The University of Warwick
Department of Engineering

Integrated Graduate Development Scheme
Engineering Doctorate

Submission to Portfolio

Executive Summary

"Service-based Strategy in the Air Express Industry"

Date of Submission : April 19, 2001

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Abstract

The air express industry has a set of characteristics very different from other logistics or transportation fields in terms of market competition, operational set up, and service strategy. There is a distinct competitive advantage if the service strategy can lead the air express company toward higher agility and customisation.

Developed along the concept of Porter's generic value chain, a new Service Strategy Implementation Model was developed for providing an integrated solution for acquiring competitiveness in the air express business. It contains two main components, namely: an 'Agility & Customisation Tool' and a 'Customer Front-end Action Tool'. The Model shows clearly all the important functions and major activities under the air express scenario that should be studied in order to arrive at the most appropriate service strategy solutions for the company. This model can be used as a map to guide the company management to plan strategically for the air express business requirements.

Two major projects have been studied in considerable detail, namely (i) Strategic Service Network Planning & Design', and (ii) Service Quality and Customer Service' to address the agility and customisation concerns respectively in the market competition. In both projects, new approaches in tackling genuine business problems were used. In the first, there was a simultaneous use of mixed 0-1 Linear Programming and computer simulation to arrive at a compromise solution. While for the latter, the derivation of a new Customer Value Model for the industry referencing PZB's* service quality concept, resulted in a successful transformation of customer feedback into action priorities.

There are also studies and discussion on the areas of technology management, service productivity and service product development that are important components of the Service Strategy Implementation Model.

** PZB is the abbrievation for Parasuraman, Zeithaml & Berry who have jointly published a series of papers on service quality topics*

Declaration

I, Yiu-Man WONG, hereby declare that this EngD portfolio, entitled "Service-based Strategy in the Air Express Industry", represents my own work. It has not been previously submitted to this or any other institution in an application for admission to a degree, a diploma, or any other qualifications.

Signed: _____

Yiu-Man WONG

Dated: April 19, 2001

Acknowledgements

The author would like to express his deep gratitude to his mentors: Mr. John Hill, Dr. C.K. Li, and Mr. Andy Tseng for their full support in the whole process of this research programme.

He is also indebted to Dr. Kevin Neailey who has provided a lot of guidance and invaluable advice that helped him while working towards an Engineering Doctorate degree.

Yiu-Man Wong

April 19, 2001

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1. *Introduction*

The title of the portfolio is '**Service-based Strategy in the Air Express Industry**'. There are three essential phrases in this title.

The first one is strategy. A strategy, according to Quinn [1], is "*the pattern or plan that integrates an organisation's major goals, policies, and action sequences into a cohesive whole*". A well formulated strategy helps to marshal and allocate an organisation's resources into a unique and viable posture based on its relative internal competencies and shortcomings, anticipated changes in environment, and contingent moves by intelligent opponents. The second key phrase of service-based defines the business environment to be within the service industry. The product offered is a service that is quite different from the usual one in manufacturing where there is a physical product. Finally, the air express industry defines the scope of this research project. Air express is sometimes also referred to as courier delivery service. Its core business is time-definite delivery of shipments around the world, and is a particular service sector of the logistics industries.

There has always been keen competition in the air express business, particularly in the Asia Pacific market, where an annual business revenue volume of US$ 5 billion exists with a strong prospect for future growth. All the major contenders are renowned international firms with a global network background. Different players use a different emphasis and strategies to compete. Some are successful, some not. There have been very few research projects or published literature that studied how air express companies should make their strategic moves. Hence, the author saw the need to study details of the above areas in order to survive and win against the competition. He was the Director of Service Operations at DHL International (Hong Kong) Ltd., and has led many improvement changes in operational aspects. He also contributed to the development and implementation of service strategies of the company.

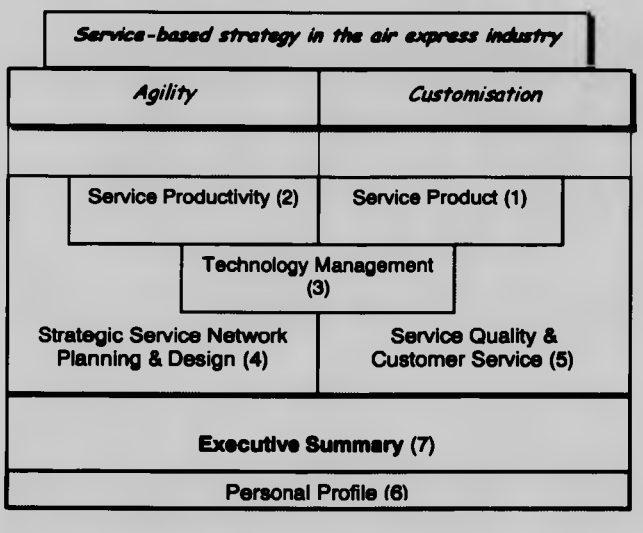
1.1 *Objectives*

The main objective of this research is to review the theory and practice of service-based strategy in the air express industry, and then to develop a new service strategy implementation model to include all important functions and major activities. This model provides a clear map to guide the company management towards an integrated strategic plan to attain higher agility and customisation in the air express business.

By analysing the key components of the model, several contributory objectives to thoroughly understand each of the important functions - such as the service network distribution, customer service and quality – were established. The methodology is to carry out a number of research projects and publish papers in these important areas to tackle the specific problems there, and to derive strategic solutions for the company to be adopted and implemented.

1.2 *Portfolio Structure*

In total, there are seven submissions to the portfolio under the overall theme of Service-based strategy in the air express industry. They are inter-related according to the schematic block diagram shown in Figure 1.



Note: Figures in brackets are the submission sequence numbers

Figure 1: Schematic relationships between Submissions of the Portfolio

The *Executive Summary* and the *Personal Profile* are the backbone of the portfolio. They are presented as Submissions 7 and 6 respectively.

There are two key research projects, namely the *Strategic Service Network Planning & Design* and the *Service Quality & Customer Service*. To a first degree of approximation, they are correspondingly related to the agility and customisation aspects under the overall theme of service-based strategy. They are presented as Submissions 4 and 5 respectively.

In addition, there are three research papers. *Technology Management* (Submission 3) is a paper that cuts across both boundaries and covers all the technology aspects. *Service productivity* (Submission 2) is slightly more biased to the agility side, and is closely associated with the Service Network project. On the other hand, the *Service Product* (Submission 1) is slightly biased towards the customisation side that is related to the Service Quality & Customer Service project.

Each of these seven submissions can be read as independent articles. This one, i.e. the *Executive Summary* should be read first, followed by the two projects (Submissions 4 and 5). Of the papers, the order of reading should be Technology Management (Submission 3) first, then Service Productivity (Submission 2), and finally Service Product (Submission 1).

Submission 6 is a *Personal Profile* of the author, and as such, is not specifically related to the overall theme of the portfolio.

1.3 Brief Overview of the Submissions

Submission 4 is a research project titled 'Strategic Service Network Planning and Design'. It addressed a genuine operational challenge due to (a) the opening of the new international airport for Hong Kong and (b) the increasing business volume with China after the hand-over of Hong Kong in 1997. This research helped DHL determine a ten-year service network distribution design to improve service performance and reduce cost. Two separate but related models were used in the overall planning framework. The first model was called the *economic network planning model*. It determined the macro optimal system configuration using Mixed 0-1 Linear Programming techniques. The second model, called the *operation simulation model,* used computer simulation techniques to evaluate the operational efficiency of the recommended network configuration on a statistical basis. A systematic and iterative use of both models helped the author arrive at a compromise solution that was most appropriate for the company in terms of providing agile service to customers.

Another project, 'Service Quality and Customer Service', went deeply into the customer aspects of the business. It is presented as Submission 5 of the portfolio. The project firstly reviewed the literature of service quality and customer service management concepts, with particular emphasis on those applicable to the air express industry. Then DHL's total quality approach and emphasis were explored in detail. The movement towards factors such as Global Service Commitment, Service Quality Index, and Multi-Dimensional Performance Measurement presented to DHL both opportunities as well as challenges. Making reference to Parasuraman, Zeithaml & Berry's service quality model [2], the author built a new Customer Value Model to link customer behaviour to the critical performance factors. The value perceived from the customers was significantly related to service quality, price perception, and company reputation. These were then validated by a large-scale customer satisfaction study. Subsequently, through a step-by-step analysis, certain service features were identified as Performance Improvement Priorities, from which genuine action plans were formulated to provide customised services to various customer segments.

Submissions 1, 2 and 3 are all published papers.

The paper entitled 'Technology Management in Sustaining Agile Competitiveness in the Air Express Industry – a case study in DHL' (i.e. Submission 3) analysed the importance of technology and cross-examined DHL's approach against those of other researchers. Materials technology, methods technology, and information technology were studied with real life illustrations. Then a number of information technology innovations at both the customer service front-end and back end were explored. There was also a description of a mobile data communications project to illustrate how to get a timely update of shipment information onto the DHL global database.

Submission 2, `Service Productivity and Quality Excellence in the Air Express Industry', reviewed the various dimensions of productivity, particularly in the service sector. There was also a discussion to link service productivity to quality excellence, and ultimately to service excellence. Concepts of `negative productivity' and `quality level discount factors' were introduced and discussed there.

Finally Submission 1, entitled `Strategic Product Launch and Implementation: making reference to the DHL Jumbo Box', was a paper for discussing various technical issues in a new product introduction programme that was constrained by a narrow time frame. The Jumbo Box was a new strategic service product that was able to fill the product sector in the range of 15 to 50 kg. To make it a success, both the design of the box and the rules of using this new product were carefully worked out. There were also other considerations such as information management, materials planning, distribution, and human factors.

The respective abstracts of the five submissions mentioned above are collected in Appendix 1.

2. *The Competitive Environment*

Air express is in a very competitive business environment. There is a need to explain the background environment to identify the important factors therein.

2.1 *The Global and Regional Picture*

The air cargo industry can be seen as a subset of the worldwide airline industry that transports passengers, freight and mail. Major participants include airlines, airfreight forwarders, air express companies, post offices, passengers and cargo shippers. Air cargo is considered a premium service in the marketplace over those transported by sea or land. Items moved by air are often characterised as having high value, being fragile, perishable, or requiring rapid transit.

2.1.1 The Emergence of Air Express

There has been a phenomenal growth in the air express business since the seventies[3]. On the whole, airfreight transportation services can be divided into three main categories:

a) low-yield airport-to-airport common carriage traffic,
b) special items e.g. perishables, valuables & dangerous goods, and
c) transportation of goods in a manner that *'adds value' to the customer* beyond merely moving those goods between two points.

It is in the final category that the air express business evolved. It provides customers with a bundle of value-added services such as:

- time-definite delivery
- track and trace capability
- rapid and expedited movement through the system
- service guarantees
- airport-to-door, door-to-door, and door-to-airport options in addition to the conventional airport-to-airport delivery
- customised logistics programmes

2.1.2 Expansion of Air Express into Logistic Services

One noticeable trend is the increasing recognition that transporting goods is only one part of a broader function called logistics. Moving goods efficiently on a global basis within the context of just-in-time methods is beyond the capabilities of most shippers' in-house shipping function. Thus, more shippers are seeking outside expertise to obtain logistic services on an out-sourced basis. Practically, logistics can be regarded as moving goods from the source of raw materials through to the end consumers, meeting every need in the distribution chain

along the way. The functions usually include inventory management, warehousing, just-in-time distribution, customs brokerage, order processing, and package testing.

In these days, the emphasis has gradually shifted from transport management to logistics, aiming to reduce logistics costs by reducing inventory costs. This in turn leads to the requirements for time-definite transportation and reduced transit time. The process is facilitated by electronic data transmission that provides visibility of where the shipments are in the supply chain. All these provide a good platform for air express to participate, and become an important tool for gaining competitive advantage within the logistics field.

2.1.3 Key Air Express Players

In the international air express services, the key players are DHL, Federal Express, UPS and TNT. All of them have been in the industry for a long time, and have a huge financial background and global operational network with which they can compete. On the whole, DHL is the largest in terms of shipment volume, then followed by Federal Express, UPS and TNT [3]. The industry's average volume growth rate is high, roughly at 18% per annum.

2.2 The Hong Kong Market

Since the eighties, the Asian market has increased its significance in the World's economic scene. It is also having a continued growth trend that is sustained by the optimistic economic development of China and the 4 'small industrialised dragons' (i.e. Hong Kong, Singapore, Korea and Taiwan). Goods movement is expected to be abundant in this region, and thus attracts many airfreight and air express companies to come to this battlefield. Being the gateway to China and a long established marketplace in the Far East, Hong Kong received the earliest attention from the key players. DHL came first, and it has been in Hong Kong since 1972. Its founders even had to fight against the postal law in those early days. Later, the other major players also joined the competition.

Hong Kong has gone through a sustained period of successful expansion in international business for the past two decades. It was relatively easy to accept time competition as a strategic tool of competition. In general, people are willing to pay for the extra time saving advantage. In terms of competition among air express service providers, the main target is to achieve the shortest shipment transit time. The industry standard these days is 'next morning delivery' to central business districts of all major Asian cities; others would be within that day before the close of business. Transit times for inter-continental deliveries would depend on the actual locations, but are still within three working days for any central business district in the World [4].

Different air express companies use different approaches to make the above happen. Some use hub-and-spoke, some use direct point-to-point, some use a mix of the two. With the growth of shipment quantities and the rise of more business cities around the World, the solution gradually favours the 'decentralised' hub-and-spoke option. Hence, in addition to main hubs in Europe and North America, all the key players have developed their Asian sorting hubs in the region during the past few years. Examples are Manila for DHL and TNT, Subic Bay for Federal Express, and Taipei for UPS.

2.3 ***Competitive Factors***

In addition to the air network hub strategy, the ground service network is also very important in meeting the flight schedule as well as the customer demands. It is the front-end service capability that makes the difference in providing shipment pick up and delivery in an agile manner. Hence, this was the major focus of the project work described in Chapter 4.

Besides transit time, other important aspects to be competed include (i) service quality, (ii) reliability of service, (iii) shipment status track and trace capability, and (iv) price.

Service quality has much to do with the expectations of the customers and the level of service provided. In addition, the service people are very important entities to manage the service delivery process. Quality performance of the service needs to be consistent and reliable. Since all the major air express companies offer a money back guarantee, there has to be a high level of achievement on the committed turnaround time and special services. Track and trace capability is also one of the key areas that make the air express industry more competitive because of higher value provided to customers. This is done through the deployment of technology resources, which really brings about significant changes. All the above together constitute another topic to be worked on, and this is covered in Chapter 5.

2.4 The Competitive Market

Porter [5] formulated a model of competitive forces that represents the general competitive situation within which a company operates (Figure 2).

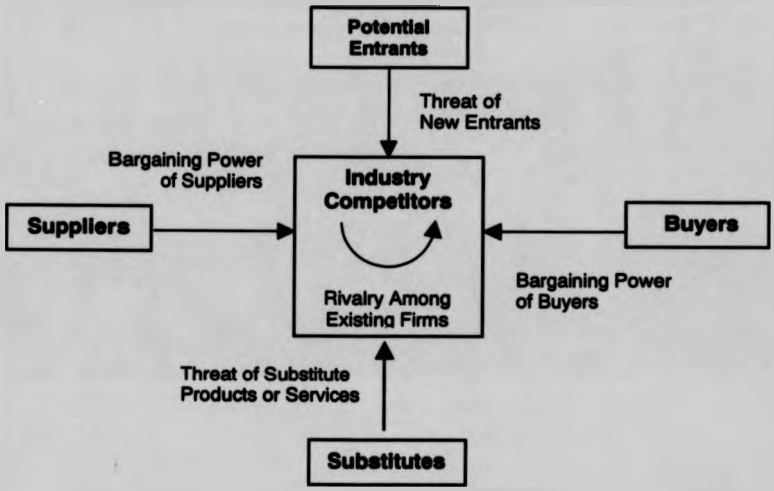


Figure 2: Forces that drive Industry Competition [5]

As evaluated by the author under the framework of Figure 2, the strength of competitive forces that DHL faces is summarised in Table 1 below. It can be seen from the evaluation that the rivalry force is the highest. Thus, DHL needs to compete hard on the related service performance attributes. The service product offering is also an important and noticeable force. Hence, both areas have been chosen to be studied in detail.

Competitive Forces	*Low*	*High*	*Remarks*
1) rivalry among existing competitors		x	Strong international competitors in the global scene
2) threat of new entrants	x		Very difficult to form a new world wide logistics network
3) threat of new service products		x	Electronic documents & Internet already impact the document business, but not the light parcels
4) bargaining power of suppliers	x		Airlines are already in keen competition themselves, hence have low bargaining power
5) bargaining power of buyers	x		Big customers and frequent shippers can enjoy a price discount, but not others

Table 1: Evaluation of Competitive Forces that DHL Faces

3. *New Considerations on Service Strategy*

After reviewing the competitive business environment, it can be seen that the need to have a service based strategy deserves a high priority and attention of the company management. In the following sub-sections, the author has developed some new concepts about the main structure of the service strategy in the air express industry.

3.1 *Agility and Customisation*

Both agility and customisation are important ingredients to the success of air express companies. In these days, the mobility of customers' choices is free and volatile. Once the service providers cannot fully satisfy the customer needs, their chance of getting future sales is quite vulnerable.

Customers using air express services would expect them to be readily available whenever they call for it. Sometimes their transportation needs are not known until the last minute. Companies like DHL have to work on a thin margin of response time, particularly during the evening cut off. Hence, the demand pattern of each weekday and the effect of the eve of a long weekend or holiday have to be understood and well planned for. The operations team has to be **agile** enough in making available the necessary resources and infrastructures with appropriate capacity and capability in serving the customers.

In addition to the day to day quick-response scenario, agility should also be demonstrated in other aspects. An example to illustrate this is the new service product development of the Jumbo Box (see Chapter 6.3). The whole company managed the programme well in deploying all the necessary resources to make this new product launch a success. In addition, the Jumbo Box itself provided a standardised package concept that increased the agility of the service operation staff's performance.

According to the customer needs, the main issues involved with service agility in air express companies include service infrastructure, product, productivity, technology, quality, human resources, and customer service. By managing these factors well, it is possible to achieve:
a) a high degree of added value that is beneficial to the customer, and
b) a high level of customer satisfaction.

Agility in the air express industry is characterised by the ability to offer:
(i) a varied combination of products and services for different market segments,
(ii) services availability at any time and in arbitrary lot (e.g. shipment) sizes, and
(iii) close awareness and attention to customers' changing needs. At the operations level, the business processes, customer relations, workflow and supplier relations are important factors contributing to success. In terms of company-wide organisation philosophy, there needs to be a shift from the traditional command and control attitude to an emphasis on leadership, support and mutual trust.

