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**Aligning Distribution Centre Operations to Supply Chain Strategy**

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## **Biography**

**Peter Baker** is a Lecturer at the Centre for Logistics and Supply Chain Management at Cranfield School of Management, where he lectures on warehousing and international transport. Following his original career in international freight forwarding, he gained a MSc degree in Distribution Technology and Management at Cranfield. Before returning to Cranfield to work in his current capacity, he undertook over 70 supply chain consultancy projects in a wide range of industries across many parts of the world. These projects ranged from supply chain strategy studies to distribution centre design and implementations. His current research interest is the interrelationship between supply chain strategies and distribution centre capabilities. He can be reached at the Centre for Logistics and Supply Chain Management, Cranfield School of Management, Cranfield University, Bedford, United Kingdom, MK43 0AL. E-mail: [peter.baker@cranfield.ac.uk](mailto:peter.baker@cranfield.ac.uk).

## **Aligning Distribution Centre Operations to Supply Chain Strategy**

### **Abstract**

A major focus of modern day logistics is on achieving a higher level of responsiveness to marketplace demand, but with less inventory. Achieving the dual targets of lower cost and higher service has implications for every stage in the supply chain and in particular for distribution centre operations.

This paper sets out to identify the extent to which organisations are adjusting their distribution centre operations to match current supply chain concepts. Based on a survey of distribution centres in the U.K., the paper explores the roles that these facilities currently play and seeks to gauge the extent to which modern supply chain theory and distribution centre operations are aligned.

This paper examines the current role of large distribution centres within the U.K. and, in particular, explores the extent to which these facilities are aligned to modern supply chain concepts.

The first section of the paper reviews the development of supply chain thinking during the past few decades, highlighting the perceived changes in the roles of distribution centres as new supply chain concepts have developed.

The second section describes the research method. This is chiefly based on a postal survey of U.K. distribution centre managers, but also draws on some supplementary information. The results of the research are presented in the third section.

Finally, conclusions are drawn from the results, examining whether large distribution centres in the U.K. currently exhibit the characteristics that may be expected from the implementation of modern supply chain concepts. Future challenges for distribution centres are examined and areas of further work are identified.

## **The development of the supply chain concept**

The development of the supply chain concept has been characterised by the increasing degree of organisational integration that has been proposed. For example, La Londe describes the stages as being: physical distribution integration, internal linkages and then external linkages [1]. Similarly for individual firms, Stevens described a baseline of functional excellence, followed by the three stages of functional integration, internal integration and external integration, as shown in Figure 1 [2].

**PLACE FIGURE 1 HERE**

The importance of warehousing theory within the context of functional excellence is fairly self-evident and there is a wide range of publications that address the ways in

which that activity can be optimised. They include fairly comprehensive books on the subject [3], as well as numerous journal articles on particular aspects of warehousing theory [4].

The next stage, physical distribution integration, recognised the need for an integrated distribution management structure [5]. This period was largely characterised by cost trade-offs, the total-cost concept and the total-system approach [6]. Under these theories, decisions were taken on the basis of the lowest overall distribution costs, including storage, inventory, transportation, and order processing costs. Although this period is largely regarded as taking place in the 1950s and 1960s, there is one reference traced back as far as 1844 [7] and it is probable that the cost trade-off concept has been practised in logistics for some considerable time. Within this concept, warehousing is a key cost element. The theories underpinning warehousing functional excellence are therefore of key importance in order to identify the costs for the various storage and inventory holding alternatives being traded-off with transportation and order processing costs. The role of the warehouse as a stockholding point was not fundamentally changed by this concept, although the full costs of storage and inventory were being recognised for the first time in many organisations.

The next stage was that of internal integration, where a much wider view was taken encompassing functions outside physical distribution such as marketing and manufacturing. This led to suggestions that the total cost approach should be superseded by a total profit approach [8]. Under this concept, service levels such as lead times were viewed as negotiable and therefore part of supply chain management

thinking [9]. Also, the parallel evolution of supply chain management from the viewpoint of purchasing and supply activities was being integrated with distribution [10]. This led to considerable attention on how these functions should work together, which tended to overshadow the changing roles of distribution centres.

This tendency has continued through the latest stage of supply chain evolution, namely external integration. This stage is where the significance of the whole supply chain, or network, is recognised, all the way from the extraction of raw materials to the final use by the end consumer, and also extending to reverse flows [11]. The degree of integration with suppliers and customers has been shown to be strongly associated with high levels of performance [12]. One of the key concepts of this stage has been to substitute information for inventory [13]. This has resulted in a diminution of the perceived role of warehouses within modern supply chains.

## **The role of distribution centres**

There is evidence that, paradoxically, this development in supply chain management thinking has not been extended fully into the area of distribution centre design. In fact, there is some evidence that most books on supply chain strategy do not mention warehousing, or only mention it in passing and, similarly, books on warehousing tend not to put warehousing concepts in the context of supply chain strategy [14]. There has thus been a separation of supply chain theory from warehousing theory, with different books and journal articles addressing each area separately. Even where books do cover both aspects, the different chapters are normally not closely linked.

