DEVELOPING A GENERIC SERVICE CAPACITY MODEL FOR HEALTH CARE SERVICES

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ABSTARCT

The services sector plays a major role in the economic growth of a country and this sector's growth is a global trend. The main focus of any service industry is to meet the demands of its customers that require a well-managed capacity. Healthcare services are one of the most demanded services in the world. An efficient and good quality healthcare system results in customer satisfaction by "providing best service in as less time as possible". Fauji Foundation Hospital (FFH), Rawalpindi is the biggest and the only tertiary care hospital of the Fauji Group of 600 beds. The beneficiaries of Fauji Foundation come to this hospital for major treatments. The female medical ward is taken as a case study for this research as it is the largest ward in terms of capacity at FFH with 132 beds in indoor patient ward and outdoor patient ward which operates 7 days a week.

The female medical ward faces high demands in terms of incoming patients. Over the years, the performance of the ward has remained stagnant and has caused lags in the provision of service. This research was carried out to identify the reasons of lags in provision of service and recommending methods to improve the system by developing a capacity management model that gives tangible results to tackle the problem.

FFH is the only welfare tertiary care hospital for ex-servicemen making it its greatest strength along with its location, which makes it easily accessible to a huge population. The inconsistency in provision of healthcare, under and over utilization of employees, no tracking system of employees, lack of capacity management techniques, under trained staff and no means to chose between alternatives for better improvisation of operations are the major areas of concern.

The research has followed various qualitative and quantitative means to develop a model that highlights the problems and gives tangible results that can improve the over all system. The research found that the capacity at female medical ward can be managed / build on by scheduling the doctor / staff duties, using past data to analyze and recommend minimum number of beds that should be in place to meet demands, proper utilization of space, staff and technology, helping employees understand the strategy and goals of the organization, reducing the frequent management changes, reducing communication gap, establishing patient information desks and choosing between alternatives based on actual research than by intuition can improve provision of healthcare and increase productivity.

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All praises and thanks are attributed to "**The Almighty ALLAH"** the compassionate; the merciful, the source of all knowledge and wisdom, who gave me enough strength and knowledge to understand things better and enabled me to complete this project successfully.

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CHAPTER 1
INTRODUCTION

1.1 Background

Service sector plays an important role in the economic development of a country. This can be seen in an increased ratio of the service sector in GDP in the modern economies. A cross-country comparison shows share of services sector in GDP is currently about 75 **percent** in developed countries[1]. As a result of which research is being attracted to the management of this field.

In today's ever changing global environment staying competitive is getting more and more difficult. In this present era, innovations, features and aesthetic values of the products are what a customer demands but how it reaches the customer is of utmost importance in other words that is where service comes in. One of the most important issues related to staying competitive in market for any service industry is "**Capacity Management**". Capacity of any industry is an amalgam of meeting customer demands and cost efficiency of operations[2]. Over the years the issue of providing the customers with the best possible service and that too in time has led to increasing importance of capacity management. In services sector the aim is to increase the service capacity but not allowing the cost of operation to increase. Hence, in all service sectors be it hotels, restaurants or hospitals the concept of having enough capacity to cater for all customers has become the single most important demand so as to provide a competitive edge, generate better revenues and build customer base.

Healthcare services are a major contributor to the service industry. The global health economy is growing faster than gross domestic product (GDP), having increased its share from **8%** to **8.6%** of the world's GDP between 2000 and 2005 [3]. A quality healthcare system contributes to a country's growth by improving the health of the population it serves, responding to people's expectations and providing financial protection against the cost of ill health[4]. It also contributes to economic growth by creating economic opportunities.

A well-developed services infrastructure that has an efficient healthcare system plays a key role in the economic growth of any country. Pakistan has one of the largest public sector owned service delivery infrastructure in the world. The country has a reasonable availability of physical facilities in the Health Sector and has an extensive and varied healthcare system. Efficient provision and management of healthcare

services is a need of time [5], as it will decrease the operational cost and will help in lowering the cost if living and improving the standard of living[6]. The health sector comes under the umbrella of social, personal and community services, which has shown a growth of **78%** since 2000 according to the Federal Bureau of Statistics, Pakistan. The government is spending **0.75 percent** of GDP in this sector [7].

Healthcare services in Pakistan are highly demanded and public sector is need of great improvements. Fauji Foundation (FF) is the welfare organization for the welfare of ex-servicemen and the families in Pakistan. The organization's basic aim is healthcare, education, educational stipends, technical and vocational training. However, it also contains number of business units, which fund the welfare services.

The FF healthcare system has 118 projects, 11 of which are hospitals. The Head Office is located at Rawalpindi. The only tertiary care hospital is Fauji Foundation Hospital, Rawalpindi that is a 600-bed hospital. To facilitate its patients it also has secondary and primary healthcare units all over Pakistan.

1.2 Problem Statement

Globalization is putting the social cohesion of many countries under stress, and health systems, as key constituents of the architecture of contemporary societies, are clearly not performing as well as they could and as they should. People are increasingly impatient with the inability of health services to deliver levels of national coverage that meet stated demands and changing needs, and with their failure to provide services in ways that correspond to their expectations.

Fauji Foundation Hospital (FFH) is the only tertiary care welfare hospital of its kind in Pakistan. Established in 1959 it has developed into one of the busiest hospitals in the country. FFH is a 600-bed hospital and extends its services to all the ex-servicemen and their families, which means a huge patient base. The hospital has improved a great deal, however, over the years, the gap in demand and supply has increased a great deal. This has resulted in deteriorated business, declined profits and customer dissatisfaction. The reason for this is lack of application of capacity management techniques.

Female Medical Ward, FFH is the largest ward at FFH. Hence, it is taken as a case study to evaluate the capacity problems occurring in Human Resource, Technology and Infrastructure etc.

This research is being carried out with a view to identify the reasons of capacity lags and recommending methods to not only improve the performance of FFH but also help it in planning for future needs before hand.

1.3 Service, Capacity and Capacity Planning

Before discussing the objectives of research it is important to understand what services and capacity are.

1.3.1 Service

Grönroos (2001) [8] describes three main characteristics that the service has:

1. Services are *processes* consisting of *activities* or a *series of activities* rather than things.
2. Services are at least to some extent *produced and consumed simultaneously*.
3. The customer *participates in the service production process* at least to some extent.

According to Fitzsimmons and Fitzsimmons, (2000)[9] a service is a time-perishable, intangible experience performed for a customer acting in the role of co-producer.

There are different capacity strategies, as discussed later on, available to the service managers but when we look at the reality we find that, there seems to be a divergence between what companies should do, according to academic literature, and what they are actually doing. In the case of industrial services the capacity of a firm has been defined as 'the highest quantity of output possible in a given time period with a predefined level of staffing facilities and equipment' (Lovelock, 1992)[10].

1.3.2 Capacity and Capacity Planning

According to Krajewski and Ritzman (2005) [11], capacity is the maximum rate of output for a process. No single measure of capacity however, is applicable to all situations. Generally, capacity can be expressed in one of two ways:

1. ***Input Measures***: Usual choice for low-volume, flexible processes.
2. ***Output Measures***: Usual choice for high-volume processes that produce only one type of product.

Capacity planning on the other hand is a long-term strategic decision that establishes a firm's overall level of resources (Russell and Taylor 2003) [12]. It is spread over a time horizon that is long enough (usually more than a year) to obtain the requirements and then resources to build capacity.

Capacity decisions affect operating costs, firm's ability to compete, customer responsiveness and product lead times. Both excess and inadequate capacities drain resources, prevent investments, lose customers and limit growth. So, when to increase capacity and how much to increase it are critical decisions. Three basic strategies for the timing of capacity expansion in relation to a steady growth in demand are:

1. ***Capacity Lead Strategy.*** Capacity is expanded in anticipation of demand growth. This aggressive method is used so as to lure customers from competitors who are capacity constrained to gain a foothold in the expanding market
2. ***Capacity Lag Strategy.*** Capacity is increased in response to a documented increase in demand. This conservative results in higher return on investment but loss of customers. However, according to this method once the capacity is expanded the customers will return.
3. ***Average Capacity Strategy.*** Capacity is expanded to coincide with average expected demand. This moderate method allows managers to be certain that a small portion of additional output will be sold at least.