Customisation is desirable in providing the most tailor-made solution to satisfy the customer needs. Apart from the basic fast turnaround and reliable delivery services, different customers may also need something different. For instance, many banking and finance customers would demand 'same day' document arrival to the USA based on the office working hours of Wall Street (New York). Some industrial customers, however, may demand logistic services in the license documentation and customs clearance processes. With the 40,000 plus customers that DHL Hong Kong is serving, true customisation is practically impossible. It can only be done by categorising customers into groups, and then offering 'segmented customisation' to each of the groups.

Poor handling of the customisation issues may cause an unsatisfactory utilisation of resources, and can result in lower productivity. On the other hand, with correct and appropriate use of strategic tools in assigning the appropriate emphasis and priorities in deploying resources, the above mentioned potential drawbacks can be reduced significantly. Once customisation is properly demonstrated, customers of different trades and sizes can be served better to satisfy their specific needs. As a result, customers will perceive that they are getting more *value* from the service delivered. Such added value is a key success factor to a company, and can be reflected in the degree of customer satisfaction as well as in the sales volume growth. This will be covered in more detail in Chapter 5.

3.2 *Adaptation from the Generic Value Chain*

Since value is a key success factor to competitiveness, service companies should find ways to maximise it. Porter derived a generic value chain in his book on competitive advantage [6], as shown in Figure 3.

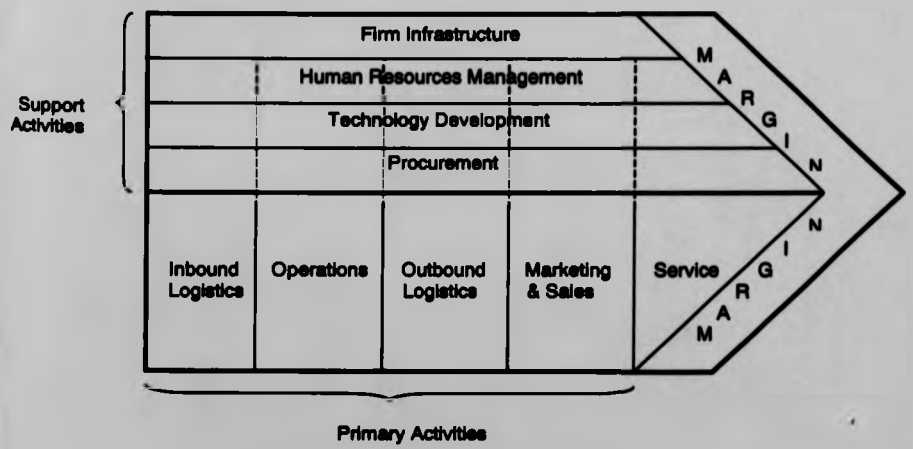


Figure 3 : The Generic Value Chain [6]

The essence of this generic value chain is that a higher profit margin can be derived through five primary activities and a number of support activities arranged in a matrix relationship. Within each of the primary and support activities, there are more detailed methods and actions involved. Improvement in one aspect alone will give rise to a certain degree of increased profit margin. Nevertheless, the main clue is that there will be a substantial increase in the profit margin if a co-ordinated approach is taken for all the various factors involved. It is a 'team-work' and synergy concept.

The author identified a similar concept to Porter's, but adapted it to become a specific value chain that is applied to the air express industry. All the primary and support activities are re-defined. The expected outcome is increased competitiveness, mainly due to agility and customisation in a cost-effective manner (see Figure 4).

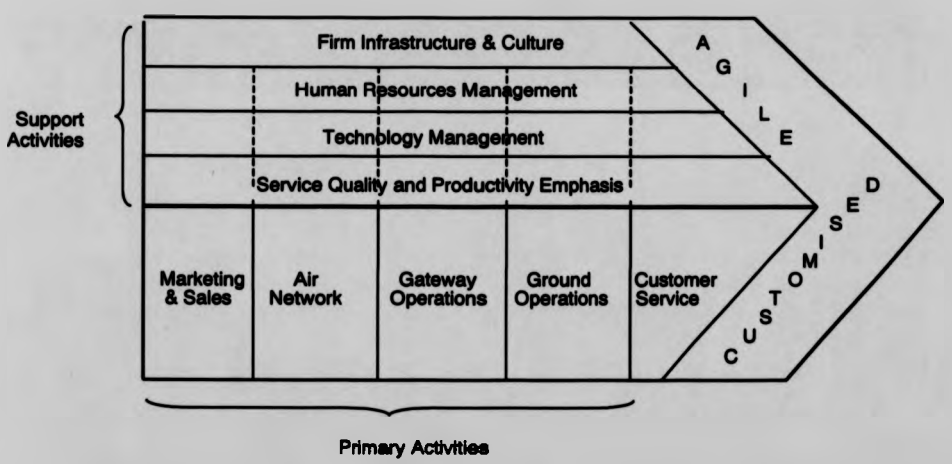


Figure 4: The Specific Value Chain for the Air Express Industry

The primary activities as shown in Figure 4 form the basis by which air express companies operate. Marketing and Sales involve those business activities related to anticipating and understanding customer needs, and to proactively communicate with customers. The Air Network is concerned with the long distance point-to-point or hub-and-spoke transportation by aeroplane. The gateway is the place where shipments get in and out of a country. There are a lot of customs and import / export regulations involved with gateway operations. The Ground Operations include all those transportation and delivery activities carried out within a certain country (or city in the case of Hong Kong). Finally, the Customer Service activities are mainly those for answering enquiries and solving customers' specific problems at a remote site.

The support activities contain important qualities that have to exist to support the primary functions described above. Firstly, the firm infrastructure and

culture is the fundamental skeleton of the company. The mission, belief, and culture need to be clearly defined and consistently pushed throughout the firm. Human resources management is of vital importance since most services are delivered in the presence of the customers. The attitude and performance of the front-end service staff have a great impact on the perception of quality and customer satisfaction. Technology makes many dreams possible, and can turn wishes into reality, provided that it is managed properly according to the strategic direction of the company. Finally there must be a persistent emphasis from the top management on service quality and productivity, both being key factors in terms of competitiveness in the market.

These nine activities have covered all the main areas on which air express companies should focus in order to become agile and customised in serving customers. The integration of all these in a synergic manner can give rise to a significant rise in the overall performance.

There are still some other factors not mentioned above that have some effect on the output. However their effect is relatively less significant than the main ones chosen in the model.

3.3 Creation of the Service Strategy Implementation Model

Within the scope of the air express industry, and making reference to DHL's market competition, the author has developed a new service strategy implementation model. The model design skeleton is shown in Figure 5.

Figure 5: Design skeleton of the Strategy Implementation Model

In essence, there is an original service strategy to start with. Such a strategy should have taken consideration of the significance of the various market competitive forces. The company then uses an *Agility and Customisation Tool* to help devise a better service strategy with a different set of configurations. However any changes recommended need to be implemented in order to realise the genuine improvement. Therefore there is a *Customer Front-end Action Tool* employed to make that happen. Consequently, better results can be achieved.

The following is a description of the step-by-step build up of the model.

3.3.1 Initial Strategic Positioning

The service strategy should be built on three main considerations, namely: a) Company Vision, b) Customer Expectation, and c) Competitor Performance. These together drive the company to a unique position in the market. The service strategy derived should be able to target a specific market position and to set the direction for the company. Figure 6 shows their causal relationship in a simple form.

Figure 6: Initial Strategic Positioning

3.3.2 *The Agility and Customisation Tool*

The specific value chain derived in Chapter 3.2 is one of the most important tools. When applied to the service strategy, it can provide the needed energy toward increased competitiveness. Figure 4, when rotated clockwise by a right angle, can be interpreted as a 'torpedo' for improvement (see Figure 7 below). An improved version of the service strategy could be obtained after setting the right configurations inside the torpedo.

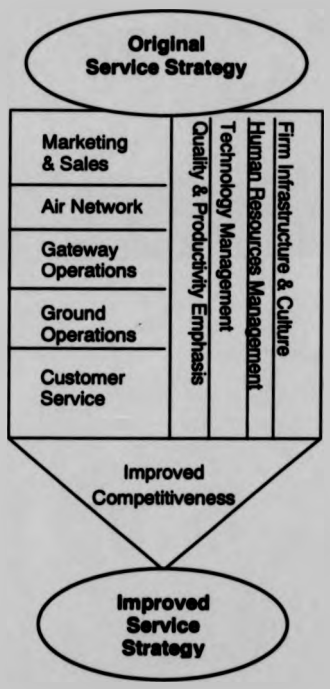


Figure 7: Agility & Customisation Torpedo

3.3.3 *The Customer Front-end Action Tool*

After the revised, i.e. improved service strategy has been derived, actions should be taken to implement any decision and to carry out the actual deployment of resources. There are two main components of service, namely material service and personal service. Both are important in the service delivery process, and have a significant impact on the customer perception of service (see Figure 8).

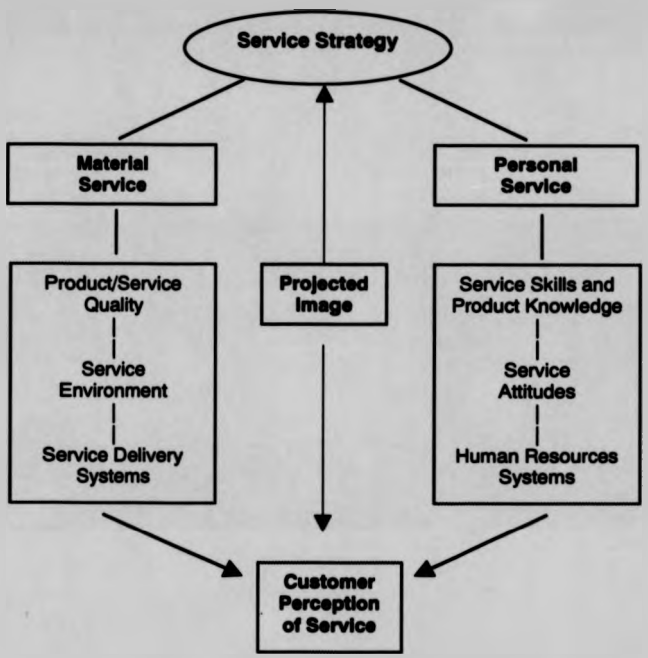


Figure 8: Actions at the Customer Front-end

There are other related elements under each of the headings of material and personal service. Also stemming from the new service strategy, there is a projected image presented to outsiders that can influence their perception about the service. The customers' level of satisfaction is highly dependent on their expectation against their perception of the service.

3.3.4 *Monitoring and Feedback Process*

The entire process cannot be complete without customer feedback into the strategy formulating cycle. Figure 9 below shows the process. There should be an internal monitoring system to continually assess how well the company is doing in terms of customer perception of service. Results of the feedback should be routed back to the Agility and Customisation Torpedo for another iteration, as required.

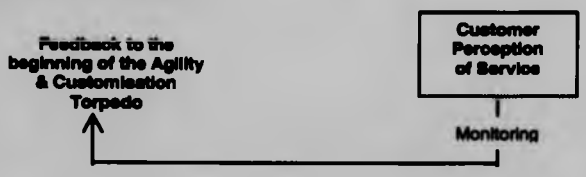


Figure 9: Monitoring & Feedback Process

3.3.5 *The Service Strategy Implementation Model*

Figure 10 is the final Service Strategy Implementation Model, after consolidating all the design components previously discussed.

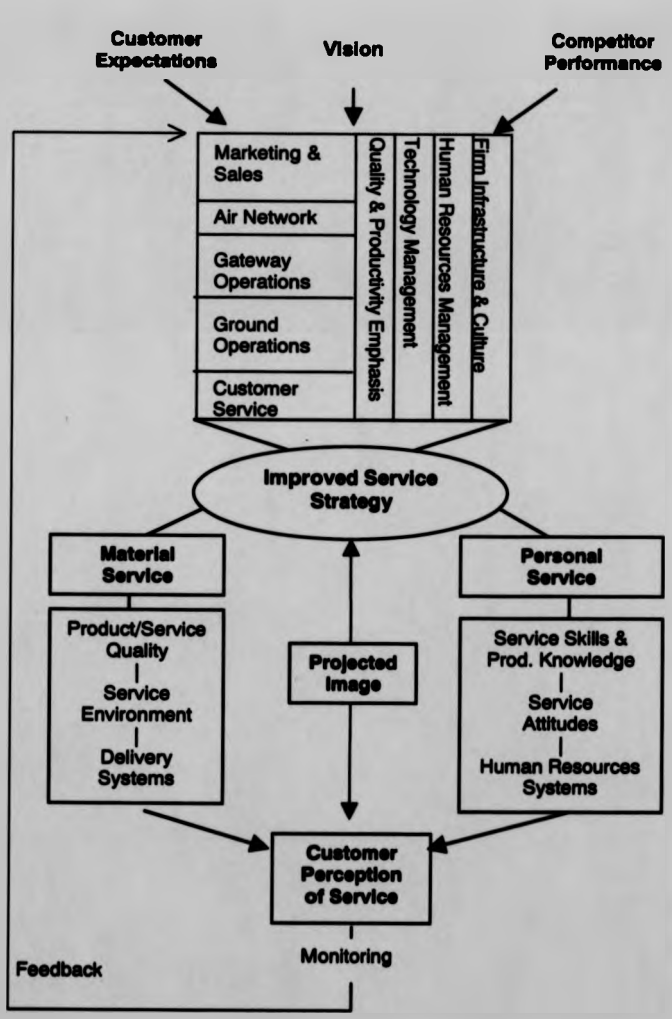


Figure 10: The Service Strategy Implementation Model

3.4 *Analysis of the Model*

The implementation model put forward above can be used as a map to guide the company towards greater competitiveness. It shows the stages of how an air express company should derive and implement its service strategy.

3.4.1 *Major Features of the Model*

While all the various model components are important, the heart of it lies in the Agility and Customisation Torpedo, and the Customer Front-end Action Chart.

The *Torpedo* helps in finding the right configurations and emphasis on the nine value-added activities. The *customer front-end action chart* is concerned with the actual deployment of resources to serve customers to their satisfaction. This research study has looked into both these areas.

The author identified 8 topics that should be studied with priority, namely: *(a) product, (b) productivity, (c) technology, (d) air network, (e) ground service network, (f) service quality, (g) customer service, and (h) human resources*. While it would be ideal to study all the topics concerned with the model, it would take too much time and effort for an exhaustive study. Hence, only the prime topics were looked into, particularly the last 4 topics that have crucial influence on the competitiveness of the company.

The first three topics, i.e. (a), (b), and (c) have been studied individually with an average amount of resources input.

During the time of choosing topics to study, DHL was in the midst of reviewing and changing the strategy of setting its air flight-route network (d) within the Asia Pacific. Hence, the author elected not to include this in his research study due to the confused situation.

Regarding (e), the strategic service network is a crucial part of the operations. It can demonstrate agility in serving the customer if the network is well designed. Moreover, due to practical needs and challenges at DHL Hong Kong, a major research project on this topic was chosen.

The last three topics, namely (f) service quality, (g) customer service, and (h) human resources are very much inter-related. Separate studies in each individual area would not be as effective as one combined research study. Hence the author grouped them together and made an integrated research project study.

Consequently, these led to the choice of topics studied, and finished as Submissions 1 to 5.

3.4.2 *Major Activities within the Model*

The major activities contained in the model are described as follows:

a) Primary Activities

The primary activities are the basic lifelines to the company and they have to be properly attended to. Under *Marketing and Sales*, the customer behaviour, price perception, company reputation, customer satisfaction and perceived value were studied. The performance of turnaround time and reliability of shipment delivery is very much dependent on the *gateway and ground operations*. Issues like inbound and outbound flight planning, customs clearance, airport-to-service centre transportation, courier operations, physical handling of shipments and checkpoint data updating should be studied. Finally, the *customer service* activities are crucial to the customers' perception of service quality.

b) Support Activities

The support activities are also very important in increasing the competitiveness of the company, and they help the primary activities function better. The *firm infrastructure and culture* define the basic skeleton of the company. These have much to do with the company vision, mission, value, belief, norms and goals. Under *human resources*, key subjects like staff recognition, people empowerment, service attitude, training and development need to be studied. *Technology management* will contribute to the physical mechanisation, customer automation, information upload and other telecommunication solutions. Service *quality* is closely related to the performance achievement against standards. Ways to improve *productivity* are needed in order to increase the cost effectiveness of using various resources. However, both quality and productivity should be evaluated together in a complementary manner.

c) Material Service Front-end

In the material service front-end, there should be emphasis on the *product quality, service environment, and delivery systems*. These relate to the 'physical content' of the service, and are the 'tangibles' that customers expect to get. The details have been discussed at length in the two research projects as reported in Chapter 4 and 5.

d) Personal Service Front-end

Personal service, which is usually considered as a 'soft issue' involves the atmosphere, devotion, and passion when service is delivered. The *service skills* of the front-end staff and their *attitude* can be recognised or felt by the customer. The related human resources support described in Section 3.4.2b above e.g. employee communication, empowerment, training, and employee satisfaction, should help the management see that a fair, open and respectable *human resources management system* is in place.

4. *Research on Strategic Service Network Planning and Design*

Hong Kong re-joined China in 1997. The Hong Kong International Airport was relocated in 1998. Recent town development has created a lot of commercial and residential land via reclamation [7], and thus changed the location distribution of customers. DHL needs to design a new service network for its Hong Kong operations to cope with the above changes and new demands.

Air express is a very competitive industry where shipments are expected to be flown out of Hong Kong on the day of pickup. An efficient network is crucial to support such a commitment. The network plan must include strategic and timely installation of satellite depots and service centres to meet changing needs over a multi-year horizon.

The author has reviewed the concepts and models of other scholars related to the development and application of specialised resources planning models. A summary of the review is shown in 4.1 below.

4.1 *Literature Review*

Many management science researchers have published papers on the development and application of specialised resources planning models. Two popularly used planning models are (i) facility location and (ii) vehicle routing. Facility location typically involves selecting locations from a set of candidate sites and then assigning a given set of customers to the facilities. Vehicle routing involves the decision of routing a fleet of vehicles from a given set of depots and customers to best serve the customers within certain specified constraints.

Though the individual use of these two types of models has been quite successful, there are a number of distribution planning applications where decisions about the location of depots and the design of vehicle routes are inter-related; and thus must be considered together. One approach to these integrated problems is to use a classical facility location model to select the depot sites and then use a vehicle routing model to design the routes. A drawback to this sequential solution approach, according to Balakrishnan et.al [8], is that the depot sites selected may only be a sub-optimal design for the distribution system.

