INVENTORY MANAGEMENT IN A HIGH TECHNOLOGY ORGANISATION: THE IMPACT ON CONSUMERS FROM PERSPECTIVE OF THIRD PARTY LOGISTICS PROVIDER

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Abstract:

Inventory management decisions are an integral aspect of organisations. This paper addresses two inventory management systems that are evident in the high technology industry being inventory postponement and inventory speculation. Inventory postponement as argued by Bucklin (1965) is where a firm deliberately delays the purchase and the physical possession of inventory items until demand or usage requirements are known with certainty. This is an effective supply chain strategy adopted by high technology organisations by reducing the inventory, and in turn reducing the cost of obsolete stock.

This paper investigates a high technology organisation with respect to inventory management decisions, and identifies factors that lead the high technology organisation to adopt inventory postponement over inventory speculation. This paper examines the relative importance of the inventory management decisions made by the high technology organisation, and the implications these decisions have on the third party logistics provider and the impact this has on the consumer. There have been 13 key qualities investigated with respect to inventory management decisions with the effect these have on the consumer. These qualities are customer satisfaction, on time delivery, strong communication with client, strong communication with customers, order fulfilment, adequate inventory levels, rapid inventory replenishment, adequate warehouse storage, accurate forecasting, reliable service providers, safety stock, reliable stock quality, and warranty. This research has shown that the three key qualities that are essential in inventory management decisions for the high technology organisation from the perspective of the third party logistics provider are customer satisfaction, on time delivery and order fulfilment.

1. INTRODUCTION

Companies face a dilemma in today's competitive marketplace, where on one hand, customers demand customised products and services and require that their orders are filled quickly, but on the other hand they do not want to pay a premium for this customisation and availability (Graman and Magazine, 2006). Therefore, organisations are exploring ways toward postponement strategy in response to constantly changing demands (Yang et al.(2004).

Graman and Magazine (2006) argued that today, the cost of holding inventory, extensive product proliferation and the risk of obsolescence, especially in rapidly changing markets, make the expense of holding large inventories of finished goods excessive and that high-demand items naturally have safety stock assigned to them, but in many organisations there are so many very-low-demand items that keeping any stock of these items is unreasonably expensive, so they argue that companies must now provide good service while maintaining minimal inventories. Therefore, inventory management approaches are essential aspects of any organisation.

Wallin et al. (2006) has argued that that a typical manufacturing firm spends on average, 56 cents out of every dollar of revenue to cover the direct cost of purchased goods, and Monczka et al. (2002) and Handfield (2002) have argued that this percentage figure is higher for the typical wholesaler or retailer. Wallin et al. (2006) argued that a firm carrying $20 million in purchased goods inventory would incur an additional $6-7 million in material handling and inventory holding costs, but once these direct and indirect costs are reduced, the firm's net profits increase. Therefore, organisations from manufacturing to wholesale to retail require effective inventory management. However, inventory management in the high technology organisations need special attention.

The consequences of poor inventory management may result in the customer’s looking elsewhere in order to have their IT requirements met. Businesses that rely on high technology needs to ensure they can have their IT issues resolved in a timely manner, as any delay may lead to a loss in revenue or production. Therefore, many leading high technology organisations may hand over the inventory management aspect of it to a third party logistics provider, in order for the high technology organisations to focus on the keys aspects of their company being research and development, customer service and customer technical support. Third party logistics providers need to ensure they have the right system and practices in place in order to carry out the priorities and duties of the high technology organisation.

Wallin et al. (2006) classified inventory management into four inventory management approaches being inventory speculation, inventory postponement, inventory consignment and reverse consignment. Inventory speculation is where a purchased item is held in inventory at the buying storage facility in advance of demand, whereas, inventory postponement the supplier waits to purchase and take receipt of the item until the demand is known. Inventory consignment, on the other hand, is where a firm physically holds the inventory even though the inventory is still with the supplier and reverse inventory consignment is where a firm pays and owns the inventory but does not hold possession of it, and this inventory is stored within the supplier’s network of storage facilities (Wallin et al., 2006).

These two latter inventory management approaches of inventory consignment and reverse inventory consignment are not applicable in this research paper as these two inventory management approaches are not applicable for third party logistics providers. This is the case

as consignment inventory is inventory in the possession of the customer but still owned by the supplier, and the customer only purchases the inventory after they have sold it. Therefore, this inventory management approach is from a retailer perspective, not from a third party logistics provider's perspective. This is also the case with reverse inventory consignment.

The purpose of this paper is to investigate the nature of inventory management in the high technology organisations with respect to inventory management approaches, with special attention given to inventory postponement and inventory speculation from the perspective of a third party logistics provider and the impacts these decisions have on the consumer.

The remainder of this paper is structured in the following manner. First, the paper presents a brief literature review with specific focus on two main inventory management approaches such as inventory postponement and inventory speculation adopted by high technology organisations. This section also discusses inventory management in high technology organisations and investigating these inventory management decisions from the perspective of the third party logistics provider and the consumer. Then the research design is presented followed by results and discussion. The paper presents its conclusion and limitations of study at the end.

2. LITERATURE REVIEW

a. INVENTORY MANAGEMENT APPROACHES

Wanke and Zinn (2004, p.466) states that inventory management approaches are a "function of product, operational and demand related variables such as delivery time, obsolescence, coefficient of variation of sales and inventory turnover" and that logistics managers are more likely to decentralise inventory in order to stock product close to the customer's facility if the customers demand a reduced delivery time.

On the other hand, Imai (1998) states that organisations that have a long lead time of production, in turn leading to a large amount of inventory, means that there is no flexibility to meet changing customer orders on a day-today basis. Therefore, the problem with this inventory management decision is that "when the forecast is off-which is usually the case-companies may be left with a volume of unsold products or its market may evaporate overnight when consumer preferences change or when a competitor comes up with a new and better product" (Imai, 1998, p.26).

Therefore, for an organisation to adopt the right inventory management approach, this inventory management approach is necessary in order to gain more customers through customer satisfaction, and in order for the third party logistics provider organisation to operate effectively through the preferable approach.

Imai (1998) has argued that there is a "push", "pull" and "just in time" inventory management system. The just in time system is based on the "pull" from the market, and this "pull production is based on a short, slim production line with the shortest possible production lead time, which allows the company to respond to the fluctuating orders from the market" (Imai, 1998, p.27). "This system ensures that the minimum-required number of the popular models is always in stock, (and) in addition to increasing flexibility and reducing inventory to the minimum, the number of operators on the line can be drastically reduced,

(and so) as a result, the overall cost of operations can be drastically reduced" (Imai, 1998, p.28).

Yang et al (2004) has argued that supply chains have evolved from traditional forecast-driven push to demand-driven pull systems over time, and that postponement is playing an increasingly important role in a supply chain. Yang and Burns (2003) argued that postponement fosters a new way of thinking about the supply chain and Van Hoek (1999) identified that postponement is an important characteristic of modern and competitive supply chains.

Chan et al. (2002, p.1446) states that "many companies have realized that important cost savings can be achieved by integrating inventory control and transportation policies throughout their supply chains". Therefore, these companies need to ensure they have an optimal replenishment plan, being an inventory and transportation strategy, in order to minimise total inventory and transportation costs over a finite planning horizon (Chan et al., 2002).

These undisclosed companies, as explained by Chan et al. (2002), rely on external third party logistics providers for the transportation of goods from suppliers through warehouses to retailers. "This cost structure, representing quantity discounts, volume-based price incentives, and other forms of economies of scale, has a major impact on the replenishment strategy. It usually reflects either incremental or all-unit discount effects, leading to the following types of cost functions" (Chan et al., 2002, p.1447).