1.4 Objectives of the Research

The main purpose of this research study is to use and validate the capacity management and capacity-building techniques for hospitals services via qualitative and quantitative analysis to determine reasons for capacity lags.

1.4.1 Research Aim

The main aim of this research is to develop a generic model for capacity management in health-care services to provide means of planning for future needs and highlight the areas that need improvement in terms of quality of service.

1.4.2 Research Objectives

The main objectives of this research study are as follows:

- To study the existing models and techniques of capacity building.
- To collect and document the data of healthcare services from different ministries and organizations in Pakistan.
- To collect and document the data related to Female Medical Ward, Fauji Foundation Hospital (FFH).
- To conduct the organizational, human resource analysis of Female Medical Ward and FFH.

- To study the existing systems of capacity planning at hospitals via surveys.
- To carry out the 7S analysis of (FFH).
- To develop a generic service capacity model for health-care services.
- To recommend the methods and changes that need to be done to improve and manage capacity at Female Medical Ward, FFH.

1.5 Research Methodology

A logical research methodology was adopted as is shown in Figure 1.1, and described as follows:

- Carry out an exhaustive literature study in order to develop relevant knowledge database of Service and Capacity Management.
- Literature review of tools available to analyze service industry.
- Review the literature in order to analyze the implementation successes of capacity management techniques (Monte Carlo Simulation).
- The study of national health policies, ministry of health's plan's, Medium Term Development Framework (2005-2010), service industry's share in GDP, structure of health care system and tabulate health facts about Pakistan.
- Analysis of capacity building models and their comparison.
- Carrying out surveys to get idea of how capacity is managed at FFH and take input(s).
- Collection of data from Female medical ward (FFH) and Fauji Foundation (FF) Headquarters.
- Analyze the data via organizational, HR, 7S, quantitative (simulations) and qualitative (surveys and interviews) analysis.
- Standardize the simulation processes to achieve steady state results.
- Develop generic model for capacity building for FFH.
- Recommendations at national level for the health care services and recommendations for the female medical ward, FFH
- Document the work as thesis.

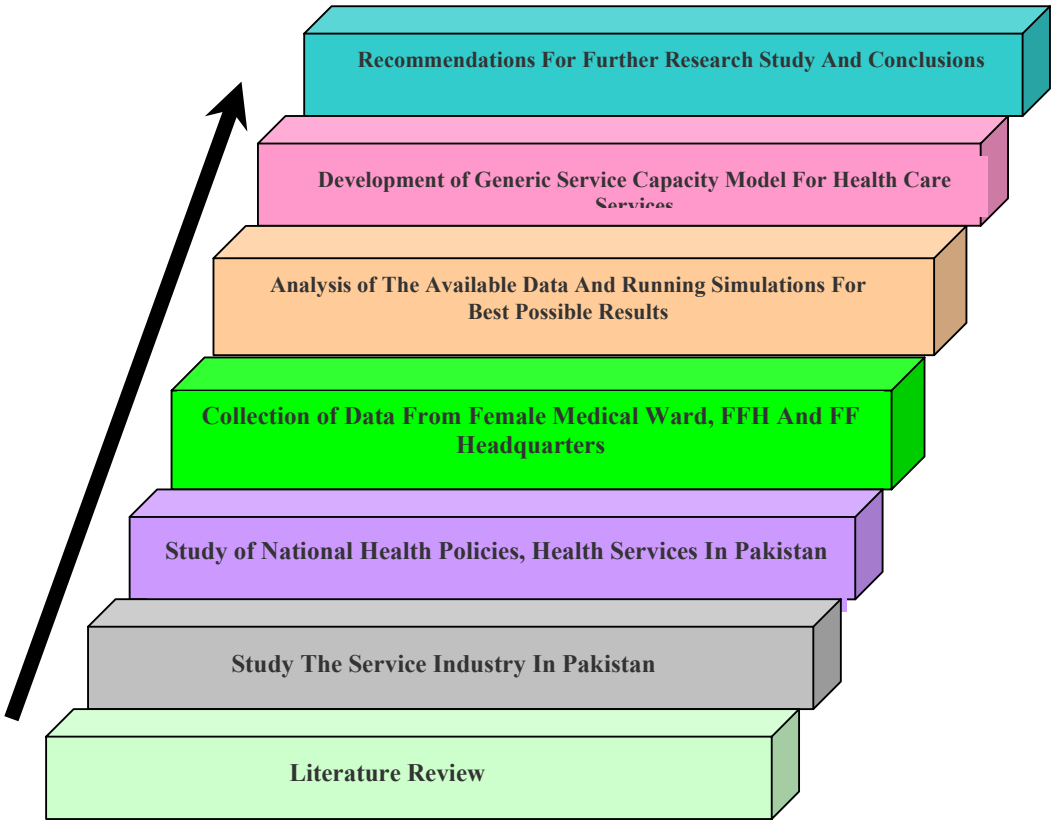

Figure 1.1. The Research Methodology

1.6 Techniques for Capacity Planning / Management

Several quantitative capacity planning / management techniques are available each useful in different situations. These involve trending, linear trend analysis, analytical modeling and simulation modeling.

1.6.1 Trending

Trending uses simple extrapolation of resource utilization over time. The advantage of this technique is that it does not require sophisticated tools. A spreadsheet will do, but it can be difficult to take into account non-linear behavior buried deep within a multi-tiered system.

1.6.2 Linear Trend Analysis

This technique looks at historical data and projects a linear trend line, applying upper and lower confidence intervals as well as a threshold at which resources will become inadequate. This capacity planning method is a quick sanity check and identifies over-utilized resources, but it does not allow for experimentation with different configurations.

1.6.3 Analytic Modeling

It calculates how a queuing network will perform. A model is built based on a description of the system. Hypothetical changes can be made to system configuration or business workloads, and the model will predict how the changes will affect performance. Done properly, analytic modeling is a fast and accurate capacity-planning technique.

1.6.4 Simulation Modeling

This is a much more sophisticated capacity planning technique than trending, simulates the queuing events that occur during execution. The downside of simulation modeling is that it can be time-consuming to build and run the models. However, simulation modeling is a much better technique as it can replicate real-world problem situations, which can be analyzed via various computer software.

1.6.4.1 Selection of Simulation Modeling

Many researchers around the globe have preferred simulation modeling to other techniques. Albright[13] provides a chapter on simulation models. The importance of the variation of output to various inputs in the organizational environment is analyzed, highlighting sensitivity analysis. A global perspective on simulation, and a real-life example is also asserted where simulation was used to obtain useful results. The

random generation of numbers in MS Excel, the lookup tables and special formulae is also used.

Law and Kelton[14] overhaul the simulation process from start to finish. This is a very comprehensive treatment of simulation, and covers all facets of simulation modeling and analysis. Of particular interest is the section on the credibility of simulation models, which includes the steps of validating and verifying simulation models. Input probability distributions and output monitoring is also covered extensively, and all the different distribution types used in simulation are explained.

Mjema[15] discusses the analysis of personnel capacity requirements in the maintenance department by using a simulation method. The paper focuses on increasing throughput in a maintenance department by using the SIMPLE++ simulation software package. Appropriate staff complement is the main focus, and this is achieved by implementing cross-functionality of staff. Uncertain variables that are unique to such an environment are examined, and these variables are incorporated into the various simulation runs.