For most classical location models, the cost of assigning a customer to be served by a facility is assumed to dependent only on the customer and the facility site. This type of cost assumption, the straight line cost model, usually computes the cost as a function of the distance between the customer and the facility. There is a popular `Moment Sum' methodology used in minimising the total delivery costs:

Cost Function : $\sum_i \sum_j C_{ij} X_{ij}$
where C_{ij} = the unit cost of shipping from warehouse i (up to M warehouse sites) to customer j (up to N customers)

X_{ij} = the quantity shipped from warehouse i to customer j

In reality, the actual cost incurred is dependent on all the customers served along the same vehicle route, thus C_{ij} will vary due to different combinations of customer j. As a result, the actual route cost situation is more difficult to model than straight-line costs.

Erlenkotter [9] compared the performance of seven approximate methods for locating new capacity over time. Also in his research, two essential characteristics were identified that determine the need for a dynamic framework for location decisions. First, there must be changes over time in demands or costs. Second, there must be significant costs for relocating or resizing facilities. The definition of the problem was

$$\text{Minimise :} \quad \sum_i \sum_j \sum_t C_{ijt} X_{ijt} + \sum_i \sum_t F_{it}(Z_{it})$$

$$\text{subject to} \quad \sum_i X_{ijt} \geq D_{jt} \quad \text{for each (j, t),}$$

$$\text{and} \quad \sum_j X_{ijt} \leq \sum_{\tau \leq t} Z_{i\tau}$$

where:

X_{ijt} = amount shipped from capacity located at source i to demand location j in time period t

Z_{it} = amount of capacity at source location i established in time period t

C_{ijt} = present value of variable operating unit cost of product produced at source i and shipped to demand j in period t

$F_{it}(Z_{it})$ = present value of fixed costs incurred by establishing capacity Z_{it} at location i in period t

D_{jt} = demand to be met at location j in period t

The objective function to be minimised in this problem is the total discounted investment, production, and transportation costs for meeting fixed demand specified over time at the various locations.

Madsen [10] combined the location–routing problems together in one model for analysis purposes. He tried three heuristic methods in solving the problem. His solution was claimed to have been applied successfully to a newspaper delivery system consisting of 4,500 customers.

Subsequently, Brandeau and Chiu [11] jointly undertook a number of researches on the queuing model, parameter analysis and testing, central location with congestion problems to push the scientific boundary of these location and routing topics toward a broader perspective.

In addition to location and routing, a third dimension of product production / distribution cost is also considered. Blumenfeld et.al [12] analysed trade-offs between transportation, inventory and production set-up cost on freight networks. Their paper contributed in understanding the interface between transportation and production set-up costs; identifying conditions when networks can be analysed on a link-by-link basis; and optimising cost functions to determine the routes and shipment size. Their approach is to decompose the network into separate sub-networks, and then solve each of them individually.

Then in 1988, Perl and Sirisoponsilp [13] provided a schematic representation of the interdependence between facility location, transportation and inventory

decisions. Then they built an integrated model for a distribution network design to minimise the total distribution costs, which was the sum of the costs of: 1) warehousing, 2) trunking, 3) delivery, 4) in-transit inventory, 5) plant and distribution centre cycle stocks, and 6) safety stock.

Under each of the above categories, there was a further breakdown of costs by function. Also, their respective behaviour was studied.

Related to the air express industry, there are a number of researches made on hub networks. Hall [14] researched the configuration of an overnight package air network in the USA. Kuby and Gray [15] studied the design of hub locations and aircraft networks for an overnight package delivery company. Again, linear programming models were extensively used to minimise the objective function of the sum of line-haul costs plus fixed costs.

Campbell [16] then introduced a new model to predict the cost for real world demand. The ideal model approximates the transportation cost for a hub network serving a continuous uniform distribution of demand in a square service region with equal origin-destination flows.

Closer to Asia, Schwieterman [17] compared Hong Kong against other Asian ports on the suitability of setting up the Express Cargo hub to serve other Asian cities in 1994. He evaluated performance against five key technical criteria, namely: geography, local market, route authority, capacity, and service input.

All the above studies were mainly concerned with `large scale' considerations that suggest solutions to an overall picture. Nevertheless, they could not address all the major challenges that DHL Hong Kong was facing. The problems that DHL had were similar to some of the above but were complicated by:

a) exact customers are not known until they call in; it is thus difficult to plan exactly when to serve them;
b) stochastic order demand;
c) varying shipment pattern on different weekdays;
d) restricted time window allowed to handle order shipments;
e) shipment volume and weight vary from order to order.

Since none of the existing models was found to be applicable to the actual case of DHL, the author thus developed a methodology of his own. He utilised an optimisation model and a simulation model to design a 10-year service network for DHL Hong Kong. The optimisation model determined in an aggregate manner the minimum cost network. The simulation model evaluated the service performance of the network. An interactive use of both models helped to find a viable solution for the company.

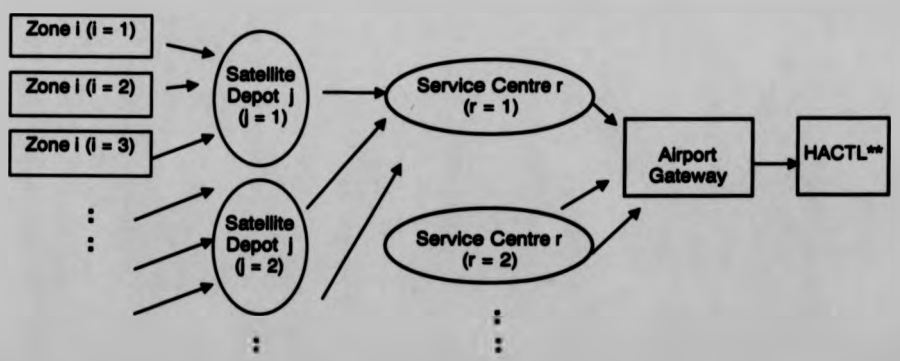
4.2 New Challenges and Opportunities

The relocation of the international airport to Chek Lap Kok (CLK) on Lantau Island significantly affected the effectiveness of the company's original service network. The new airport is much farther away from the city centre, thus increasing commuting time and operating costs [18]. The customs office employs electronic data interchange (EDI) technology to help shorten the customs clearance process for those shippers who can provide an EDI manifest before flight arrival. Moreover, the new concept of setting up an express cargo terminal inside the new airport makes it possible to carry out some shipment registration processes while waiting for customs clearance. In many ways, the new airport has brought both challenges and opportunities to DHL Hong Kong.

Successful operations should be directed towards the new scenario explained above. Increasingly, to maintain a competitive edge there is a need to shorten the turnaround time. This is already recognised as a basic survival issue. In order to respond quickly to customer requests, the couriers have to stay close to the customers and be agile in serving them. They should also have the necessary logistics support to quickly transport the shipments to the planned flights. There is a need to balance between (a) improved service level with (b) the fixed costs of installing facilities and the variable costs of operating the service network.

4.3 Objective of the Project and the Service Network

The planned service network consists of demand zones, satellite depots, service centres, and the airport. The conceptual shipment flow is shown in Figure 11 below.



*note: ** HACTL means the Hongkong Air Cargo Terminal Ltd. It is the authorised air cargo handling entity at the airport*

Figure 11: Conceptual Shipment Flow Diagram

Demand zones are predetermined service areas organised according to the level of customer demand as well as geographical characteristics. There are more zones in busy and commercial areas where the order pattern is concentrated. Most outlying zones are large in area but the order demand is small and scattered. When a customer of a demand zone places an order, the information is forwarded to couriers responsible for pickups in that zone. At the satellite depots, packages will be consolidated; the consolidated load will then be delivered to the corresponding service centre responsible for the depot. A service centre is responsible for several depots. At the service centre, all major processing such as labeling, x-ray screening, re-weighing, documentation and formality checking are done. Shipments will be further consolidated into air containers or canvas bags and then be transported to the airport for transfer onto the corresponding aeroplane.

DHL Hong Kong has to manage effectively this process of pickup, consolidation, processing, further consolidation, and delivery to the airport. The service network is at the heart of this process. The critical decisions in the design of the service network are the installation decisions of depots and service centres:

- Locations of satellite depots and their coverage of zones.
- Locations of service centres and their coverage of satellite depots.
- Capacities of these facilities.
- Installation schedule of these facilities.

As a summary, the main objective of this research project is to develop a strategic service network that would be most economically and operationally desirable for DHL Hong Kong over a ten-year period.

The entire study involves designing the overall framework, formulating mathematical models, collecting and preparing data, interpreting results, setting operating rules and policies, and making recommendations to the top management. The principal strategic recommendations are:

(a) Installation decisions of depots and service centres
(b) Strategic cut-off time that balances capturing more business and missing the service promise.

4.4 ***Planning Considerations and Information Requirement***

There are five main planning considerations in operating the models.

(a) Inbound and outbound shipments. As an air-express company, DHL has to handle both inbound and outbound shipments. For DHL Hong Kong, the inbound shipment flow and outbound shipment flow patterns are basically the same (but in opposite directions) and have roughly the same volume. Between the two flows, there is no conflict in competing for resources because they occur at different times of the day. Unlike inbound shipments that are collected at the airport according to a pre-determined schedule, outbound shipments require more processing and must reach the airport by a specific time; therefore they have more stringent time requirements. To simultaneously consider both inbound and outbound shipments in the network planning would unnecessarily

complicate the design task. It is very likely that the optimal conditions for outbound shipments will be close to optimal for inbound shipments as well. Hence, in this study, only outbound traffic was considered.

(b) Multiple-year demand profiles. The business habitation within Hong Kong and business volume between Hong Kong and Mainland China will change in the years to come. The changes will not only affect the quantity of shipment demand in the zones but will also affect the characteristics of the shipments. A service network that is optimal for now may not be adequate in later years and yet the established facilities cannot be abandoned, relocated, or scaled down without penalty. Therefore, the network design must be based on a long-term demand forecast. In the preparation process, the following aspects were examined: demand fluctuations (such as seasonal effect, daily variations, and peak loads), types of shipments, potential changes in market structure, regulatory issues, macro-economic profile, and development of new industrial and residential zones.

(c) Cut-off time and decentralisation. Determination of service cut off time and level of decentralisation versus centralisation in services are two vital and related policy issues. Cut-off time is the time of day before which a customer's package is guaranteed to arrive at the airport in time to catch a flight on the same day. It is a critical competitive factor among air express companies. An unnecessarily early cut off time would mean a loss of potential business. Whereas an unreasonably late cut off time would mean very little time left for processing and transportation, thus increasing the risk of not reaching the airport in time. A way to achieve late cut off while meeting service promise is to decentralise the service network. The extreme case of decentralisation would mean one depot and one service centre at each demand zone. Clearly, the response time for pickups would be the most desirable, and would result in the shortest delivery time per zone. However, the facility installation cost would be tremendous; and since there is no consolidation, the total transportation cost would be very high and the utilisation of resources very poor as well. On the other end, a centralised service network would mean having a super-service centre that takes care of all shipments. All couriers would originate from this super-facility for pickups and would return to it for processing and consolidation. There would be economies of scale, more efficient consolidation, better utilisation of resources, and better control of shipments. However, the response times for pickups would be longer on average and there could be problems in meeting flight schedules for some outlying zones. In determining the optimal cut-off time, the trade-off between the level of customer coverage, risks of missing flight and costs of accomplishing certain level of decentralisation must be carefully weighed.

(d) Capacities and costs of satellite depots and service centres. For each potential depot and each potential service centre, it is important that the capacity sizes that can be installed be identified. The corresponding installation costs must also be accurately determined. Because of a tremendous variation in terms of real estate cost, the analysis will have to be specific to each location. The elements included in the cost assessment are: physical plants, material handling systems (e.g. trucks, vans, and conveying belt systems), human

resources (e.g. a driver's pickup and delivery capability), and information-processing capability. Other capacity-related factors which need to be determined include utilisation rates of existing facilities and acceptable utilisation rates, and over-time costs of facilities and human resources.

(e) Fluctuations and random behaviour. The operating environment of DHL Hong Kong consists of many dynamic elements that can fluctuate drastically and are subject to randomness as well. Typically, customer demand varies according to the time of the day as well as the day of the week. Customer requests peak around the daily 'close-of-business' time. The peak is higher on a Friday, on the day before a holiday or before major holiday season like Christmas or Easter. Facilities with capacities sufficient to handle average daily demand will not be enough to cover these peak hours and days. This is an issue of facility utilisation, which needs to be properly addressed. Furthermore, the randomness in transportation times means that some shipment routings that are feasible under normal traffic conditions may not be feasible during peak hours and traffic congestion. To be able to examine the service performance of the network, voluminous operational data is required.

4.5 ***The Planning Methodology***

4.5.1 Basic Considerations

The design of the long-term service network cannot be totally separated from the short-term operational considerations. Within the context of operations research methodology, the service network design can be approached using facility location models or variants of such models. The approach is a practical one where least-cost locations are determined while meeting certain demand and logistics requirements (as can be seen from other researchers described in Chapter 4.1). Because of the problem size, such models can only use average or aggregate information such as average annual cost, average utilisation, and annual demand. However, to design a service network using merely an optimisation model is unlikely to be adequate. An optimisation model is not suitable for handling operational factors such as demand uncertainty, randomness in travelling and processing times, and dynamic consolidation. The model prescribes the overall least-cost network design but lacks specific operational details. For an air-express company, a network design cannot be accepted unless certain operational specifications on a daily basis are satisfied.

Uncertainty and fluctuations in large dynamic systems can be formulated using simulation models. The descriptive nature of simulation methodology often allows the decision-maker to examine the behaviour of a complex system operating under an uncertain environment. However, before a simulation exercise with operational details (e.g. product flow, pickup and delivery schedule, product-mix demand patterns, and probabilistic behaviour of travel times and processing times) can be run, there is first a need to have a network design.

4.5.2 Network Planning Framework

The author's network planning framework utilises both an optimisation model and a simulation model, see Figure 12. The former is an economic network-planning model that determines the macro optimal network configuration in an aggregate fashion. The latter is a simulation model that evaluates the daily, operational performance of the recommended network configuration.

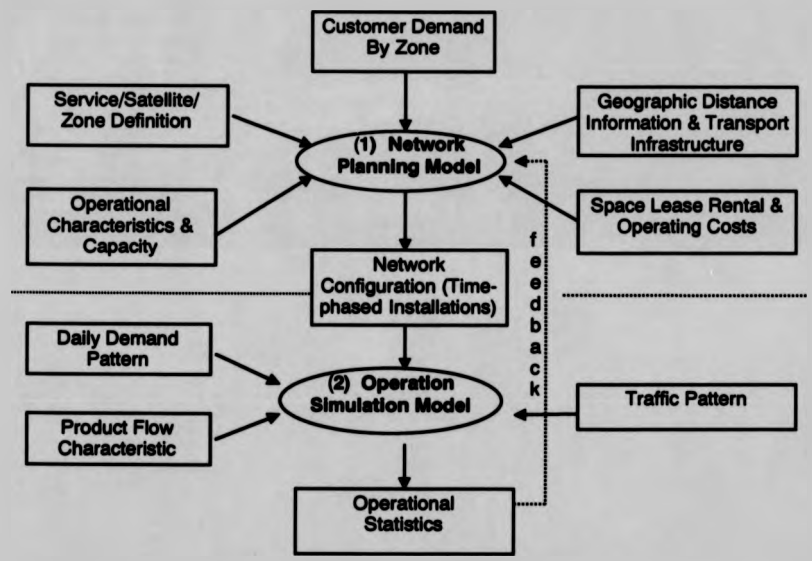


Figure 12: Overall Strategic Network Planning Framework

4.5.3 Working on the Models

(i) The macro network planning model. The detail of linear programming (LP) formulation is shown in Appendix 2 (for a single period) and Appendix 3 (for multiple period). The mixed 0-1 LP model takes on the following framework.

Min: *Present Value of (Fixed cost + Variable cost)*
such that *Flow distribution = Demand*
Individual flow ≤ Capacity
Flow time ≤ Time window

The objective of the model is to minimise the sum of present value costs of transportation and facility installation. The variable transportation costs depend on the assignment decisions of shipments from zones to depots and from depots to service centres. The installation costs depend on the installation decision, the

choice of capacity level, as well as the schedule of the installations, for both depots and service centres.

There are constraints to ensure that the assignment of shipment from zone to depots to centres will meet the forecast demand. Also, there must be capacity constraints to ensure that the assignment decision to a particular facility is in conjunction with the corresponding facility installation decision as well as the appropriate capacity decision. Further, the total flow time for any given zone-depot-centre-airport assignment cannot exceed the maximum time window (elapsed time between cut-off and due time at the airport). Logical constraints are also needed to ensure that only one installation per site is allowed and that certain correlated time-dynamic installation limitations are not violated.

(ii) The micro operation-simulation model. There are three main streams of computer simulation languages popularly used by many researchers, namely GPSS, SIMAN, & SIMSCRIPT [19]. All these can run the discrete event simulation experiments required by the project. SIMAN, which is FORTRAN based [20] (using a block diagram concept), and has superb display capability for 3-D animation (through the CINEMA utility) was chosen. The package that ran the simulation exercise is called ARENA [21] distributed by the System Modeling Corporation. It was available at the university, and was widely used by many other researchers.

Based on the results of the macro-planning model, the simulation model evaluates the service performance of the network. It simulates daily operational activities. Multiple scenarios in terms of peak loads and average loads are constructed and important operational statistics are collected. These include the workloads of couriers, capacity and utilisation of facilities, arrival patterns of vehicles to the facilities, pickup requests not honoured, and shipments that miss the flight.

(iii) The simulation environment. The simulation experiment considers the dynamics of courier pickups, delivery to satellite depot and service centres, and delivery to the airport. A schematic depiction of the simulation environment is shown in Figure 13. The locations of the depots and service centres, as well as shipment assignments of zone-depots-centres, are in accordance with the results of the planning model. Three types of vehicles (van, truck, and lorry) are used to transport shipments from zone to satellite depot, depot to service centre, and from service centre to airport gateway respectively. Shipment consolidations from vans to trucks, and from trucks to lorries are simulated. The entire operation is applied to the two major product types (*Document* and *Package)*, that collectively represent over 95% of the total shipment volume.

