[This question paper contains 15 printed pages.]

4219 *Your Roll No.* .....

MBA (FT) **A**

Paper F–3405 – LOGISTICS MANAGEMENT

(Admissions of 1998 and onwards)

Time : 3 hours *Maximum Marks : 70*

(Write your Roll No. on the top immediately on receipt of this question paper.)

Instruction to the students : Answers to the questions should be precise and brief.

SECTION A

Case : DAIKIN INDUSTRIES

Read the given case and answer the questions that follows :

Early in June, 1998, Mr. Toshinari Oka, recently appointed president of the Shiga Factory, paused to reflect on the gloomy news. The long-term weather forecast pointed towards an unseasonably cold summer, when the Shiga Factory had large quantities of finished goods inventory in anticipation of strong sales. Mr. Oka's concerns were not just for the current year, however, but also for the factory's long-term survival. He thought, "We may not be able to stay in this business."

Summer temperatures had a major impact on the total sales of residential air conditioners, and the business was only marginally profitable. Mr. Oka knew that he would need to make major changes if he wished to become more competitive and improve profitability. The question was, "How?"

THE RESIDENTIAL AIR CONDITIONING MARKET

Competition for domestic market share in Japan was fierce. There were over 10 players, including Matsushita, Mitsubishi, Hitachi, Sharp, Sanyo and Fujitsu General. Fortunately, Japan's complex retail distribution systems, together with strict environmental and energy-saving laws, had so far deterred overseas players based in Korea and China. Of Daikin's domestic competitors, Matsushita was the leader with over 20,000 exclusive nationwide retailers operating under the

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[1]*Mr. Oka was a member of Daikin's board of directors, and managing director of residential air conditioning production prior to assuming direct responsibility for the Shiga Factory.*

Panasonic and National banners, Daikin and most of the other competitors, on the other hand sold through non-exclusive appliance and home entertainment dealers who carried products from several competing manufacturers.

Industry demand in recent years had been static. Historically, new housing had been the primary source of growth, but Japan's lengthy recession had greatly reduced housing starts. As a result, industry players aimed most of their efforts at increasing their share of replacement sales. Residential air conditioners typically lasted 10 to 12 years before being replaced. Competition was intense and profit margins were slim as players strived to increase their sales in a near-zero growth market by taking market share from their competitors. In spite of its best efforts, however, Daikin's market share hovered in the nine percent range (see Exhibit 1).

Typically, consumers in Japan bought an air-conditioner for each room in their house or apartment, so homes often had three or four installed. The typical set-up consisted of two components. A refrigeration unit was mounted outside the dwelling in a place where it did not block the light or the view through the windows, and where its coils could exchange heat with the outside air (see Exhibit 2). The exterior unit was connected by coolant lines to an interior unit that contained a heat exchanger. The latter was frequently mounted on a wall or ceiling so that it did not take up living space.[2]

Exhibit 3 shows a typical product and its room location. Products were priced from about ¥80,000[3] for basic low-powered models, to almost ¥250,000 for high-powered products that, in addition to cooling the air in the room, heated it during the winter, as well dehumidifying, freshening and cleaning the air.

Residential air-conditioners in Japan were common enough to be considered commodities. Most manufacturers tried to differentiate their products by including value-added features such as on-off timers, energy-savers and noise-minimizers. Although they hoped to avoid direct price competition, features tended to be quickly matched by the competition. Product quality was comparable across brands and was not considered a significant factor in brand choice. Similarly, a manufacturer's installed base was not a factor when customers selected replacement units, since the cost of installing a new brand, was no more than replacing an existing brand.

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[2] *Window air conditioners and whole house air conditioning systems were much less common in Japan than they were in North America.* [3] *¥1,000 = US$7.17, June 1, 1998.*

For these reasons, air Conditioners were mostly chosen according to installed price and the amount of cooling required. During periods of extreme heat, however, customers also wanted their air conditioners to be installed quickly, so speed of delivery and installation were significant competitive factors. If their first choice could not be installed within three or four days, they would switch to a competing brand or store. Independent dealers, which accounted for all of Daikin's sales, avoided the risk of lost sales by recommending only those products that were either in stock or could be obtained from their regional warehouse within three days.