Christer and Al-Zubaidi[16] present a study on the determination of the appropriate manpower requirements in the maintenance department of a modern hospital (the Withington Hospital in Manchester, England). Utilizing the terminating theory of simulation presented by Law and Kelton [14], they simulate various policies under consideration by management, and present the input-transformation-output simulation by using **E**xtended **C**ontrol **a**nd **S**imulation **L**anguage (ECSLPLUS). The model also incorporates sickness and holidays, and takes into account all types of maintenance jobs occurring in the hospital – i.e. electrical, mechanical, plumbing, and joinery. A discussion of the results addresses the critical number of maintenance staff versus the actual number of maintenance staff.

Duffuaa[17] provide valuable insight into the field of maintenance systems. They list all the activities performed by a typical maintenance department, and concede that simulation modeling in this area of study is lacking. The main features of a maintenance system are discussed, and the maintenance process is graphically depicted. They then build a generic conceptual model for maintenance systems as the first phase in the construction of a simulation model. They demonstrate the application of the conceptual model by using modules, and an explanation of each module is provided.

In this research we will however use Monte Carlo Simulation to quantitatively analyze the capacity related issues. The results will be used as a building block along with other qualitative analysis results in developing a service capacity model.

1.7 Monte Carlo Simulation

The term Monte Carlo is synonymous with probabilistic simulation. Russell and Taylor [18] define Monte Carlo technique as 'A method of selecting numbers randomly from probability distribution for use in a computer run simulation'.

In large and complex systems, it is often difficult to analyze the systems using analytical methods because of the often-stochastic nature of the business environment. In these cases running simulation models over time can provide useful output data to determine the optimal policy or action for the organization to implement. A clearly defined simulation model has the advantage of being easily understood by anyone who decides to use it. Analytical models invariably require a multitude of assumptions, whereas simulation is a simpler approach that can deliver clear results. These results can then be analyzed statistically, to the ultimate benefit of the organization.

Stochastic simulation implies the sampling of stochastic variables from their different distributions. It is worth noting that not all the inputs to the simulation model maybe of a stochastic nature, but that at least one of the inputs must be of a defined distribution type.

A number of simulation methodologies are available to study different types of systems. Monte Carlo Simulation (MCS) is typically used to study stochastic systems (some system variables are random) that are static – i.e. evolution of the system over time is not important. Monte Carlo Simulation was chosen to study the hospital services, since it is simpler to use and the purpose of the simulation was to obtain certain output variables like the minimum number of beds required to handle patients over a week.

The Monte Carlo Simulation technique involves the generation of input variables by using a random number generator. This generator will provide the input variable in accordance with its real-life probability distribution, enabling the simulation to provide the most accurate solution for the system under scrutiny.

1.7.1 Application of Monte Carlo Technique to Similar Problems

The Monte Carlo technique is selected as it has been employed by many researchers to manage capacity in healthcare services. A few researches done on similar problems are listed below.

- E.J Rising, R. Baron and B. Averill, "A System Analysis of a University Healthcare Service Outpatient Clinic", Operations Research 21. No. 5 (Sep – Oct 1973) 1030 – 47.
- Robinson, L. W. and R. R. Chen (2001), "Scheduling Doctors' Appointments: Optimal and Empirically - Based Heuristic Policies," Unpublished working paper. Johnson Graduate School of Management, Cornell University, Ithaca, New York.
- Bailey, N. (1952), "A Study of Queues and Appointment Systems in Hospital Outpatient Departments with Special Reference to Waiting Times," Journal of the Royal Statistical Society.
- Xiaolan Xie, Ecole des Mines de Saint Etienne, “A Monte Carlo Optimization Method for Operating Rooms Planning with Elective and Emergency Surgery Demands”.
- Lawrence Pixely, Stroud-Water Associates, “Hospital Risk Management using Monte Carlo Simulation”.
- Cayirli, Tugba, Veral, Emre, “Outpatient Scheduling In Health Care: A Review Of Literature”.

1.8 Significance of Research

The most important aim of any service industry is to fulfill the demands of its customers and achieve customer satisfaction. In order to entertain its customers at all times the service organization needs to maintain enough capacity to avoid any demand lags. Hence, managing capacity is of great importance. Healthcare services all across the globe and in Pakistan too are often faced with the problem of capacity lags. This problem needs to be solved by careful analysis of what causes this lag and how can the capacity is managed and build.

The FFH is the only tertiary care hospital of its kind that comes under the umbrella of Fauji Foundation. It caters for all the ex-servicemen and their families and is hence facing reduced capacity. This research work will help the organization improve its

capacity by efficiently utilizing present resources and planning for the future needs via the developed model.

The idea is to identify the problematic areas and apply simulation techniques along with basic analysis via surveys to develop a service capacity model for Female medical ward, FFH. This will help the management in knowing what to expect in near future and areas that need consideration so as to improve present capacity and ultimately quality.

1.9 Structure of Thesis

The thesis consists of eight chapters in all. A brief description of it is given below:

Chapter one covers the background, structure of thesis, problem statement, objectives and the significance of the study.

In **Chapter two** brief introductions to some basic issues related to the service industry are presented. Further more service industry in Pakistan and healthcare services are specifically discussed.

Chapter three discusses the capacity management issues and how they should be dealt with in the service industry from the available literature.

Chapter four reviews the four sample models chosen for research reference.

In **Chapter five** the introduction to the organization that is Fauji Foundation, its assets, the core lines of its business, resources, details of its welfare services and strategic directions are discussed.

Chapter six covers the analysis of the Female Medical Ward, FFH, organizational, human resource, 7S analysis along with the qualitative and quantitative analysis of capacity determining resources such as labor, infrastructure, technology et. to deduce results so as to develop a model for managing capacity.

Chapter seven compares the model developed in this research to the four sample models studied depending upon some 14 aspects that are essential in developing any service capacity model via research.

In **Chapter eight** the solution to the problems and recommendations for improving the service capacity at the under subject organization are given along with discussing some areas for possible future research.

CHAPTER 2

LITERATURE REVIEW OF SERVICE INDUSTRY IN PAKISTAN

2.1 Introduction

This chapter is intended to provide the reader with a basic understanding and underlying objectives of the work. Some very basic concepts have been given below related to the service industry in general and in Pakistan before exploring the capacity management issues in detail in later chapters.

Services lie at the very hub of economic activity in any society. Writing about the role of service sector in world development Dorothy Riddle formulated the economic model shown in Figure 2.1 below, (After Dorothy in Fitzsimmons and Fitzsimmons, 2000)[9]. This model shows the flow of activity among the three principal sectors of economy: extractive (mining and farming), manufacturing, and service, which are divided into five subgroups. All activity eventually leads to the consumer.

Examples of services in each of the five subgroups are (Fitzsimmons and Fitzsimmons, 2000)[9]:

1. *Business services*: Consulting, finance, banking.
2. *Trade services*: Retailing, maintenance, repairs.
3. *Infrastructure services*: Communications, transportation.
4. *Social/personal services*: Restaurants, healthcare.
5. *Public administration*: Education, government.

In an industrialized economy, specialized firms can supply business services to manufacturing firms more cheaply and efficiently than manufacturing firms can supply these services for themselves. Thus, more and more often we find advertising, consulting, financing, testing, and other business functions being provided for the manufacturing sector by service firms.

Many definitions of service are available but all contain a common theme of intangibility and simultaneous consumption. But a precise definition of goods and services should distinguish them on the basis of their attributes. “A good is a tangible physical object or product that can be created and transferred; it has an existence over time and thus can be created and used later. A service is intangible and perishable. It is an occurrence or process that is created and used simultaneously or nearly simultaneously. While the consumer cannot retain the actual service after it is produced, the effect of the service can be retained” (Sasser et al., 1978)[19].

