

**No. 1011**

ECR for Freshness

by

Yasuaki Takeda and Hirofumi Matsuo

November 2002

# **ECR for Freshness**

by

**Yasuaki Takeda\* and Hirofumi Matsuo\*\***

**October 2002**

\*Mitsubishi Corporation (This research was conducted as a graduate student at the University of Tsukuba)

2-3-1 Marunouchi, Chiyoda-ku, Tokyo 100-8986, Japan

[yasuaki.takeda@mitsubishicorp.com](mailto:yasuaki.takeda@mitsubishicorp.com)

\*\*Institute of Policy and Planning Sciences,

University of Tsukuba

1-1-1 Tennoudai, Tsukuba, Ibaraki 305-8573, Japan

[matsuoh@sk.tsukuba.ac.jp](mailto:matsuoh@sk.tsukuba.ac.jp)

Please correspond to the second author.

## **Abstract**

Japanese consumers highly value freshness of food products. In this paper, we report a result of our three case studies on supply chains for delivering fresh products within 24 hours. The 24-hour products investigated include oven-fresh bread at small convenience stores, and morning-harvested vegetables and raw tuna sashimi at grocery stores. After reviewing the difficulties in delivering 24-hour products, we propose six methods for overcoming the difficulties. We also present five ways of reducing the logistics costs.

Japanese consumers highly value freshness in food: products like oven-fresh bread, morning-harvested vegetables, raw tuna Sashimi and Sushi, which is consumed preferably within two hours after being thawed from frozen fish and sliced. (Sliced raw fish discolors thereafter and is discounted or discarded.)

Delivering freshness is definitely a competitive advantage in Japan, but to do so cost effectively, Japanese retailers have to compress all their key activities into a 24 hour time scale or less. This pushes regular ECR to the limit – a limit where business processes are designed to work on an hourly basis; procurement is done one-to-one; collaboration is tight and frequent and the supply chain is thought out from the ground up in order to deliver goods within 24 hours.

The challenges are immense. Using three case studies – oven fresh bread from Seven Eleven convenience stores, morning-harvested vegetables at York Mart and sliced raw tuna sashimi at Ito-Yokado – identifies six ways in which Japanese retailers have shaped ECR to deliver freshness.

### **The value of freshness**

Japanese consumers highly value freshness – products that should be consumed within 24 hours of being harvested or cooked. In stores, they sell well at a premium price, contributing significantly to total sales volume while improving the store’s overall image, thereby attracting and retaining loyal customers. So freshness is a key differentiator for Japanese retailers.

The definition of freshness varies from product to product. Table 1 provides a classification of 24-hour products by the time limit to be perceived fresh. For example, tuna sashimi discolors rapidly at shelf, and consumers perceive it fresh within two hours after being sliced. Thereafter, the products have to be discarded to keep a fresh store impression or discounted.

Time limit to be perceived fresh	Categories	Examples
0 to 2 hours	Immediate consumption	sashimi(i.e., raw seafood) pre-cut vegetables and fruits
0 to 6 hours	Home meal replacement	deep-fried food deli / baked food
0 to 12 hours	Morning-harvested	morning-harvested vegetables morning-catch fish
0 to 24 hours	One-day product	fresh produce / cut flower freshly processed food

Table 1. Classification of 24-hour products by the time limit to be perceived fresh

In designing a supply chain for 24-hour products, three factors need careful attention: product perishability; supply uncertainties; and fragmented suppliers. Let's look at each of these in turn.

### **Perishability**

Perishability generates high markdown and spoilage costs, and high logistics costs. Consumers are highly sensitive to how fresh 24-hour products are. Fresh produce and raw fish visibly change color as time goes by, and home meal replacement items have the time and day of their production printed on their packages. Based on such visible clues, consumers tend to search for the freshest item on the shelf, which results in first-in-last-out (FILO) of shelf-space inventory. This is in stark contrast to the FIFO (first-in-first-out) rule for regular packaged food items, and increases the proportion of inventory that has to be discarded or discounted.

York Mart removes items that have lost freshness from its fresh produce section, and places them at a discounted section located at an inconspicuous corner. This helps maintain an impression of freshness for the category itself and for the entire store. It also helps reduce dilution of category sales. A discounted unit right next to a non-discounted one might cause a customer to buy the cheaper one. This is avoided by placing them in a separate section.