SUPPLY CHAIN

Daikin had the widest product line-up in the industry. There were about 600 combinations of options, which included several cooling capacities, inside mounting types (wall versus ceiling, and built-in versus surface-mounting), outside mounting types (roof, ground, wall, etc.), and functionalities (cool-only, or cool-and-heat). Because product designs changed every year, a determined effort was made to avoid carrying goods produced in one year over to the next. Seasonal peaks and troughs could be anticipated, but their exact timing and magnitude could not, since they depended on the precise days on which extremely high levels of heat and humidity occurred. Consequently, there were large fluctuations in weekly demand. And, of course, it was never easy to predict in advance whether the coming summer would be extremely hot. The extent of the annual variations in seasonality is shown in Exhibit 4. The graph displays cumulative weekly demand as a percentage of the annual totals for four consecutive years. By the end of May 1998, Daikin had sold about 180,000 units, the annual demand for Daikin's products tended to vary by about plus or minus 15 percent.

Sales Companies

Daikin served the domestic market through 21 regional sales companies. Each sales company handled the needs of the retailers in its geographic region. The sales companies, which did not carry inventory, relied on the factory to carry sufficient inventory to support the orders they received. Generally, the sales companies would not be aware of retailer inventory at either the store or warehouse level.

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The sales companies provided the factory with forecasts of dealer requirements based on experience and discussions with the retail organizations' buyers. Actual retailer orders were an important input to demand forecasts, but a manufacturing manager said, "Because the sales companies are afraid of stock-outs, they often withhold the actual level of dealer orders from the factory, and do not provide precise forecasts."

The Shiga Factory called the forecasts "pre-purchase orders" (pre-POs). Pre-POs could be cancelled by the sales companies at any time up to one month before the requested delivery date. At that point, the pre-POs automatically became firm purchase orders (POs) that the sales companies were obliged to sell. In normal years, the pre-POs and POs received by the first day of June were sufficient to fill, the factory's capacity for all of June and July.

Shiga Factory Warehouse

Products were shipped by truckload from the factory[4] directly to retailers' warehouses nationwide once a week. This provided economical transportation quantities for Shiga, since each warehouse would be ordering for many of its stores. Deliveries took one to two days. During the peak season, additional midweek deliveries were made in response to urgent orders from retailer warehouses.

Retailer Warehouse and Store Operation

The retailers were mostly chains that maintained their own regional warehouses. The retailers' warehouses would ship consolidated loads of an assortment of merchandise (air conditioners, TVs, refrigerators, etc.) to their stores, so that they also had economical transportation quantities. Shipments were timed to arrive at the stores at the start of the weekends when most air-conditioners were sold. It took a day or two for the retailer warehouses to pick and move the required merchandise to the stores.

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[4]Several of Daikin's competitors maintained warehouses at their sales companies, whereas Daikin held all of its air conditioner inventory at the Shiga Factory.

The individual retail stores did not have much space, so they would only stock what they expected to sell over the weekend, plus a safety margin. With potential demand for 600 different Daikin product variations, however, it was difficult to carry anything more than the most frequently requested options. Therefore, the stores relied on rapid order fulfillment from their regional warehouses.

MANUFACTURING

The Shiga factory was established for mass production of residential room air conditioners in Kusatsu City, Shiga prefecture, in 1970. The factory was located 20 miles from Daikin's corporate headquarters in Osaka, Japan. The 276,000 square-metre factory was Daikin's only production base for home room air conditioners.

About 670 thousand units were produced for domestic consumption in 1997. An additional 15 thousand units were exported.

The Assembly Lines

The manufacturing process was predominantly light assembly. There were approximately 100 components in each product. About 20 components were varied to produce the 600 different product combinations, while 80 components were common across most models. All the components that might be required at a particular work station were positioned behind the assembly workers. Defects occasionally occurred when workers installed the wrong component after an option change.

Assembly was divided between interior and exterior units. The components for the indoor units consisted of a plastic outer cover, a steel inner frame and a heat exchanger. These components were produced on four automated lines before merging into the final assembly line (see Exhibit 5). Purchased parts, including tubing, fan motors and fans were installed by line workers. After assembly, functional checks were performed by sensor machines. Products that passed inspection were packaged at a final stage.

The components for the outdoor units consisted of parts that were also mostly produced automatically. Refrigerant tubing was automatically checked for leakage before being merged with the other items on the final line. The main component

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installed on the final line was the compressor, which compresses and circulates refrigerant through the system. It took 138 minutes for each unit to flow through the entire assembly process.