This separation has not however been total. This can be seen by examining the literature on two classifications of supply chain strategy that have been developed: namely, supply-focus and demand-focus strategies [15]. These correspond broadly to the cost and service foci that characterise lean and agile concepts respectively [16]. The lean concept is primarily centred around the elimination of supply chain waste which may manifest itself in terms of, for example, excess resources, high levels of inventory or unnecessarily long lead times. Agility, on the other hand, aims to take advantage of volatile market places and thus the ability to respond rapidly to market opportunities is the critical factor. Lean and agile concepts are not mutually exclusive and may, in fact, be combined effectively to offer, for example, a high volume lean supply pipeline supported by agile pipelines for surges in demand and for special products [17]. Although these two concepts have different emphases in terms of cost and service, there are common themes and these have significant implications for the role and design of distribution centres. These may be summarised as follows:

**Inventory holdings:** There appears to be a general consensus that inventory should be minimised in supply chains. Inventories have been described as balancing mechanisms of last resort [18]. The true cost of inventory is now recognised including for example the cost of obsolescence, deterioration, stock losses and insurance [19], as well as inventory being an impediment to customer responsiveness and often leading to price mark-downs. In an agile supply chain, inventory is held at few echelons, if at all [20]. The goods pass through the supply chain quickly so that companies can respond rapidly to exploit market-place demand [21], without the risk of holding inventories of goods that may become obsolete. This view is reinforced as

being a necessary, although not the only, condition for a supply chain to be agile [22]. Similarly, in lean supply chains low inventory levels are regarded as a key element in reducing costs and eliminating waste [23]. However, there is some recognition of the need for inventory in modern supply chains. For example, strategic inventory may act as a decoupling point between lean manufacturing and an agile supply chain [24]. It is also acknowledged that high levels of availability are imperative when faced with volatile markets [25] and this implies holding some type of inventory. Furthermore, global sourcing has led to lengthy and uncertain international pipelines, which tend to lead to higher inventories [26].

**Customer lead times:** Whether inventory is held or not, short lead times from the receipt of customer order to delivery are regarded as critical, particularly in agile supply chains where service is regarded as an order winner [27]. These short lead times are essential to enable agile supply chains to respond to volatile demand patterns and to exploit market opportunities as soon as they arise. Similarly, in lean supply chains a reduction in lead times is generally viewed as being an important element in the elimination of waste. Thus, the proper reengineering of supply chains to reduce lead times is directly associated with cost reduction [28].



## **Inventory and distribution centre strategies**

In response to these pressures of lower inventory levels and reduced lead times, the literature on modern supply chain concepts offers the following possible solutions within distribution centres:

**Service level segmentation:** Aligning logistics operations with customer segments is recognised as an important means to achieving profit growth [29]. The identification of customer value is a key first step [30], and this then enables supply chain strategies to be developed for each customer group, or down to individual customer level [31]. There is now a general acceptance that a “one-size-fits-all” supply chain is not sufficient and that different supply chains need to be designed for each market sector. For example, the recognition of cost and service as market winners in lean and agile supply chains respectively may lead to different order lead times being provided in each segment.

**Postponement:** When inventory is held within an agile approach, the majority may be held as work-in progress awaiting build / configuration instructions from the final customer [32]. This is often referred to as postponement [33] or postponed fulfillment [34]. By postponing product differentiation, supply chains are able to respond to precise market demands, rather than supplying too many items of one particular product line (leading to excess inventories) or too few of another line (leading to service failures). Not only is the service element of postponement important under the agile concept but the cost element (i.e. reduced inventories) is also important within the lean concept. Postponement can take place at various points in the supply

chain but the warehouse is viewed as a key option as it is often the last point in the supply chain prior to despatch to the customer [35].

**Cross docking:** This is where goods move through a warehouse without being put into storage [36]. Under agile supply chains, distribution is frequently regarded as taking place directly to the final customer [37] or via cross docking and in transit merging [38]. It is recognised that cross docking can lead to a reduction of order cycle time, thereby improving the flexibility and responsiveness of the distribution network [39]. Cross docking may also occur for goods arriving from distribution centres holding central inventories of slow moving goods [40] or from warehouses at the same echelon level [41]. The latter is in line with the concept of virtual inventory, whereby all distribution centre inventories are controlled as one and goods moved to where they are needed [42]. Postponement and cross docking may be combined together in the concept of “flow through distribution” [43], whereby value added services are performed as products continuously flow through a warehouse. The current interest in cross docking has been substantiated by a UK survey in the retail grocery logistics sector, which placed this as one of the most important changes likely to occur in transport and warehousing practice [44]. Cross docking can have significant implications in terms of warehouse design. For example, it implies the rapid movement of goods from inbound vehicles to outbound vehicles. Thus, the inbound and outbound docks either need to be adjacent to each other on the same face of the warehouse or they need to be on two faces of the warehouse that are very close together. The former may be suitable where cross-docking is occurring within a warehouse that is holding inventories of other product lines (giving a general U-shape flow) and the latter is likely to be appropriate in a warehouse which is primarily

undertaking cross docking (normally being designed as a long, thin warehouse with numerous docks on the two long sides) [45]. Goods need to be sorted, or at least marshalled, between the two sets of vehicles and this may be undertaken either conventionally (e.g. with powered pallet trucks) or using automated equipment (e.g. sorters). Both types of solution are normally performed at ground level and thus require low bay warehousing, rather than high-bay facilities which are often used for inventory-holding warehouses [46].