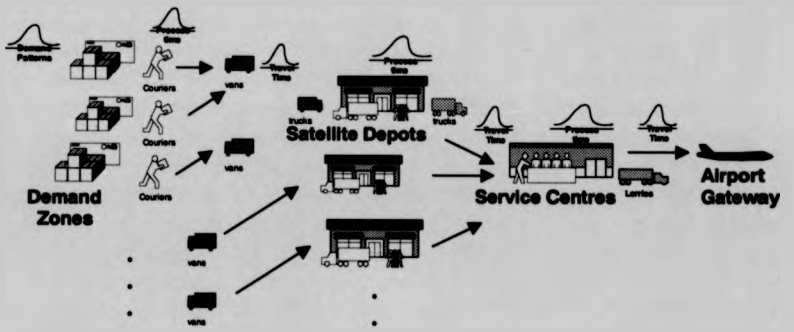


Figure 13: An Overview of DHL's Daily Operations Simulation

The workforce includes couriers and shipment-processing workers. A typical working day starts at 9:00 am when couriers leave depots by vans to pick up shipments in zones. The cut-off time is 5:15 p.m. and can be adjusted depending on the cut-off policy. Each week has five and a half workdays. Probabilistic behaviour occurs in three categories of events, namely shipment arrivals, travel time, and processing time.

Essentially, both zones and service centres are modelled as one-line multiple-server queuing resources. The capacity of a resource is related to either the number of couriers in a zone or the number of processing workers in a service centre. At the end of each day, entities that remain in the queue of each zone are lost-sale shipments. Entities that remain in the queue of each service centre are undelivered shipments and are to be delivered on the following day. Since no processing is needed in the satellite depots except consolidating shipments, a depot is modeled as a simple storage with a queue, where a time delay is incorporated for the unloading and loading of vehicles. Three types of transport means (representing van, truck, and lorry) are created to handle entity movements. Each simulation run covers ten weeks.

There are 34 demand zones in Hong Kong, 15 of which are candidates for depots and 9 of which are potential sites for service centres. With inputs from the demand profile, fixed and variable cost estimates, travel and processing times, and a cut-off time, the macro planning model is solved using the PC-based MPSIII (Ketron 1994 [22]).

4.6 *Service Performance of Network: Coverage and Reliability.*

The current network configuration can only be viewed as a preliminary result as the network's service performance has yet to be scrutinised. To evaluate the service performance of a network, two related measures are defined:

(i) Service Coverage: the % of requests that arrive before cut-off time.
(ii) Service Reliability: the % of pick-ups that make the same-day flight.

These two criteria are important to an air express company's service performance. The former addresses the coverage of customer order requests and the latter the success of keeping the same-day delivery promise.

In the macro model, both service coverage and service reliability are 100%, since all demands are met and all assignments are within the maximum time window. However, the parameters of the macro model are merely deterministic averages. The actual daily fluctuations and randomness in activities will result in varying levels of coverage or reliability. Here the simulation model was used to give a realistic assessment of a network's coverage and reliability. Based on the preliminary network configuration, the daily activities are simulated.

With the simulation results, the levels of service coverage and service reliability with respect to a range of cut-off times are shown as solid curves in Figure 14. The relationship between service coverage and service reliability is an inverse one. That is, extending cut-off time will result in a higher level of customer coverage, but will decrease the level of reliability as less time is allowed for transportation and processing. A low level of coverage means a significant loss of business while a low level of service reliability will eventually lead to the same result.

The simulation results indicate that the reliability of the preliminary network is in the acceptable range while coverage is close to being acceptable. (Realistically, it is impossible to have 100% both in coverage and reliability.) The trade-off between service coverage and service reliability is then judiciously examined. DHL needs to explore ways of improving service coverage without impairing service reliability.

It should be pointed out that efforts are made to ensure that the various facilities in the network are neither over- nor under-utilised. The results of the simulation experiments provide a good indication of the utilisation of various facilities, and answer whether the capacities prescribed by the macro model are genuinely workable.

(1) Improving coverage and reliability with more workforce. Service reliability can be improved by increasing the workforce level. Figure 14 shows different levels of service reliability with respect to changes in the workforce. When service coverage is improved via cut-off extension, reliability drops. DHL can increase the workforce to restore reliability back to an accepted level. Invariably, the decision-maker will have to judge whether the incremental cost incurred in an increase in workforce justifies the improvement in reliability or coverage.

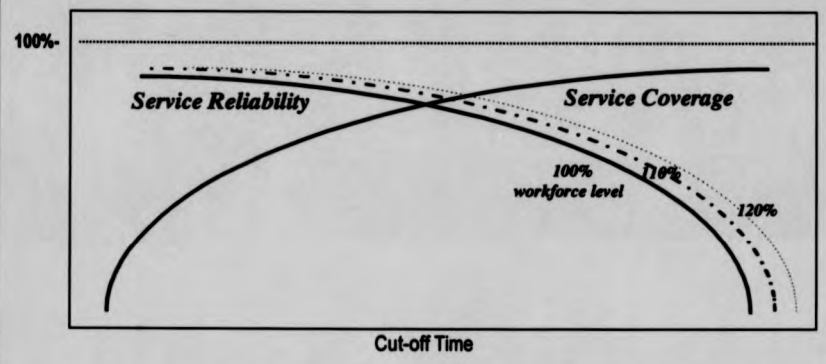


Figure 14: Service Performance with respect to Different Workforce Levels

(2) Improving service reliability via network redesign. Another approach to increase service reliability is to redesign the distribution network using a more stringent time window, i.e., a later cut-off time. The resulting network will have a higher cost, but will also be more time efficient (or at least as good) since less time is allowed for services.

Essentially, there are two results for cut-off times, one from the network model (planning cut-off) and one for simulation (operational cut-off). Management can design the network with considerations of these two sets of cut-off time. This example illustrates the interrelationship in designing the network using planned operational cut-off times. Again, the decision-maker will have to judge whether the incremental cost in constructing a more time-efficient network justifies the improvement in reliability or in coverage.

4.7 ***The Recommended Solution***

After a number of iterations and deliberations, the final compromised schedule of facility implementation is shown in Table 2. Further details can be referred to in Submission 4.

Satellite Depot (j)				
Year	Location	Capacity	Equivalent Shipment	Accumulated Shipment Capacity
1	Sai Wan Ho	Medium	15,000	
1	Sai Ying Pun	Small	5,000	
1	Wan Chai	Tiny	2,000	
1	Kowloon Bay	Small	5,000	
1	Kwun Tong	Tiny	2,000	
1	To Kwa Wan	Tiny	2,000	
1	Yuen Long	Tiny	2,000	
1	Kwai Chung	Tiny	2,000	
1	Tai Kok Tsui	Tiny	2,000	37,000
2	Cheung Sha Wan	Tiny	2,000	
2	Kwai Chung	Small	5,000	44,000
4	Sai Ying Pun	Small	5,000	49,000
5	Yuen Long	Tiny	2,000	51,000
6	Cheung Sha Wan	Tiny	2,000	
6	Yuen Long	Tiny	2,000	55,000
7	Yuen Long	Tiny	2,000	57,000
8	Kwai Chung	Small	5,000	62,000

Service Centre (r)				
Year	Location	Capacity	Equivalent Shipment	Accumulated Shipment Capacity
1	Sai Wan Ho	Medium	15,000	
1	Sai Ying Pun	Small	5,000	
1	Kwai Chung	Small	5,000	
1	To Kwa Wan	Small	5,000	30,000
4	Kwai Chung	Small	5,000	35,000
5	Sai Ying Pun	Small	5,000	40,000
6	Yuen Long	Small	5,000	45,000
8	Yuen Long	Small	5,000	50,000
9	Kwai Chung	Small	5,000	55,000

Table 2: Optimal Schedule of Facility Erection

4.8 Summary and Conclusion

An important characteristic in the air-express industry is the close relationship between a service network and its agile operations team. Hence, the network has to be designed with considerations of long-term capacity needs as well as short-term operational goals. The network plan should include strategic and timely installation of satellite depots and service centres to meet changing customer needs over a multi-year horizon. The plan should also be developed with careful examination of the service performance, an element that is most vital to the success of an air-express company.

In this project, the author has created a network planning methodology suitable for air express service providers. The methodology consists of first using a mixed 0-1 LP model to determine a least-cost distribution network. The network then forms the basis of a simulation model that analyses the network's operational characteristics. The methodology is accompanied by careful articulation of the major design issues and the performance measures in the service operations.

The multi-year distribution plan is determined based on many elements in the future. Since changes in aspects such as demand and transport structure are common, the distribution network with its expansion plan needs to be continually updated. Essentially, the network planning process should be performed periodically (e.g. every 12 months). The micro model can be used on a regular basis to analyse operational performance. Other than developing modification criteria and modification actions for the recursive use of the two models, future research should be conducted to develop the simulation model into a more general tool for tackling routing, material handling, or shipping problems.

There are several areas considered to have the potential for future development and further studies in this project area. The details are discussed in Chapter 8.3.

The company has adopted the main recommendations from this project, and had a smooth transition over to the new airport in 1998. DHL is still running an updated version of this computer programme to help make the best arrangements to maintain the agility needed to serve customers.

5. Research on Service Quality and Customer Service

Service quality and customer services are very important topics to the air express industry. The customer is essentially the focus of the whole business, while frontline employees can influence the customer's perception of service quality or value.

The objective of this project is first to explore the conceptual aspects of service quality and customer service management through a literature review. Then the key factors behind the success track of DHL are studied. The innovative part lies in the author's creation of a customer value model, which is then validated with a customer satisfaction survey. Finally, through a step by step analysis, statistical results are transformed into performance improvement priorities on which the company can take action for improvements.

5.1 Quality in the Service Environment

The service sector of the economy has grown at a fast rate since the seventies. Levitt [23] and [24] pointed out that service could also be industrialised, and suggested ways that could drastically improve its quality and efficiency.

There were very few systematic collections of papers on service-based quality until the early eighties. Parasuraman, Zeithaml & Berry (abbreviated as PZB) jointly undertook a series of studies on the quality of services. In 1985, they laid the foundation of the conceptual model of service quality [25] as shown in Figure 15.

When the level of expectation and perception do not match, there exists a gap. There are 5 gaps identified in PZB's model. Out of them, GAP5, which is the difference between customer expectations and perceived service, was found to be the most influential to the consumer's satisfaction and buying intention.

Later PZB [2] further developed a 22-item scale grouped under 5 dimensions (details shown in Appendix 4) called SERVQUAL to measure service quality as perceived by customers.

After their first successful introduction of the service quality model, they further refined it and came up with an extended version [26] in 1987 to show the inter-relationships among the various service quality gaps (Appendix 5) more clearly.

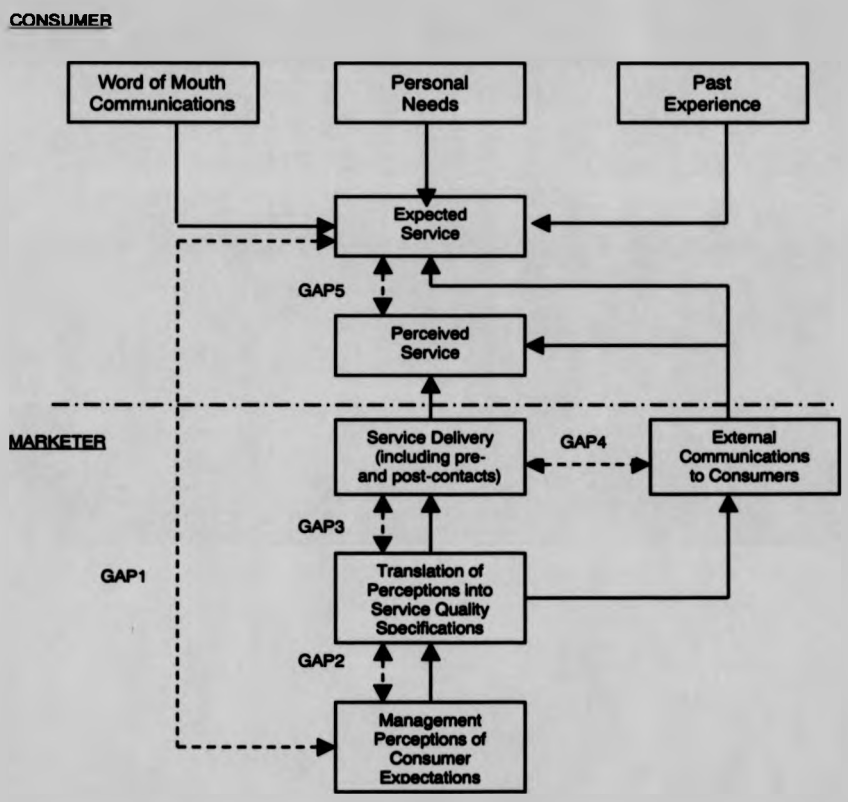


Figure 15: A Conceptual Model of Service Quality developed by PZB [25]

In the nineties, a number of other researchers like Duffin [27] and Cronin et.al [28] pursued further studies stemming from PZB's findings and subsequently came up with challenging ideas for PZB to refine their models to make them more suitable to measure service quality. Some related papers are listed in the bibliography section. Meanwhile, there are several other contributions that are worth mentioning below.

In 1991, Bolton and Drew [29] asserted that service quality is analogous to an attitude as a basis to suggest that satisfaction is an antecedent of service quality. They postulated that service quality (ATTITUDE $_j$) is a function of:

(i) the consumer's residual perception of the service quality from the prior period, and
(ii) his level of satisfaction with the current level of service performance (CS/D_j).

Thus, $ATTITUDE_t = g(CS/D_t, ATTITUDE_{t-1})$

In 1992, Cronin and Taylor [30] then developed a performance-based measure, SERVPERF as an alternative to PZB's SERVQUAL. After some studies, they concluded that:

a) SERVPERF, a performance-based measure of service quality may be a better means of measurement;
b) service quality is a precedent of consumer satisfaction;
c) consumer satisfaction has a significant effect on purchase intentions; and
d) service quality has less effect on purchase intention than does consumer satisfaction.

Deming's 14 points were reviewed by Rosander [31] under the framework of service quality. He illustrated that most of Deming's concepts also worked in the service environment.

Pruett and Thomas [32] made a good comment on the value of a product. They asserted that what people want when they buy goods or services is not necessarily the product itself but what it does for them. Hence, they decompose product quality into generic dimensions from the users' point of view (Appendix 6). Then they can focus on improving the performance of the dimensions in order to increase the overall value of the product.

Cues that signal quality to consumers may change over time due to competition, the marketer's promotional effort, changing technology, changing customer tastes, or availability of information.

More recently in 1996, Berry and Yadav [33] discussed the pricing of intangible products. They offered a framework that reconciles the implications with customers' quest for value. They put forward three distinct but related strategies for setting the price of a service: satisfaction-based pricing, relationship pricing, and efficiency pricing. This can explain why some services have a very different price from others.

5.2 *Customer Service and People System*

The customer is the focal point of all services. It is therefore worth making intensive efforts to understand customers and to learn how to serve them well. In most cases, people-to-people contacts are involved in the service delivery process. Hence, the `people' element at the service front-end is crucial in making the business a success. Service encounter between people is in itself a specialised area to study.

The following subsections on customer service address the major areas of concern leading to customer satisfaction. The concepts discussed are a very important foundation to gain an understanding of the various frontiers of service management.

a) Service-Profit Chain

Heskett, et.al. [34] developed a Service-Profit Chain in 1994 that linked profitability, customer loyalty, employee satisfaction & loyalty, and service productivity together. Figure 16 below shows the relationship.

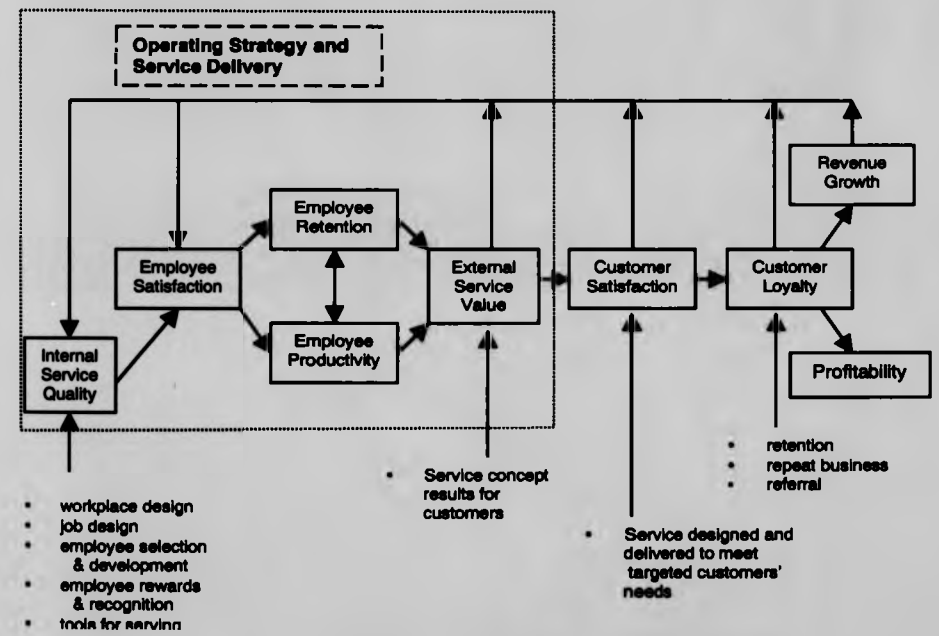


Figure 16: Links in the Service-Profit Chain [34]

The main essence is that the revenue growth and profitability on the right are driven by the customer loyalty, which in turn is driven by employees on the left. Both external service value and internal service quality are important factors to make customers and employees satisfied.

b) Customer Complaints and Service Recovery

Some managers are timid in facing complaints, and sometimes even try to ignore their existence. On the other hand, some may treasure complaints as a valuable gift [35]. Their philosophy is that dissatisfied customers will normally go away, and through word-of-mouth spread out bad expressions to their friends. When customers complain to the service provider, they are in fact giving the company a chance to improve and to rectify the situation.

Practically it is very difficult to be 'mistake-free' all the time. The fact is, in services, errors such as missed deliveries and damaged shipments are sometimes quite inevitable. While companies may not be able to prevent all the problems from arising, they can learn how to recover from them. A good recovery may turn angry, frustrated customers into loyal ones. It can even create more goodwill than if things had gone smoothly in the first place [36]. In the process of service recovery, the customer expects:

(i) to receive a sincere apology,
(ii) to be offered a fair resolution for the problem, and
(iii) to be treated in a way that shows the company cares about the problem and the inconvenience caused to them.

c) Customer Retention and Defection

From time to time, there are customers who do not come back. Such customer defection has a great impact on the profitability of a service company. According to Reichheld and Sasser [37], more profits will be generated from a customer over time. The longer he can be retained, the more profits can be generated.