Human Resources

Shiga Factory had about 330 permanent employees who worked year-round. Daikin attempted to closely follow seasonal demand by employing over 600 temporary workers at the peak. Long-term relationships were formed with many of the temporary workers. They returned, year after year, under contracts that promised them a minimum number of hours during the peak season, but they allowed Daikin to specify when the hours were to be worked.

To compensate for the work's unpredictability, hourly pay was slightly more than the wages that were paid to full-time, permanent workers. Permanent workers had an unbalanced schedule that also helped address the seasonal peaks. Permanent employees worked 50 hours or more per week in the peak and only 30 hours during the off-peak. The extra help and the extra summer work hours allowed Daikin to staff three eight-hour shifts for six days a week during the peak.

The system worked well since it provided the factory with experienced workers who had to be paid only when they were needed. In return for their service, temporary workers were given first consideration for full-time employment when the factory required more permanent workers.

Production Planning

The factory's capacity requirements were accumulated by requested pre-PO delivery date and prioritized according to date received. The factory did not accept orders for delivery during weeks in which it had already filled its capacity. When orders were refused, the sales companies attempted to convince retailers to accept a different — usually later — delivery date, but retailers usually declined, opting for another supplier. Orders were frequently lost because the factory was unable to promise delivery in the requested week. Hence, the sales companies' forecasts' tended to err on the side of optimism.

Production plans and employment schedules at the Shiga factory were updated once a month, based on the pre-POs received. The factory made from 50 to 70 different product variants each day, following a mixed model production strategy. The factory maintained centralized control over all finished goods inventory. Highly seasonal demands forced the factory to carry large inventories. The monthly average finished goods inventory amounted to 86 days in the 1997 fiscal year (April 1997 to March 1998).

Purchasing and Research and Development

The factory was also responsible for research and development (R&D) and purchasing. A wholly owned Daikin subsidiary supplied electronics components and pipe assemblies. The suppliers of heat converters, copper and aluminum components frequently collaborated with the factory in technology development. Supplier relationships were based on close interactions within the Daikin Group, and, where cross-share holdings did not exist, long-term associations were maintained with outside suppliers.

These arrangements provided the factory with reliable deliveries of high-quality inputs at the lowest cost consistent with reasonable returns on supplier investments. Materials were ordered from suppliers once a month based on the production plan. The longest component lead time was three months, but most items were received and processed through the factory eight to 10 days after being ordered.

Material cost, at 85 percent of the cost of goods sold, dominated the typical product cost. Direct labor accounted for six percent, while overhead added the remaining nine percent. Mr. Oka reflected back on the cost reduction efforts that the factory had made to date. "We have achieved a cost reduction of ¥50 billion over the last three years, but it is still not enough to surpass our competitors."

OPERATIONS IN CHINA

Many Japanese manufacturing companies considered China to be a strategic location for producing products for export to Japan and North America. China was also an attractive domestic market due to China's extremely large and mostly under-serviced

population. Labor costs for line workers in China were about five percent of their counterparts in Japan, making production in China especially attractive for labor-intensive assembly operations like Daikin's.

There would also be opportunities to reduce the costs of material purchased in China due to suppliers' low labor rates. While competitors, such as Matsushita, had residential air conditioner plants in China, Daikin did not. It did, however, have some manufacturing presence in China (see Exhibit 6).

Mr. Oka wondered about the implications of moving production from Japan to China. If it did move, Daikin's relationships with its 21 sales companies, 91 suppliers, and even the consumers who purchased its products, could change. For example, what would be the effect of the longer supply chain ?[5] Who would take care of the logistics from the factory to the port in China, from there to the port in Osaka and then on to Shiga Factory ? Would the sales companies insist on opening their own warehouses ? Would acceptable input materials be available in China ? If not, would Daikin's suppliers be willing to move to China, or would Daikin be forced to import its materials from Japan ? Would consumers perceive the quality of "Made in China" products to be lower ? It seemed that the competitive advantages and disadvantages of producing offshore needed more thought.

THE DECISION

In addition to current efforts to forecast demand fluctuations, Mr. Oka was considering the following alternatives to the status quo.