Ito-Yokado removes raw tuna sashimi from its shelves two hours after being sliced. In this way it avoids placing raw tuna sashimi with different freshness on the shelf – thereby side-stepping consumers' FILO shopping habits – and maintains the impression of freshness for the category.

Seven-Eleven discards items that have lost freshness, instead of discounting them. Not-so-fresh items on the shelf do not meet the customers' expectation on freshness at Seven-Eleven, and the limited shelf-space of the convenience store format – which need to maintain a higher sales rate per square centimeter – means it cannot afford to keep items that do not exactly match customers' wants and needs. The reduced price of stale items dilutes sales per square centimeter and is not consistent with Seven-Eleven's "quality concept."

Perishable products also cause high logistics costs because they often require multiple deliveries a day. Oven-fresh bread is delivered three times a day at Seven-Eleven stores. So done are morning-harvested vegetables at York Mart. In addition, these items also require frequent re-shelving. Raw tuna sashimi at Ito-Yokado requires continuous monitoring of shelf-space inventory and replenishment.

Another factor associated with 24-hour products is temperature control. Most such products have to be kept at less than room temperature, not only in store but in transportation and warehousing as well.

### **Uncertain supply**

Packaged food has uncertainties only in demand. In contrast, fresh produce and seafood have uncertainties both in demand and supply. Unstable supply leads to unstable prices and sales. The price of the product is usually determined in bidding sessions held at a wholesale market. These transactions tend to be on the spot, unlike the longer term sales contract often found in collaborative efforts in ECR for fast moving packaged goods.

### **Fragmented supply base**

Harvesting fresh produce is highly seasonal, and harvesting locations shift geographically over time. In addition, many Japanese farmers and fishers are individually owned: the supply base is highly fragmented. As a result, a typical supply chain of fresh produce and seafood has many layers and is complex, and thus difficult to streamline. Most products are transacted at wholesale markets. If retailers procure directly from a huge number of small suppliers, then they have to work out a way of dealing with them efficiently and effectively.

### **A Framework for ECR for freshness**

Selling 24-hour products without charging too much premium requires careful design of a supply chain able to overcome the difficulties associated with this market. We have identified six key methods of achieving this, which together create a business model we call 'ECR for freshness'. They are:

1. Matching consumers' sensitivity to freshness with supply chain configuration
2. Hourly logistics coordination
3. Tight cost reduction mechanism
4. One-to-one procurement
5. Revenue management
6. Tight collaboration (Team merchandising involving co-developing new products, co-developing supply chain, and co-managing logistics and marketing)

### **Matching consumers' sensitivity to freshness with supply chain configuration**

The first step to ECR for freshness is identifying customers' sensitivity to freshness. Of course, individual's sensitivity varies, but the main driver of sensitivity is the product itself. We measured different products' degree of sensitivity by the percentage of customers who applied the FILO rule at shelf, picking up the freshest item of all. Such consumer behaviors can be easily observed at stores. Table 2 shows the results for three classes of fresh produce.

If more than 80% of customers apply FILO for an item, we classify it as high sensitivity to freshness. Products with 40-80% of customers applying FILO are designated as medium sensitivity, while those with less than 40% are designated as low sensitivity.

The more customers apply the FILO inventory rule, the more customers value the freshness of the product and the more spoilage and markdown result. Therefore, a supply chain tailored for delivering freshness has to be designed for products in the category of high sensitivity to freshness.

York Mart stores repeat three cycles a day of ordering, harvesting, and delivering for produce in the category of high sensitivity to freshness. On the other hand, produce with low sensitivity to freshness does not require such an arrangement. Rather, such produce should be moved through a supply chain designed to achieve the lowest cost.

High Sensitivity to Freshness		Medium Sensitivity to Freshness		Low Sensitivity to Freshness	
strawberry	egg plant	asparagus	sweet corn	squash	hot pepper
cabbage	Chinese chive	snap bean	broad bean	goboh root	yam
cucumber	broccoli	soy bean	daikon radish	sweet potato	carrot
komatsuna green	spinach	enoki mushroom	bamboo shoot	taro	garlic
shiitake mushroom	bean sprout	pea	green onion	potato	lotus root
perilla	lettuce	okra	nappa cabbage	ginger	
celery	bok choy	turnip	green pepper	onion	
watermelon	tomato	cauliflower	mulukhiyya		
garland chrysanthemum	tricholoma				
More than 80% customers in FILO		40-80% customers in FILO		Less than 40% customers in FILO	
Freshness oriented supply chain			Low-cost oriented supply chain while keeping acceptable freshness		

Table 2. Fresh produce categorized by consumer's sensitivity to freshness

### Hourly logistics coordination

Because 24-hour products deteriorate rapidly, their logistics need to be planned and implemented hourly.