Tarn et al. (2003) has described that when a consumer places an order, "the order goes to the fulfilment operation, the distributor, the manufacturer, or a combination of the above (where) it is then picked, packed, handed to a shipper, and delivered to the customer" (Tarn et al., 2003, p.350). The consumer who orders quickly expects delivery also quickly, but when the merchandise is not there, a consumer may not return, a lost sale has just been created and this places increased pressure on managing demand and planning up and down the supply chain (Tarn et al., 2003). This loss of sale can be attributed to the inventory management principle of inventory postponement.

Through the exploration and research of inventory postponement and inventory speculation, these inventory management approaches will be applied in the high technology organisations to observe which one of these is adopted or if in fact both inventory management approaches are adopted. By understanding which inventory management approach is being applied in the high technology organisations, the implications of this approach, whether it is inventory postponement or inventory speculation, will be investigated in this industry.

i Inventory Speculation

The most common inventory management method is inventory speculation (Wallin et al., 2006). Bucklin (1965) has explained this by stating that a firm would purchase items and physically hold this inventory within its storage facilities before there is a demand from the consumer. There are several advantages to this inventory management method being that there is an ability to respond quickly to demand or requirement as well as the ability to protect itself against fluctuations in prices (Wallin et al., 2006). Wallin et al. (2006) has also cited Bucklin (1965), Zinn and Bowersox (1988), and Pagh and Cooper (1998) showing that another advantage of inventory speculation is that there can also be a reduced inbound

transportation costs from buying in bulk. The main disadvantages with inventory speculation, is that “besides the opportunity cost and financial burden of having cash tied up in physical inventory, there is also the incurrence of high inventory holding costs, given the need for storage, material handling and tracking, and given the threat and expense of inventory obsolescence, particularly when operating in highly volatile competitive environments” (Wallin et al., 2006, p.53).

Pagh and Cooper (1998) has argued that inventory speculation makes it possible to gain economies of scale in manufacturing and logistics operations, and limit the number of stock outs and Svensson (2003) has argued that inventory speculation is the movement of goods to forward inventories and that they should be carried out at the earliest possible time in the marketing flow in order to reduce the costs of the marketing system. Svensson (2003) has also argued that speculative inventory will appear at each point in a distribution channel whenever its costs are less than the net savings to both buyer and seller from postponement.

ii Inventory Postponement

Rietze (2004) has argued that inventory postponement refers to delayed decision-making about a product, and that it is beneficial to delay commitment to product-specific characteristics as late as possible in order to avoid a mismatch between orders and inventory on hand. Bucklin (1965) supported this explanation agreeing that a firm operating under an inventory postponement approach would deliberately delay the purchase and the physical possession of inventory items until demand or usage requirements are known with certainty. Wallin et al. (2006) has elaborated this point by stating that through inventory postponement, a firm can minimise the risk of inventory obsolescence, reduce the opportunity cost of having capital tied up in these items, and avoid acquiring inventory storage and tracking expenses since this inventory is physically located with the supplier. However, there are drawbacks to inventory postponement as revealed by Zinn and Bowersox (1988) and by Pagh and Cooper (1988). These researchers have shown that inventory postponement can lead to a risk of lost sales caused by the firm being unable to respond quickly to consumer requests but not having the inventory readily accessible and available. Xu et al. (1994) has also shown another drawback of inventory postponement being that there would be an increase in transportation and materials handling costs by the need to purchase in smaller batch sizes, and this can lead to price increases.

Wallin et al. (2006) has cited Zinn and Bowersox (1988), stating that when the dollar value per unit of a purchased item is high and when sales volume for units of this item fluctuates greatly, inventory postponement would be preferred over inventory speculation. However, “according to Pagh and Cooper (1998), inventory speculation would be a "better approach" than inventory postponement when a purchased item is a relatively standard product in early stages of the product life cycle and faces low demand uncertainty and low customer order-to-delivery time but high-delivery frequency” (Wallin et al., 2006, p.55).

Rietze (2006) has argued that the length of delay is specific to a product but the common strategic motivation is to gain better information about customer demand by waiting to customise a product for a particular market or customer. Rietze (2006) continues arguing that postponement enables forecasters to make better predictions about end product demand over time since the standard module is built-to-forecast and the finished product is built to a better forecast or even built-to-order. Rietze (2006) explains that a major benefit of inventory postponement is that there are better end product forecasts and the ability to respond quickly

to demand signals by holding unfinished goods in inventory awaiting final assembly or customization, and that postponement also creates opportunities to lower inventory costs due to risk pooling because goods are kept in unfinished or component form and can be used to assemble more than one type of finished goods.

b. INVENTORY MANAGEMENT IN TEH HIGH TECHNOLOGY INDUSTRY

Wallin et al. (2006) study has shown how Dell operates on a "build-to-order" business model, where Dell waits until customer orders are firm before placing its own purchase orders for subsystems and components in the case of new computing systems or accessories. Wanke and Zinn (2004) has described the differences between Dell Computer electing to make to order with their emphasis on the pull demand by only manufacturing and distributing computers in response to a customer order, and in doing so, maintains a minimal investment in inventory, as opposed to their direct competitor, Hewlett-Packard, that elects to manufacture products to stock on the basis of a sales forecast.

This “build-to-order” system that Dell Computer elects to use, has been adopted by Compaq Computer Corporation, the world's largest PC maker in 1997 (Imai, 1998), and that they will be built after Compaq receives an order joining other industry leaders of Dell Computer and Gateway, which also wait to build until an order comes in (Imai, 1998).

Billington et al. (2004), has shown that “the uncertainty surrounding inventory-driven costs creates the dual problem that these costs are both difficult to calculate and difficult to forecast (and) one year ahead in the budgeting process is impossible to know for certain which products will be in high demand and which will be in low demand; which components will be delayed; and which suppliers will have quality problems” (Billington et al., 2004, p.61). Billington et al. (2004, p.61) uses HP as an example “saying that too much inventory of the wrong type or at the wrong place in the chain can increase obsolescence costs; on the other hand, too little of the models in demand can create allocation conflicts and lost sales” and that this is the main reason why HP holds safety stock at various points in the supply chain to ensure high service levels Billington et al. (2004).

With IBM, Fleischmann et al. (2003) has shown that IBM has recognised the benefits of closed-loop supply chains that integrate product returns into business operations, and that through the area of reverse logistics, there is a return of used products at the end of their normal life cycles, which are a valuable resource. IBM has found that refurbishing, remanufacturing, and recycling, allows it to recapture part of the original value added or the value of materials, thereby extending their profits (Thierry et al. 1995).

Kapuscinski et al. (2004) mentions that Dell management is concerned that, although the firm carried almost no inventory, its suppliers might be holding much more inventory than was needed to provide desired customer service. It is through this reason “Dell sought recommendations for a sustainable process and decision-support tools for determining optimal levels of component inventory to support the final assembly process” (Kapuscinski et al 2004., p.192). Dell typically carries very little inventory with the whole organization concentrating on speeding components and products through its supply chain (Kapuscinski et al., 2004). “By employing the concept of postponement and combining it with a holistic view of the supply chain, a small number of best practice companies have managed to increase the performance of their firms and the supply chain as a whole” (Pagh and Cooper, 1998, p.13). However, is inventory postponement bettering the high technology industry?

i Inventory Speculation in the High Technology Industry

Pagh and Cooper (1998) has explained that inventory speculation is traditionally the most often used by companies and that full speculation of all manufacturing and logistics operations is practiced. An example of this in the high technology industry is with Xerox. Pagh and Cooper (1998) have shown that since 1990, Xerox has been working on integrating the supply chain from supplier to end customer, with one of these needs being Xerox's standard commodity products such as their plug-and-play products like small workstations, small copiers, telecopiers, etc.). Pagh and Cooper (1998) have shown that these products are now both fully manufactured and distributed in anticipation of future demand.