Product Consolidation

Consolidation of the 600 product variants would surely help the factory reduce inventory and improve operational efficiency, However, Mr. Oka was unsure how the sales companies, and ultimately the customers, would respond to the consolidation, given the fact that Daikin's market share was under downward pressure and that providing maximum choice was an explicit sales strategy.

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[5]*Sourcing from China would add about five days to Daikin's lead time. Some competitors were already operating supply chains times that were five days shorter than Daikin's.*

Build a Factory Outside Japan

Another possibility would be to build a new factory in China or Malaysia to take advantage of the lower labor costs. This could allow a stronger emphasis on competitive prices. It was not clear how the move would affect Daikin's relationships with its suppliers and sales companies. The move of the manufacturing base would mean that the employees in the effected areas at Shiga Factory would have to be laid off. The company had a policy of no lay-offs, which it was reluctant to abandon. A few could probably be transferred to other Daikin factories in Japan. Other stakeholders might also be effected, so the costs and benefits of this option needed to be thought out carefully.

Exit the Business

While Mr. Oka did not give it much thought, now might be the right time to simply exit the business and divest itself of its assets.

RECOMMENDATIONS TO THE BOARD

Mr. Oka wondered whether there were other alternatives that might help Daikin gain a competitive advantage. While mindful of the rapidly approaching peak season, Mr. Oka was more concerned about long-term survival. Mr. Oka knew that procrastination would diminish the chances of staying in business, much less of growing the business. He also knew that whatever changes he made, he must think of their ramifications for employees, suppliers, retailers and, most importantly, consumers. He had only two weeks until the board meeting at which he would be presenting his recommendations.

Exhibit 1

MARKET SHARES IN THE 1997 SEASON
(October 1996 to September 1997)

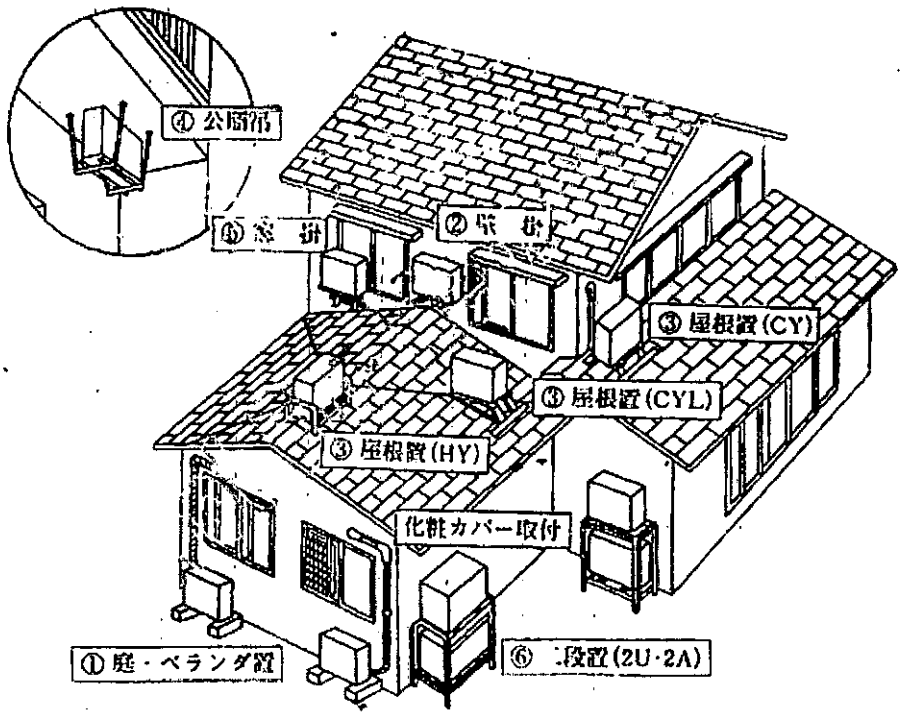
Manufacturer	Market share (%)
Matsushita	18.0
Mitsubishi Electric	15.0
Toshiba	11.0
Hitachi	10.5
Sanyo	10.0
Daikin	9.0
Others	26.5

Total Industry Unit Sales: 7,154,000

Source: Company files.

Exhibit 2

ALTERNATIVE MOUNTING OF OUTSIDE AIR CONDITIONING UNITS



Source: Company files.