Table 3 summarizes the timing of several key steps at the supply chain for oven-fresh bread at Seven-Eleven Japan. In a typical operation, a store places an order a day for three deliveries. The corporate headquarters of Seven-Eleven provides each store with information on demand in general. Store personnel are then responsible for forecasting demand and placing orders by incorporating their local information as well as the information given by the headquarters. Since Seven-Eleven places emphasis on making accurate forecasting and placing effective orders, store personnel expense much time and

efforts. Because it is time consuming, each store places orders simultaneously for the three deliveries. Each baking factory receives orders in real time directly from stores through EDI although it does not receive POS data.

	Order placed at store	Order receipt at baking factory	Dispatch from DC	Delivery to store	Lead-time from order to receipt
First	11:00 (-1)	11:15 (-1)	1:00	3:00	16 hours
Second	11:00 (-1)	11:15 (-1)	8:00	10:00	23 hours
Third	11:00 (-1)	11:15 (-1)	14:00	16:00	29 hours

Table 3. Timing of activities for delivering oven-fresh bread at Seven-Eleven Japan:  
(-1) in the table indicates the previous day.

Table 4 indicates the timing of activities in logistics of fresh vegetables including morning-harvested vegetables at York Mart. Two cycles of ordering, harvesting, and delivering are managed hourly. The table corresponds to a case where harvesting locations can be reached from a distribution center within two hours. Distribution centers apply cross-docking for delivering each store. Stores, York Mart headquarters, distribution centers, and farmer groups are connected by EDI, although POS information is not shared with the farmer groups.

	Start to harvest	Order placed at store	Order receipt at supplier	Dispatch from supplier	Dispatch from DC	Delivery to store	Lead-time from order to receipt
First	8:00 (-1)	14:00 (-1)	15:30 (-1)	20:00(-1)	6:30	7:30	17.5 hours
Second	14:00 (-1)	20:00 (-1)	21:30 (-1)	10:00	13:00	14:00	18.0 hours
Morning-harvested	6:00	20:00 (-1)	21:30 (-1)	10:00	13:00	14:00	18.0 hours

Table 4. Timing of activities for delivering fresh vegetables at York Mart:  
(-1) in the table indicates the previous day.

Ito-Yokado grocery stores continuously monitor the shelf space inventory of raw tuna sashimi, and keep the past hourly sales data. Based on such information, the stores thaw the frozen raw tuna and slice it into sashimi for sales. Products like raw tuna sashimi deteriorate in freshness very quickly, and the deterioration can be easily detected by customers. Therefore, its shelf space inventory is continuously monitored and replenished.

### **Tight cost reduction mechanism**

As discussed above, ECR for freshness requires hourly coordination of logistics, but it

does increase the logistics costs. Although consumers are willing to pay a premium for freshness, reducing the total logistics cost is critical in increasing the profit leverage and offering an attractive price. We have observed five ways companies decrease logistics costs in ECR for freshness.

### **Five Methods for Reducing Logistics Costs in ECR for Freshness**

1. Reduction of inventory related costs by frequent deliveries
2. Reduction of shelf space requirement by frequent deliveries
3. High-density and clustered store location
4. Four separate temperature-controlled trucks and distribution centers
5. Mixed loading

We discuss these five ways of reducing logistics costs for delivering freshness in detail.

#### *Reduction of Inventory related costs*

At Seven-Eleven, the order for the first delivery of oven-fresh bread is processed in two batches. The first batch is made-to-stock, and the second batch is made-to-order. In a typical example, a baking factory receives the order at 11:15 in the previous day, and the delivery to the store is at 3:00. The baking factory thaws the frozen dough and ferments it for the first batch in a make-to-stock fashion before 11:15, and then starts baking after 11:15. The second batch is processed after the order is received. That is, the factory starts producing a quantity that will certainly be required in the first batch, and then produces an extra amount in a make-to-order fashion to precisely match demand with supply.