Wallin et al. (2006) has discussed an example of IKON Office Solutions that integrates imaging systems and services, helping businesses to manage document workflow and enabling them to increase efficiency. Wallin et al. (2006) has elaborated further arguing that IKON is in the business where when office equipment breaks down, the typical consumer demands a quick resolution, often expecting the service technician to have repair parts readily available upon diagnosis of breakdown problem without the need of scheduling a second visit. IKON has approximately 7,000 service technicians in the field, which represents 7,000 store locations of multiple repair parts that are stocked in anticipation of potential usage that is tremendously difficult to predict (Wallin et al., 2006).

ii Inventory Postponement in teh High Technology Industry

In the high technology industry, as shown by Wallin et al., (2006, p.53) inventory postponement can cause the "consumer the risk of lost sales because the firm may not be able to respond in as timely a manner as having these items readily available within its own storage facilities". This is the case, as if an IT server goes down, affecting the production of a key business line, and spare parts are not available due to inventory postponement, repair to this IT server and activating the production line again may take anywhere between 3-5 days. A business losing 3-5 days production can be a significant loss to their organisation.

An example of inventory postponement is with Hewlett-Packard's employment of decentralised final customization of their DeskJet printers for the European and Asian markets (Pagh and Cooper, 1998). With HP Deskjet printers, HP decided to postpone the final manufacturing operations (power supplies, packaging, and manuals) until the local distribution centres, so that it is only necessary to manufacture, distribute and stock (at the local distribution centres) one kind of DeskJet printer (Pagh and Cooper, 1998). Pagh and Cooper (1998) describe that the "final customization at the local distribution centres is based on customer orders, and as a result of the decentralization of the final manufacturing operations, manufacturing cost has increased slightly, but the number of SKU's and the safety stock has dropped, and furthermore, the total manufacturing, shipping and inventory costs were reduced by 25%" (Pagh and Cooper, 1998, p.17).

Inventory postponement is apparent in the white good industry as well as Rietze (2006) described the postponement of approaches made about the product during its distribution lead time (from finished product to customer delivery). Rietze (2006) describes the example of Whirlpool, a popular manufacturer of household appliances, where holding inventory of large appliances such as refrigerators and washing machines at local stores is costly because of the high product value and the space taken up in a back storage room. Therefore, as Rietze (2006)

explains, Whirlpool will send finished goods to a central distribution centre and ship directly to the home once a customer order is placed, which saves the retailer in inventory cost and eliminates additional transportation cost by bypassing the retailer, as well as reducing the risk that is inherited in sending a dedicated number of products to individual stores and having to tranship orders between retailers.

Inventory postponement has its benefits and costs. The major benefit that inventory postponement has is the potential to decrease the total delivered cost of a product. Other benefits include allowing businesses to offer a wider selection of products to their customers, enabling businesses to improve forecast accuracy, enabling businesses to reduce inventories, and improving customer service levels. Rietze (2006) argue that the costs of inventory postponement include implementation and manufacturing, as well as the cost to implement and maintain inventory postponement.

By the high technology organisations offering a wider selection of products to their customers, they can meet their customer requirements and in return the high technology organisation can increase their sales as well as price. As mentioned previously, Dell has adopted a "build-to-order" strategy. This strategy enables Dell to manufacture a product according to customer specifications, and offers its customers a wide selection of products in a cost effective way. More specifically, Dell has one product on the market called Dimension 4600C desktop. This desktop, as shown in Table 2 Shen et al. (2003) as cited in Rietze (2006, p.24), can make 100 million different computers using different combinations of the components as per Table 2. Dell does not stock each of the 100 million varieties of computers, but wait for the customer's order before they build the computer.

TABLE 2: COMPONENT LIST AND OPTIONS FOR DELL 4600C

PARTS	OPTIONS
Intel Pentium 4	5
Operating Systems	5
Productivity Software	6
Memory	8
Hard Drive	4
Floppy/Storage Device	4
CD/DVD Drive	6
CD/DVD Software	4
Storage Devices and Media	2
Keyboards	3
Mouse	4
Monitor	9
Total Combinations	100 million

Reproduced from Shen et al (2003)

Dell has thrived in this strategy to the point where Dell is able to shape demand and produce popular combinations to forecast as well as offering discounts on combinations that are popular and can carefully encourage customers to choose components that are in stock using discounts Rietze (2006). This strategy allows them to offer a quick turnaround and ensures that customers will not have to wait more than a week for a new product.

c. THIRD PARTY LOGISTICS PERSPECTIVE OF INVENTORY POSTPONEMENT AND INVENTORY SPECULATION IN THE HIGH TECHNOLOGY INDUSTRY.

Much of the research carried out has been focusing on the challenge of inventory management approaches from the perspective of the organisation, or from perspective of the consumer, and how the inventory management decision of the organisation affects them. However, with respect to the logistics aspect whereby the third party logistics provider handles the inventory of the organisation, and distributes the stock accordingly to the consumers, there has been minimal research found.

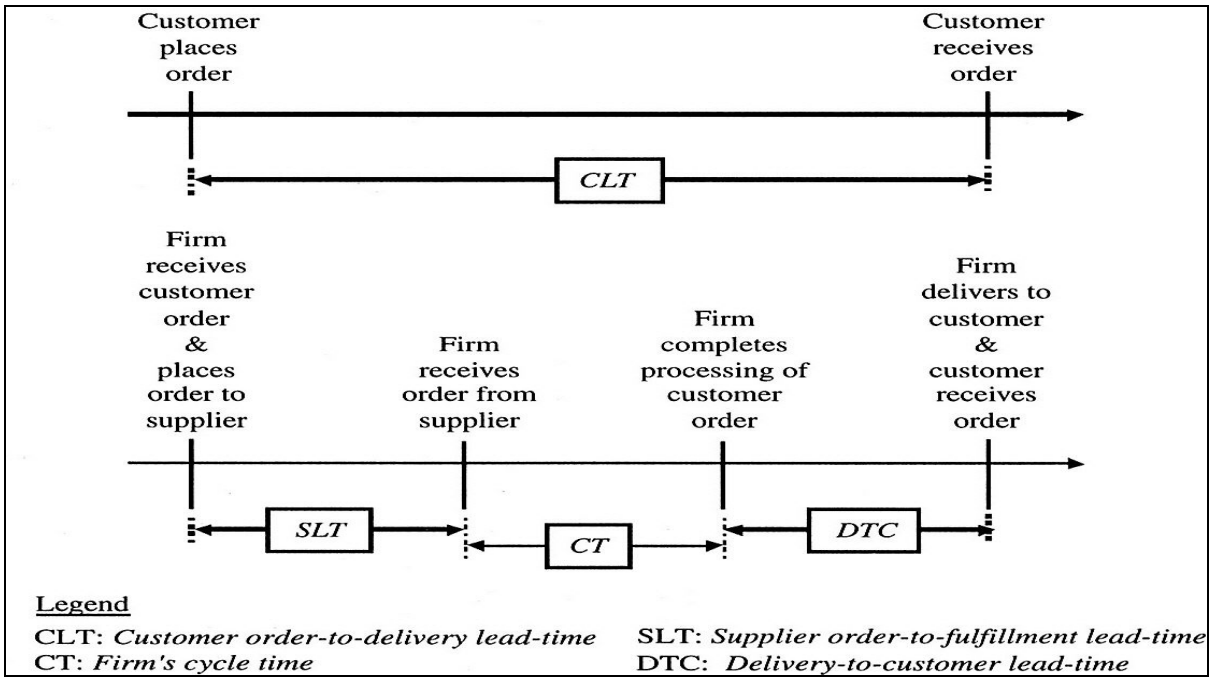
In many instances, it is the third party logistics provider who handles the product, ensures right product is dispatched to the consumer, communicates with the consumer regarding delivery address and delivery time, and in some instances, communicates with the technician, if a service technician is required. Pagh and Cooper (1998) argued that many third party providers are now capable of performing operations such as labelling and packaging, and in some cases even light manufacturing and final assembly, and even at a very competitive price and quality, and that many companies have decided to offshoot such operations, and as a result employ a manufacturing postponement strategy.