Customers who defect to the competition can tell exactly what part(s) of the business the company must improve. Nevertheless, many companies seem not to have learned from the lessons. Reichheld [38] uncovered seven main reasons for customer defections (Appendix 7) in many companies. Some suggestions to improve the situation have been discussed there.

d) Employee Retention

Albrecht [39] said in his book, Service America, "*The way your employees feel is the way your customers are going to feel*". A satisfied employee is committed to the company and its service expectations. He will go the extra-mile for the customer, manage himself, and respond well to the pressure from customers. As a result, greater customer satisfaction and higher profit margins can be achieved.

There are many positive ways to achieve employee satisfaction, such as to broaden job responsibilities, empower customer-contact authority, and provide continuous training to build the skills base. According to Heskett [34], both Employee Retention and Employee Productivity can be improved with raised Employee Satisfaction. The longer the employees stay with the company, the more productive they are likely to be.

e) Service Guarantee

Service guarantee is a popular customer service tool used in the air express industry. Customers can get free replacement shipments or other compensation if service guarantees are not met. According to Hart [40], a good service guarantee can help a company perform better. There are several clues that make these guarantees work. They should be unconditional, easy to understand

and communicate, meaningful, and easy to invoke. Firnstahl [41] added that employees should be empowered to do anything to keep the customer happy. In the event of a mistake or delay, any employee should be able to trigger a service recovery action or honour a guarantee.

f) Listening Through Service Research

Listening to customers is an important element in the service process. The quality of listening will affect the quality of service provided. Successful service companies that strive to improve services need to listen to three types of customers: *external customers, competitors' customers, and internal customers (i.e. employees).* Berry and Parasuraman [42] pointed out the benefits of effective listening, and put forward a comprehensive list of research approaches for service improvement (Appendix 8). Users can choose one or more of these approaches at the same time for their applications.

5.3 DHL's Route to Success

5.3.1 Corporate Culture

DHL's success in maintaining the leading position in the market is highly related to its corporate culture toward service quality and customer service. Corporate culture is directly associated with the values, beliefs, and norms that are shared by the people in the organisation. It provides the meaning, direction, and mobilisation that drive organisational behaviour. Details of the cultural characteristics [43] are listed in Appendix 9. This set of positive values has guided DHL performance and helped achieve good results. Amongst these characteristics, the 'can do' attitude, emphasis on people care, freedom of expression, orientation toward delighted customers, and encouragement of teamwork are the major ingredients of success.

DHL's decentralised decision making, performance measurements, incentives, and team spirit are a source of competitive advantage. Maintaining this culture is critical to DHL's success, and it has to continue to be nurtured and developed. However, the increasing complexity of the business requires more consistency within the DHL Global Network. This involves common rules, global standards, and prioritised Network Programmes.

5.3.2 Employee Aspects

Then comes the 'employees' factor. Since the *human* factor is so much related to the customer value and corporate culture, DHL is spending considerable effort to nurture the best team. The approach is mainly on developing people, empowering them, and mobilising them towards providing better service.

Good communications with employees is very important. The company concentrates on this by its regular publications and various types of communications with employees. Conversely, there are also channels for employees to voice their concerns as well as what they think customers would need. Opinions and comments are regularly collected by frontline employees since they are the `antenna' of the company through their service delivery to customers. There are also other forms of encouragement, such as suggestion award schemes, employee of the month, employee of the year, and the Bill Walden Award to encourage employee participation.

On average, DHL Hong Kong employees should attend 60 hours' training in a year. Training covers such areas as new product and service, management development, technical / engineering skills, customer service concepts (e.g. `I Make the Difference' course), and new strategy and product programme update.

Employee satisfaction surveys are regularly carried out, as this is an integral part of the Service-Profit Chain. Selected questions in such surveys generate an Employee Satisfaction Index (ESI) which can be compared against those of previous years.

As a means for the management to gain a genuine understanding of the actual front-end operations, there is a regular exercise for the Ground Service Department managers to understand the difficulties couriers face in carrying out their duties. In addition to the questionnaires asking them what needs to be improved to help them perform better, there is also an observation (or 'coaching') session. Through working together with the couriers for one day every 3 months, the managers are able to understand the real working environment. These are practical means of getting true feedback, and help the couriers overcome the problems they face on a day to day basis. Appendix 10 shows the set of questionnaires and the observation checklist.

It is also a general management process to regularly review the employee's career development and training needs as a part of the performance appraisal. In addition, the performance of how a manager develops his subordinates is an area assessed in the appraisal. This helps create a culture within the company related to developing oneself as well as subordinates. This long-term policy ensures that senior positions are more likely be filled by up-and-coming executives within the organisation.

5.3.3 DHL Global Network Directives

As a global service provider, DHL needs a unique standard of service quality level to all customers around the World. Directives such as Global Service Commitments, Service Quality Index, multi-dimensional performance measures (MDPM), and quality performance monitoring are important programmes.

All these can help DHL achieve a high level of consistency and competitiveness in customer service and service quality.

5.4 Creation of the Customer Value Model

The Customer Value Model developed by the author is meant for the study of the causal effect between the service features and the service quality, then value, and finally the loyalty of customers. The model is composed of 4 blocks; namely (i) customer behavioral intention block, (ii) value block, (iii) service quality block, and (iv) service dimension block.

5.4.1 Customer Behavioral Intention Block

Firstly, the customer loyalty is represented by the customer's willingness to re-use as well as to recommend others to use a certain service provider. This loyalty should be driven by their perception of how much value they can get from the service (see Figure 17).

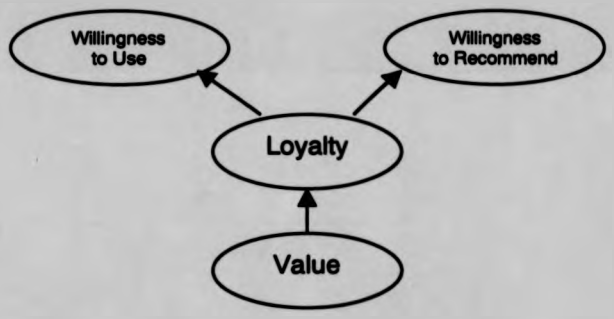


Figure 17: Relationship between Customer Re-purchase, Loyalty and Value

5.4.2 Customer Value Block

These customer value perceptions, in turn, are influenced by perceptions about (a) the price paid for services; (b) the overall satisfaction with the quality of service received; and (c) the public image or reputation of the company. Please refer to Figure 18:

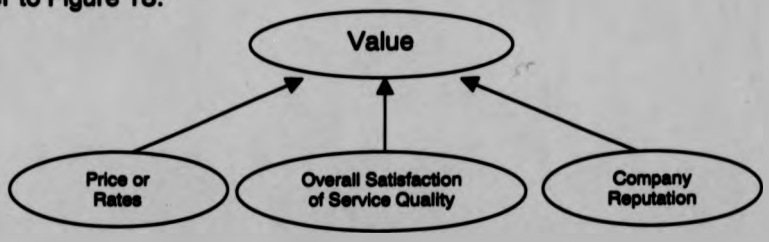


Figure 18: Relationship among Value, Price, Service Quality and Company Reputation

5.4.3 Service Quality Block

Then for the third block, the customer's level of satisfaction with service quality is further analysed with regard to the service dimensions of the service delivery system. This is similar to the five dimensions of GAP5 as put forward by PZB discussed earlier in Chapter 5.1.

The major difference from PZB is that the dimensions (e.g. tangibles, reliability, etc.) are the titles used to categorise a total of 22 service items. These 22 items attend to different issues in the overall sense, but are not in themselves specific enough. For instance, `Dependability' and `Customer Feeling Safe' can be interpreted quite differently in different industries. Hence, it would be appropriate if PZB's model is adopted as the backbone, but to replace the dimensions and service items by more suitable ones for the air express service.

Ultimately the new set of service dimensions (see Figure 19) is re-defined as:

1. Account Servicing and Sales Representatives
2. Account Management and Billing
3. Outbound Delivery
4. Courier Services
5. Customer Services
6. Service Recovery

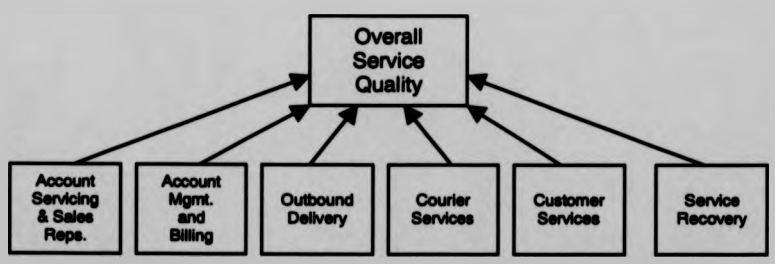


Figure 19: Service Dimensions related to the Overall Service Quality

5.4.4 Service Dimension Block

In the fourth block that relates the individual service dimensions to their respective service features, there are a total of 47 features identified. Details of these features are shown in Appendix 11.

5.4.5 The Customer Value Model

Finally, the entire customer value model incorporating all the considerations in the above discussions is shown in Figure 20.

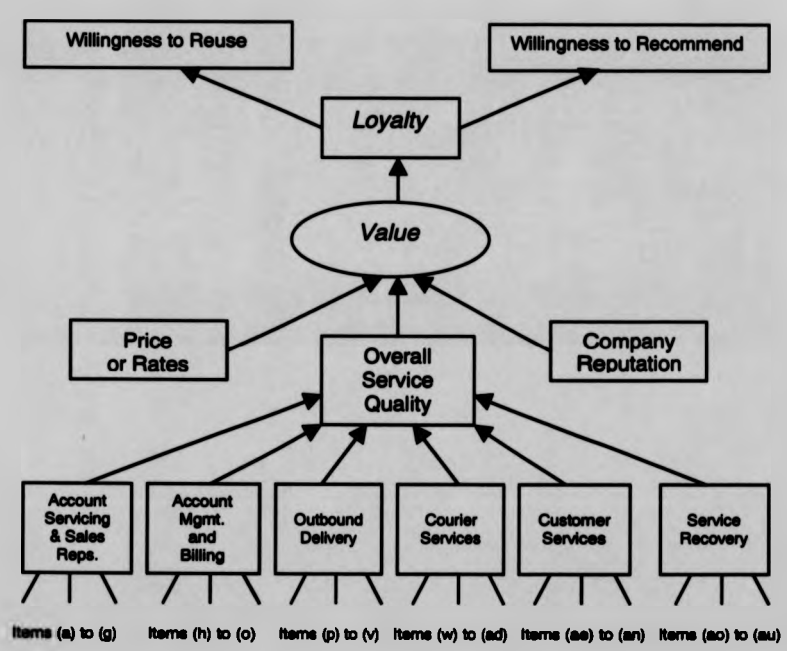


Figure 20: Structural Relationship of the Customer Value Model

5.5 Customer Satisfaction Study

A customer satisfaction survey was carried out with a structure built in accordance with the conceptual framework of the Customer Value Model shown in Figure 20.

A stratified customer list (according to different customer segments) for use in selecting interview participants was firstly prepared, and then randomly picked to form a total base of 2,097 targets. Each participant received an introductory letter explaining the purpose, content, and approximate length of the interview. During the telephone interview, participating customers were asked to assess service quality, indicate their level of overall satisfaction with DHL and the value they receive from using DHL for air express shipments on a 7-point Likert scale.

Ultimately 632 customers responded to the entire survey, representing a feedback rate of 30.1%. The final version of the survey, including appropriate scaling for each interview question can be referred to in Submission 5.

In examining the relationship between variables, the multiple regression principle is explained in detail in Appendix 12.

From the customer value model, the variables are defined in Table 3 below.

Variable	*Definition*
X_1	Satisfaction with Service Quality
X_2	Willingness to Reuse
X_3	Willingness to Recommend
X_4	Perception of Value
X_5	Perception of Price or Rates
X_6	Perception of Company Reputation
X_7	Account Servicing and Sales Representative
X_8	Account Management and Billing
X_9	Outbound Delivery
X_{10}	Courier Services
X_{11}	Customer Services
X_{12}	Service Recovery
X_{23}*	Loyalty = willingness to reuse and to recommend

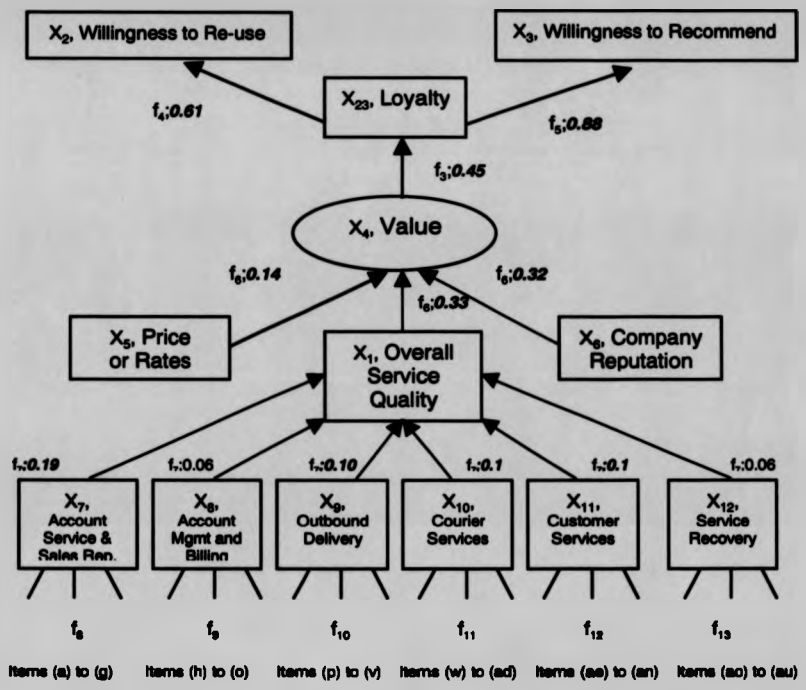
*Note: * X_{23} is the mean value of X_2 and X_3 meaning the average of the willingness to re-use and the willingness to recommend DHL*

Table 3: Definition of Variables in the Customer Value Model

The general linear regression relationship is: $Y = f(X_i)$ *for* $i = 1$ *to* p
The functional relationships are defined as per the details contained in Appendix 13.

5.6 ***Interpretation of Results***

The results of examining the relationships among the concepts of the Customer Value Model for all the 632 samples are summarised in Figure 21 below. These results confirmed that the model is a valuable tool for understanding DHL customers.



Note : Figures in bold mean 'high impact' relationship, i.e. significant at $\alpha = 0.01$ and $b \geq 0.1$

Figure 21: Summary of Results on the Customer Value Model

The Customer Value Model postulates that there is a relationship between customer perceptions of overall value of service and their loyalty to DHL (i.e. f_3). Furthermore, the Model also stipulates there is a strong relationship between the loyalty and the customer's behavioral intentions to purchase additional DHL services and to recommend it to others (i.e. f_4 and f_5).

The statistical tool used in this analysis task is the MatLab software package owned by the U.S. MathWorks, Inc. It is a powerful and yet easy-to-use software that gives users an interactive and visual effect on the analysed results.

The results show that all functional relationships are significant, and many have a high impact with high b_i values. Take for instance, f_3, the relationship between value and loyalty. It has a coefficient of 0.45 and is highly significant. A 10% increase in this variable alone will lead to a 4.5% increase in the customer loyalty. Since these relationships are positive, it indicates that the customer loyalty index score will be increased by improving customer's perceptions of overall value through improvements in overall service quality. A corresponding increase in the customer's willingness to reuse and recommend DHL should also occur.

Another output from this study is to find out how well the various DHL service dimensions are performing (on a 1-7 Likert scale) from the customer's perspective. These results together with their degree of impact are summarised in Table 4.

Code	Service Dimension	Mean Score	b_i	Degree of Impact
X_7	Account Servicing & Sales Rep.	4.92	0.19	High
X_8	Account Billing	5.06	0.06	Low
X_9	Outbound Services	4.95	0.10	High
X_{10}	Courier Services	5.00	0.16	High
X_{11}	Customer Services	4.79	0.13	High
X_{12}	Service Recovery	4.34	0.06	Low

Table 4: Performance of Service Dimensions and their impacts to Service Quality

Four out of the six dimensions (with the exception of X_8 and X_{12}) are found to be of high impact to the service quality satisfaction.

The low significance ($b_i = 0.06$) of X_8 with a high mean score indicates customers do not care too much about this dimension, and they are still quite happy with it.

Conversely, X_{12} has a low score and low impact. This may indicate that customers are unhappy with the service recovery performance, but that they do not expect any better to come. They may have given up hope or quest for a better performance. This poses a potential threat of having this service dimension overlooked by both DHL and the customers. Should DHL be able to improve the service recovery performance to a level significantly better than its competitors, then the customers might give higher scores to the service quality satisfaction.

5.7 ***Segmentation Analysis and Performance Improvement Priorities***

For the sake of more customisation, there is a segmentation analysis to divide customers into 5 main segments for study. Providing high quality services to these segments is important to accomplish DHL's business objectives and to further develop competitive advantages in the markets. These segments include:

a) High Revenue Customers
b) Low Revenue Customers
c) Heavy Weight Customers
d) Non Heavy Weight Customers
e) At-Risk Customers

Then within each segment, analyses are done to provide a basis to determine the special service requirements of each group of customers. This identifies which service features have to be improved to achieve higher quality perception to that customer group. In essence, the segmented analysis includes:

- service dimension performance;
- service dimension impact analysis;
- service feature performance;
- service feature impact analysis;
- Performance Improvement Priorities (PIP) identification.

PIP's are a list of the most important service features that have a high impact on the customer's satisfaction in that service dimension. These in turn would affect the overall service quality, value, and ultimately customer loyalty. Therefore, these service features provide a means of establishing performance improvement objectives to uplift the overall service quality delivered to customers. PIP's are determined by evaluating and combining the results of the progressive analysis according to their magnitude and consistency of results across all statistical procedures and performance assessment. PIP's indicate where management should direct efforts and resources to effectively improve the quality of the company. Finally, all the PIP's by segment are consolidated together and then put forward to management for determining a series of actions (may be company-wide, or may be just for certain customer segments) to be taken.

Through this entire process, DHL's service delivery system can be improved according to customers' perception and priority. Figure 22 below shows the flow of analysis of this study.