**Third party logistics providers:** The achievement of higher levels of supply chain agility requires different organisational models. Terms such as the extended enterprise [47], organisational agility [48], a virtual corporation [49], virtual teaming [50] or fluid clusters [51] imply the type of organisational networks that may need to be created. As third-party logistics providers operate throughout the supply chain, they are regarded as being in a good position to coordinate and integrate capabilities to provide a flexible and dynamic supply chain network [52]. Thus, management expertise, physical assets, staffing and information systems may be brought to bear on a particular operation (or, equally, switched away from an operation) more rapidly than is possible for an individual manufacturer or retailer. These capabilities may apply to information resources (e.g. track and trace systems) as well as physical resources. The degree of flexibility is likely to be particularly marked in the case of shared-user facilities, where only fairly short commitments to staff levels and space may be required, as compared to dedicated facilities, where the third-party logistics providers may seek to align the contract length more closely to the life of the assets. The use of third party logistics providers is also compatible with lean supply chains as

reduced supply chain costs is one of the most frequently cited benefits of outsourcing logistics [53].

The purpose of this paper is to explore the extent to which the above pressures and proposed solutions are actually reflected in the operations of large distribution centres within the United Kingdom.

## **Research method**

The research was based on a database of UK warehouses compiled by King Sturge (international property consultants) in order to monitor developments in the market. Additional information has been obtained from publicly available sources where appropriate.

The warehouse database comprised 340 warehouses over 100,000 square feet in size, built and “taken up” in the period 1995 to 2001. The definition of “taken up” for this purpose is the acquisition of the warehouses for use by end users and thus excludes any speculative developments remaining empty. Later transactions were excluded, as the warehouses may not have been fully operational at the time of the survey (late 2002-early 2003). From this database, 250 contacts were derived on the basis of those facilities where full postal address details could be readily obtained using such techniques as Internet searches and telephone calls to company head offices. In most cases a named individual (normally the warehouse manager) was identified.

A postal survey form was addressed to the named individual for each site on the database. A 20% response rate was achieved, giving 50 completed forms. From these, 5 were then discounted as being unusable, chiefly because they fell outside the original parameters of size and date. Thus, 45 usable survey forms acted as the basis of analysis.

These 45 usable responses came from warehouses totalling 12.2 million square feet, representing 16% of all new warehouses of this size built and “taken up” during the period 1995 – 2001.

These 45 responses were from distribution centres operated by, or on behalf of, companies in the industry sectors shown in Table 1. Thus, the responses represent a cross-section across a number of sectors.

**PLACE TABLE 1 HERE**

The category shown as “shared user facilities” represent distribution centres operated by third party logistics companies handling goods for a variety of different companies. Where a dedicated facility is operated by a third party logistics company, this is shown in the table under the relevant industry of the client company.

The survey questionnaire asked the Distribution Centre Managers either to insert specific data (e.g. percentage of throughput cross-docked) or to select from a series of

options (e.g. for order lead time: same day, next day, 2-5 days, etc). The relevant questions from the survey form are shown in the Appendix.

## **Results**

The research results are presented under each of the six headings identified from the literature.

### **i      Inventory levels**

An analysis of all distribution centres in the database indicates that the take-up (i.e. occupation) of large warehouses, has been increasing in recent years, as shown in Figure 2. The pronounced peak in 2001 was due to a number of initiatives occurring at the same time, including distribution centres for Argos, Asda, Ikea, Sainsbury's and Somerfield (all major retailers).

**PLACE FIGURE 2 HERE**

This is not necessarily representative of general warehousing trends as the figures only include warehouses of 100,000 sq. ft. or over in size. These larger warehouses may of course be replacing a number of smaller warehouses. In fact, 60% of the

warehouses were replacing smaller sites. However, the figures do indicate an increasing use of large distribution centres in today's supply chains.

Overall levels of inventory for UK industry are published by the Office for National Statistics and these indicate that the ratio of total inventories to Gross Domestic Product has remained fairly constant in recent years (see Figure 3).

### **PLACE FIGURE 3 HERE**

In fact, as Gross Domestic Product has been growing (by about 2.8% per annum) during this period, the level of total inventory in the economy has been growing in real terms. These figures reflect a similar pattern to that experienced in the USA during most of the 1990's [56].

The national statistics on inventory ratios, as well as the take-up of large warehouses, raise some doubts as to whether inventories are being driven down, as would be associated with many modern supply chain concepts.

The survey results indicate that the average level of inventory holding in large distribution centres is 7.5 weeks. Whilst 16% of the respondents reported an inventory holding of less than 2 weeks (and a similar number between 2 and 3.9 weeks), over one quarter reported a holding of 12 weeks inventory or more. The full

breakdown is shown in Figure 4. This provides some indication as to the levels of inventory being held in large distribution centres in the U.K.

#### **PLACE FIGURE 4 HERE**

The indications from this research are that, although there are some “fast throughput” warehouses, there are also significant inventory holdings of goods in some facilities. The latter may be in line with the concepts of “decoupling” points and global supply lines, mentioned in the literature. In particular, there has been a switch in recent years from sourcing materials and products from UK suppliers to sourcing globally [57]. This has lengthened supply chains considerably leading to increases in safety stocks to cater for the potential variability in demand during the longer lead times, as well as for variations in shipping times. This switch to global sourcing is reflected in the growth of container traffic at UK ports, measured in TEUs (twenty foot equivalent units). This rose by 6.8% per annum in the period 1991 to 1999 (after which the recording base was changed slightly) [58], compared to a growth in real Gross Domestic Product of about 2.7% during the same period.