DAIKIN

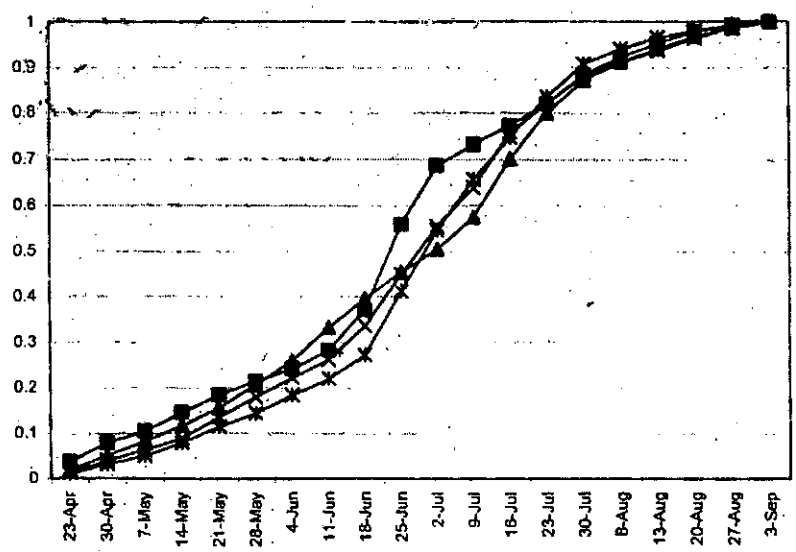
Exhibit 3

A TYPICAL INTERIOR UNIT MOUNTED ABOVE-WINDOW

Source: http://global.daikin.com/global/our_product/index.html July 22, 2004.

Exhibit 4

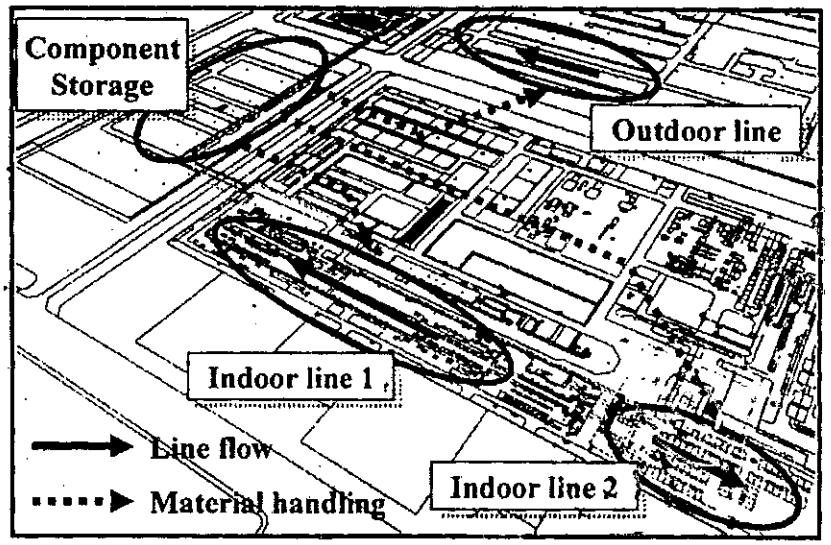
CUMULATIVE DEMAND IN EACH WEEK AS A PERCENTAGE OF ANNUAL TOTAL DEMAND



Source: Company files.

Exhibit 5

SHIGA FACTORY ASSEMBLY LINE



Source: Company files.

Exhibit 6

DAIKIN MANUFACTURING IN CHINA

Division	Products	Application
Shanghai Daikin Air conditioning	Commercial air conditioning	Commercial sales in China
Xi'an Daikin Qian'an Compressor	Compressors	Large commercial air conditioners
Hui Zhou Daikin Suns Air conditioning	Water Chilling units	Shipping container refrigeration
Daikin Fluoro Coatings Shanghai	Fluorocarbon resin coatings	Refrigerators and freezers

Source : Company files.

(a) Trace the information flow from the end-consumer back through the supply chain to the Shiga Factory's suppliers to the end consumer of its residential air-conditioners and the physical supply chain forward from its suppliers back to the consumer. How long does it take to place orders, order materials, convert them into product and have the products available for purchase by consumers ?

(b) Which steps in the supply chain, if any, would you like to tighten up or eliminate ? If so, how would you proceed ?