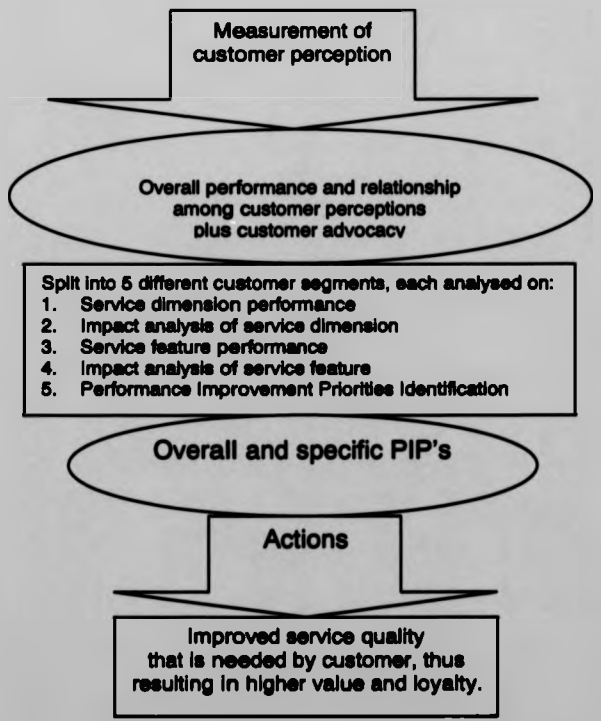


Figure 22: Flow of Analysis

The PIP's collected in each customer segment are consolidated in Appendix 14 The suggested company-wide PIP's are those features that score at least 4 out of the total of 5 customer segments. There are six of them, namely:

Code a: frequency of visit and contact (under X_7)
Code g: accuracy of information provided (under X_7)
Code w: friendliness, courtesy & professionalism of courier (under X_{10})
Code e: speed in responding to request (under X_7)
Code ad: care in handling shipment (under X_{10})
Code au: time to investigate lost shipment (under X_{12})

Improvement in the delivery of these six service features should have a positive impact on the greatest number of DHL customers. DHL management should devise methods and deploy the needed resources toward these six features according to the agreed priority.

The other service features not on the company-wide PIP list but on individual customer segments (e.g. high revenue, heavy weight) should be taken care of by the respective customer-sector management or by the functional management (e.g. customer service, courier service).

5.8 Summary and Conclusion

Service quality and customer service are important topics in the air express industry. A literature review on service quality and customer service management was conducted to identify the success factors in the service industry, particularly for those applicable to DHL's environment. For instance, the service-profit chain brings out the overall relationships between customer, employee, their respective satisfaction level, service quality and profitability. Listening to the customers and receiving their complaints are important steps in achieving success as these can help remove problems that the company management may not currently be aware of. A good service recovery may create more goodwill than if things had gone smoothly in the first place.

The importance of customer retention and employee retention was considered. A popular customer service tool of service guarantee was discussed, and this requires the service provider to be always on the alert to the commitments made to customers. Finally, the different approaches of service research were discussed for listening to the customers and other stakeholders.

The last section is an innovative approach in creating a Customer Value Model that links customers' behaviour to the organisation's critical performance factors. Also studied were perceived value, service quality, price, and reputation as they are all inter-related. PZB's service quality model was adopted, but revised to accommodate the industry's specific characteristics. The relationship between service quality and the different service dimensions (and then in turn between

dimensions and service features) were also studied. A multivariate regression approach was taken to replace the subjective assessment of the gap between the importance and perception of these features. The results obtained confirmed that the Model was valid and suitable to be used to explain the relationship between customers' behavioral intention and the actual performance of service dimensions and service features. Finally, the step-by-step flow analysis process effectively transformed the statistical results into performance improvement priorities. This is a creative way to turn ideas into actions.

There are several areas considered to have the potential for future development and further studies on this project area. The details are discussed in Chapter 8.3.

As a postscript, it is encouraging to note that the company has accepted the recommendations of the project. Working groups were set up to formulate detailed action plans aimed at making drastic improvements on those six service features that were identified as company-wide PIP's. Upon successful experience gained with this exercise, it would be introduced to other DHL offices throughout the Asia Pacific region.

6. Other Topics Studied

There are three other important topics in the portfolio, namely *technology management, service productivity, and service product* that have also been studied by the author.

6.1 Technology Management

The use of technology has become increasingly a competitive edge in the air express industry. The author believes that technological innovations have the power to influence industry structure and competitive advantage [44]. In many instances, the quest for higher agility and customisation could not be made possible without the appropriate use of technology, particularly information technology (IT).

The author used a systematic approach to analyse the application of different technologies in attaining agile competitiveness against the competition. Large American rivals like Federal Express and UPS have deployed their US models to compete in Hong Kong whereas DHL Hong Kong designed their own under the regional office's guidelines. Hence, the more custom-made DHL model has considered more local issues that may influence the validity of the results.

The author collected all the different applications of technology around the DHL Asia Pacific country offices, and selected those ones suitable for use in Hong Kong. He also predicted the technology trend of going toward (i) more effective and timely shipment movement communications, and (ii) making it easier for customers to employ DHL's service.

Among the various categories of technologies (Material, Method and Information [45]), IT is the most competitive battlefield that demands a huge investment. Nevertheless in this electronic information age, IT can make a lot of impossible tasks possible [46], and can create genuine value for customers, e.g. real time track and trace, pre-arrival shipment clearance at the customs, and instant customer order confirmation.

Quite a heavy emphasis was also given to the customer service front-end and back end application to serve customers directly. Particularly for the front-end applications, technologies for customer integration, customer automation, and customer service were studied in detail. This helped the company to know the strength and weaknesses, and the areas that it should improve.

The author also represented the Hong Kong office to run to the DHL Asia Pacific regional Mobile Data capturing project [47]. He has personally studied the technology products in the market, compared available options, and jointly decided on the solution for the next decade. Finally, the shipment information uploading to the worldwide network was made much faster than before.

6.2 Service Productivity

The author noticed that there was very little literature that explored productivity measurement in the service industry. DHL Hong Kong, in common with other establishments in Hong Kong [48], was not too aware of this issue. It just relied on a general feel to assess how productive its operations were. With a couple of new automatic processing systems up and running as well as more added value tasks that the couriers have to carry out in front of the customers, there was a genuine need to have an appropriate measurement of productivity.

There are three main types of productivity measures [49], namely (i) partial productivity, (ii) total-factor productivity, and (iii) total productivity. In 1996, the author encouraged the operations team to pay more attention to continual improvement in operational productivity. Since then, the company has measured and monitored the productivity performance on a regular basis using the partial productivity measure.

As shown in Chapter 5, the quality of service has a big influence on the value perceived by the customer. Higher productivity with reduced service quality is considered to be worse than the other way round. Hence, the author put forward the idea of quality-adjusted productivity. In the case of complete failure needing many remedial actions, even negative productivity could be appraised.

The company management welcomed the concept of quality-adjusted service productivity. However, this new concept was quite a sensitive issue since this might affect the incentive and bonus of many employees. In addition, the evaluation of quality factors may involve some personal subjective measurement. Hence, it has not yet been accepted to have that approach rolled out in the personnel compensation system. Instead, the service quality performance was added to the incentive scheme as a new measuring criterion according to the suggestions made by the author.

6.3 Service Product

It was in mid 1995 that the DHL Hong Kong management decided to launch a new product in the range of 15 to 50 kg. It was based on the recommendation of market research that such a strategic product would be beneficial to the long-term business development of the company. This new product was named the "Jumbo Box" (Figure 23).

Figure 23: External Shape of the Jumbo Box

This new product can help DHL in providing a full range of products from a few grams to many tons. Its standardised external dimensions can also increase the agility of the front-end staff. This effect has also been considered in the model parameters of Chapter 4.

The author took the lead in managing all the operational aspects including the physical design of the box and the process flow. Operational aspects covered included: (i) calculating the stuffing load into the air container to maximise the line-haul cost usage, (ii) deciding the number of boxes to be delivered to the new customers, (iii) setting the optimal box inventory holding level, (iv) considering the human aspects in handling the boxes, as well as (v) receiving the shipment information feedback.

Ultimately, the product launch was successfully achieved with virtually no initial teething problems. In the first year, the sales from this new product sector took 4 to 5% of the total revenue figure. Later when a smaller version (called the Jumbo Junior Box) also came into existence, the product line of the Jumbo Box series has consistently taken 6 to 8% of the total sales revenue. In addition, the saving due to the standardised packaging concept is estimated to be 1 to 1.5% of the total line-haul costs.

7. Results and Achievements

There have been a number of achievements by the company (i.e. DHL) during 1995 to1998. These results, to a large extent, were the consequence of having taken the recommendations of the author's research study.

The various components as well as the service strategy implementation model itself help the company management conceptualise a bird's eye view of the service strategy that the company should take. Accordingly, the respective crucial areas and key factors are attended to. It needs an integrated approach to put in the correct amount of effort and emphasis to places intended to have improvements.

7.1 Business-related Achievements

DHL continued to be the leader of the air express industry and maintained the biggest market share over the years, despite the fierce competitive pressure exerted by their rivals. Between the different regions, Asia Pacific was the most energetic and promising one within the DHL global business. Even though Hong Kong is a small place, the business volume ranked number 5, just after USA, UK, Germany and Japan. The average growth rate for DHL Hong Kong during 1995 to 1998 was 19% per annum in terms of sales revenue, 25% in terms of number of shipments, and 30% in terms of weight. From market intelligence, these strongly indicated that the company was performing above the industry's norm (of about 18% annual growth in terms of weight). The company's business growth rate during this period was also very much bigger than before. To a certain degree, these gains were contributed to by the company's adoption of the correct strategic configurations as recommended by this portfolio.

The introduction of the Jumbo Box in 1995 (and later the Jumbo Junior Box in 1996) was a total success in introducing a standardised packaging mode with easy-to-use application to help customers deal with the shipping process. The author contributed to the design of the box and its process flow; and by standardising the box dimension to fit in an air container (LD3 Type), he succeeded in saving some line-haul costs.

In addition to the usual document, parcel and freight transportation, DHL Hong Kong has offered a logistics service to customers since 1996. An Express Logistics Centre was set up to help specific customers with their needs for pick and pack, spare parts warehousing, inventory collection and re-distribution. This was also part of the strategic service product offering, thinking along similar lines to the Jumbo Box.

Through the aggressive emphasis of customer focus, the company invested more resources in the customer service and related functions. As a result, more favorable comments from customers were received. The areas of improvement

were (i) easier to contact through telephone, and (ii) improved service attitude of the customer service agents and couriers. Also, in response to the author's customer satisfaction study which showed a low score in the service recovery performance, a Customer Care Section was set up in March 1997 to focus more on recovering service failures and accommodating the special needs of particular customers.

7.2 Operations-related Achievements

To cope with the increased shipment volume as well as shipment weight, expansion in capacity through additional working space and advanced technology was required. Physical goods movement through automatic conveyor systems, and checkpoint data upload to the central shipment information database were successfully upgraded in 1996. This resulted in great savings of operational costs and reduced the number of mistakes or delays.

During the research process on the service network, the author also made improvements in the vehicle fleet. A specially designed 'Supervan' was introduced, and equipment for capturing shipment checkpoint data on the road was deployed. This greatly increased the timeliness of data available for customer enquiries, hence achieving higher customer satisfaction.

Through strong emphasis of the service productivity, the actual labour productivity (in terms of shipment per courier) was also increased by about 6% per annum. This achievement was considered satisfactory in view of the increased number of processes to be carried out in front of the customer.

Finally, through the research project of Strategic Service Network Planning and Design, there was a smooth transition of operations from the old airport to the new Chek Lap Kok Airport in July 1998. Also, the company has clear vision and plans for the service network in the short to medium term.

7.3 New Ideas Developed during the Research

In the Strategic Service Network Project, the author's simultaneous use of two scientific models together was totally new. Also, the forecasting of sales revenue over the 10 years' planning horizon and the adoption of weight-equivalent number of shipments were new attempts.

For the Service Quality and Customer Service Project, the collection of various critical factors to substantiate the route to success for DHL was a new idea found to be very appropriate to DHL's real life situation.

The design of the Customer Value Model incorporating the concept of Parasuraman et al's (PZB) service quality model and the step-by-step

development into Performance Improvement Priorities have never been attempted by others. Consequently, the results and recommendations of the author's research were very useful to the company.

The strategic positioning of the Jumbo Box to be between 15 to 50 kg was totally new. It also resulted in a great success in terms of business results. As reflected by the customers, Jumbo Boxes could serve their needs. On the other end, the standardised packaging also made DHL's operational processing much easier.

In the planning and design of launching the Jumbo Box, the author's comprehensive considerations of box design, process flow, material management and distribution, and human factors are considered unique. These had not been adopted by anyone in the air express industry before.

In the study of service productivity and quality, the ideas of negative productivity and quality-adjusted productivity measurement help people link quality and productivity together when performance is being assessed.

There was a systematic classification of technology management into three areas, namely: (i) materials, (ii) methods and (iii) information according to Heskett's format. This helped DHL in formulating a balanced technology investment plan.

Grouping of information technology into customer front end and back end applications is a very suitable way of explaining the systems that DHL uses. In addition, the inclusion of the Mobile Data Capturing Project illustrated how information technology could help improving the agility in serving customers.

8. Conclusion

8.1 Summary

The research has been successfully carried out with a wide spectrum of business and operational considerations. The theory of service-based strategy in the air express industry was reviewed and a new concept of a Service Strategy Implementation Model was introduced. A detailed review was carried out to assess the external and internal environments of DHL (world wide as well as in Hong Kong), from which the above model was formulated. A practical approach to apply the model in improving competitiveness via agility and customisation was demonstrated.

It is strongly believed that this Service Strategy Implementation Model can provide a map to guide the company management toward a totally integrated solution for improving competitiveness in the air express business.

A considerable amount of detail was covered by the other submissions when exploring the various important topics, namely, service network plan, service quality, customer service, technology management, productivity, and product/service. They are all important components, and together they build up the entire model.

8.2 Areas of Innovation Demonstrated

The areas of innovation demonstrated in the Portfolio are described as follows:

8.2.1 *Creation of New Models and Methods*

a) In this Executive Summary, the creation of a completely new Service Strategy Implementation Model was based on a building block concept. The various components are added one by one to develop its structure. The model can be used as a map to help management understand the whole picture of how the various strategic components come together to drive the company toward higher levels of competitiveness.

b) In the Strategic Service Network Planning and Design Project, the use of two separate but related scientific models to develop and analyse the eventual distribution plan was a new attempt that has not been tried by other researchers before. The iterative use of an economic network planning model and the operations simulation model gave rise to viable and cost effective solutions.

c) In order to understand the details of the inter-relationship between customer's behavioral intention and the important performance factors, a Customer Value Model was invented and then verified by a large scale customer satisfaction survey.

Then the author developed a step-by-step analysis to derive a list of Performance Improvement Priorities (PIP) from which genuine action plans for improvement could be made.

d) The concept of negative productivity and quality-adjusted service productivity measurement was introduced in Submission 2. This led to the inclusion of quality performance as a complementary part of the productivity and efficiency measurement.

8.2.2 Adaptation of Established Theory and Concepts

a) There was an adaptation of Porter's Generic Value Chain to a Specific Value Chain that is more appropriate to the air express industry. The ingredients of primary and support activities were all revised. The outcome was higher competitiveness due to agility and customisation toward serving customers.

Through the derivation of the Specific Value Chain, the author later converted this into an 'Agility and Customisation Torpedo'. This torpedo then became the heart of the Service Strategy Implementation Model.

b) In the Service Quality and Customer Service Project, there was an adaptation of the dimensions used by PZB's famous service quality model. The new dimensions were defined to suit the new Customer Value Model. The corresponding service features under each service dimension were also tailored to the air express industry.

c) The technology management approach of DHL was cross-examined with respect to Porter and Heskett's concepts; and it was found to be in close alignment. Accordingly, the various technologies applied by DHL were classified and explained under the three main categories, namely: materials, methods, and information technology. These were then substantiated by numerous illustrations in the paper (Submission 3).

8.2.3 Re-grouping of Items to Generate New Meaning

a) The suitable grouping of information technology applications into customer front-end and back-end could help readers clearly understand the scope of applications.

b) The author split the customer front-end innovations into three levels namely, Customer Integration, Customer Automation, and Customer Service. Each level required a different set of information technology tools.

8.2.4 *Other Innovative Points*

a) In the project on Service Quality and Customer Service, the author suggested the company consider linking the Customer Satisfaction Index (CSI) to the Employee Satisfaction Index (ESI). This can test the assertion of Heskett's 'Service Profit Link Model' that Employee Satisfaction and Customer Satisfaction should be inter-related.

b) The author's contribution in the Mobile Data Capturing Project led to a new information technology age for DHL Hong Kong in the instant updating of shipment information in the DHL global database network. While rivals like Federal Express and UPS just transferred their American technology to Asia, DHL pioneered a tailor-made solution to the Asia environment, and hence is more likely to be successful in the actual implementation.

c) The standardised packaging concept of the Jumbo Box can benefit both the customer and the company. This has led to the creation of a new product line in the air express industry.

8.3 *Further Research and Development Work*

There are several areas considered to have the potential for future development and further studies with the two main research projects:

8.3.1 *Strategic Service Network & Design*

a) The Express Cargo Terminal (ECT) inside the restricted area of the Airport is a new concept to Hong Kong (but not new to Europe or North America). There may evolve a need for a new set of operations game plans since some inbound and outbound shipment processing activities are carried out there before customs clearing. Hence further studies would need to be made on

- the new strategic service network of satellite depots and service centres
- the facilities layout and hardware installation
- operational analysis

b) With variable cut-off times for different zones and/or very important customers, the impact on operations and service quality generated should be studied.

c) The extent of the simulation model may be increased to incorporate the air cargo space booking system. In other words, the shipments received will immediately be linked to the destination gateway register. Then as soon as the cut-off time is reached, the space requirement and the line-haul costs are known. In addition, space booking with airlines can be confirmed immediately.

d) This exercise of simultaneously using Mixed 0-1 LP and Simulation Models should also be applied to other DHL country offices as well. Then the solutions and results can be compared across countries to form a regional strategic alliance.

e) With more airports being built and used within the Pearl River Delta, e.g. Shenzhen Airport, the current scope of study may be extended to the entire south China region using multiple airports for selected flight itineraries. This would require another level of modeling, and it will be a more complicated exercise.