#### **ii Order lead times**

Within the literature there is general agreement that short order lead times are frequently a key service level factor, particularly in agile supply chains. Figure 5 shows the survey findings in this regard. As the survey only concerned distribution centre operations, lead time was defined in this context as the length of time from the



receipt of customer order to despatch. Multiple answers were allowed as many distribution centres provide different lead times to the various market segments that they serve.

### **PLACE FIGURE 5 HERE**

This indicates that 20% of distribution centres provide a same day lead time and 69% a next day lead time. Some of the sites were offering both same day and next day service and, hence, the total percentage offering a same and/or next day lead time amounts to 73%. The results of the inventory holdings and lead times appear to suggest that agile responses to the market are being provided, but from relatively high inventory holdings. This may reinforce the literature regarding the importance of availability in agility and also the concept of decoupling points. Thus many of the distribution centres may be holding the “strategic inventory” which defines the supply chain decoupling point.

### **iii Customer segmentation**

A further analysis of the above figures provides some indication as to whether different service levels are being provided from the distribution centres. This would be expected if customer (or product) segmentation is being applied.

For this purpose, the categories used in Figure 5 have been used. This does not provide a strict count of the number of different lead times provided, as for example a 3 day service to one customer group would appear in the same category as a 5 day service to another group. However, it does provide an indication.

**PLACE FIGURE 6 HERE**

The results indicate that 67% of distribution centres are just offering one service level (within the above definition). Most of these (36% of respondents) offer a next day service level. These figures indicate that segmentation, in terms of lead times, only occurs in about one third of the distribution centres.

**iv Added value activities**

For the purposes of the survey, added value activities were classified into two groups: those prior to despatch and those associated with reverse flows. Postponement activities may be associated with added value activities prior to despatch and these results are shown in Figure 7.

**PLACE FIGURE 7 HERE**

A total of 71% of distribution centres undertook some form of added value activity prior to despatch (described as “any activity” in Figure 7). The most common type of activity (56%) involved labelling, pricing or tagging goods. This may be a form of postponement (or may indeed be an activity previously conducted at store level). Production postponement may be more closely allied to final assembly and this was undertaken at 31% of sites. Interestingly, 11% of sites also undertook testing activities.

As regards reverse flow activity, this was conducted in 42% of distribution centres, with disassembly (18% of sites) and refurbishment (also 18%) being the most common activities. Only 4% of sites conducted repair activities and the same percentage modification activities.

In terms of the scale of these added value activities, it can be seen from Figure 8 that they occupied only 5% of the floor area of the distribution centres. Thus, although the majority of distribution centres undertake these activities, they are normally fairly minor in nature.

**PLACE FIGURE 8 HERE**

## v **Cross docking**

The survey indicates that a relatively small proportion of goods is cross docked through most distribution centres (see Figure 9). In fact, 74% of distribution centres cross-dock 5% or less of their total throughput; the majority of the throughput coming from inventory held within the distribution centres themselves. Only 7% of the sites cross-dock more than 20% of their throughput.

### **PLACE FIGURE 9 HERE**

The floor area usage in Figure 8 supports this finding that most large distribution centres are chiefly involved with supplying goods from inventory. Just over 50% of the floor areas of the distribution centres were taken up with storage and a further 22% with picking and packing (presumably chiefly in relation to these stored goods). Goods in / out activities accounted for 18% of the floor area, which again would suggest typical activities in stockholding warehouses.

It should be noted that this survey only covered large distribution centres and it is possible that cross-docking may be more frequently found in smaller depots. For example, large central distribution centres often send goods to a number of smaller depots where they are cross-docked for final delivery to the customer.

## **vi Third party logistics providers**

As regards the use of third party logistics providers, 64% of the distribution centres were operated by such companies. Most of these were dedicated facilities. Shared user facilities represented 11% of the total. This could be interpreted as a high proportion of companies potentially forming “extended enterprises” or “virtual organisations”, but a fairly low proportion making use of the variable amount of space that may be possible within a shared user facility.

## **Challenges**

When asked the main challenge that the distribution centre operation has faced since opening the most common reply was cost reduction (73% of respondents). In looking ahead over the next three years, the major challenge was viewed however as shorter lead times (64%), whilst cost reduction reduced to 51% of respondents. This may indeed signify a shift in emphasis from the “lean” paradigm, which is often associated with cost reduction, to the “agile” paradigm where service levels are regarded as the market winner.

A change from a “lean” to an “agile” paradigm would be a major challenge for most supply chain infrastructures, particularly as many warehouse equipment types, as well as the buildings themselves, have long asset lives. In addition, the requirement to maintain high service levels and efficiency during any period of major equipment commissioning is very difficult to achieve. This challenge is exemplified by the U.K.

grocery retailer, Sainsbury's, which is changing from predominantly stockholding Regional Distribution Centres to "flow through" Fulfilment Factories. This has involved moving from an infrastructure chiefly comprising conventional wide aisle racking to one combining automated storage and retrieval systems (AS/RS), pick conveyors and sophisticated sortation systems. The investment and implementation consequences have been a significant cause of concern to financial analysts and investors during this period of change. This demonstrates the severe difficulties and risks that many companies face in developing their infrastructure in this way.