(c) Inventory levels over the year average 86 days. How could this be ? What would you do to reduce inventories ?

(d) Would a move to a low-cost country such as China be in your plans ? If so, when and how ? (25)

SECTION B

Answer any **TWO** *of the following.*

1. SuperPart, an auto parts distributor, has a large distributor in Chicago region and is deciding on a policy for the use of TL or LTL transportation for inbound shipping. LTL shipping costs \$1 per unit. TL shipping costs \$800 per truck plus \$100 per pickup. Thus a truck used to pick up from three suppliers costs $800 + 3 \times 100 =$ \$1100. A truck can carry upto 2000 units. SuperPart incurs a fixed cost of \$100 for each order placed with a supplier. Thus, an order with three distinct suppliers incurs an ordering cost of \$300. Each unit costs \$50 and SuperPart uses a holding cost of 20%. Assume that product from each supplier has an annual demand of 3000 units.

   (i) What is the optimal order size and annual cost if LTL shipping is used ? What is the time between orders ?

   (ii) What is the optimal order size and annual cost if TL shipping is used with a separate truck for each supplier ? What is the time between orders ?

   (iii) What is the optimal order size and annual cost per product if TL shipping is used but two suppliers are grouped together per truck ? (9)

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2. Motorala obtains cell phones from its contract manufacturer located in China to serve the US market. The US market is served from a warehouse located in Memphis, Tennessee. Daily demand at the Memphis warehouse is normally distributed, with a mean of 5000 and a standard deviation of 4000. The warehouse aims for a CSL of 99%. The Company is debating whether to use sea or air transportation from China. Sea transportation results in a lead time of 36 days and costs $0.50 per phone. Air transportation results in a lead time of 4 days and costs $1.50 per phone. Each phone costs $100 and Motorala uses a holding cost of 20%. Given the minimum lot sizes, Motorala would order 100,000 phones at a time (on average, once every 20 days) if using sea transport and 5000 phones at a time (on average daily) if using air transport. To begin with, assume that Motorala takes ownership of the inventory on delivery.

   (i) Assuming that Motorala follows a continuous review policy, what re-order point and safety inventory should the warehouse aim for when using sea or air transportation ?

   (ii) How many days of safety and cycle inventory will Motorala carry under each policy ? (9)

3. (a) Suppose you want to forecast the number of students who will sign up for a class. Information for the 'previous years' registration is year 1 = 41, year 2 = 44, year 3 = 50, year 4 = 57, year 5 = 59. Furthermore, the estimate of initial level and trend are 39 and 2.0 respectively. Assume alpha = 0.25, beta = 0.5. Answer the following questions :

   (i) At the end of year 5, what is your forecast for enrolment in year 6 ?

   (ii) What would be your most up-to-date forecast for year 8 ?

   (b) Why do time-series forecasting methods work well for short-term forecasting but do not work very well in long-term forecasting ? What information does the MAPE provide to a manager ? (5+4=9)

SECTION C

Answer any **THREE** *of the following.*

4. (a) What are the advantages of moving the push-pull boundary earlier in a supply chain ? What about later ?

   (b) Is it possible for the appropriate supply chain (push, pull, push-pull) to change during a product's life cycle ? If not, explain why. If it is possible, what are some specific examples of products for which the appropriate supply chain changed ? (4+5=9)

5. (a) Compare between two types of retailer-supplier partnerships: Quick response and Continuous replenishment. Under what conditions, one is preferred over the other two.

   (b) What are the key functional roles of IT in a supply chain ? (5+4=9)

6. (a) Compare and contrast the supply chains followed by the two food product firms mentioned below :

   (i) A firm offering a food product targeted at the lower end of the economic pyramid (e.g. Tiger biscuit offered by Britannia).

   (ii) A firm offering a premium food product (e.g. Lays offered by Pepsi).

   (b) Identify one product each in the functional and innovative categories. Identify similarities and differences in the supply chains for these products managed by their respective firms. (5+4=9)

7. (a) Over a period of time, Amazon.com has built new warehouses located at geographically different parts of the USA. Why should an e-retailer need multiple warehouse located at different parts of the country ?

   (b) Discuss how each of the following helps alleviate the bullwhip effect :

   (i) E-commerce and internet.

   (ii) Express delivery

   (iii) Everyday low pricing

   (iv) VMI (5+4=9)