Van Hoek (2000) has argued that third party logistics services providers have, by operating warehouses and transportation systems for manufacturers, successfully earned a position in the distribution channel operations, and by offering these services, TPLs have penetrated into segments of the supply chain with higher value-added operations. These services, as argued by Van Hoek (2000) are rapidly becoming a necessity with low involvement from clients, low margins and stability of relations and by offering customisation and postponement services, supplementary to existing services, third party logistics services providers can give services a specialty or differentiation edge. Third party logistics services providers can add value for customers, improve margins, as well as attaining customer relations and can deepen the relation with customers, possibly even giving the third party logistics services providers a value-added solutions provider position. Van Hoek (2000) has indicated that typically postponed manufacturing activities such as final assembly and sizing of products are outsourced to third parties by only a few companies and to a lower extent than traditional services such as warehousing. With respect to the high technology organisation, one aspect of its operation, the inventory management of the after sales service, has been outsourced to the third party logistics services providers. This is the aspect this paper is focusing on.

d. CONSUMER PERSPECTIVE OF INVENTORY POSTPONEMENT AND INVENTORY SPECULATION IN THE HIGH TECHNOLOGY INDUSTRY

The key aspect of investigating the consumer perspective of inventory postponement and inventory speculation in the high technology industry is by focusing on lead-times. One underlying aspect to appreciate in terms of customer demand or usage requirements is the relationship between the customer order-to-fulfilment lead-time (CLT) and the sum of the supplier order-to-fulfilment lead-time (SLT), the firm's cycle time (CT), and the delivery-to-customer lead-time (DTC) (Wallin et al. 2006). Wallin et al. 2006 elaborates on these explaining that CLT denotes the amount of time a customer is willing to wait, once an order has been placed, to be satisfied by the firm; SLT denotes the amount of time the firm is willing to wait for its own wishes to be met by its suppliers in producing what the customer wants once the customer order is received; CT denotes the amount of time it takes the firm to manufacture and process a customer order and finally, DTC denotes the amount time it takes the firm to deliver a completed customer order to the customer, so that CLT = SLT + CT + DTC.

FIGURE 1: LEAD TIMES



Reproduced from Wallin et al. (2006)

As shown by Wallin et al. (2006), Figure 1 illustrates the definitions for these various lead times pictorially and depicts ideally that CLT = SLT + CT + DTC. Wallin, et al. (2006) has shown in Figure 1 that in terms of customer demand or usage requirements there is a relationship between the customer order-to-fulfilment lead-time (CLT) and the sum of the supplier order-to-fulfilment lead-time (SLT), the firm's cycle time (CT), and the delivery-to-customer lead-time (DTC). Wallin et al. (2006) has emphasised that CLT indicates the amount of time a customer is willing to wait once an order has been placed and that SLT indicates the amount of time the firm is willing to wait for its own requirements to be met by its suppliers in producing what the customer requires once the customer order is received. Wallin et al. (2006) has explained that CT indicates the amount of time it takes the firm to manufacture and process a customer order and Silver et al. (1998) has shown that DTC indicates the amount time it takes the firm to deliver a completed customer order to the customer.

An example of this in practice as illustrated by Wallin et al. (2006) is with a case of a build-to-order business typified by many firms in the personal computer industry, who operate primarily as final assemblers. Wallin et al. (2006) has described an average customer who places an order for a personal computer by telephone or over the internet, and are willing to wait up to ten days from when they place the order for their personal computer to when they receive the product, so CLT = 10 days. Wallin et al. (2006) has offered a scenario of supposing a final assembler, upon receipt of the customer order, places its orders for the various parts, components, and/or subsystems, with the bottleneck supplier requiring a three-day lead time, so that SLT = 3 days. Wallin et al (2006) then shows that the bottleneck supplier of a firm is going to take the longest time in terms of being able to fulfil the firm's order for the particular part, component, or subsystem, and so once the bottleneck part arrives at the final assembler, it takes two days for the finished product to be assembled and tested, so that CT = 2 days. Finally when the product is completed, the finished product is shipped with the shipping time being three days so that DTC = 3 days (Wallin et al., 2006). Therefore,

this example from Wallin et al. (2006) has shown that CLT = 10 days and SLT + CT + DTC = 8 days, and that the amount of time needed to satisfy the customer is less than the amount of time needed for the customer who is willing to wait, once their order has been placed.
With respect to the high technology industry in the case of a build-to-order business typified by many firms who operate primarily as final assemblers, the average customer places an order for a personal computer system by phone or over the internet is willing to wait up to ten days from when he or she places the order for the personal computer system to when he or she receives the product (Wallin et al., 2006). Therefore, the customer order-to-fulfilment lead-time (CLT) = 10 days.

Ozer (2003) has shown that customers with positive demand lead times place orders in advance of their needs and effective inventory policies for a distribution system are developed to account for this information. "A supply chain may improve its profit by satisfying customers who are willing to pay higher prices for shorter demand lead times, and by offering price discounts to those customers who are willing to accept longer demand lead times" (Ozer, 2003, p.255).

Ozer (2003) elaborates on this with a classical example of Dell's distribution system (Dell, 2000). It has been shown that "Dell has a new initiative called "Intelligent Fulfilment," which allows for four different levels of response time to customer orders: (1) standard (conventional; 5-day promised order lead time), (2) value delivery (slower; lower shipping cost), (3) premium delivery (if the order is in by 8:00 a.m.; next-day delivery by 10:30 a.m.), and (4) precision delivery (specific date)" (Ozer, 2003, p.256). Ozer (2003) continues explaining that the wider choice for "delivery mode and timing will presumably enhance Dell's interaction with its customers, because customers have more choice in selecting delivery options and costs, (and that) this flexibility also allows Dell to provide better service levels, because they can better optimize their own inventory and manufacturing needs based on specific customer needs" (Ozer, 2003, p.256).

It can be stated that some high technology organisations adopt inventory postponement as their primary inventory management decision in order to reduce the cost of inventory, and to reduce the risk of holding excess obsolete stock. However, drawbacks include risk of lost sales and increase in transportation and materials handling costs, which can lead to price increases. Other high technology organisations adopt inventory speculation as their primary inventory management decision as they are able to respond more quickly to demand or requirement, able to protect themselves against price fluctuations and have a reduced inbound transportation costs from buying in bulk. However, drawbacks include the financial burden of having cash tied up in physical inventory, high inventory holding costs, material handling and tracking, and the expense of inventory obsolescence.