## **Conclusion**

The research results indicate that there is an increasing take-up of large distribution centres in the U.K and that these are still fulfilling the traditional role of warehouses, namely holding inventory and breaking bulk for customer orders. The levels of cross docking activity appear to be fairly low. However, most of the distribution centres surveyed do provide a rapid response to customer orders. Most also provide some form of added value activities but these services tend to relate to finalising the presentation of the goods, such as labelling, pricing and tagging. Some production postponement, in the form of final assembly, is undertaken, although, on the whole, relatively little floor area appears to be given over to added value activities.

This picture tends to fit with such concepts as decoupling points, whereby there are strategic inventory holdings in supply chains from which agile responses can be given to the market place. As indicated in the literature, this may be due to the need to manage volatility in local markets along with global supply chains. In fact, such

factors as global sourcing and product proliferation may well be counteracting the application of contemporary supply chain concepts as reflected in the constant national inventory ratios during the past few years.

The relatively low use of production postponement and cross docking in many of the distribution centres surveyed may indicate that many companies are still driven by inventory based thinking (e.g. economic batch quantities and replenishment points) rather than by the use of information based concepts (e.g. Efficient Consumer Response, and Collaborative Planning Forecasting and Replenishment). However, it may be that these concepts are only fully applicable in a limited range of circumstances.

Further research is needed to understand the precise relationships observed. For example, it might be that agile strategies would not involve large distribution centres such as the type surveyed. However, the increasing take-up of such sites does tend to indicate that such centres still play a major role in modern supply chains. Research is therefore needed to investigate how agile, and other, strategies can be implemented and what type of facilities are required.

On the basis that the major challenge foreseen by the distribution centre managers over the next three years is to reduce customer lead times, the issue becomes one of defining the exact role of distribution centres within supply chains and the implications for their design.

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## Appendix

### Survey Questions

The relevant survey questions used for this article were as follows.

Please indicate the approximate stock-turn in terms of the number of times per annum.

What is the order lead time from customer order to despatch?

- Same day
- Next day
- Two to five days
- More than five days.

Please indicate which, if any, of the following value adding activities are undertaken in your warehouse.

Prior to despatch

- Labelling, pricing, tagging
- Final assembly
- Testing

Reverse flows:

- Disassembly
- Refurbishment for resale
- Repair
- Modification

Other (please specify)

What percentage of the warehouse floor area is used for:

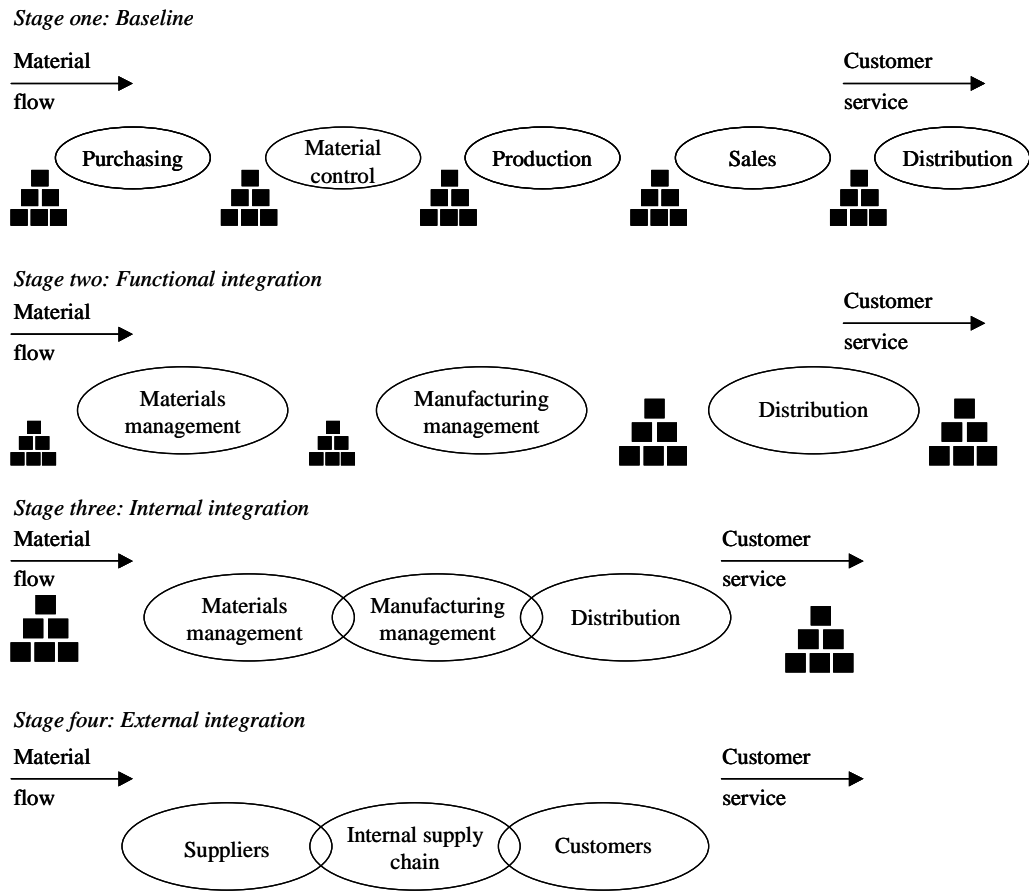
- |                              |                          |
|------------------------------|--------------------------|
| Goods in / out / marshalling | <input type="checkbox"/> |
| Storage                      | <input type="checkbox"/> |
| Picking / packing            | <input type="checkbox"/> |
| Added value activities       | <input type="checkbox"/> |
| Other                        | <input type="checkbox"/> |
| Total                        | 100%                     |

Approximately what percentage of the throughput is cross-docked?

