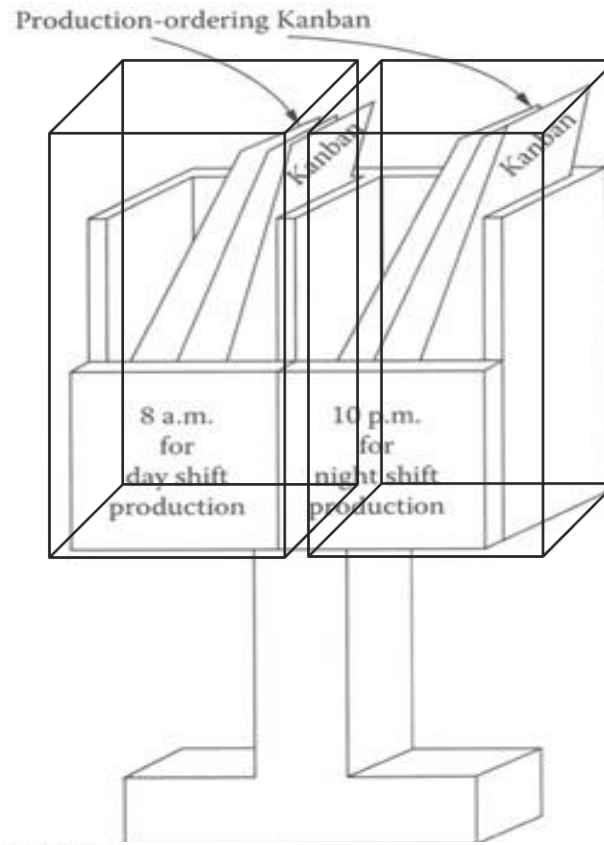
### ❖ Advantages of this system

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

## 4.2 LATER REPLENISHMENT SYSTEM

### ❖ Production-ordering