Third party logistics provider's involvement in the operation of the high technology organisation is to provide the spare parts for the customer's orders and to handle the inventory of the high technology organisation. The gap in the research is that there may be a great deal of research in inventory management approaches in high technology organisations and their impact these have on the consumers, but no research has been uncovered relating to the perspective of the third party logistics providers, and the implications the inventory management approaches have on their handling on the inventory and the customer service they carry out. This is significantly important with regards to the after sales servicing aspect of the high technology organisation, where customers expect their computer, printer or server hardware problems to be repaired promptly and to have the spare parts available to rectify

their dilemma. The intent to fill the gaps is to first identify the inventory management approaches adopted by high technology organisations and to examine the implications of inventory management approaches these have on the third party logistics provider.

In summary of the literature review, it can be stated that high technology organisations adopt inventory speculation and inventory postponement, and that in the case of Dell Computers, inventory postponement is the inventory management approach adopted. The implications these approaches have on the consumers, is that in respect to the after sales aspect of the high technology organisation, when consumers need their high technology equipment repaired, they need to have these systems repaired in a timely manner. When these requirements are not met, these consumers can lose productivity and in turn can lose business, which has a negative effect on their relationship with the high technology organisation that provides the parts and service. The gap in the research is that there is a great deal of discussion in terms of inventory management approaches from the perspective of the consumer and the high technology organisation, but little or no research has been documented from the perspective of the third party logistics provider. This research attempts to fill the gap.

3. RESEARCH DESIGN

The broad objective and this research are to determine any particular inventory management approach made within the high technology organisation. The specific objectives of this research are as follows:

(i) To determine the inventory management approach of high technology organisations and the relative importance of the inventory management approaches adopted by the high technology organisation
(ii) To examine the implications these approaches have on the third party logistics provider and
(iii)To examine the implications these approaches have on the consumer.

This research used a case study method as the case study method allows the researcher to investigate contemporary events within its real life context when the limitations between observable fact and context are not clearly evident, and in which multiple sources of evidence are used (Yin, 2003). Case studies also provide a unique way of collecting, organising, and analysing data to gather comprehensive, systematic, and in-depth information about each case of interest (Yin, 2003). Data was collected from seven respondents via face to face in-depth interview. A carefully designed semi structured study protocol with thirteen items was as data collection instrument. Respondents were asked to rate by assigning score from 1 to 5 where 1 denoted not important and 5 denoted very important. Following the rating, one or two open ended questions were asked on the respective item. Data was analysed by following three steps, adapted from Patton (1990) which are as follows:

- Accumulate and organise all the raw data together (raw data includes interview transcripts and typed notes from observations)
- Edit the data, while summarising the case information and removing any data that is irrelevant.
- Build up the data around the case study.

4. PROFILE OF PARTICIPATING ORGANISATIONS

a. PROFILE OF ORGANISATIONS PARTICIPATE IN RESEARCH

i High Technology Organisation

The high technology organisation participated in this study is a leading American computer hardware company based in Texas and is known for its development, manufacturing, selling and support of personal computers, servers, data storage devices, network switches, personal digital assistants (PDAs), software, televisions and computer peripherals. The organisation is a global high technology organisation, and within its company, there are many divisions to it, with one division being the after sales service division. This organisation has outsourced the aspect of after sales service, with respect to handling the spare part inventory to a third party logistics organisation.

As of 2006, the organisation had employed more than 78,700 people worldwide and as of 1996 began selling computers via its web site. In 1999, the organisation became the largest seller of personal computers in the United States of America with $25 billion in revenue reported in January 2000. In the last four quarters the company revenue was 57.4 billion. The organisation delivers products and services to customers in more than 180 countries. The organisation also is efficient in keeping costs down by selling direct to customer with no retailers.

The aspect of the high technology organisation that is being researched on is the after sales service division. This division operates in the following way:

For example, a customer has a computer problem and needs it to be urgently repaired. The customer rings up the organisation's technical support and they speak with the customer over the telephone to diagnose the problem. The technical support team first request the customer's service tag number from their computer and this brings up their computer model, all the components from their computer and their customer details. From speaking with the customer the technical support team can work out whether the computer problem is hard drive related or whether it is a memory problem, etc.

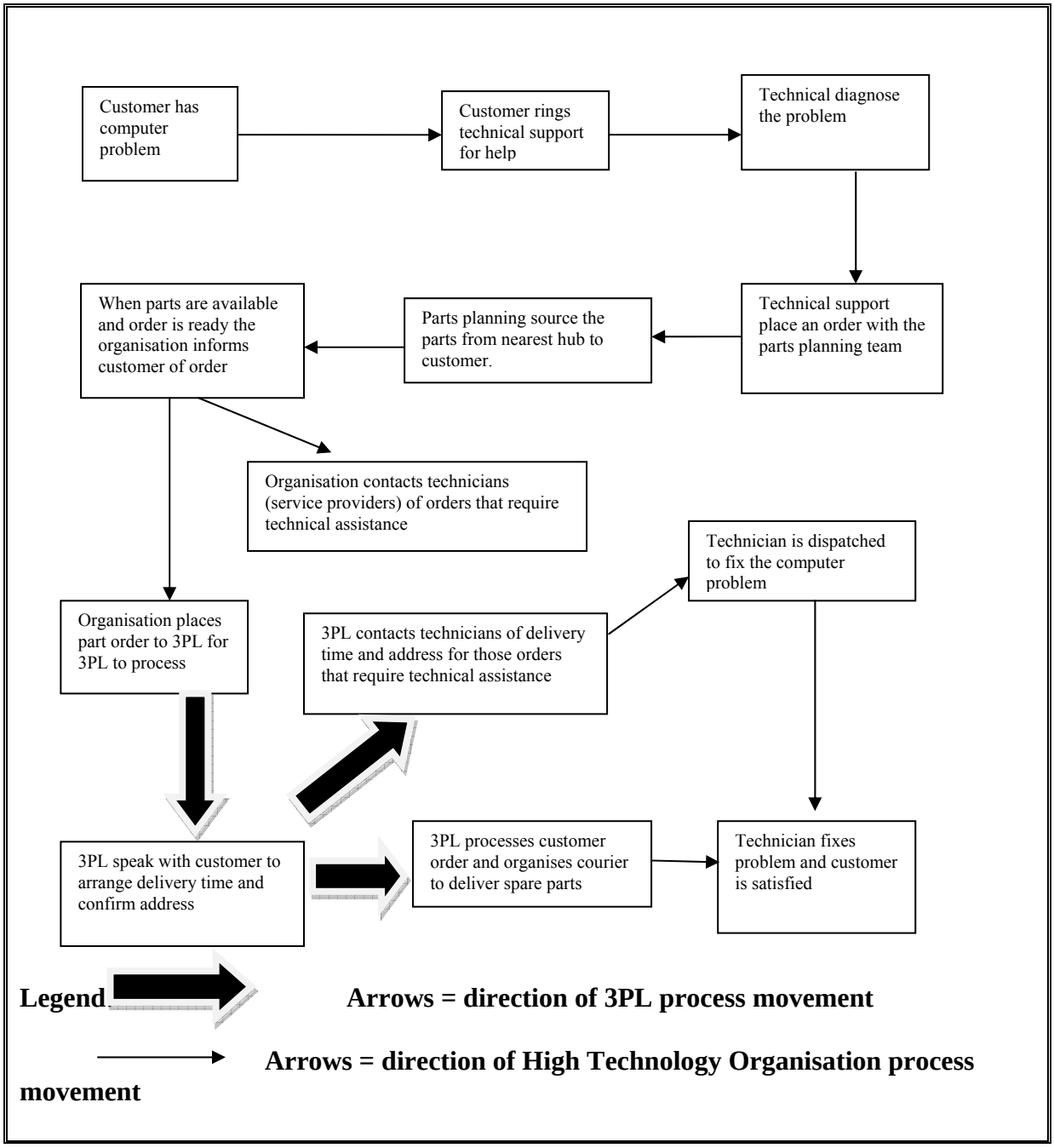
From this stage the customer's computer problem goes directly to a parts planning team that has access to the inventory on hand in each third party logistics provider's warehouse. From this they can determine whether the parts in stock will help fix the customer's computer or not. If the customer resides in Melbourne for instance, the parts planning team would check the inventory on hand in the Melbourne hub. They then place the order on the system, which is over the internet, where the third party logistics providers fulfil the customer's order scheduling technicians to the servicing of the computer and organise the couriers to take the parts to either the technicians or to the customer depending on the urgency of the customer order.