Respondents were invited to provide multiple answers, where appropriate.

Classification by industry group and third party logistics provider involvement were obtained by inspection of the company, product and operational details supplied by the respondents.

**Figure 1: Achieving an integrated supply chain**

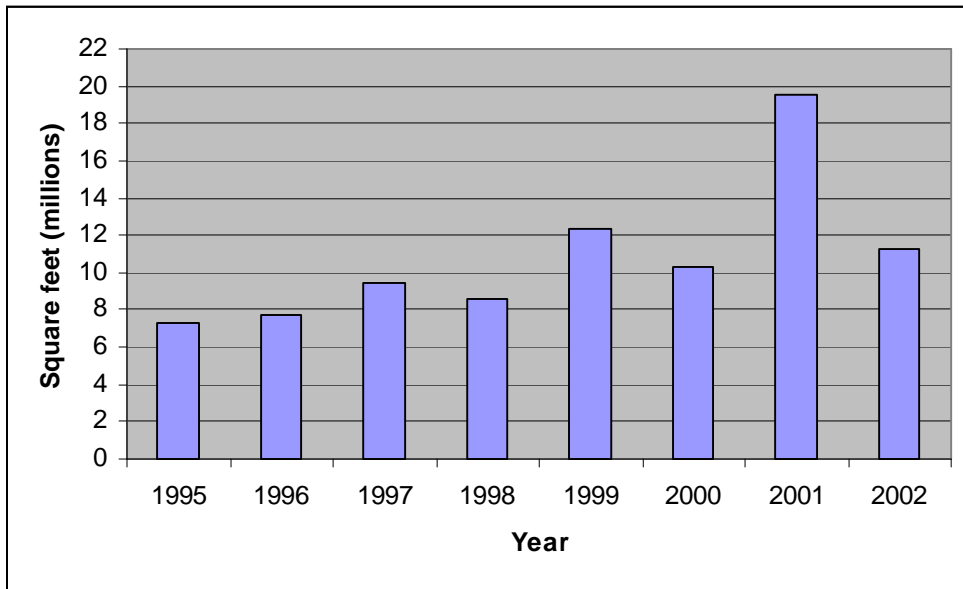


Source: [2]

**Table 1: Industry sectors represented by survey responses**

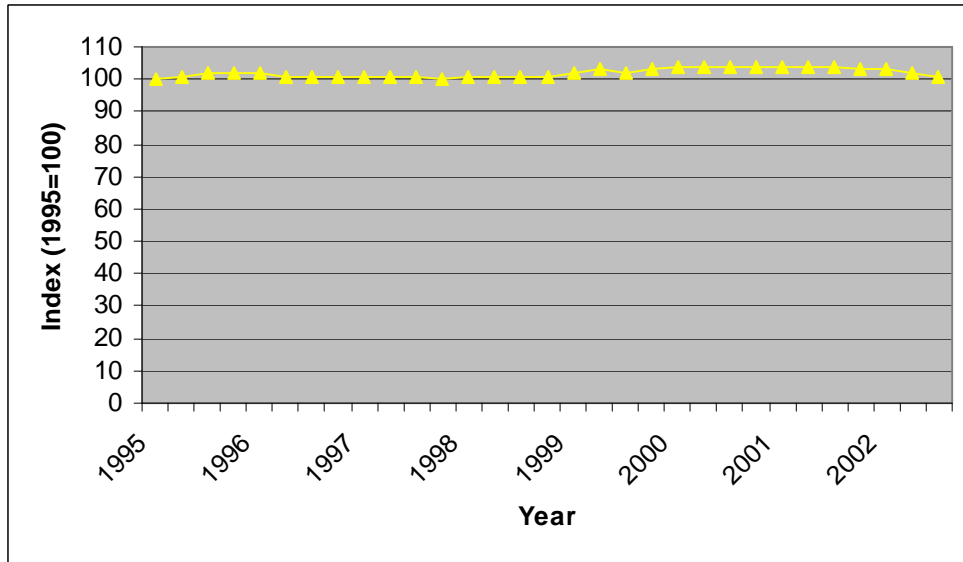
<b>Industry sector</b>	<b>Number of responses used</b>
Food producers	7
Other manufacturing companies	13
Wholesalers	6
Retailers	14
Shared user facilities	5
<b>Total</b>	<b>45</b>