kanban in the supplier

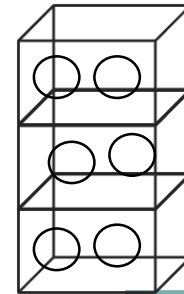
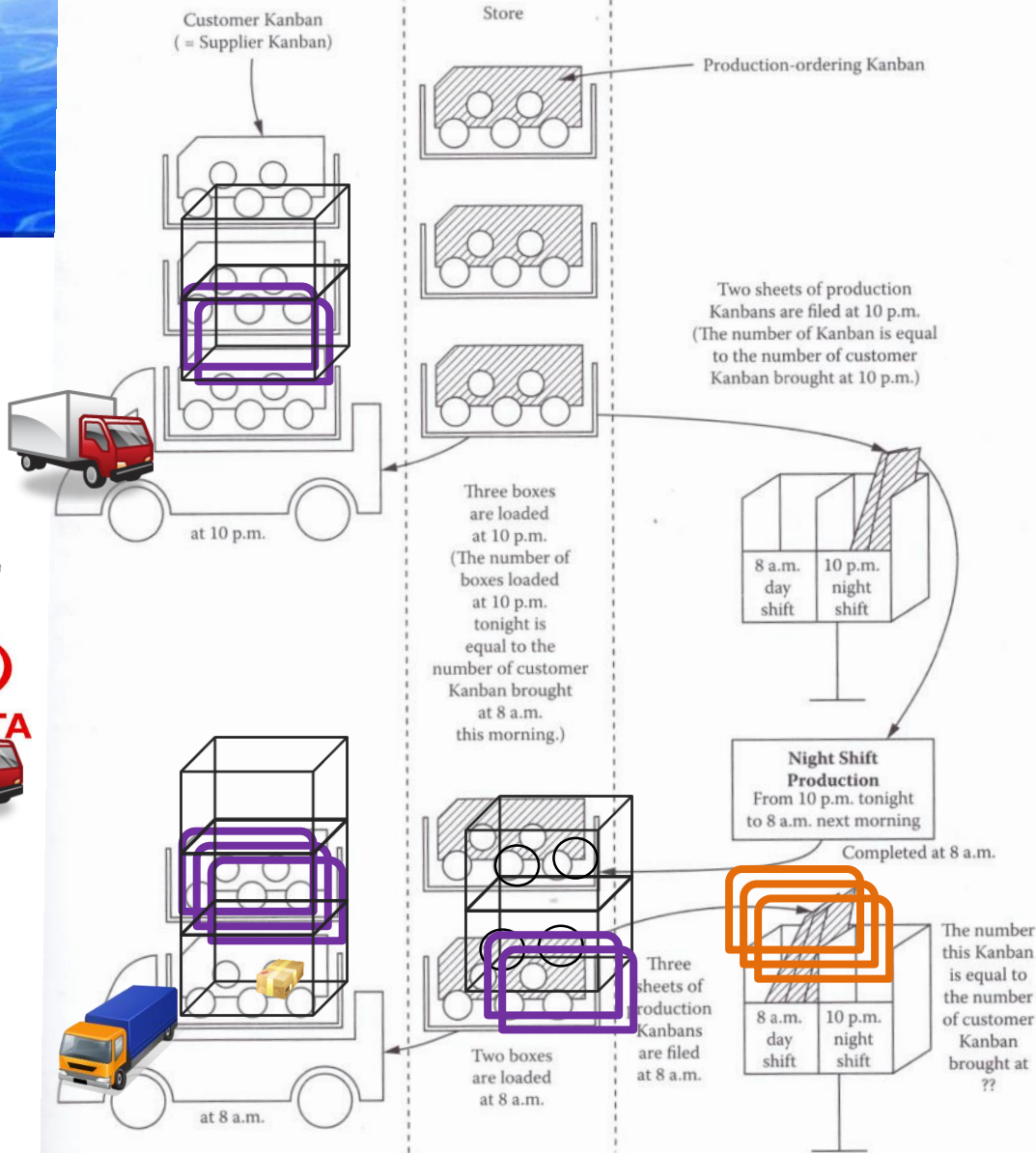
- Kanban brought at 8 a.m.
- Should be finished before 10 p.m.