8.3.2 Service Quality and Customer Service

a) The Customer Value Model was developed to explain the entire inter-relationship between the customer's behavioral intention, value, and service quality. Nevertheless, the survey has focused on customer perception of service quality (hence CSI). There can be an extension to measure a Customer Value Index (CVI) as well. This CVI may be more directly linked to the loyalty of customers than the CSI, and thus may be a better factor to deal with.

b) Another possible development can be on the linkage of Customer Satisfaction Index (CSI) and Employee Satisfaction Index (ESI). There should be some way to build into the surveys a link between these two indices. Once that relationship is identified, it can help to further validate Heskett's service-profit link model, and to treat employees in a suitable way to directly improve CSI through ESI.

c) In the statistical analysis, a multiple linear regression relationship was assumed. It would be better if other possible relationships were also considered. Potential ones might include quadratic function, stepwise regression, or Fuzzy Logic. These may give a more thorough search of relationships among the variables.

d) The PIP's identified in Chapter 5.7 led to a list of actions to be taken in improving the concerned service attributes. If the unit cost of improvement (e.g. dollars per percentage point increase in customer satisfaction) is known for all the items, then a priority list can be generated that has also considered the cost effectiveness of investment as well.

e) Further down the road there is a need to expand the current scope of `customer-only' within the context of the entire supply chain. So far, only customers and employees are being surveyed. It could extend to cover suppliers as well. This may be a worthwhile exercise to do since this can ensure DHL's suppliers are satisfied and willing to supply products or services on a continual basis. This supplier re-assurance can reduce DHL's risks of failure to serve its customers due to supplier's problems

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Note: PZB* stands for Parasuraman, A.; Zeithaml, V.A. & Berry, L.

Appendix 1: Abstracts of the five project and papers submissions

1. Paper on ***"Strategic Product Launch & Implementation: making reference to the DHL Jumbo Box"***

DHL is the World's largest international air express company. Documents delivery was the major market during the early days, and the corporate strategy in recent years was to move towards heavyweight shipments. Recent market research indicated a great potential to grow the business in the range of 15 to 50 kg, hence a strategic service product, called Jumbo Box, was designed to capture this market segment. Consequently, DHL could offer a full line of value-added products to serve customers, thus contributing to their Service Excellence.

This paper discusses how the various technical issues are considered and addressed in a new product introduction programme that is constrained by a narrow time frame. Besides the front-end promotional and advertising activities, there are also a number of 'behind-the-screen' activities involved. The author took the viewpoint of an industrial engineer to explore details of the innovative designs and operating plans. These included box design, process flow and management information, materials management and distribution, and human factor considerations.

Finally, the author invites industrial engineering practitioners to help develop some standard templates or tools for the product development and product introduction applications so that other engineers can manage similar projects more effectively.

2. Paper on ***"Service Productivity & Quality Excellence in the Air Express Industry"***

Hong Kong has gone through a transition from manufacturing dominance to service dominance over the last 15 years. Traditional productivity is well defined and managed under the manufacturing scenario. As the service industry continues to grow, there is a genuine need to study productivity in the service environment.

In this paper, the providers of productivity awareness, the types of productivity measures, the basic factors underlying productivity and its improvement techniques are discussed. There is an analysis of the benefits of productivity improvement and ideas on how to treat employees fairly as a result of productivity gain. Then the consideration of quality together with service productivity and how it leads to Quality Excellence are discussed. Concepts of 'negative productivity' and 'quality level' discount factors are introduced. Finally the

approach of a leading air express company in service productivity and quality excellence is discussed.

3. Paper on ***"Technology Management in Sustaining Agile Competitiveness in the Air Express Industry- a case study in DHL"***

The air express industry moves both physical packages and shipment information. Market competition will allow survival only to those contenders operating under an excellent quality environment. Technology management is one major ingredient to help achieve high competitiveness. Porter and Heskett's concepts on technology management are cross-examined with respect to the approach at DHL, and found to be in close alignment. Materials, methods, and information technology (IT) innovations are further discussed with real-life illustrations from DHL in the Asia Pacific region.

The IT innovations at both customer front end and back end are then explored, with a vision to go toward more effective & timely shipment movement communications and ways of making it easier for customers to employ DHL's service.

There is also a description of a project on mobile data communications to illustrate how to get shipment information updated onto the global network faster.

As a result of the right strategy and applications of technology management, particularly in the IT aspects, DHL has become agile, competitive, and can sustain market leadership into the 21st Century in the air express industry.

4. Research Project on ***"Strategic Service Network Planning and Design"***

DHL currently operates in a main service centre near the Kai Tak Airport and another smaller one on the Hong Kong Island side, both logistically supported by a couple of satellite depots. With the opening of the new Chek Lap Kok Airport on Lantau Island and the increasing business volume with China, DHL seeks to determine a ten-year service network distribution design which will be most desirable in that it would capitalise opportunities, minimise cost and improve customer service.

The overall service network planning framework consists of two separate but related models, which are formulated to develop and analyse the eventual distribution plan. The first model, called the *economic network planning model*, determines in an aggregate fashion, the macro optimal system configuration. The second model,

called the *operation simulation model*, evaluates the operational efficiency of the recommended network configuration in a micro operational fashion. A systematic and iterative use of both models helped in arriving at a viable network design.

After a thorough analysis of DHL's processes and actual collection of the necessary data, this new approach was proven to be able to provide a practical solution that was ultimately adopted by the DHL management for actual use.

5. Research Project on ***"Service Quality and Customer Service"***

Service Quality and Customer Service are very important topics to the air express industry. The customer is obviously the centre of focus, while front-line service employees can significantly influence the customer's perception of service quality.

A literature review of quality and service management concepts and principles was undertaken under the air express scenario. Concepts proposed by other researchers were also discussed, with particular reference to Parasuraman, Zeithaml & Berry (PZB)'s Service Quality Model, Heskett's Service-Profit Chain, Sasser's Lifetime Value of Customers, and Berry's Service Quality Research.

As the industry leader, DHL's total quality approach and emphasis were explored in detail. The forthcoming movement into Global Service Commitment, Service Quality Index, and Multi-Dimensional Performance Measurement provided opportunities as well as challenges.

Referencing PZB's model and DHL Asia Pacific's Corporate Culture mechanism, a new `Customer Value Model' was built to link customers' behaviour to the organisation's critical performance factors. Perceived value, service quality, price, and reputation were inter-related. A customer satisfaction survey was subsequently performed on the model that later confirmed it to be of appropriate use. Then through a step-by-step analysis, statistical results were then transformed into performance improvement priorities (PIPs), from which genuine action plans were formulated.

Appendix 2: Linear Programming Formulation of the Network Planning Model

(Basic Model with Single Period Consideration)

The following paragraphs show the modelling details for the mixed 0-1 LP model. Before getting into the complicated full 10-period (one period equals one year) situation, it would be easier to discuss the single period formulation first.

a) Model Parameters :

- d_i = demand in number of equivalent shipments in zone i
- t_D = order dispatch to courier in minutes
- t_i = pickup response time within zone i
- t_{ij} = transport time from zone i to satellite depot j
- t_J = shipment processing time at satellite depot j
- t_{jr} = transport time from satellite depot j to service centre r
- t_R = shipment processing time at service centre r
- t_{rA} = transport time from service centre r to airport
- t_A = shipment processing time at airport gateway
- t_{total} = total flow time from order intake to hand over to HACTL
  (= $t_D + t_i + t_{ij} + t_J + t_{jr} + t_R + t_{rA} + t_A$)
- T_{max} = maximum allowed time from order intake to delivery to HACTL
- C_k = handling capacity of satellite depot of k^{th} type
  (e.g. tiny for 2,000 shipments, small for 5,000 shipments)
- S_m = handling capacity of service centre of m^{th} type
  (e.g. medium for 15,000 shipments, large for 30,000 shipments)
- M = a very large number
- V_{ij} = variable cost of picking up a shipment in zone i and transporting to satellite depot j, plus processing there
- V_{jr} = variable cost of transporting from satellite depot j to service centre r, plus processing there
- V_{rA} = variable cost of transporting from service centre r to the airport gateway, plus processing there
- F_{jk} = fixed cost of installing and maintaining k^{th} capacity in satellite depot j
- F_{rm} = fixed cost of installing and maintaining m^{th} capacity in service centre r

b) Decision Variables

- X_{ijr} = quantity of shipments picked up in zone i being transferred to satellite depot j and processed in service centre r
- Y_{jk} = {1, if capacity type k is installed in satellite depot j
  {0, otherwise

Z_{rm} = {1, if capacity type m is installed in service centre r
{0, otherwise

W_{ijr} = {1, if $X_{ijr} > 0$
{0, otherwise

c) Objective Function

(1) Minimise : $\sum_i \sum_j \sum_r \{(V_{ij} + V_{jr} + V_{rA}) X_{ijr} + \sum_j \sum_k F_{jk} Y_{jk} + \sum_r \sum_m F_{rm} Z_{rm}\}$

d) Constraints

I. Demand in zone i must be met

(2) $\sum_i \sum_j X_{ijr} = d_i$ $\forall i$

II. Total flow time has to meet flight schedule

(3) $X_{ijr} \leq M W_{ijr}$ $\forall i,j,r$

(4) $W_{ijr} \{T_{total}\} \leq T_{max}$ $\forall i,j,r$ [to limit the choice from feasible routes only]

III. Handling Capacity of Satellite Depot j must not be exceeded

(5) $\sum_i \sum_j X_{ijr} \leq \sum_k C_k Y_{jk}$ $\forall j$

(6) $\sum_k Y_{jk} \leq 1$ $\forall j$ [to limit at most one choice of capacity type]

IV. Handling Capacity of Service Centre r must not be exceeded

(7) $\sum_i \sum_j X_{ijr} \leq \sum_m S_m Z_{rm}$ $\forall r$

(8) $\sum_m Z_{rm} \leq 1$ $\forall r$ [to limit at most one choice of capacity type]

$X_{ijr} \geq 0$, Y_{jk}, Z_{rm}, $W_{ijr} \in (0, 1)$

e) Other Comments

As can be seen from the above modelling exercise, it is not only the X_{ijr} that have to be determined. Two other types of decision, namely satellite depot capacity (Y_{jk}) and service centre capacity (Z_{rm}) are also considered. X_{ijr} needs to be 0 or a positive number while Y_{jk} and Z_{rm} must be either 0 or 1. W_{ijr} is used as a logic variable to recognise those non-zero X_{ijr} flows.

When the objective function is examined, it is apparent that there is a variable cost portion and a fixed cost portion; and both are split under the satellite depot and the service centre categories. The decision of choosing a facility in a particular zone will be heavily dependent on the relative impact on cost they have in the objective function. Finally, optimising a series of single-year problems is not equivalent to optimising an aggregate ten-year problem.

Appendix 3: Linear Programming Formulation of the Network Planning Model

(Full Model with Multiple Period Consideration)

It would not be difficult to interpret the multiple period model once the principle of the single period principle is understood. In this multiple period version, an additional term of '$\sum_t$' is added to the objective function. Most of the parameters, decision variables and constraints need to have an extra subscript 't' to designate the time period.

f) Model Parameters :

d_{it} = demand in number of equivalent shipments in zone i in period t

t_{Ot} = order dispatch to courier in minutes in period t

t_{it} = pickup response time within zone i in period t

t_{ijt} = transport time from zone i to satellite depot j in period t

t_{Jt} = shipment processing time at satellite depot j in period t

t_{jrt} = transport time from satellite depot j to service centre r in period t

t_{Rt} = shipment processing time at service centre r in period t

t_{rAt} = transport time from service centre r to airport in period t

t_{At} = shipment processing time at airport gateway in period t

$t_{total,t}$ = total flow time from order intake to hand over to HACTL in period t
(= $t_{Ot} + t_{it} + t_{ijt} + t_{Jt} + t_{jrt} + t_{rRt} + t_{rAt} + t_{At}$)

$T_{max,t}$ = maximum allowed time from order intake to delivery to HACTL in period t

C_k = handling capacity of satellite depot of k^{th} type
(e.g. tiny for 2,000 shipments, small for 5,000 shipments)

S_m = handling capacity of service centre of m^{th} type
(e.g. medium for 15,000 shipments, large for 30,000 shipments)

M = a very large number

V_{ijt} = variable cost of picking up a shipment in zone i and transporting to satellite depot j, plus processed there in period t

V_{jrt} = variable cost of transporting from satellite depot j to service centre r, plus processed there in period t

V_{rAt} = variable cost of transporting from service centre r to the airport gateway, plus processed there in period t

F_{jkt} = fixed cost of installing and maintaining k^{th} capacity in satellite depot j in period t

F_{rmt} = fixed cost of installing & maintaining m^{th} capacity in service centre r in period t

g) Decision Variables

X_{ijrt} = quantity of shipments picked up in zone i being transferred to satellite depot j and processed in service centre r in period t

Y_{jkt} = {1, if capacity type k is installed in satellite depot j in period t
{0, otherwise

Z_{rmt} = {1, if capacity type m is installed in service centre r in period t
{0, otherwise

W_{ijrt} = {1, $X_{ijrt} > 0$
{0, otherwise

h) Objective Function

(1) Minimise: $\sum_i\sum_j\sum_r\sum_t \{(V_{ijt}+V_{jrt}+V_{rAi})\, X_{ijrt} + \sum_j\sum_k F_{jkt}Y_{jkt} + \sum_r\sum_m\sum_t F_{rmt}Z_{rmt}\}$

i) Constraints

I. Demand in zone i must be met

(2) $\sum_i\sum_j X_{ijrt} = d_{i,t}$ $\quad \forall i,t$

II. Total flow time has to meet flight schedule

(3) $X_{ijrt} \le M\, W_{ijrt}$ $\quad \forall i,j,r,t$

(4) $W_{ijr}\{T_{total,i}\} \le T_{max,i}$ $\quad \forall i,j,r,t$ [to limit the choice from feasible routes only]

III. Handling Capacity of Satellite Depot j must not be exceeded

(5) $\sum_i\sum_j X_{ijrt} \le \sum_k C_k Y_{jk1} + \sum_k C_k Y_{jk2} + \ldots + \sum_k C_k Y_{jkt}$ $\quad \forall j,t$

(6) $\sum_k Y_{jkt} \le 1$ $\quad \forall j,t$ [to limit at most one choice of capacity type]

IV. Handling Capacity of Service Centre r must not be exceeded

(7) $\sum_i\sum_j X_{ijrt} \le \sum_m S_m Z_{rm1} + \sum_m S_m Z_{rm2} + \ldots + \sum_m S_m Z_{rmt}$ $\quad \forall r,t$

(8) $\sum_m Z_{rmt} \le 1$ $\quad \forall r,t$ [to limit at most one choice of capacity type]

$X_{ijrt} \ge 0$, $\quad Y_{jkt}, Z_{rmt}, W_{ijrt} \in (0, 1)$

j) Other Comments

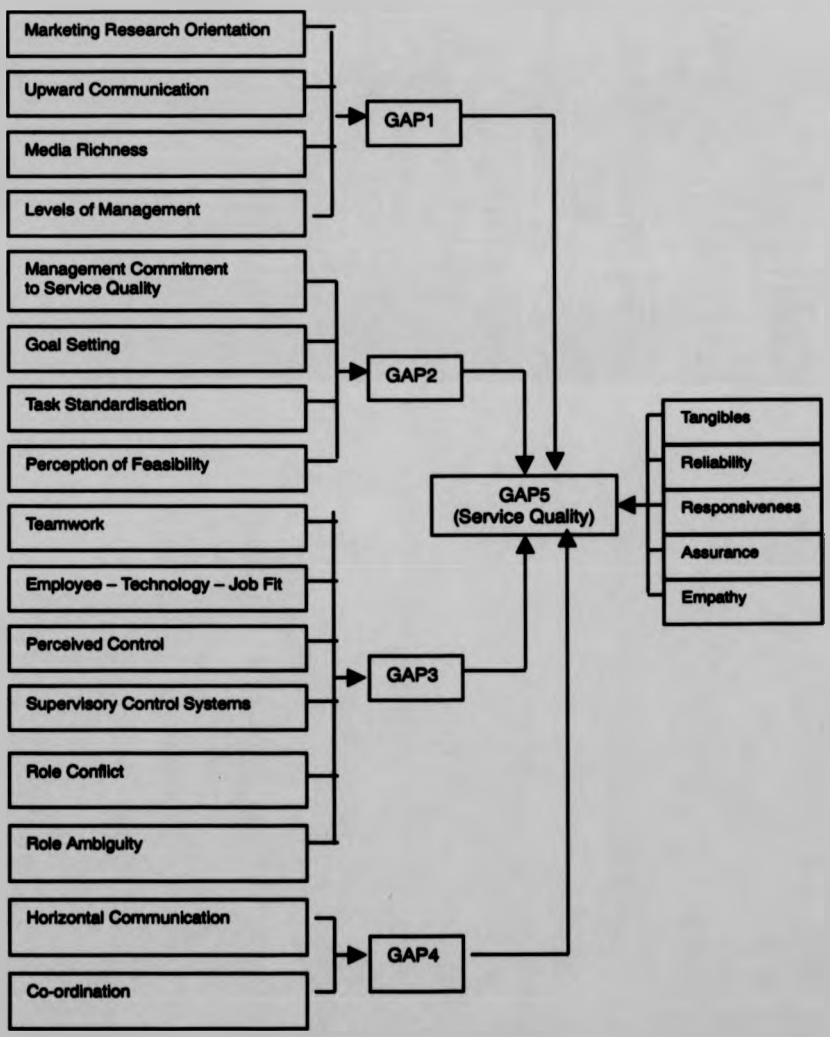
Since there is one more `time' dimension added to the multiple period model, the input data will theoretically be 10 fold. This is true for the demand, d_{it}, as these do vary according to the estimated market movement over the years. The cost figures will be subject to 5% inflation but under 15.5% DCV each year. All the other parameters, such as time of transportation and processing, are assumed unchanged over the 10 time periods.

There is also a rule that once a satellite depot or service centre is installed in a certain zone, it will stay on in the subsequent periods. This saves the potential wastage of setting up & closing down facilities between successive years due to a marginally competitive situation at around sub-optimal conditions. Therefore the decision variables (Y_{jkt} and Z_{rmt}) determined at period t, and before, will affect the choice of period t + 1. This is reflected in equation (5) and (7) of Section I) above.