Geographical distribution is another important consideration when scheduling production and distribution. To deliver fresh bread to distant stores in time, the first batch of baking is delivered to the distribution center as soon as it is completed. By combining make-to-stock and make-to-order with careful scheduling Seven-Eleven matches demand with supply and avoids both excess production and stock-outs.

Fresh vegetables at York Mart stores are ordered twice a day. As in Table 4, the first order for the next day is placed at 14:00, which covers approximately 60% of forecasted one-day demand. Thereafter, the store experiences the peak evening shopping at around 17:00, and the second order for fresh and morning-harvested vegetables is placed at 20:00 after observing the POS data and left-over inventory. The forecasting of next day demand incorporates information on past POS data, the numbers of customers, weather, local events, and popular TV program coverage on healthy food. Since such information becomes available and more accurate at 20:00 than at 14:00, the later forecasting is usually more



accurate. However, since the cycle time of the order is up to 18 hours, it is necessary to order a part at 14:00 and the balance at 20:00. This practice leads to the reduction of spoilage and lost profit particularly for fresh produce.

*Reduction of shelf-space requirements*

Three deliveries a day of oven-fresh bread reduce the shelf space requirement into roughly one third that of one daily delivery a day, assuming the same amount of bread is sold under both scenarios. We estimate the cost of shelf space as the total store expense, minus personnel cost, divided by the shelf-space area of a typical store. This leads to an estimate of ¥114,690 as an annual space cost for oven-fresh bread per store, and the estimate of ¥291,521 as that for the case of selling the same amount of bread in one delivery. This roughly corresponds to the saving of ¥3 a piece of bread by applying three deliveries a day vs. one delivery.

*High-density and clustered store location*

Seven-Eleven Japan determines store locations so that stores are densely located and clustered. In Tokyo metropolitan area alone, 1,211 stores are located inside a 2,100 km<sup>2</sup> region. One truck dispatched from a distribution center visits 6 stores on average in one route from a distribution center. Since the distances between stores are short, the average tour length for each truck tends to be short, and transportation efficiency is high. Note: many areas in Japan are still not covered by any cluster of Seven-Eleven's convenience stores.

*Temperature-controlled trucks and distribution centers*

To maintain freshness of products, Seven-Eleven Japan uses four temperature categories. They are shown in Table 5. There are four groups of distribution centers and trucks classified by temperature.

	Temperature	Product
Frozen	-20°C	Ice cream / Frozen food / Ice cubes
Chilled	5°C	Sandwiches / Delicatessen foods / Milk
Rice dishes	20°C	Box lunches / Rice balls / Oven-fresh bread
Dry grocery	Room temperature	Canned foods / Instant noodles / beverage / dry grocery

Table 5. Temperature categories for transportation at Seven-Eleven Japan

### *Mixed loading*

Delivering the same item multiple times a day is necessary for ECR for freshness. However, multiple deliveries do increase transportation costs. To improve transportation efficiency, Seven-Eleven Japan applies mixed loading. Each distribution center (as discussed above) belongs to a temperature category. All items belonging to this temperature category are gathered at this distribution center and then, typically using the cross-docking operations, items that are scheduled to ship to 6 stores are loaded onto a truck for delivery. Applying this mixed loading mechanism, each store now can receive only 10 truck deliveries per day as a whole.

Oven-fresh bread at Seven-Eleven is delivered to each store by a truck in which the temperature is controlled at 20 degrees centigrade. Seven-Eleven Japan delivers oven-fresh bread three times a day as indicated in Table 3, mixed with other items. They sell a piece of oven-fresh bread for ¥110 on average as compared with the regular bread for ¥100 which is delivered once a day.

Below, we give an estimate of product costs for three different logistics arrangements in order to see the effect of mixed loading on the total product cost. Scenario 1 corresponds to a typical current operation of Seven-Eleven Japan, where three production batches and deliveries a day with mixed loading are made via a distribution center. The second scenario assumes that bread is delivered three times a day directly from a baking factory where a truck only carries bread. The third scenario corresponds to one delivery a day from a baking factory to a store, which is the usual case of a major bread maker. Some more detailed assumptions to derive product cost estimates are described below.

#### **Scenario 1: Three deliveries a day via a distribution center**

As in Table 6, this current supply chain of oven-fresh bread has 4 dough factories, 19 baking factories, 61 4-ton-trucks(20°C), 61 distribution centers, 1,434 20°C-trucks, and 8,602 stores. They sell 552 million pieces of oven-fresh bread per year for ¥110 per piece on average. Each truck covers six stores in one route which takes 4 hours over 60 km.