**Figure 2: The take-up of new warehouses over 100,000 sq. ft. in the U.K.**



*Source: [54]*

**Figure 3: Inventory levels within the United Kingdom**

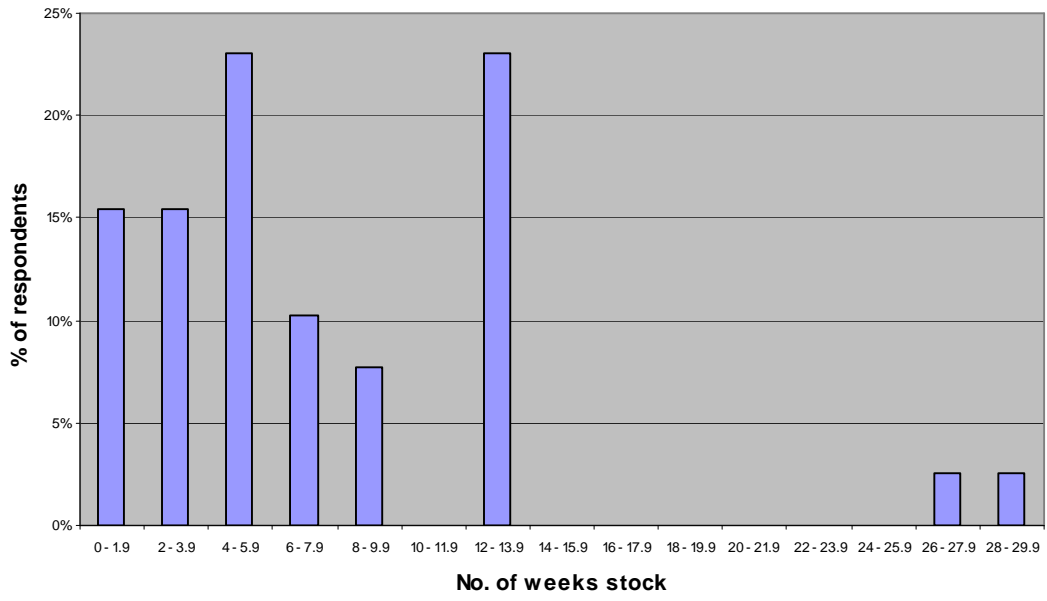


**Definition:**

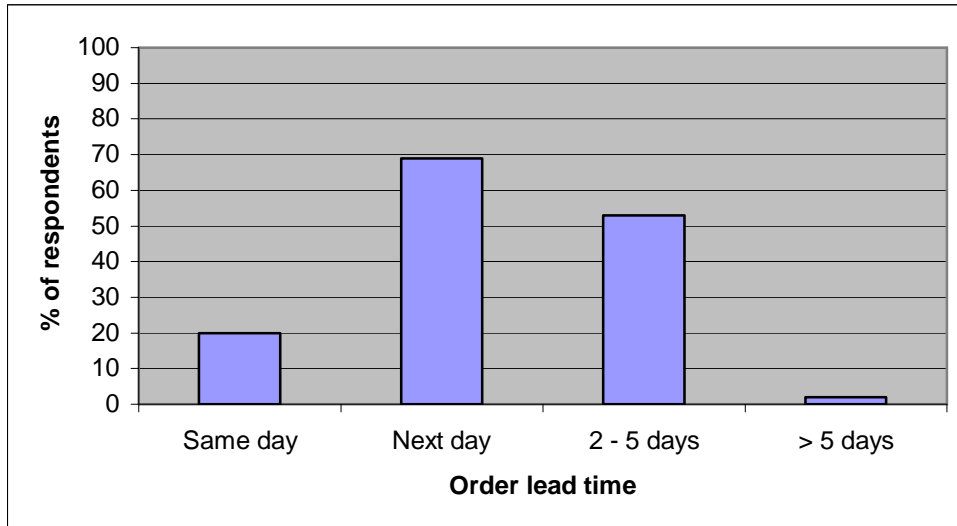
*Inventory level shown as ratio of total inventories to Gross Domestic Product.*