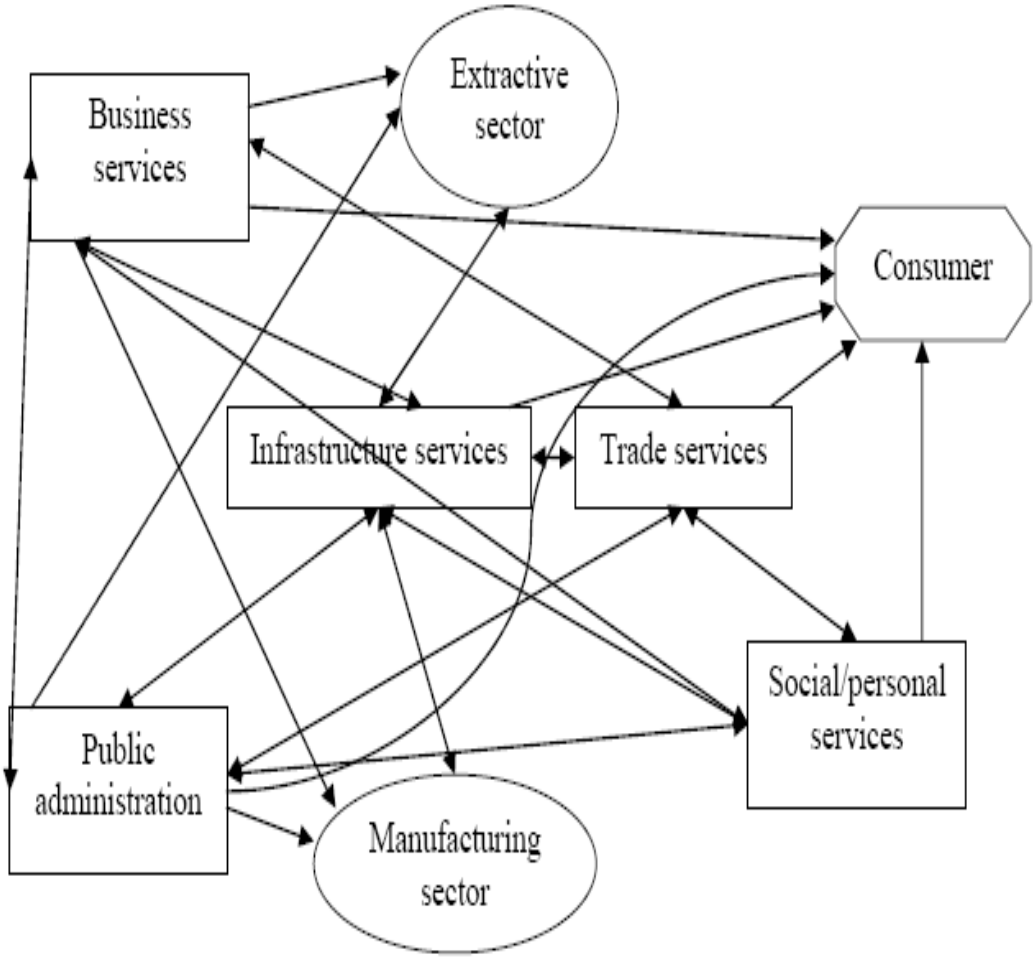

Figure 2.1. Interactive Model of Economy

Source: Riddle 1986, p.27. in Fitzsimmons and Fitzsimmons, 2000

The service environment is sufficiently unique that allows the question of direct application of traditional manufacturing based techniques to services without some modification, although many approaches are analogous. Ignoring the differences between manufacturing and service requirement leads to failure, but more importantly; recognition of the special features of services provides insights for enlightened and innovative management.

In today's world the distinction between a *product* and *service* is difficult to make, because the purchase of a product is accompanied by some facilitating service (e.g., installation) and the purchase of a service often includes facilitating goods (e.g., food at a restaurant). In short, each purchase includes a bundle of goods and services in varying proportions, as shown in Table 2.1.

2.2 Service classification

As suggested by the literature the concepts of service management should be applicable to all service organizations. For example, hospital administrators could learn something about their own business from the restaurant and hotel trade things such as house keeping. To help demonstrate that management problems are common across service industries, Roger Schmenner[20] proposed the *service process matrix* in Figure 2.2 below:

In this matrix services are classified in two dimensions that significantly affect the character of service delivery process. The vertical dimension measures the degree of labor intensity, which is defined as the ratio of labor cost to capital cost. Thus, capital-intensive services such as airlines and hospitals are found in the upper row because of their considerable investment in plant and equipment relative to labor costs. Labor-intensive services such as schools and legal assistance are found in the bottom row because their labor costs are high relative to their capital requirements.

The horizontal dimension measures the degree of customer interaction and customization, which is a marketing variable that describes the ability of the customer to affect personally the nature of the service being delivered. Little interaction between customer and service provider is needed which the service is standardized rather than customized. For example, a meal at McDonald's, which is assembled from prepared items, is low in customization and served with little interaction occurring between the customer and the service providers. In contrast, a doctor and patient must interact fully in the diagnostic and treatment phases to achieve satisfactory results.

Table 2.1. Proportions of Goods and Services in a Typical Purchase Bundle

	Goods				Services		
100%	**75**	**50**	**25**	**0**	**25**	**50**	**75**
100%							
	……Self-service Gasoline……						
	……Personal Computer……						
	……Office Copier ……						
	…… Fast Food Restaurant ……						
	……Gourmet Restaurant ……						
	…… Auto Repair ……						
	…… Airline Flight ……						
	…… Haircut ……						

Source: Sasser (1978), Management of Service Operations, Text, Cases and Readings

	Low	**High**
Low	***Service factory:*** ➢ Airlines ➢ Trucking ➢ Hotels ➢ Resorts and recreation	***Service shop:*** ➢ Hospitals ➢ Auto repair ➢ Other repair services
High	***Mass service:*** ➢ Retailing ➢ Wholesaling ➢ Schools ➢ Retail aspects of commercial Banking	***Professional service:*** ➢ Physicians ➢ Lawyers ➢ Accountants ➢ Architects

Figure 2.2. The Service Process Matrix

Source: Schmenner (1986)

Patients also expect to be treated as individuals and wish to receive medical care that is customized to their particular needs. It is important to note, however, that the interaction resulting from high customization creates potential problems for management of the service delivery process.

The four quadrants of the service process matrix have been given names, as defined by the two dimensions, to describe the nature of the services illustrated. *Service factory* provide a standardized service with high capital investment, much like a line flow manufacturing plant. *Service shops* permit more service customization, but they do so in a high capital environment. Customers of a *mass service* will receive an undifferentiated service in a labor-intensive environment, but those seeking a *professional service* will be given individual attention by highly trained specialists.

According to Roger W. Schmenner [20] managers of services in any category, whether service factory, service shop, mass service, or professional service, share similar challenges, as noted in Figure 2.3 below. Services with high capital requirements (i.e., low labor intensity), such as airlines and hospitals, require close monitoring of technological advances to remain competitive. This high capital investment also requires managers to schedule demand to maintain utilization of the equipment. Alternatively, managers of highly labor-intensive services, such as medical or legal professionals, must concentrate on personnel matters. The degree of customization affects the ability to control the quality of service being delivered and the perception of the service by the customer.