#### **Scenario 2: Three deliveries directly from a baking factory**

This scenario differs from Scenario 1 in delivering directly from 19 baking factories to the stores. Since each truck only carries bread, the load per truck is less than that in Scenario 1. We assume here that they use 3-ton trucks in this estimation.

#### **Scenario 3: One delivery per day directly from a baking factory**

In this scenario, we assume that a major bread maker supplies Seven-Eleven's 8,602

stores and 7,683 additional competing stores once a day. A route by a truck covers 24 stores in 8 hours over 120 km. We also assume that 679 4-ton trucks are used.

The cost per bread for each stage and for each scenario is shown in Table 6. The estimates for the cost per bread for the three scenarios are ¥84.3, ¥111.4, and ¥86.1, respectively. Comparing Scenarios 1 with 2, we estimate that the current mixed loading arrangement as compared with loading only bread to trucks contributes to saving ¥27.1 per piece of bread. Comparing Scenarios 1 with 3, the total landed costs seem to be roughly even between Seven-Eleven's three deliveries a day and a major bread maker's one delivery a day. If that is the case, most of ¥10 premium charged for oven-fresh bread contributes to the bottom line.

[Scenario 1] Mixed-Loading, 3 deliveries	Dough factory	Transpor- -tation	Baking factory	Transpor- -tation	Distribution center	Transpor- -tation	Store	Consumer
	4 factories		19 factories	61 trucks	61 centers	1,434 trucks	8,602 stores	552 million
Activities	mix ferment mold/freeze	transport	defrost ferment bake/pack	transport	pick sort load	transport	receive display	purchase consume
Single/Mixed	Single			Single	Mixed	Mixed		
Cost per bread	¥58			¥1.30	¥5.50	¥2.20	¥17.30	Total ¥84.3

[Scenario 2] Single-Loading, 3 deliveries	Dough factory	Transpor- -tation	Baking factory	Distribution center	Transpor- -tation	Store	Consumer	
	4 factories		19 factories	19 centers	1,434 trucks	8,602 stores	552 million	
Activities	mix ferment mold/freeze	transport	defrost ferment bake/pack		pick sort load	transport	receive display	purchase consume
Single/Mixed	Single			Single	Single			
Cost per bread	¥58			¥5.50	¥30.60	¥17.30	Total ¥111.4	

[Scenario 3] Single-Loading, 1 delivery	Dough factory	Transpor- -tation	Baking factory	Distribution center	Transpor- -tation	Store	Consumer	
	4 factories		19 factories	19 centers	679 trucks	16,285 stores	1,045 million	
Activities	mix ferment mold/freeze	transport	defrost ferment bake/pack		pick sort load	transport	receive display	purchase consume
Single/Mixed	Single			Single	Single			
Cost per bread	¥58			¥5.50	¥5.30	¥17.30	Total ¥86.1	

Table 6. Cost comparison for loading methods and delivery frequencies

### One-to-one procurement

24-hour products like fresh produce and fish have uncertainties in both supply and demand. This should be contrasted with manufactured products like oven-fresh bread. Fresh produce and fish are supplied through wholesale markets where demand is matched with supply through pricing mechanisms such as bidding. Less supply than demand moves prices higher. This leads to undesirable situations of unstable supply and/or price of fresh produce at grocery stores. On the contrast, more supply than demand may collapse prices,

which might cause producers to sell below cost.

One mechanism to ensure stability of supply of fresh produce is one-to-one procurement. This also speeds up the cycle time of procurement. York Mart, for instance, has long-term collaborative agreements with supplier groups on supply of fresh produce without going through wholesale markets. Table 7 indicates the changes in fraction of transactions that go through wholesale markets in Japan. This indicates an increasing trend towards direct transactions between producers and retailers without going through wholesale markets.

	1985	1990	1998
Vegetables	87.4%	85.2%	82.8%
Fruits	81.4%	76.1%	61.7%
seafood	76.9%	72.1%	71.6%

Table 7. Percentage of monetary value of transactions via wholesale markets

York Mart and the supplier groups for fresh produce frequently exchange information. Table 8 indicates the mechanism used for matching demand with supply.