ii Third party Logistics Service Providers

The third party logistics organisation (3PL) is the global market leader in international express, overland transport and air freight. It is also the world's number 1 in ocean freight and contract logistics. 3PL offers a full range of customised solutions from express documents

shipping to supply chain management. 3PL has around 285,000 employees and around 6,500 offices. 3PL has more than 450 hubs, warehouses, and terminals with 240 gateways. 3PL use 420 aircraft including aircraft they own and those that are foreign owned, and operate in 220 countries, shipping more than 1.5 billion shipments covering 120,000 destinations.

FIGURE 2: FLOWCHART OF AFTER SALES SERVICE DIVISION OF HIGH TECHNOLOGY ORGANISATION AND ITS LINK WITH 3PL



Regarding the high technology organisation, the high technology is one of 3PL's contract logistics, and the most important and profitable contracts. From the perspective of 3PL, contract logistics is one of the most dynamically growing fields in the logistics sector and is a sophisticated variant of logistics management performed by a specialised service provider. 3PL has argued that companies from both industry and commerce entrust the management of

the entire supply chain to an external partner who in turn develops an integrated customer-specific solution for this purpose. Contract logistics involves a long-term partnership based on an appropriate contract, and 3PL is currently the fourth largest provider worldwide in the growth market of contract logistics. In 2004 3PL's contract logistics sales grew by 10 percent to an approximate 1.8 billion Euros.

b.LINKING HIGH TECH ORGANISATION WITH 3PL

As previously stated the high technology is one of many contract logistics that 3PL is in partnership with. The division of the organisation that 3PL is taking control of is the after sales service division. In this division, 3PL represents the organisation to the organisation's customers, and in the minds of these customers, these third party logistics providers are a part of the high technology organisation. 3PL controls the spare part inventory involved in the after sales service division.

5. RESULTS AND DISCUSSION

Table 3 presents the results thirteen qualities as per interview protocol. As shown in Figure 3, framework adopted from Khan (2003), the majority of the answers reflected important and essential requirements.

From the research, it has been shown that inventory postponement is the preferred as well as adopted option that the high technology organisation adopts as opposed to inventory speculation. This has been shown from the respondents that have unanimously agreed that the inventory management approach adopted by the high technology organisation is order driven instead of forecast driven.

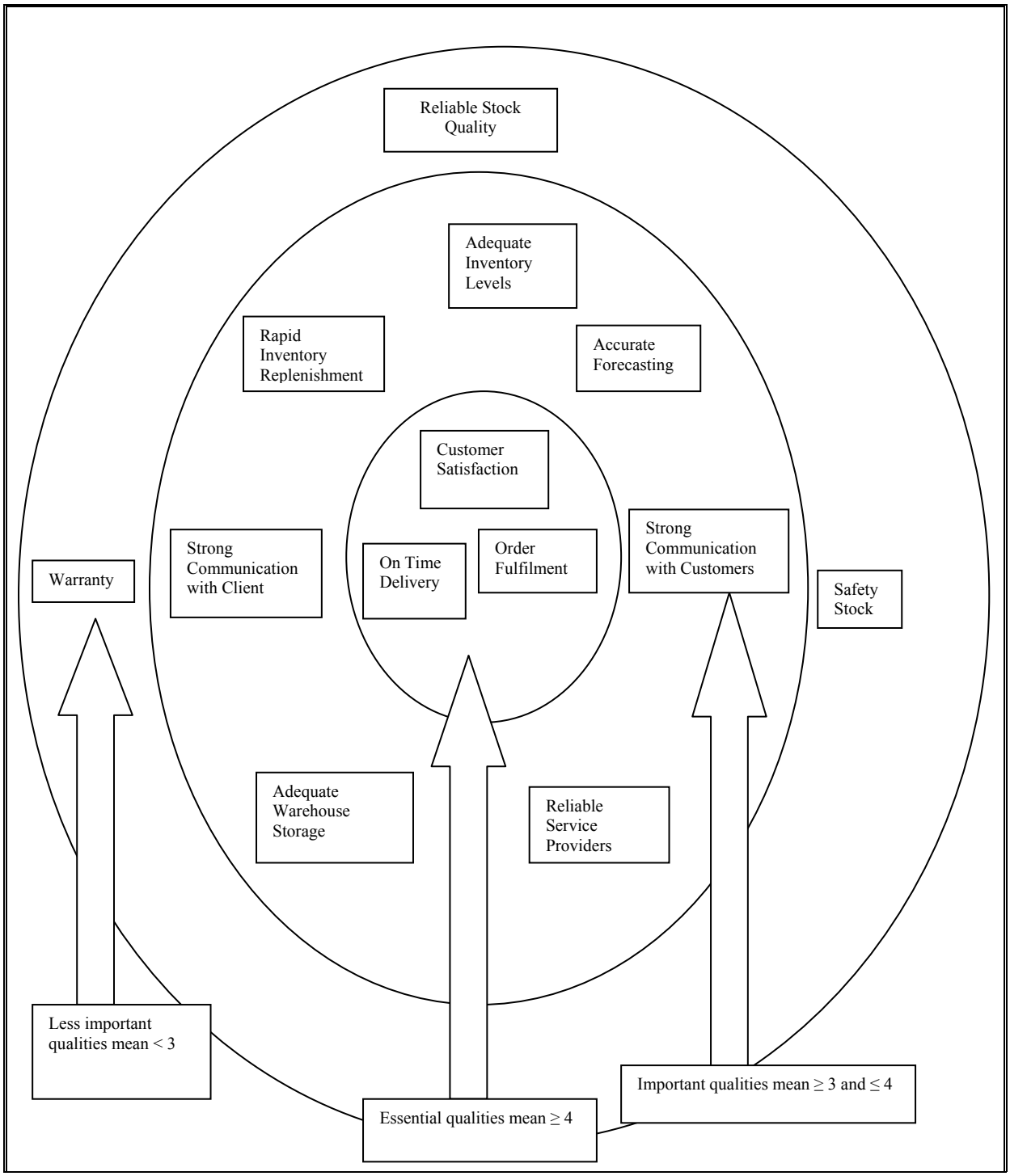
TABLE 4: RESPONSES REGARDING QUALITY OF THIRD PARTY LOGISTICS PROVIDER

QUALITIES			RESPONDENTS (A-G)						
	MEAN	SD	A	B	C	D	E	F	G
Customer Satisfaction	4.43	0.53	5	5	4	5	4	4	4
On Time Delivery	4.14	0.69	5	5	4	4	4	4	3
Strong Communication With Client	3.42	1.27	5	5	4	3	3	2	2
Strong Communication With Customers	3.42	1.27	5	5	4	3	3	2	2
Order Fulfilment	4	0	4	4	4	4	4	4	4
Adequate Inventory Levels	3.57	0.53	3	3	4	4	3	4	4
Rapid Inventory Replenishment	3.86	0.69	3	3	4	4	5	4	4
Adequate Warehouse Storage	3.14	0.38	3	3	3	3	4	3	3
Accurate Forecasting	3.71	0.49	3	3	4	4	4	4	4
Reliable Service Providers	2.14	0.38	2	2	3	2	2	2	2
Safety Stock	2.71	0.49	3	3	2	2	3	3	3
Reliable Stock Quality	2.28	0.49	2	2	3	2	3	2	2
Warranty	2	0	2	2	2	2	2	2	2

Table 4 shows the 13 qualities from the perspective of the third party logistics provider. It can be shown from the Table that customer satisfaction, on time delivery and order fulfilment has the highest mean. From the perspective of the respondents (where n=7), these are the three

most important qualities. The standard deviation is the greatest with strong communication with client and strong communication with customers.