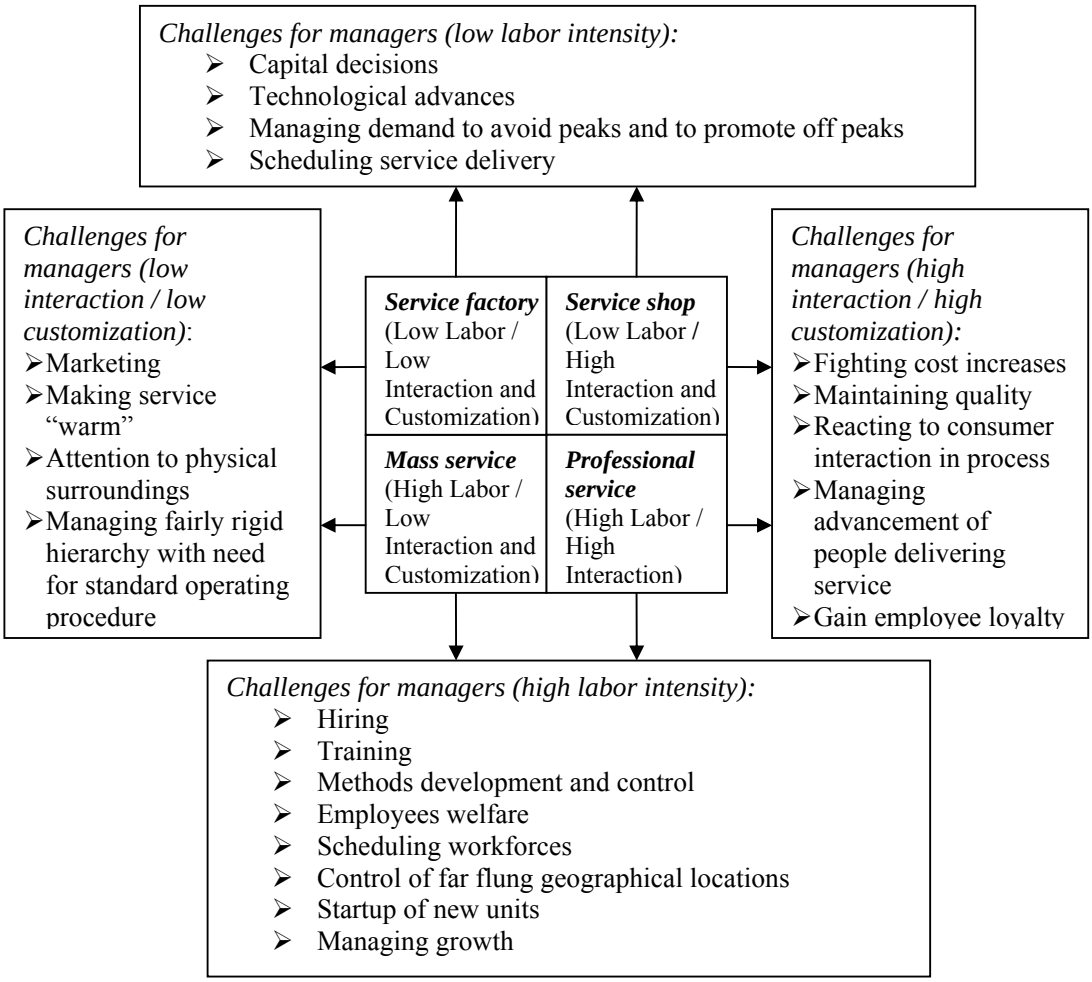

Figure 2.3. Challenges for Service Managers

Source: Schmenner (1986)

2.3 Characteristics of Service Operations

Some of the very distinctive characteristics of the service operations as described by Fitzsimmons and Fitzsimmons, (2000)[9] are listed below:

2.3.1 Customer Participation in the Service Process

The presence of customer as a participant in a service process requires an attention to facility design that is not found in traditional manufacturing operations. Physical surroundings of the service facility also require attention that is not necessary for the factory. Since service in an experience the quality of service is enhanced if the service facility is designed from the customers' perspective.

Thus it is always an important consideration in providing a service is the realization that the customer can play an active part in the process.

2.3.2 Simultaneity

One of the critical features in the management of services is that services are created and consumed simultaneously. Services cannot be inventoried for later use as in the case of manufactured goods.

Thus this issue also requires considerable attention of the service managers.

2.3.3 Perishability

A service is a perishable commodity. Since a service cannot be stored, it is lost forever when not used. The full utilization of the service becomes a management challenge, because customer demand exhibits considerable variation and building inventory to absorb these fluctuations is not an option.

Thus faced with variable demand and service perishabiltiy the manager has to take decisions that are best suitable according to the company's requirements and policy.

2.3.4 Heterogeneity

The combination of the intangible nature of services and the customer as a participant in the service delivery system results in variation of service from customer to customer. A customer expects to be treated fairly and to be given the same service that others receive.

Thus in such cases the development of standards and of employee training in proper procedures is the key to ensuring consistency in the service provided.

2.4 Service Industry In Pakistan

Pakistan is one of the emerging economies of the world. It has shown great economic growth due to dynamism in its industrial, agriculture and services sectors. A cross-country comparison shows share of services sector in GDP is currently about 75 percent in developed countries; within Asia, share of services in GDP was 65 percent in Singapore, followed by 54 percent in case of Sri Lanka, **53 percent** for **Pakistan**, 52 percent for India and 42 percent for Indonesia.[21] In Pakistan the services share in GDP has increased to **74 percent** in 2007-08[22].

The services sector alone has continued to perform strongly and has averaged growth of over 8% per annum since 2000[23].

Transport, storage, communications, finance, and insurance account for 24% of this sector, and wholesale and retail trade about 30%. Pakistan is trying to promote the information industry and other modern service industries through incentives such as long-term tax holidays. The government is acutely conscious of the immense job growth opportunities in service sector and has launched aggressive privatization of telecommunications, utilities and banking despite union unrest.

Snapshot of the services sector

Number of services enterprises	2.65 million (80% of all enterprises)
Average employee size	less than 50 persons
Average sales	between PKR 60,000 and PKR 400,000
Contribution to GDP	53.3%
Construction	2.3%
Retail & Wholesale	19.1 %
Transport & Communication	10.3%
Finance & Insurance	5.6%
Other services	9.6%
GDP growth rate	over 8.7% annually since 2004
Employment generation	40% of skilled labour force (70% of employed)
Share in global exports	0.13% (US$3.34 billion)
Share of local exports	19.2% (PKR 200.7 billion)
FDI	US$2.6 billion during 2006-07

Source: Economic Survey of Pakistan, 2006-07

Figure 2.4 Snapshot of the Services Sector in Pakistan

Source: Economic Survey of Pakistan 2006 - 07

The services sector grew by 8.2% in 2007-08 as against 7.6% growth the previous year[24]. The finance and insurance sector remained the major driver of growth, while better performance in the wholesale and retail trade sectors also contributed.

The growth performance of the various economic sectors over time can be seen as shown in Table 2.2.

Finance and insurance sector displayed a stellar growth performance by posting a growth of 17.0 percent during 2007-08 that is higher than 15 percent growth of 2006-07[25]. Value added in the wholesale and retail trade is based on the margins taken by traders on the transaction of commodities traded in the wholesale and retail market. In 2007-08, the gross value added in wholesale and retail trade increased at 6.4 percent as compared to 5.4 percent in last year[25]. Value added in the transport, storage and communications sector is based primarily on the profits and losses of Pakistan Railways, Pakistan International Airlines and other airlines, Pakistan Post & Courier Services, Pak Telecom and motor vehicles of different kinds on the road. This sector sub-sector saw a deceleration in growth to 4.4 percent in 2007-08 as compared to 6.5 percent of last year[25].

Public administration and defense posted growth of 10.9 percent as compared to 9.1 percent in 2006-07, while ownership of dwellings remained constant at 3.5 percent and the social services sector improved its growth performance to 9.4 percent from 8.8 percent last year[26].

The construction sector continued its strong showing, partly helped by activity in the private housing market, spending on physical infrastructure, and reconstruction activities in earthquake affected areas.

Telecom, energy (oil, gas and power), financial services, trade, construction, chemicals, food and personal services were the major recipients of Foreign Direct Investment (FDI), accounting for almost 88% or US$3.7 billion[19]. The telecom sector was the single largest recipient of FDI with US$1.4 billion, followed by the financial services (US$871 million), energy sector (US$585 million), food services (US$492 million), wholesale and retail trade (US$133.9 million), construction (US$117.1 million), personal services (US$74.1 million) and cement (US$15.2 million)[19].