**Data source:** [55]

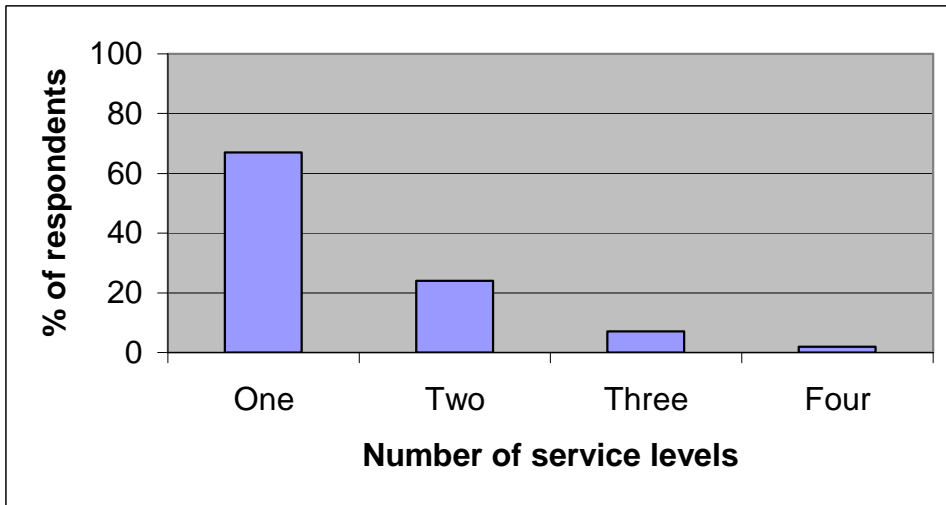
**Figure 4: Inventory holding levels**



**Figure 5: Order lead times**

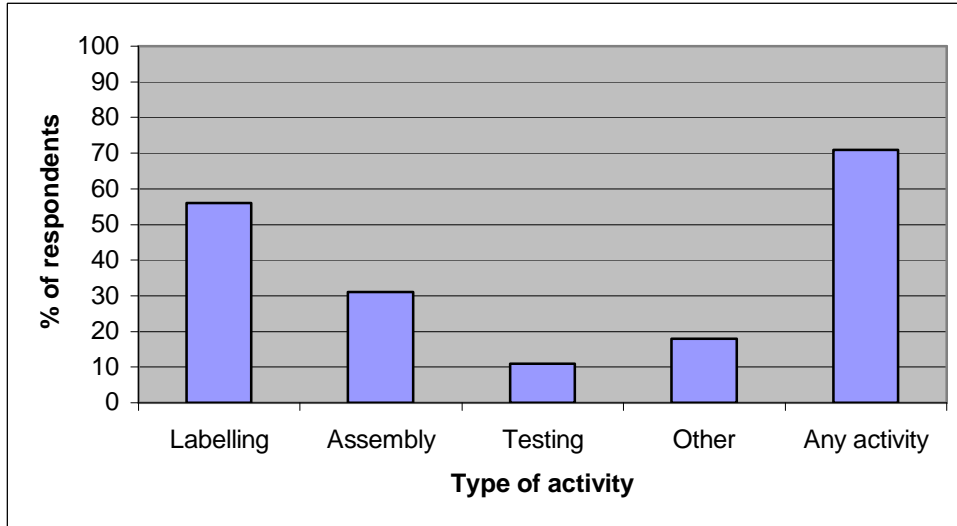


**Figure 6: Number of service levels provided**

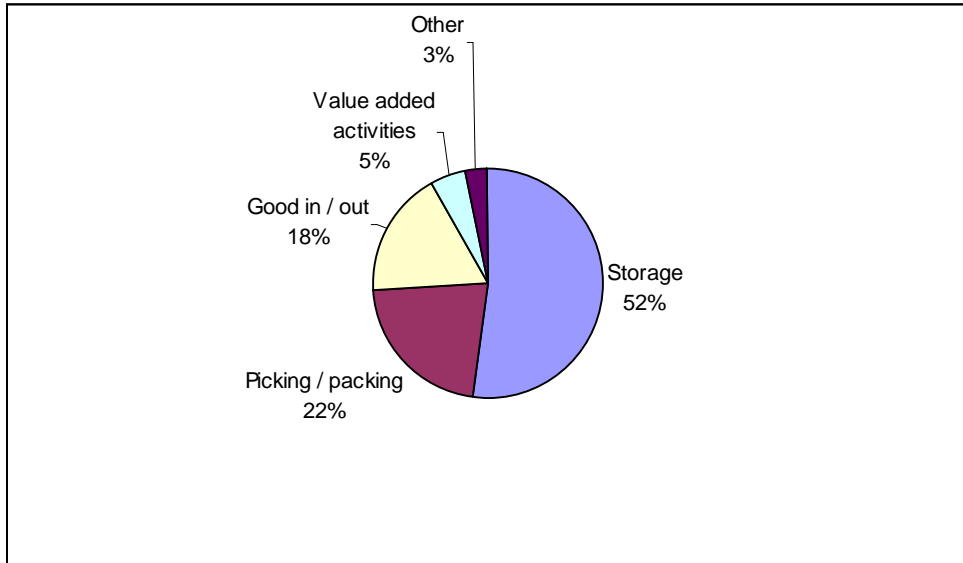




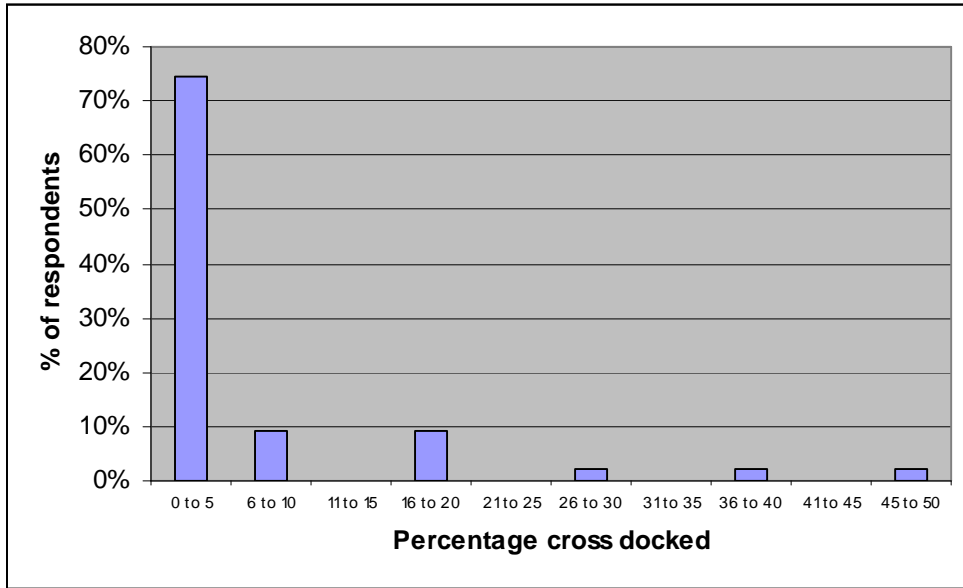
**Figure 7: Added value activities prior to despatch**



**Figure 8: Floor area usage**



**Figure 9: Cross docking**



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