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

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





**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 every 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.

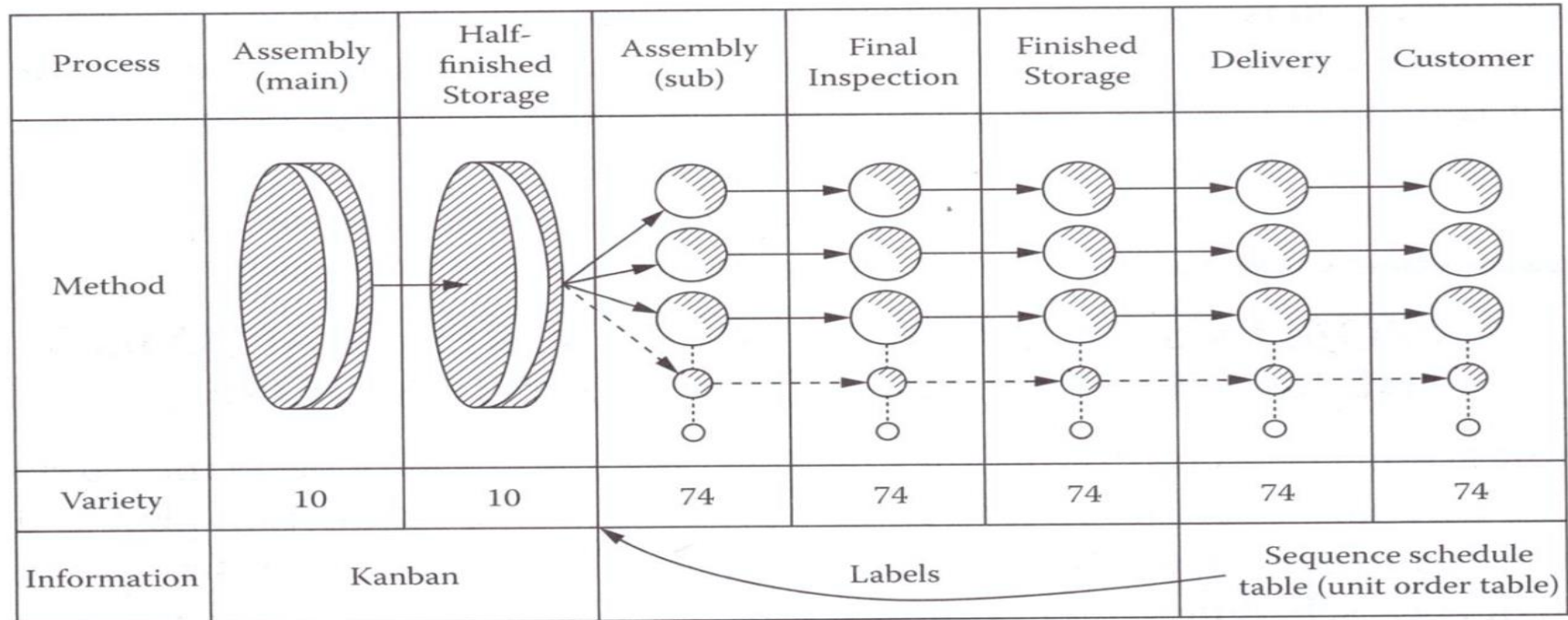
## 4.3 SEQUENCED WITHDRAWAL SYSTEM

- ❖ 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 each transmission that sequences the 74 varieties.



**FIGURE 4.7**

Information and production method on the assembly lines.

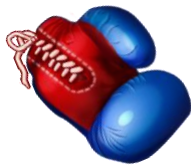


## 4.4 PROBLEMS AND COUNTERMEASURES

- ❖ 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



TOYOTA



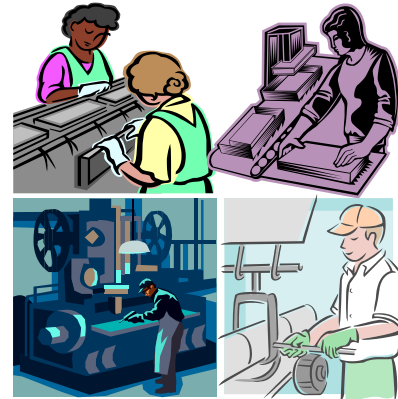
公正取引委員会

Japan Fair Trade Commission



# 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 in 1947).
- ❖ The Fair 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.