Table 2.2:Growth Performance of Parts of GNP (%growth at constant factor cost)

Economic group	1990s	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08
Commodity Producing Sector	**4.6**	**4.2**	**9.3**	**9.5**	**5.1**	**6.0**	**3.2**
1. Agriculture	4.4	4.1	2.4	6.5	6.3	3.7	1.5
- Major crops	3.5	6.8	1.7	17.7	-3.9	8.3	-3.0
- Minor crops	4.6	1.9	3.9	1.5	0.4	-1.3	4.9
- Livestock	6.4	2.6	2.9	2.3	15.8	2.8	3.8
- Fishing	3.6	3.4	2.0	0.6	20.8	0.4	11.0
- Forestry	-5.2	11.1	-3.2	-32.4	-1.1	-29.5	-8.5
2. Mining & Quarrying	2.7	6.6	15.6	10.0	4.6	3.1	4.9
3. Manufacturing	4.8	6.9	14.0	15.5	8.7	8.2	5.2
- Large scale	3.6	7.2	18.1	19.9	8.3	8.6	4.8
- Small scale*	7.8	6.3	-20.0	7.5	8.7	8.1	7.5
4. Construction	2.6	4.0	-10.7	18.6	10.2	17.9	15.2
5. Electricity & Gas Dist	7.4	-11.7	56.8	-5.7	-26.6	2.5	-14.7
Services Sector	**4.6**	**5.2**	**5.8**	**8.5**	**6.5**	**7.6**	**8.2**
6. Transport	5.1	4.3	3.5	3.4	4.0	6.5	4.4
7. Wholesale,Retail Trade	3.7	6.0	8.3	12.0	-2.4	5.4	6.4
8. Finance & Insurance	5.8	-1.3	9.0	30.8	42.9	15.0	17.0
9. Ownership of Dwelling	5.3	3.3	3.5	3.5	3.5	3.5	3.5
10. Public Admin & Def	2.8	7.7	3.2	0.6	10.1	9.1	10.9
11. Services	6.5	6.2	5.4	6.6	9.9	8.8	9.4
12. GDP	4.6	4.7	7.5	9.0	5.8	6.8	5.8
13. GNP	4.0	7.5	6.4	8.7	5.6	6.7	6.1

Source: Economic Survey of Pakistan, 2007-08

2.5 Services Sector Contribution to GDP Growth

Pakistan's economic growth is broad-based and is shared by all the major sectors of the economy. The contribution to economic growth is dominated by the services sector with almost three-fourth stake. Just over one-fourth contribution came from Commodity Producing Sector (CPS), which accounts for 46.8 percent of the GDP[28]. The contribution of CPS to GDP growth has declined to 26.6 percent from 42.4 percent last year[28]. The decline in contribution was caused primarily by a comparatively slower growth in manufacturing and major crops-led-agriculture sectors. Agriculture sector contributed only 0.3 percentage points or 5.6 percent to GDP growth in 2007-08 as against 0.8 percentage points or 12 percent contribution last year. The reliance on the agriculture sector has declined with the passage of time. The manufacturing sector contributed 1.0 percentage point or 17.7 percent to GDP growth as against 1.5 percentage points or 22.2 percent last year. Industry contributed 1.2 percentage points or 20.9 percent to this year's real GDP growth[28]. Commodity Producing Sectors has been overshadowed by another year of exceptional growth in the Services sector, which contributed 4.2 percentage points or 73.4 percent to overall growth this year[28]. It is encouraging to note that the contribution of wholesale and retail trade is increasing. It has contributed 18.7 percent or 1.1 percentage points to GDP growth in 2007-08[28]. Construction with many forward and backward linkages is also making impact on the economic growth. Less labor intensive sector such as finance and insurance has also contributed 18.7 percent or 1.0 percentage point to this year's growth[28].

Table 2.3. Sectoral Contribution to GDP Growth (% points at Constant Factor Cost)

Sector	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08
Agriculture	1.0	0.6	1.5	1.4	0.8	0.3
Industry	1.0	3.8	3.1	1.1	2.1	1.2
-Manufacturing	1.1	2.3	2.7	1.6	1.5	1.0
Services	**2.7**	**3.1**	**4.4**	**3.3**	**3.9**	**4.2**
GDP	4.7	7.5	9.0	5.8	6.8	5.8

Source: Economic Survey of Pakistan, 2007-08

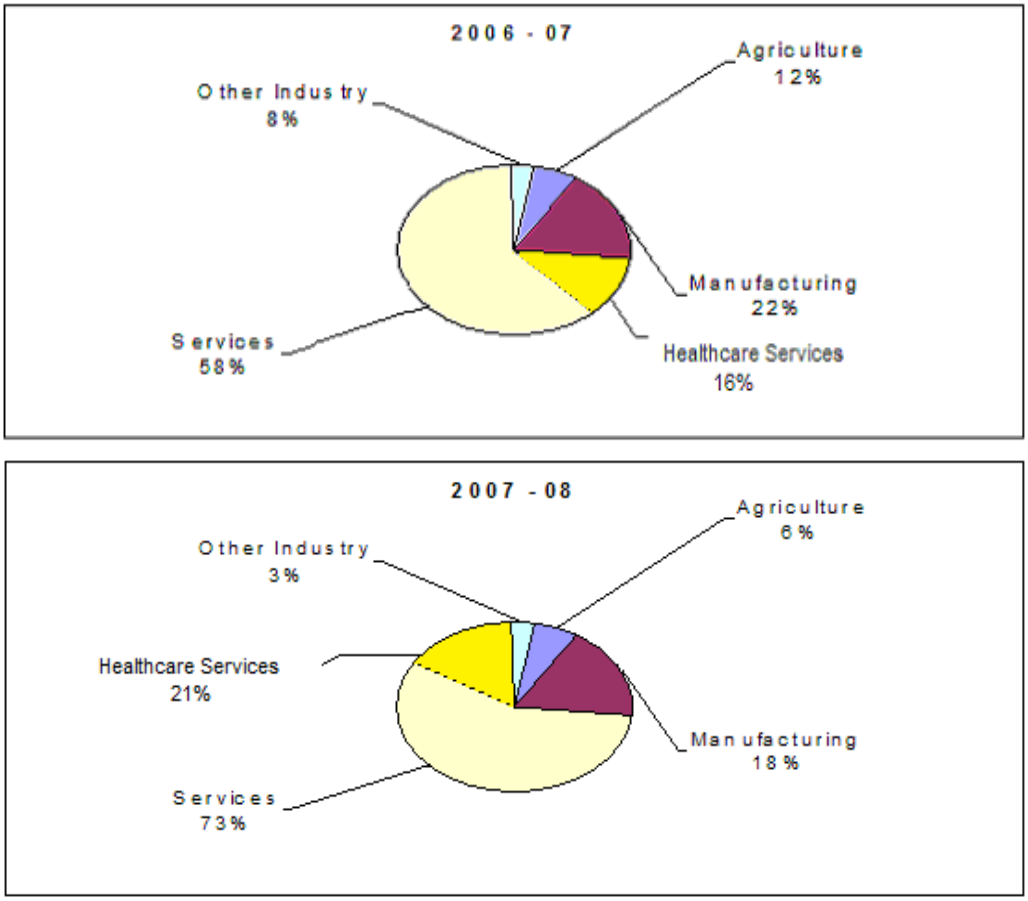

Figure 2.5.Contribution to the Real GDP Growth

Source: Economic Survey of Pakistan, 2007-08

2.6 Breakdown of Service Sectors

The service sectors in Pakistan can be divided into seven major groups. A brief description of them all is as follows:

2.6.1 Transport, Storage and Communication

Pakistan Telecommunication Company Ltd has emerged as a successful conglomerate with over $1 billion in sales in 2005[29]. Cell phone market has exploded fourteen fold since 2000 to reach a subscriber base of 91 million in 2009 in addition to 3.1 million fixed lines and 2.4 million wireless loop connections[30].As a result, Pakistan won the prestigious Government Leadership award of GSM Association in 2006[31].