Appendix 4: SERVQUAL as a means to measure Service Quality [2]

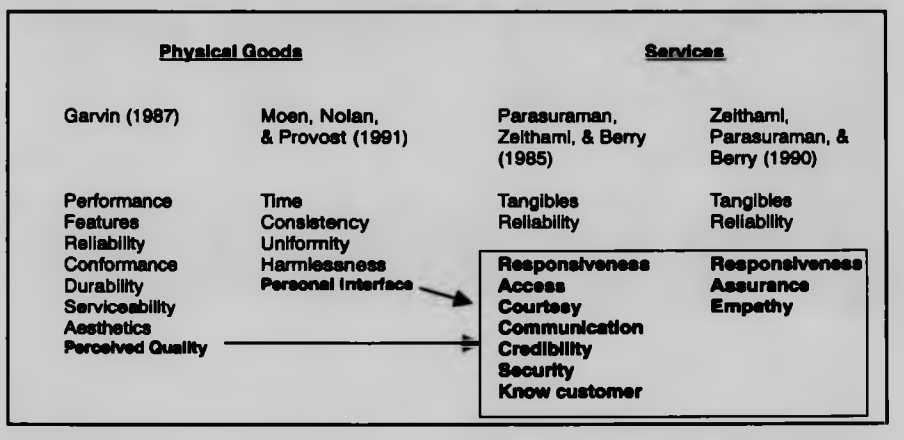
	Dimension	**Item Description**
1	Tangibles	Up-to-date equipment
2	Tangibles	Visually appealing physical facilities
3	Tangibles	Neat and well dressed employees
4	Tangibles	Physical facilities kept with the type of service provided
5	Reliability	Keep promise to the time of doing it
6	Reliability	Sympathetic and re-assuring to customers' problems
7	Reliability	Dependability
8	Reliability	Provide service by the time promised
9	Reliability	Accurate record keeping
10	Responsiveness	Tell customer exactly when the service will be performed
11	Responsiveness	Receive prompt service upon arrival or on demand
12	Responsiveness	Employees are always willing to help customers
13	Responsiveness	Not-so-busy employees to respond to customer request promptly
14	Assurance	Trustworthy employees
15	Assurance	Customer feeling safe
16	Assurance	Polite employees
17	Assurance	Adequate support to make employees work well
18	Empathy	Individual attention
19	Empathy	Employees who give you personal attention
20	Empathy	Employees who know what your needs are
21	Empathy	A firm which has your best interest at heart
22	Empathy	Convenient operating hours

Appendix 5: Extended model of Service Quality by PZB [26]



Appendix 6: Different customer-based dimensions of Quality [32]

Prutt and Thomas decomposed quality of product (both physical goods and services) into generic dimensions as shown below. By improving the performance of certain dimensions, it is possible to increase the overall value of the product as perceived by the customers.



Appendix 7: Main reasons for companies not learning from Customer Defection[38]

Reichheld studied the reasons for customers to turn to other suppliers (or service providers). However he found that many companies did not learn from such defection experiences. The following list shows the 7 main reasons why they have barriers to learning:

(1) Many companies are not really alarmed by customer defections – or react too late – or because they don't understand the intimate, causal relationship between customer loyalty and profits.

(2) It is unpleasant to study failure too closely.

(3) Customer defection is often hard to define, e.g. if a customer divides the purchase into two suppliers

(4) Sometimes, even the term '*customer*' itself is hard to define.

(5) It is sometimes hard to uncover the real root causes of a customer defection and extract the appropriate lessons.

(6) Getting the right people in the organisation to learn those lessons and then commit to acting on them is a challenge.

(7) It is difficult to conceptualise and set up the mechanisms that turn the analysis of customer defections into an on-going strategic system, closely supervised by top managers and quickly responsive to changing circumstances.

Appendix 8: List of Research Approaches for Service Improvement [42]

Type	Description	Purpose	Limitations
Transactional surveys	Service satisfaction survey of customers following a service encounter.	Obtain customer feedback while service experience is still fresh; act on feedback quickly if negative patterns develop.	Focuses on customers' most recent experience rather than their overall assessment. Non-customers are excluded.
Mystery shopping	Researchers become "customers" to experience and evaluate the quality of service delivered.	Measure individual employee service behaviour for use in coaching, training, performance evaluation, recognition, and rewards; identify systemic strengths and weaknesses in customer-contact service.	Subjective evaluations, researchers may be more "judgmental' than customers would be, expense limits repetitions; potential to hurt employee morale if improperly used.
New, declining, and lost-customer surveys	Surveys to determine why customers select the firm, reduce their buying, or leave the firm.	Assess the role service quality and other issues play in customer patronage and loyalty.	Firm must be able to identify and monitor service usage on a per-customer basis.
Focus group interviews	Directed questioning of a small group, usually eight to twelve people. Questions focus on a specific topic. Can be used with customer, non-customer, or employee groups.	Provide a forum for participants to suggest service improvement ideas; offer fast, informal feedback on service issues.	Dynamics of group interview may prevent certain issues from surfacing. Focus groups are, in effect, brainstorming sessions; the information generated may not worth a project to be carried out for the whole population of interest.
Customer advisory panels	A group of customers recruited to periodically provide the firm with feedback and advice on service performance and other issues. Data is obtained in meetings, over the telephone, through mail questionnaires, or via other means.	Obtain in-depth, timely feedback and suggestions about service quality from experienced customers who co-operate because of the "membership" nature of the panel.	Excludes non-customers. Panellists may assume role of "expert" and become less representative of customer base.
Service reviews	Periodic visits with customers for a class of customer(s) to discuss and assess the service relationship. Should be a formal process with a common set of questions, capture of responses in a database, and follow-up communication with customers.	Identify customer expectations of perceptions of the company's service performance and improvement priorities in a face-to-face conversation. A view of the future, not just a study of the past. Opportunity to include decision-makers in the discussions.	Time consuming and expensive. Most appropriate for firms marketing complex services on an ongoing, relationship basis.

(continued)

Type	Description	Purpose	Limitations
Customer complaints, comment, and inquiry capture	System to track, retain, categorise, and distribute customer complaints and other communications with the company.	Identify most common types of service failure for corrective action. Identify through customer communications opportunities to improve service or otherwise strengthen customer relationships.	Dissatisfied customers frequently do not complain directly to the company. Analysis of customer complaints and comments offers only a partial picture of the state of service.
Tool market surveys	Surveys that measure customer's overall assessment of a company's service. Research includes both external customers and competitors' customers, i.e., the total market.	Assess company's service performance compared to competitors; identify service-improvement priorities; track service improvement over time.	Measures customers' overall service assessments but does not capture assessments of specific service encounters.
Employee field reporting	Formal process for gathering, categorising, and distributing field employee intelligence about service issues.	Capture and share at the management level intelligence about customers' service expectations and perceptions gathered in the field.	Some employees will be more conscientious and efficient reporters than others. Employees may be unwilling to provide negative information to management.
Employee surveys	Surveys concerning the service employees provide and receive, and the quality of their work lives.	Measure internal service quality, identify employee-perceived obstacles to improved service; track employee morale and attitudes. Employee surveys help answer "why" service performance is what it is.	The strength of employee surveys is also a weakness; employees view service delivery from their own vantage point, subject to their own biases. Employees can offer valuable insights into the root causes of service problems but are not always objective or correct in their interpretations.
Service operating data capture	A system to retain, categorise, track, and distribute key service-performance operating data, such as service response times, service failure rates, and service delivery costs.	Monitor service performance indicators and take corrective action to improve performance as necessary. Relate operating performance data to customer and employee feedback.	Operating performance data may not be relevant to customers' perceptions of service. Focus is on what is occurring but not why.

Appendix 9: Characteristics of DHL culture [43]

I. Corporate Attitude

a) Which encourages a `Can Do' attitude in its people.
b) Which values, nourishes and rewards motivated, friendly and caring people.
c) With a commitment to innovation, challenge of the status quo and continual pioneering within the industry.
d) Has a commitment to respect, openness, honesty and integrity in all its dealings with stake holders (e.g. customers, staff and suppliers).
e) Which provides a climate of `freedom of expression' in which people feel they have a right to be heard.
f) Which is committed to the success of its people's personal missions and supports the growth, development and welfare of its people.
g) Which encourages a sense of belonging, of `common interest', amongst its people.
h) Which enshrines the right of people to be informed and to be involved in matters that affect them.
i) Which enables and rewards its people with the ownership to make decisions.
j) Which recognises that mistakes are inevitable in an innovative company and concentrates on fixing them, learning from them and sharing the lessons.

II. DHL People

k) Have a passion to exceed customer expectations, to delight not just satisfy them.
l) Are personally committed to the success of the customers' businesses.
m) Have a passion to do their best in any circumstances, never let anybody down and always project a professional image of the company.
n) Have a passionate commitment to the value of time.
o) Are honest, open and trustworthy in their personal relationships and communication.
p) Are proud of their company, its culture and achievements.
q) Take ownership and provide personal leadership.

III. Organisation

r) Which demonstrates a commitment to decentralisation, to allowing local decision-making at the lowest level of business unit.
s) Which encourages and supports working together as a family or one-team regardless of country, function or department.

Couriers' Difficulty Survey Questionnaire

Date : _____
Time : _____

Route code : _____

Type of Vehicle : _____

Arrival Time : _____

1. What do you think about our supply of safety facilities to you ?
   - ☐Enough
   - ☐Not Enough _____

2. How do you rate our godown's equipment ?

	Very Enough	Just Enough	Not Enough
- Trolley	☐	☐	☐
- data upload terminals	☐	☐	☐
- packing machine	☐	☐	☐
- SDR Printer	☐	☐	☐

3. Is there enough backup supplies for daily use ?

	Enough	Not enough
- HAWB	☐	☐
- Labels	☐	☐
- Trolley	☐	☐
- Others _____		

4. Is there any air-conditioning inside the vehicle ?
   ☐Yes ☐No

5. Is there enough parking place along your route ?
   ☐Enough ☐Not enough

6. What is the availability of the oil station ?
   ☐Around the route ☐Outside the route ☐Difficult to arrive

7. Is there any shipment protection from raining(e.g. rain coat) ?
   ☐Yes ☐No

8. What is your opinion about the quality of the existing uniform ?

	Satisfied	Not satified,suggestion ?
-durability	☐	☐_____
-seasonal changes	☐	☐_____
-comfortable	☐	☐_____
-others _____		

9. How is the transmission ability of your pager ?

_____

10. What is your comment on the design of the bar code scanner ?

	Satisfied	Not satified,suggestion ?
- size	☐	☐_____
- weight	☐	☐_____
- functions	☐	☐_____
- level of battery	☐	☐_____
- others _____		

11. What is your comment on the design of HAWB ?

	Satisfied	Not satified,suggestion ?
-sequence	☐	☐_____
-others _____		

12. Do you think our equipment are sufficient for your pickup procedure ?

☐Yes ☐No,opinion?_____

13. What will you do if your bar code scanner in case of malfunction ?

_____

14. How do you think about our shipment box ?

	Satisfied	Not satified,suggestion ?
-size	☐	☐_____
-position	☐	☐_____
-key availability	☐	☐_____
-others _____		

15. Do you have any suggestion of any means to keep the shipment during Pick up and Delivery procedure other than shipment box ?

_____

_____

16. What is your opinion about your existing route ?

_____

17. What is your opinion about the Mark Deduction Scheme ?

_____

18. What will you do if the customer request you to wait in case of time limitation ?

_____

19. Is there any different category for the pick up or delivery procedure (e.g. Urgent, Public Holiday) ?

☐Yes ☐No

OBSERVATION

1. The supply of safety facilities

	Enough	Not Enough
-fire extinguisher	☐	☐
-first aid box	☐	☐
-others _____		

2. The design of trolley in vehicle

	Satisfied	Not satified,suggestion ?
- shape	☐	☐_____
- size	☐	☐_____
- weight	☐	☐_____
- materials	☐	☐_____
- portability	☐	☐_____
-others _____		

3. The type of equipment for handling heavy goods
   a) ☐Efficient ☐Not efficient_____
   b) ☐Enough ☐Not enough_____

4. The cargo room area
   ☐Enough ☐Just enough ☐Not enough

5. The distance between the customers and the parking place
   ☐Far away(10-20min) ☐Not so far(5-10min) ☐Very close(0-5min)

6. Placement of goods in open area
   ☐Never ☐Sometimes ☐Always

6a. If yes, place in where _____

6b. Is it safe ? Why ?
_____

7. The distribution of customer within one location
   ☐Far away(10-20min) ☐Not so far(5-10min) ☐Very close(0-5min)

8. Restriction from

	Always	Sometimes	Never
-Security	☐	☐	☐
-Lobby	☐	☐	☐
-Lift	☐	☐	☐
-others _____			

9. The knowledge to answer inquire

☐ Sufficient ☐Need more training ☐Never occur

10. The skill of handling the shipments(especially for heavyweight shipment) to reduce lead time

☐ Skillful ☐Normal ☐Need more training

11. The traffic jam in the route

☐Low ☐Normal ☐Heavy

12. The amount of traffic light

☐Rare ☐Normal ☐Numerous

Remarks

_____

_____

_____

_____

_____

_____

Appendix 11: Service features for the various Service Dimensions

There are a total of 47 service items (or features) grouped under 6 dimensions.

1. Account Servicing and Sales Representatives

a) frequency of contact / visits
b) ease of contacting the sales representatives
c) helpfulness of sales representatives in resolving problems
d) ability to give tailor-made service
e) speed of response to enquiries or problems
f) ability to provide latest DHL service information
g) accuracy of information provided

2. Account Management and Billing

h) time period allowed before payment is due
i) ability to meet special request on billing
j) handling of credit notes and refunds
k) helpfulness in resolving problems
l) ability to handle billing enquiries
m) speed in responding to billing enquiries
n) readability and clarity of invoices
o) accuracy of billing

3. Outbound Delivery

p) competitive transit time to major cities, e.g. New York, Tokyo
q) competitive transit time to remote destinations, e.g. Vietnam, South Africa
r) efficient clearing of shipments
s) ability to have shipments arrive in good condition
t) ability to deliver shipments on-time
u) flexible shipment pickup times
v) ability to notify customer of anticipated delays

4. Courier Services

w) friendliness, courtesy and professionalism
x) punctuality of DHL pickups
y) helpfulness in solving problems
z) willingness to wait or come back for shipments that are not ready
aa) willingness to extend special considerations (e.g. help fill out forms, bring packaging materials)
ab) reliability of couriers' pickup
ac) keep customer informed if pickup is delayed
ad) care in handling shipments

5. Customer Services

ae) waiting time to get through to a customer service agent
af) friendliness of customer service agents
ag) ability of customer service agent to answer enquiries accurately
ah) promptness in responding to queries
ai) speed in tracking and tracing shipment
aj) ability to meet requests for packing materials or air waybills
ak) ability to meet special requests, e.g. urgent pickup or delivery
al) accessibility of the Customer Service hot line
am) knowledge about price rates and flight schedules
an) timeliness of tracking information

6. Service Recovery

ao) ability to inform customer that shipment has been lost
ap) ability to trace and recover shipment
aq) keep customers informed of the status of investigation
ar) thoroughness of `lost shipment' investigation
as) ability to provide a reasonable explanation for a lost shipment
at) providing fair compensation for a lost shipment
au) time required to investigate lost shipments

Appendix 12: <u>The principle of multiple regression for linear relationship</u>

In examining a relationship between variables, the multiple regression principle runs as follows:

Let Y be the dependent variable, and X be the independent variable, bearing a linear relationship

$$Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \ldots + \beta_p X_{i,p} + \varepsilon_i$$

for $i = 1$ to n, and p = no. of independent variables

or, put them in matrix form :

$$\underset{Y_{n\times 1}}{\begin{pmatrix} Y_1 \\ Y_2 \\ \vdots \\ Y_n \end{pmatrix}} = \underset{X_{n\times p+1}}{\begin{pmatrix} 1 & X_{11} & X_{12} & \cdots & X_{1p} \\ 1 & X_{21} & & & \vdots \\ \vdots & \vdots & & & \vdots \\ 1 & X_{n1} & \cdots & & X_{np} \end{pmatrix}} \underset{\beta_{p+1\times 1}}{\begin{pmatrix} \beta_0 \\ \beta_1 \\ \vdots \\ \beta_p \end{pmatrix}} + \underset{\varepsilon_{n\times 1}}{\begin{pmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_n \end{pmatrix}}$$

Then (1) $Y = X\beta + \varepsilon$

(2) expected value of Y, $\hat{Y} = Xb$ where $b = \begin{pmatrix} b_0 \\ b_1 \\ \vdots \\ b_p \end{pmatrix}$

Appendix 13: Linear regression relationship among variables

The general linear regression relationship is

$$Y = f(X_i) \quad \text{for} \quad i = 1 \text{ to } p\text{-}1$$

I) Customer Behavioural Intention Block

$X_2 = f_1(X_4)$
$X_3 = f_2(X_4)$
$X_{23} = f_3(X_4)$
$X_2 = f_4(X_{23})$
$X_3 = f_5(X_{23})$

II) Value Block

$X_4 = f_6(X_5, X_1, X_6)$

III) Service Quality Block

$X_1 = f_7(X_7, X_8, X_9, X_{10}, X_{11}, X_{12})$

IV) Service Dimension Block

$X_7 = f_8$ (service features a to g)
$X_8 = f_9$ (service features h to o)
$X_9 = f_{10}$ (service features p to v)
$X_{10} = f_{11}$ (service features w to ad)
$X_{11} = f_{12}$ (service features ae to an)
$X_{12} = f_{13}$ (service features ao to au)

Appendix 14: Performance Improvement Priorities for different Customer Segments

	Service Dimension & Service Feature	High Rev	Low Rev	Heavy Weight	Non-Heavy Weight	At-Risk	No. Count	Suggested for Company-wide PIP
X_7	Account Servicing & Sales							
	a) Frequency of visits & contacts	✓	✓	✓	✓	✓	5	✓
	b) Ease of contracting representatives	✓					1	
	c) Helpfulness in resolving problems	✓		✓		✓	3	
	d) Provide tailor-made services	✓		✓		✓	3	
	e) Speed in responding	✓	✓	✓	✓		4	✓
	f) Provide latest information	✓		✓			2	
	g) Accuracy of information	✓	✓	✓	✓	✓	5	✓
X_8	Account Management & Billing							
	h) Length of time for payment					✓	1	
X_9	Outbound Delivery Services							
	s) Shipment arrives in good shape	✓					1	
	t) On-time delivery	✓		✓			2	
	u) Flexibility of pick-up times	✓			✓		2	
X_{10}	Courier Services							
	w) Friendliness, courtesy & professionalism	✓	✓ ✓	✓	✓	✓ ✓	5 2	✓
	z) Willingness to wait or come back	✓					1	
	ab) Reliability of pick-up	✓					1	
	ac) Notification of delay	✓	✓		✓	✓	4	✓
	ad) Care in handling shipments							
X_{11}	Customer Services Department							
	af) Friendliness of service agents		✓	✓			2	
	ak) Meet special requests		✓	✓			2	
	am) Knowledge of rates and schedules	✓		✓			2	
	an) Timeliness of tracking information		✓	✓	✓		3	
X_{12}	Service Recovery							
	ao) Notification of lost shipment		✓		✓	✓	3	
	as) Provide reasonable explanations		✓		✓	✓	3	
	at) Provide fair compensation					✓	1	
	au) Time to investigate lost shipment	✓	✓		✓	✓	4	✓