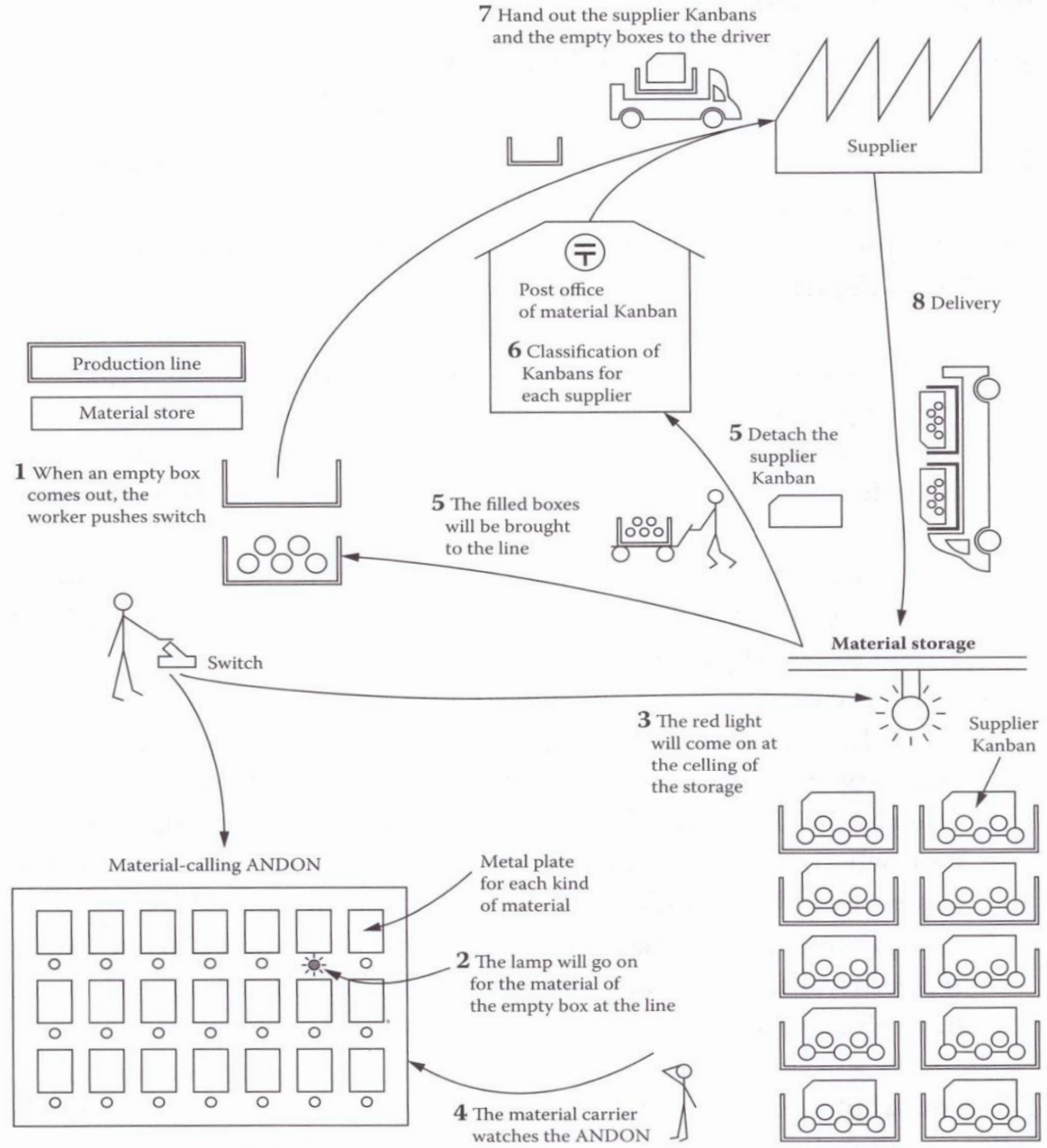
## 4.4 PROBLEMS AND COUNTERMEASURES

- ❖ 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.



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	2 - Motomachi plant 1 - 10 - 10
4	3			7:40	11:30	17:30	
5		2		7:20	11:20	17:30	3 - Takaoka plant 1 - 6 - 6
6	4			11:10	14:10	23:20	
7	5			12:20	15:50	24:30	4 - Tahara plant 1 - 4 - 5
8		3		11:50	15:20	1:00	
9	6			14:20	21:00	2:30	5 - Hino 1 - 2 - 4
10	7			16:10	22:10	4:20	
11		4		15:10	21:20	3:20	
12	8			18:30	24:30	6:50	
13		5		18:20	24:20	6:30	
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