In Pakistan, following are the top mobile phone operators:

1. Mobilink (Parent: Orascom, Pakistan/Egypt)
2. Ufone (Parent: PTCL/Etisalat, Pakistan/UAE)
3. Telenor (Parent: Telenor, Norway)
4. Warid (Parent: Dhabi Group, UAE}
5. Zong (Parent:China Mobile, China)

The cellular base in Pakistan is growing at around 14% per year and already the cellular customer has outpaced the fixed line customers. Telecom is by far the most attracted sector in terms of Foreign Direct investment coming in Pakistan.

Pakistan International Airlines, the flagship airline of Pakistan's civil aviation industry, has turnover exceeding $1 billion in 2005[32]. The government announced a new shipping policy in 2006 permitting banks and financial institutions to mortgage ships. A massive rehabilitation plan worth $1 billion over 5 years for Pakistan Railways has been announced by the government in 2005[33]. Private sector airlines in Pakistan include Airblue, Aeroasia and Shaheen Air International. Many private airlines are in pipeline including Air Mahreq, Dewan Air and Pearl Air.

The Federal Bureau of Statistics (FBS) registered this sector’s growth in 2005 as over 91% since 2000 and is currenlty values at Rs. 1.174,090 million.

2.6.2 Wholesale and Retail Trade

The Federal Bureau of Statistics (FBS) registered its growth in 2005 as over 96% since 2000 and is currently values at Rs. 1.760,491 million.

2.6.3 Finance and Insurance

A reduction in the fiscal deficit has resulted in less government borrowing in the domestic money market, lower interest rates, and an expansion in private sector

lending to businesses and consumers. Foreign exchange reserves continued to reach new levels in 2003, supported by robust export growth and steady worker remittances. Credit card market continued its strong growth with sales crossing the 1 million mark in mid-2005[34]. Since 2000 Pakistani banks have begun aggressive marketing of consumer finance to the emerging middle class, allowing for consumption boom (more than a 7-month waiting list for certain car models) as well as a construction bonanza.

The Federal Bureau of Statistics (FBS) registerd its growth as over 166% since 2000 and is currenlty values it at Rs. 582,620 million.

2.6.4 Ownership of Dwellings

The property sector has expanded twenty-threefold since 2001, particularly in metropolises like Lahore[35]. Nevertheless, the Karachi Chamber of Commerce and Industry estimated in late 2006 that the overall production of housing units in Pakistan has to be increased to 0.5 million units annually to address 6.1 million backlog of housing in Pakistan for meeting the housing shortfall in next 20 years. The report noted that the present housing stock is also rapidly ageing and an estimate suggests that more than 50 percent stock is over 50 years old. It is also estimated that 50 percent of the urban population now lives in slums and squatter settlements. The report said that meeting the backlog in housing, besides replacement of out-lived housing unit is beyond the financial resources of the government. This necessitates putting in place of framework to facilitate financing in the formal private sector and mobilize non-government resources for a market-based housing finance system[36].

The Federal Bureau of Statistics (FBS) registered its growth as over 49% since 2000 and currently values it at Rs. 235,838 million.

2.6.5 Public Administration and Defence

The Federal Bureau of Statistics (FBS) registered its growth as over 65 % since 2000 and currenlty values it at Rs. 577, 554 million.

2.6.6 Social, Community and Personal Services

The Federal Bureau of Statistics (FBS) registered it growth as over 78% since 2000 and currenlty values it at Rs. 923,324 million.

2.6.7 Electricity

The matter of balancing Pakistan's supply against the demand for electricity has remained a largely unresolved matter. Pakistan faces a significant challenge in

revamping its network responsible for the supply of electricity. While the government claims credit for overseeing a turnaround in the economy through a comprehensive recovery, it has just failed to oversee a similar improvement in the quality of the network for electricity supply. Some officials even go as far as claiming that the frequent power cuts across Pakistan today are indicative of an emerging prosperity as there is fast rising demand for electricity. And yet, the failure to meet the demand is indeed indicative of a challenge to that very prosperity

2.7 Services sub-sectors

A closer look on the composition of sub-sectors that contribute most to the services sector shows that retail trade, wholesale trade, research and educational consultancy services, restaurants and hotels, hospitals, financial, construction, and some business services, such as computer and information technology (IT) services, and professional services, such as engineering, legal and accounting services. IT and related services are the most significant in terms of scope and scale of export markets and the extent to which these services are currently being delivered. Professional services, such as legal and accounting, is a promising sector. While it is rare to find a Pakistani architectural firm with an office abroad, a handful of engineering companies have extended their presence outside Pakistan. Medical and health services are delivering primarily to foreign nationals in the domestic market.

The courier services sector stands out in terms of scale, and the Internet-related services sector distinguishes itself in terms of scope. Environmental services have significant exports in the area of environmental impact assessments. The banking sector is very prominent, while securities and asset management firms are also actively involved in international transactions mainly to solicit funds from foreign institutional and private investors. The insurance sector lags behind compared to the rest of the financial sector. Communications, distribution and transport services are significant in terms of scale of services traded but their supply is limited.

Table 2.4. Statistics by Economic Sector, 2008

Economic Sector	Median Employment	Median Sales(PKR)	Number of Firms	Total Sales (PKR)	Total Employment	Contrib. to Employment
Retail Trade	2	216,000	1,439,340	697,299,877,664	2,371,419	28.47%
Research Services & Institutions	2	72,000	311,545	43,919,690,727	1,360,015	16.33%
Personal & Household services	2	72,000	463,728	51,576,177,143	820,281	9.85%
Government (excl. Defense)	6	108,000	21,207	5,073,952,619	456,445	5.48%
Restaurants & Hotels	2	180,000	145,922	43,151,511,256	344,654	4.14%
Wholesale Trade	2	480,000	89,574	274,603,864,296	212,207	2.55%
Real Estate & Business services	2	180,000	49,926	22,838,542,584	130,828	1.57%
Communication	1	144,000	49,892	12,706,640,967	117,340	1.41%
Recreation & Cultural services	1	84,000	52,994	6,851,800,206	88,378	1.06%
Financial Instittions	6	720,000	8,252	33,248,144,612	69,445	0.83%
Transport Storage	3	288,000	12,151	10,517,242,726	54,047	0.65%
Manufacturing, Paper & Paper Production/ Printing & Publishing	3	300,000	10,735	19,554,739,689	42,169	0.51%
Water Works & Supplies	2	62,400	3,155	30,532,582	11,682	0.14%
Insurance	4	480,000	874	1,453,666,072	6,235	0.07%
Const., Rep & Maintenance Drainage, Hydraulics	2	108,000	965	285,074,354	2,486	0.03%
Building Construction	2	120,000	653	1,215,859,094	2,065	0.02%
Construction/Repair/Maintenance of Streets, Roading	2	360,000	288	58,037,651	529	0.01%
Electricity Gas & Water	6	22,800	30	1,246,032	421	0.01%
Financing, Insurance, Real Estate & Business Groups	5	108,000	102	1,863,900	387	0.00%
Community Social & Personal services	181	-	2	-	181	0.00%
Construction Repair, Maintenance of Railway P	3	204,000	10	2,089,050	27	0.00%
Construction Group	2	90,300	14	180,600	26	0.00%
Transport Storage & Communications	4	42,000	6	710,400	14	0.00%
Construction, Repair, Maintenance of Pipe Lines	3	480,000	1	480,000	3	0.00%
Construction, Repair, Maintenance of Sports Premises	2	-	5	-	3	0.00%

Source: Economic Census of Pakistan, Federal Bureau of Statistics (FBS) – tabulated by SMEDA

2.8 Health Services in Pakistan

Pakistan has a reasonable availability of physical facilities in the Health Sector. It has one of the best health care infrastructures in the developing world, but the delivery of service is poor because of several factors, one of which relates to the utilization and the institutional capacity of these facilities. Comparison of healthcare infrastructure amongst the South Asian countries is shown in Figure 2.6.

A snapshot of Pakistan's statistics is shown in Table 2.5.