	Then suppliers do	Then York Mart does
If supply < demand	1- Harvest additional amount early in the morning (Two deliveries per day) 2- Use other contracted suppliers (one delivery per day)	1- Use other long-term suppliers 2- Use the suppliers set aside for shortage 3- Use wholesale markets or buy substitutes
If supply > demand	1- Ship products to other customers or wholesale markets	1- Use promotion fliers two weeks in advance 2- Use store front promotion two days in advance

Table 8. Matching demand with supply of fresh produce at York Mart

In order for one-to-one procurement to work for stabilizing supply and prices, the following four conditions have to hold:

1. short procurement lead-times
2. information sharing
3. long-term collaborative relationships
4. concurrent use of other supply channels like wholesale markets.

Because of the advance of EDI, internet, and cellular phones, a large number of information sharing arrangements and transactions with fragmented producers become possible.

York Mart procures two thirds of fresh produce by one-to-one procurement, and the rest is procured from wholesale markets to ensure stability of supply and price along with freshness. Prices applied in the one-to-one procurement reflect those of wholesale markets.

However, they do not completely coincide with those of wholesale markets in order to ensure price stability for both producers and York Mart. This is the case for the transactions of raw tuna fish between Toyo-Reizo and Ito-Yokado. They agree not to change prices at least for one month.

### Revenue management

Another aspect of ECR for freshness is revenue management. Revenue management is standard practice in industries like airlines and hotels where a large proportion of total costs are fixed, and great efforts are made to maximize revenue through careful pricing, inventory management, and detailed customer segmentation. Like 24-hour food, products such as airline seats and hotel rooms are highly perishable and cannot be inventoried for sale the next day. Therefore, some principles for revenue management can be applied, and can be observed in the case of Toyo-Reizo and Ito-Yokado for the sales of raw tuna sashimi.

Tuna products are distinguished in many ways: by species, fishing ground, fishing method, temperature, parts and grade (See Table 9). A whole tuna fish or tuna fish in one vessel can be sold as tens of varieties of tuna products. Each variety has different customers, and the price varies tremendously. Hence a retailer cannot sell effectively a whole tuna fish.

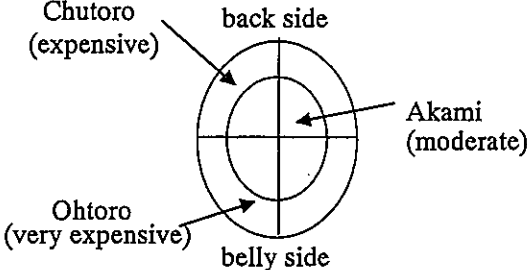
1	Species	Blue-fin / southern blue-fin / yellow-fin	
2	Fishing ground	Far sea	3 weeks per navigation. Tuna caught within 10 days can be shipped and eaten raw.
		Inshore	Shorter navigation. Tuna caught can be eaten raw.
3	Fishing method	Longline	Using baited hooks. Some tuna die of long lifting time like 15 hours. Fishing grounds are far away.
		Perse seine	Enclosing fish with seine. Most tuna are alive on being caught. Fishing grounds are inshore.
4	Temperature	Chilled	Chilled using ice. About 0°C
		Frozen	Frozen to under -50°C
5	Part and grade	Fin and head	To be processed as inexpensive parts.
		Body	

Table 9. Varieties of raw tuna sashimi

In order to maximize the revenue coming from a whole tuna fish, Toyo-Reizo has established long-term relationships with many customers, one of which is with Ito-Yokado (See Figure 10). Ito-Yokado shares the forecasts of their own raw tuna demand with Toyo-Reizo. They sell relatively inexpensive varieties at their stores. Toyo-Reizo can secure a stable channel to sell certain varieties of tuna, and Ito-Yokado can procure steadily what their customers want. Since it can sell certain varieties for sure, it is easier for Toyo-Reizo to maximize revenue coming out of a whole tuna fish by combining with other channels and customers. This collaborative relationship helps reduce the procurement and logistics cost of raw tuna sashimi for Ito-Yokado and also stabilizes its supply.