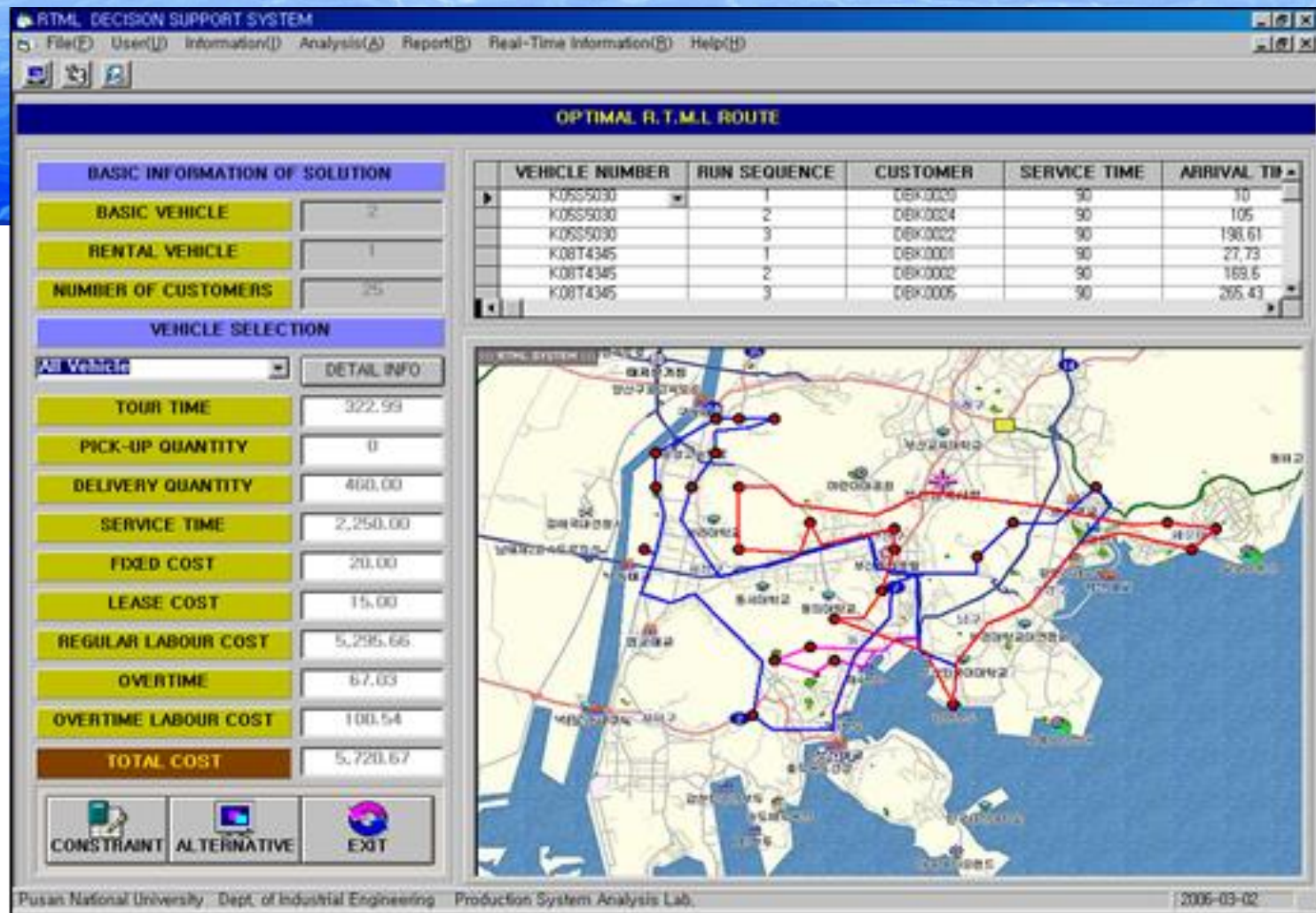
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- Step 2. Warning      More than two-hour delay  
The plant takes action

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- 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.



RTML DECISION SUPPORT SYSTEM

File(E) User(U) Information(I) Analysis(A) Report(R) Real-Time Information(B) Help(H)

### DETAILED INFORMATION OF RTML ROUTE

**INFORMATION**

VEHICLE CODE: K08T4345

RENTAL VEHICLE:  YES

NUMBER OF CUSTOMERS: 12

**CUSTOMER SELECTION**

DUSUNG.CO

SERVICE TIME: 90

DELIVERY QUANTITY: 10

PICK-UP QUANTITY: 0

WAITING TIME: 0

ARRIVAL TIME: 10

**LOADING INFORMATION**

CODE	NAME	SIZE
Item1	CANON 100	15X20X20
Item10	CANON 1D MK2	25X30X30
Item11	CANON 1Ds MK2	25X30X30
Item12	NIKON D100	15X20X20
Item13	NIKON D70	14X18X19
Item14	NIKON D70s	14X18X19

CONSTRAINT ALTERNATIVE EXIT

DEPOT	27.73	169.6	265.43	390.15	504.23
0	161	259.6	375.43	480.15	1493

ROUTE: DEPOT → DONGWOO → DAEJIN.CO → TAEKYUNG → SAMHYO.CI → THICKER.C

Pusan National University Dept. of Industrial Engineering Production System Analysis Lab. 2006-03-02

Detailed information screen for a vehicle route.