FIGURE 3: THREE LEVELS OF THIRD PARTY LOGISTICS PROVIDER'S QUALITIES IN ORDER OF IMPORTANCE



Based on the means of responses with respect with these 13 qualities, Figure 3 has been constructed to show that customer satisfaction; on time delivery and order fulfilment are the three essential qualities that the third party logistics providers perceive as most important.

Through the high technology organisation's current inventory management approaches of inventory postponement, 3PL has observed that customer satisfaction has been compromised by cost effective means to reduce inventory by the high technology organisation. However, the respondents have observed a gradual shift away from inventory postponement towards inventory speculation with an increased level of inventory holding. This may eventually improve customer satisfaction, improve on time delivery and will enable customer orders to be fulfilled more readily.

Figure 3 shows that the next important qualities from the perspective of the third party logistics provider are; rapid inventory replenishment, accurate forecasting, adequate inventory levels, strong communication with client and strong communication with customer and adequate warehouse storage. These are all directly related to the customer, to the client and focusing on the inventory levels.

The least important qualities from the perspective of the third party logistics providers are; reliable stock quality, safety stock, reliable service providers and warranty. Apart from safety stock, these are indirectly related to the inventory, with one focusing on the service aspect and other two on the quality and warranty of the product which are unrelated to the responsibility of the third party logistics provider, and are out of their control.

a. INVENTOR SPECULATION OR INVENTORY POSTPONEMENT

All respondents argued that the high technology organisation adopts inventory postponement as its primary inventory management approach, as opposed to inventory speculation. All seven respondents also argued that the inventory is order driven, as opposed to forecast driven. One respondent as quoted below echoes the feelings of others when they said:

> *It is obvious to me that the inventory in the warehouse is order driven as there are some stock items that do not get dispatched often. However, when this item does get dispatched, it quickly gets replenished.*

Another respondent said in this respect which further supports the above:

> *I was always under the impression that the inventory in this facility was very much order driven, and that postponement was the likely explanation, but it seems to me there is a shift to speculation and being forecast driven as the inventory levels keep increasing substantially to the point that we are currently receiving much more inventory than we are dispatching.*

Another respondent spoke about an example with a project for an Australian bank. He said the following:

> *We were all part of a monitor swap out program for a customer, which was done in all hubs across Australia. This was very much forecast, as these monitors arrived in our warehouse about a month before the orders were placed. I think when projects are needed to be carried out for a large number of customers, these must be forecast driven. I recall this happened in the case of the battery swap out project. Every customer that had a laptop needed to have the batteries replaced due to battery problems.*

b. LEAD TIME AND STOCK REPLENISHMENT

The respondents were questioned regarding lead time and stock replenishment. One respondent explained the situation like this:

> *The stock gets replaced quickly. As one stock item goes out, another item is reordered to replenish the item that just got dispatched. This inventory gets replenished by other hubs, either interstate hubs or international hubs. Lead time is generally about two days for interstate items, and about five days for international stock. However, for important customers that require parts urgently to fulfil their order, the next flight option is used and that is usually fulfilled in 6 hours.*

c. CUSTOMER SATISFACTION

The respondents were questioned with respect to customer satisfaction. One respondent mentioned:

> *I was on the phone to one customer and they were very frustrated. They told me that they logged a call with technical support four times now, as three times in a row the parts planning team logged the wrong part on the call. This is out of my control. I felt sorry for them.*

Another respondent said:

> *I understand that is impossible to stock every part in the warehouse, and I can fully accept that postponement is the preferred option, but there must be another way to make this area work better. I hate telling a customer that their parts are not available and their parts are being sourced from another location; especially when it comes to urgent customer orders. I remember a few weeks ago there was this customer telling me that his whole production was down in his company due to these parts and the company was unable to do anything until these parts arrived. He told me that his company is losing a lot of money in lost production.*

On the positive side, when parts are available, the customer is very satisfied. One respondent said:

> *There was one customer I spoke to yesterday. He was very surprised that his order had already been received by us. He said he only just got off the phone from technical support and was very happy that parts were available and were on their way to his location. He thanked me for the quick service and organisation of his order.*

The third party logistics providers said that they face these phone calls every day. Some customers are happy that parts are available and are being shipped to their location quickly. Some customers get upset when they have to wait before parts arrive. These customers normally take out their frustrations on the respondents as these respondents represent the high technology organisation and communicate directly to these high technology organisation customers.

The most important requirement from the perspective of the third party logistics provider was customer satisfaction, which was ranked first with a mean of 4.43. One respondent said:

> *I believe that with any inventory management decision, customer satisfaction is a very important quality. A few months ago I was speaking with an important customer on the phone. This customer was considerably angry as he logged an order with technical support first thing in the morning. He said he was promised by technical support that his spare part would be arriving to his location that morning. The order did not become available until later in the afternoon. This delay upset the customer a great deal.*

This illustration pointed out by one of the respondents shows how important it is to get the inventory levels right. The respondent continued saying that even though the customer knew it was not the respondent's fault that the delay took place, he was angrier about being promised something by the high technology organisation and not having the organisation deliver what was promised. The respondent explained that he had encountered many of these instances and therefore, believes that customer satisfaction is the highest priority and that inventory management approaches are very important in order to ensure customer satisfaction and customer requirements are met.

Another respondent shared a few more examples. One example he shared was with another important customer. He said:

> *Once I was delivering a spare part after hours to an important customer. I organised the part, and organised the service provider and after delivery I was on the way home. I was rung up by the service provider who informed me that the part I took to site was "dead on arrival." This was one of the refurbished parts. I had to go back to work to reprocess the order to give it to the service provider in order to fix the customer's computer. The customer was very upset about the whole situation.*

The same respondent also shared a positive example being:

> *There was one morning I rang up a customer to organise delivery of the spare parts. The customer was very surprised on the phone that the spare parts were available so quickly and that parts would arrive on his location at a very rapid rate. He thanked me for organising the part delivery and service so efficiently. He was a satisfied customer.*

This respondent argued that it was necessary for the organisation to have positive customer satisfaction. He emphasised the importance of the organisation getting the inventory management decision and forecasting right in order to achieve customer satisfaction, and mentioned that it is imperative for the organisation to match inventory levels with customer demand, to avoid a delay in part delivery or service.

d.ON-TIME DELIVERY

The second ranked most important quality from the perspective of the third party logistics provider was on time delivery. All seven respondents made comments relating to this point. One respondent said:

> *I find it difficult to set an estimated time of delivery with customers due to poor courier service.*

Another respondent reiterated this point saying

> *I get frustrated when spare part delivery is delayed from the courier company, as it means I will need to inform the customer of the delay, and I really don't like doing that.*

Another respondent added to this saying:

> *There are countless times I need to ring up the courier company to confirm delivery time.*

Another respondent said that:

> *Due to poor courier service I need to inform the service providers and the organisation of the courier delay, and reorganise delivery time with the customer, and listen to the customer's dissatisfaction and complaining over the phone.*