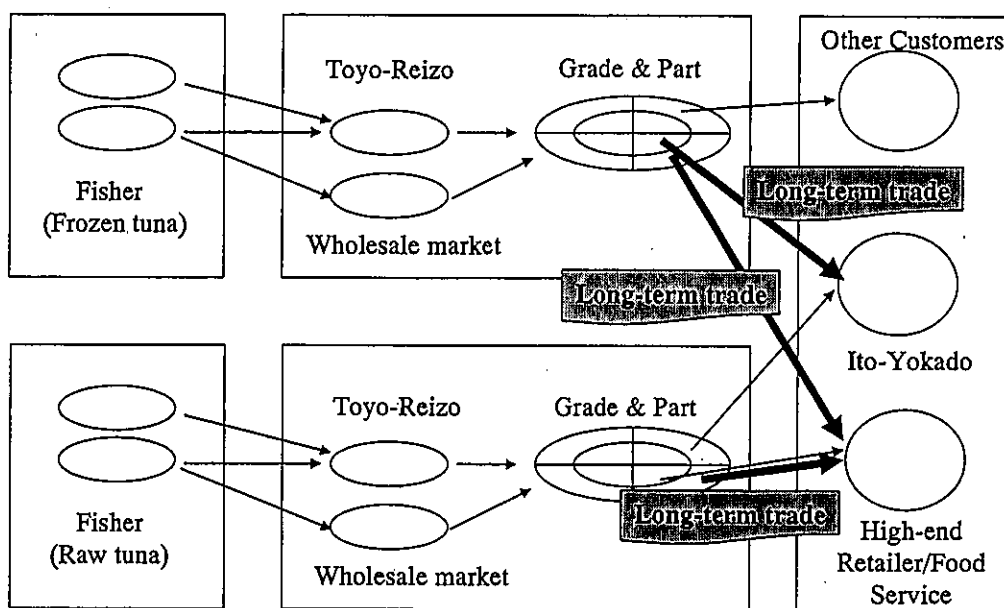


Figure 10. Collaboration for retailing raw tuna sashimi

### **Tight collaboration (Team merchandising)**

ECR for freshness involves tight collaboration between producers and retailers. Since perishable 24-hour products are moved through a supply chain on an hourly basis, the degree of collaboration is tighter than regular ECR. The two parties collaborate in terms of new product development, supply chain configuration, and logistics and marketing management. Table 11 summarizes the features of collaboration for the three cases that we have investigated.

In morning-harvested vegetables, York Mart and producer groups discuss specifications required for each vegetable, and the producers grow it as specified. In that sense, they co-develop their own brand of vegetables. At store fronts, York Mart establishes a brand by posting the names and photographs of producers to appeal the freshness and quality of

produce to customers. This can only work under one-to-one procurement arrangements as discussed above.

Oven-fresh bread is a result of collaboration between Seven-Eleven Japan and a bread producer. Seven-Eleven Japan calls such a collaborative development of new products Team Merchandising, and calls a new product an original product. Oven-fresh bread is an example of original product. Seven-Eleven has approximately 2,800 items in assortment at each store. Among them, almost half are such original products. Every week, approximately 100 items are introduced as original merchandises. Seven-Eleven Japan applies this Team Merchandising to distinguish them from their competitors.

	Co-developing new products	Co-developing supply chain	Co-managing logistics and marketing
Oven-fresh bread	Seven-Eleven Japan and bread maker jointly develop new products using POS data.	Seven-Eleven Japan, DC, and a bread maker jointly design hourly-logistics to supply oven-fresh bread.	Seven-Eleven Japan, DC, and a bread maker jointly manage hourly-logistics.
Morning-harvested vegetable	York Mart and producers jointly develop new products and packaging.	York Mart and producers jointly develop hourly logistics to supply freshly-harvested vegetable.	York Mart and producers jointly market products by posting producers names or photos, and also manage hourly logistics.
Sliced raw tuna sashimi	N/A	Toyo-Reizo processes tuna in advance based on Ito-Yokado's specifications, which reduces the work requirement at stores.	Ito-Yokado manages shelf inventory by continuous review, which is supported by Toyo-Reizo.

Table 11. Examples of tight collaboration for the three cases

### Summary

This paper has reported a framework of ECR for freshness, based on three case studies focused on the design of supply chains for the 24-hour products in Japan. We have identified six methods of ECR for freshness: matching customers' sensitivity to freshness with supply chain configuration, hourly logistics coordination, tight cost reduction mechanism, one-to-one procurement, revenue management, and tight collaboration. We have also discussed details of reducing logistics costs: reduction of inventory costs and shelf-space

requirement by frequent deliveries, high-density and clustered store location, temperature controlled trucks, and mixed loading. In the process, we have shown that when the time scale of all activities in retailing is compressed to at most 24 hours, ECR is pushed to a new limit.