RTML DECISION SUPPORT SYSTEM

File(F) User(U) Information(I) Analysis(A) Report(R) Real-Time Information(B) Help(H)

### REAL-TIME INFORMATION

REAL-TIME INFORMATION			
VEHICLE NUMBER	R03E3321		
PICK-UP QUANTITY	0		
DELIVERY QUANTITY	10		
CURRENT LOCATION	MOVING		
CURRENT CUSTOMER	TAECHANG.CO		
SERVICE TIME	90		
WAITING TIME	0		
NEXT CUSTOMER	THICKER.CO		
EXPECTED ARRIVAL TIME	1502.1		
REMARKS			
basic vehicle no,3, driver: ALEN, overtime:0,			
<b>CURRENT TIME</b>	2006-03-02 09 : 20 : 19		
<b>CONNECT RFID/GIS CENTER</b>			
CONSTRAINT	RE-SCHEDULING	SAVE	EXIT

**VEHICLE INFORMATION**  
 Vehicle Number : R03E3321 [Basic Vehicle No.3]  
 Current Location : 478-552,Busan, Korea  
 Current Customer : TAECHANG.CO  
 Next Customer : THICKER.CO

ITEM INFORMATION CLOSE

LOADING INFORMATION						
	Vehicle Number	R03E3321 Basic Vehicle No.3	PALLET #1	PALLET #2	PALLET #3	PALLET #4
CODE	NAME	SIZE	WEIGHT	REMARKS		
Item1	CANON 10D	15X20X20	2210	none		
Item10	CANON 1D MK2	25X30X30	1024	none		

Pusan National University Dept. of Industrial Engineering Production System Analysis Lab. 2006-03-02

Real-time information screen.




RTML DECISION SUPPORT SYSTEM


File(F) User(U) Information(I) Analysis(A) Report(R) Real-Time Information(R) Help(H)