All respondents emphasised the importance on getting the delivery time right with customers. They agreed that with inventory management decision, by having couriers delay parts on time and on the estimated time of arrival, there is satisfaction from the customer, and an improved customer relationship with the logistics providers.

e. Order Fulfilment

Regarding inventory management approaches, order fulfilment was argued to be ranked third by the respondents. One respondent said:

> *Without proper inventory management approaches, customer orders would not be fulfilled. It is imperative for the customer orders to be fulfilled, as otherwise the business misses the point of doing business and misses the point of customer satisfaction.*

f. Rapid Inventory Replenishment, Accurate Forecasting And Adequate Inventory Levels

Rapid inventory replenishment, accurate forecasting and adequate inventory levels were ranked fourth, fifth and sixth respectively. Regarding rapid inventory replenishment one respondent said:

> *Rapid inventory replenishment is important for any inventory management decision as when one stock item is dispatched it should be replaced quickly as you never know when it will be needed again.*

With respect to accurate forecasting one respondent said:

> *I think accurate forecasting is essential in this business as the last thing you need is to have not enough stock of one item and too much of another.*

In response to adequate inventory levels one respondent said:

> *If the forecasting was accurate then the inventory levels of those parts would be reasonably accurate as well. By having adequate stock levels, customer orders can be fulfilled more readily and there would be less delay from customer's point of view, and would make my job a whole lot easier.*

g. Strong Communication with Client and Customers

The next two qualities were both ranked equal seventh. These were strong communication with client and strong communication with customers. With respect to strong communication with client, one respondent said:

> *I believe strong communication with the client is the key to success. By communicating well with the client, we can find out what the client expects and what the client plans to do with the inventory levels. We can also find out about any urgent or immediate deliveries that the client has organised for significant customers. A closer bond with the client would also help us to know how to serve the client better as well as to be made more aware of the operations of the business.*

Regarding the strong communication with customers, one respondent said:

> *I am on the phone a lot with customers, organising part delivery, organising couriers, confirming delivery times, and informing them of any spare part delivery delays or from not being able to fulfil their order currently due to no stock in warehouse.*

Inventory management approaches are important in this area, as by having stronger communications with the client (the high technology organisation) it is possible to acquire information relating to inventory levels, and to gain knowledge of the high technology organisation's expectations and requirements. Strong communication with the customer would enable more positive customer interactions, and to be more transparent with them.

h. Warehouse Storage

The ninth quality in order of importance is adequate warehouse storage. One respondent said:

> *Adequate warehouse storage is essential as currently we are running out of space in this warehouse. It is clear to me that the current inventory levels have increased substantially as we are receiving much more stock in. I think the organisation has altered the way they handle their inventory as we never used to receive this much in.*

i. SAFETY STOCK, RELIABLE STOCK QUALITY, RELIABLE SERVICE PROVIDERS AND WARRANTY

The last four qualities were seen by all respondents as lesser, and therefore may not need much exploration. The tenth most important requirement was safety stock, followed by reliable stock quality, followed by reliable service providers, followed by warranty. These were all generally seen as little importance to all respondents. Little comments were made regarding these.

From the results it has been shown that from the perspective of the third party logistics provider's that customer satisfaction, on time delivery and order fulfilment are the most important qualities regarding inventory management approaches from the high technology organisation.

The other results are mixed due to difference in personal opinion. Some respondents believe that strong communication with customers and strong communication with the client is very important to them, whereas not all respondents have this view. Other respondents argue that other qualities are more important, being rapid inventory replenishment as well as adequate warehouse storage. It has been recorded that respondents primarily responsible for the receipting, inwards goods, and stock relocation from the high technology organisation place greater emphasis on those areas that are more significant to them. Whereas, those respondents that are responsible for the dispatching for the client have their primary focus on the customer and the client and so therefore, their answers reflect their primary responsibility, being order fulfilment, on time delivery, and customer satisfaction.

It can be therefore stated that despite the small sample size, there is a strong differing of opinion due to the daily tasks the respondents are responsible for. However, it can be stated that inventory management approaches are important not only for the high technology organisation but also for the third party logistics provider and the consumer. Therefore, it is imperative that whichever decision is made from the high technology organisation, there should be information passed down to their partners, their third party logistics providers to strengthen their partnership and relationship.

It has been observed by all the third party logistic providers in this research that in the case study of the high technology organisation, that they adopt inventory postponement. This is the case as the third party logistics providers have clearly explained that their operation is order driven, and only when the projects are taking place are there enough stock to fulfil these projects, but generally speaking, these are also order driven, with the orders being placed before the project takes place.

It can also be shown that any decision made from the top filters down to the bottom, and affects the consumers at the end. Therefore, it is imperative for the high technology organisation to do more research in inventory management techniques and in forecasting to improve the customer satisfaction.

6. LIMITATIONS AND FUTURE RESEARCH

This study has several limitations. The first limitation is the small sample size of seven Respondents. Even though these seven Respondents represent the whole third party logistics provider's Melbourne Hub providing logistics support for a high technology organisation, this could be cross-examined by other hubs across Australia to determine whether these third party logistics providers reflect similar results. By a single case study, more research into other hubs across Australia could be carried out within the third party logistics provider's organisation, and would prove to show even more valuable and remove bias derived from small sample size.

Future research could investigate two other inventory types being inventory consignment and reverse inventory consignment, and to investigate each with its own advantages and disadvantages, and to determine whether the high technology organisation adopts either of

these two principles. These inventory types can also be investigated from the perspective of the third party logistics organisation.

Other research could investigate the financial aspects of the third party logistics providers and the costs involved in adopting more accurate forecasting, rapid stock replenishment from the perspective of the high technology organisation.

7. CONCLUSION

It has been shown that from the perspective of the third party logistic providers, their view on inventory management approaches from the high technology organisation can be improved. Their highest ranking requirement is customer satisfaction, and through an example of inventory postponement, there are situations where inventory is not available and part delivery is delayed and orders cannot be fulfilled on time. This is a concern for the third party logistics provider as these are their highest ranking requirements. In order to meet these requirements, the high technology organisation needs to have more accurate forecasting, and to strengthen its communication with its customers and third party logistics provider's organisation.

In order for the high technology industry to work out how to incorporate inventory postponement and inventory speculation to incorporate consumer demand and to align this consumer demand with the organisation's supply chain, the forecasting and planning processes needs to be improved (Langabeer & Stoughton, 2001). This "can be achieved, and the supply chain performance metrics (and overall firm performance) will be maximized if the demand forecasting processes are collaborative, sophisticated, oriented towards the product life cycle, and developed using non-constrained consumer demand data. When high technology companies achieve these effects, the end result will be a more positive correlation between improved demand planning and overall firm performance" (Langabeer & Stoughton, 2001, p.10).

The implication of inventory management approaches from the perspective of the third party logistics provider is that through inventory postponement, customers are frequently waiting for stock to fulfil their requirements, and in turn puts added pressure on to the third party logistics provider who faces these inventory management issues directly with the customers. The implications of this can be negative feedback and negative customer relationships, as opposed to positive customer relationships if the inventory management approach adopted a level of inventory speculation, where forecasting would increase the inventory and would be more likely be available to fulfil the customer's requirements.

Svensson (2003) concludes arguing that in a managerial context the ultimate goal is to achieve a balance and harmony between the inventory postponement and inventory speculation of one's business activities, and that both inventory management approaches contribute to explain the reasoning behind a company's inventory management, and provide a platform for cost efficient inventory management in order to deal with effective supply chains.

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