### RESULTS OF RESCHEDULING


#### VEHICLE SELECTION


BASIC VEHICLE		RENTAL VEHICLE	
VEHICLE	VEHICLE	VEHICLE	VEHICLE
K08T4345		R03E3321	

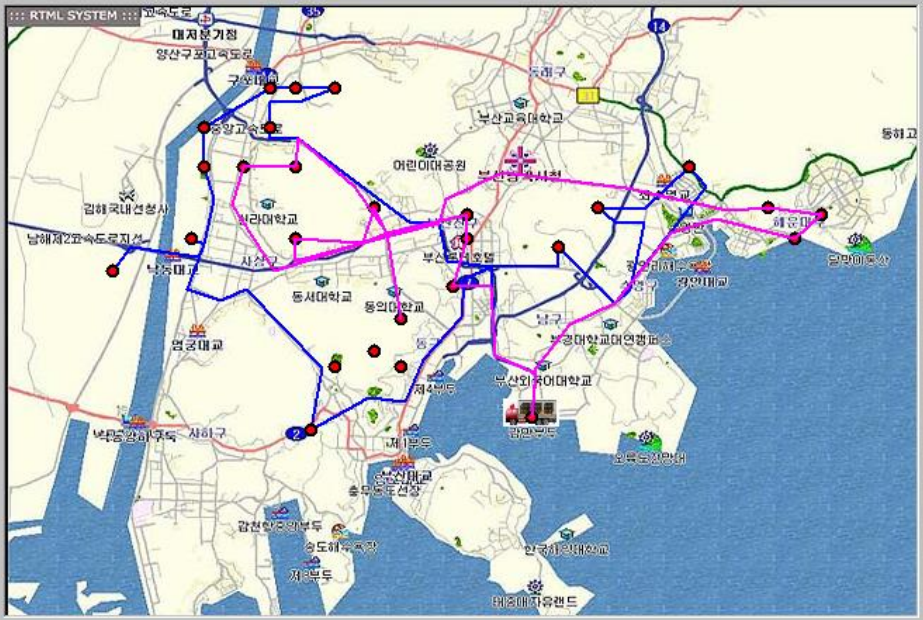
  
**COMPARE RESULT**

  
**ROUTE**

  
**SAVE**

  
**EXIT**

  
**VEHICLE ROUTE and RUN SEQUENCE**



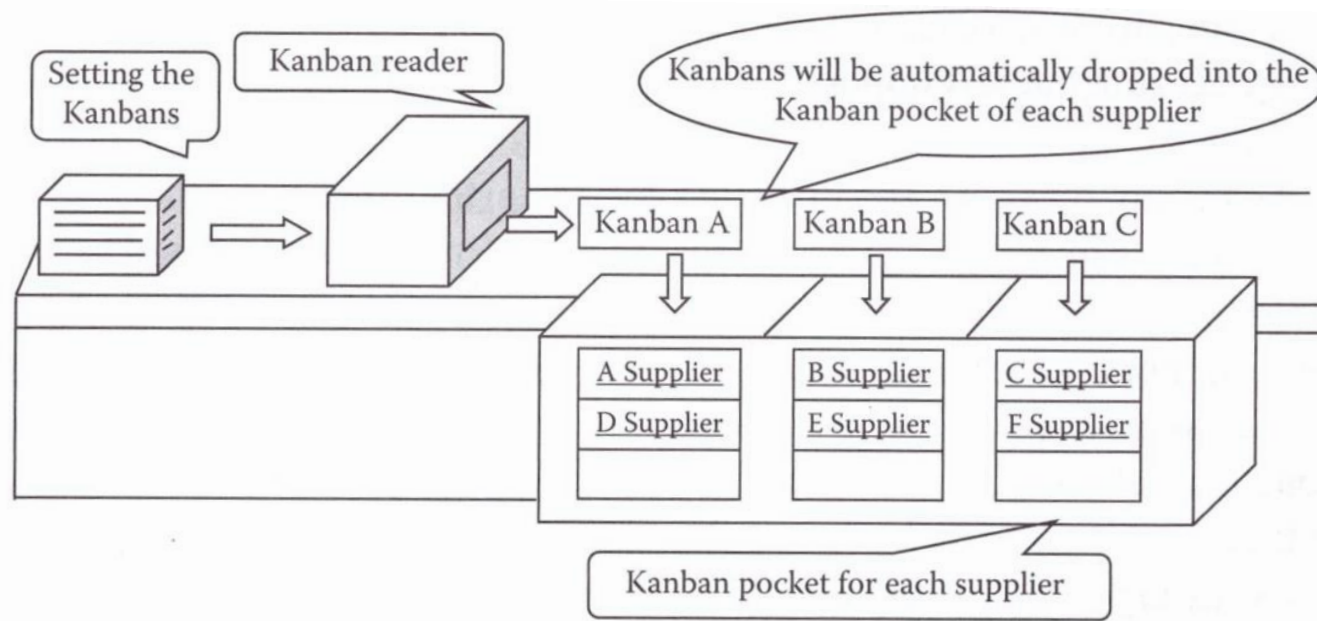
#### RUN-SEQUENCE

VEHICLE NUMBER	RUN SEQUENCE	CUSTOMER	SERVICE TIME	ARRIVAL TIME	OVERTIME	WAITING TIME	DELIV
K08T4345	1	DBK0014	90	1502		284	
K08T4345	2	DBK0012	90	1879		0	
K08T4345	3	DBK0016	90	1974		0	

Pusan National University Dept. of Industrial Engineering Production System Analysis Lab. 2006-03-02

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.)