2.8.1 Health Facts about Pakistan

Pakistan's government is spending a considerable amount on health care services. The expenditure breakdown can be seen in Table 2.6.

The level of health care services can be measured by assessing the health indicators like infant, maternal and under 5 mortality rate, fertility rate, population etc. A snapshot of some health indicators shedding some light in health services standards is shown in Table 2.7.

The health services delivery depends upon the availability of health facilities, Human resource, medical colleges etc. A brief detail of these is given in Table 2.8.

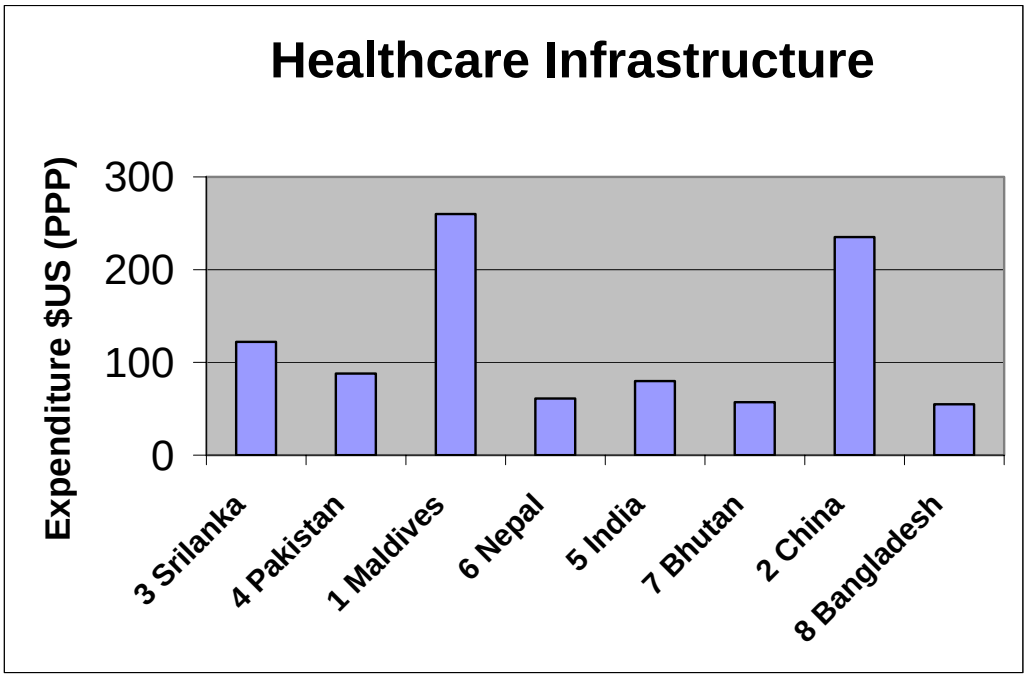

Figure 2.6. Healthcare Infrastructure Comparison of South Asian Countries

Source: South Asian Forum

Table 2.5. Snapshot of Pakistan's Health Statistics

Total population	160,943,000
Gross national income per capita (PPP international $)	2,410
Life expectancy at birth m/f (years)	62/63
Healthy life expectancy at birth m/f (years, 2003)	54/52
Probability of dying under five (per 1 000 live births)	97
Probability of dying between 15 and 60 years m/f (per 1000 population)	218/194
Total expenditure on health per capita (Intl $, 2006)	51
Total expenditure on health as % of GDP (2006)	2.0

Source: WHO Statistics 2008

Table 2.6: Expenditure on Health (2007-08)

Federal Government Expenditure on Health (2007-08)	
Development Expenditure	Rs. 14.272 billion
Current Expenditure	Rs. 3.791 billion

Source: Ministry of Health, Pakistan

Table 2.7: Health Indicators in Pakistan

Health Indicators	
Infant Mortality Rate (IMR) (per 1000 persons)	76.7
Maternal Mortality Rate (MMR) (per 100,000 live births)	350
Under –5 mortality rate (per 1000 persons)	101
Parasite Incidence of Malaria (per 1000 persons)	0.75
Incidence of TB (per 100,000 persons)	181
Fertility Rate (percentage)	4.1 (source: NIPS)
Contraceptive prevalence rate %	30 (source: NIPS)
Births attended by skilled persons %	19
Population growth rate	1.9
Total Population	159.06 million (sourceNIPS)

Table 2.8: Health Services Delivery

Health Services Delivery (2006-07)	
Total Health Facilities	13,937
Hospitals	965
Dispensaries	4,916
Basic Health Units (BHUs)	4,872
Rural Health Center (RHUs)	595
Maternal and Child Health Center (MCHs)	1,138
TB Centers	371
First Aid Points:	1,080
Beds in hospitals & dispensaries	105,005
Population per bed	1,515
Population to health facility ratio	11,413
Human Resource (Registered, 2007)	
Doctors	107,835
Doctors registered as specialists	19,623
Dentists	7446
Dental specialists	433

Nurses	43,646
Midwives	2,788
Lady Health Visitors (LHV)	3,864
Lady Health Workers (LHW)	95,000
Lady Health Supervisors (LHS)	3,385
Population per doctor	1,475
Population per dentist	21,362
Population per nurse	3,644
Academic Institutions (2007)	
Public sector: Medical colleges	23
Dental colleges	9
Private sector: Medical colleges	24
Dental colleges	12
Federally Administered Medical Facilities	
Hospitals	7
Dispensaries	39
TB clinic	1
MCH Centers	4
RHCs	3
BHUs	14
Reported data for 09 hospitals and dispensaries (2006-07)	
Patients treated in OPD	4,637,970
Patients operated	74,444
Patients attended in emergency	922,037

Source: Ministry of Health, Pakistan

2.8.2 Public Health Services

The Public Health delivery system in Pakistan has 4 major components[1]. They are:

1. Outreach and community-based activities, which focus on immunization, malaria control, maternal and child health and family planning, and the LHWs program
2. Primary care facilities, mainly for outpatient care
3. Tehsil and district headquarters hospitals for basic inpatient as well as outpatient care
4. Tertiary care hospitals located in the major cities, and in case of medical colleges teaching hospitals for more specialized care.

Primary care facilities basic health units/sub health centers (BHUs/SHCs) and rural health centers (RHCs) are mostly managed by a medical officer, except for maternity and child health centers, which are managed by a lady health visitor (LHV). Dispensers generally run dispensaries

2.8.3 Federal Level

Although health is a provincial subject but diseases (particularly communicable diseases) cross-geographical boundaries and therefore, Federal Government has the responsibility to design a National Health Policy to provide certain parameters to maintain a uniform standard of health status in line with the international standards. In light of the same, Federal Government provides sufficient support for prevention and control of communicable diseases like Malaria, TB, HIV/AIDS, Hepatitis, six fatal diseases of children under EPI, diarrheal diseases and other gastro-intestinal diseases.

The Federal Government has to keep caution on the epidemics and other health issues of emergent nature arising anywhere in the country. So, it not only coordinates health activities of the provincial Health Departments but also keeps close cooperation with the international agencies like WHO, UNICEF, JICA, USAID, DFID, World Bank, Asian Development Bank etc.[37].

2.8.4 Provincial Level

There is a vast network of Health Care Facilities under the control of Provincial Health Departments, which include 965 hospitals, 4916 Dispensaries, 4872 Basic Health Units and Sub-health Centers, 1138 Mother and Child Health Centers, 595 Rural Health Centers and 371 TB Centers run by the provincial governments[37].

2.8.5 District Level

Each district has established District Health Committees and Village Health Committees to oversee the health care services at all levels, in their respective areas. The district health system needs to be strengthened through provision of financial and technical assistance to provide quality health care to the communities. The ability of the district government to actively manage and develop the health facilities is crucial for public health.

The key element is to strengthen District Health Systems in all the districts. This involves transferring all recruitment, financial and management functions to district authorities. It also involves integrating curative and preventive services and placing them under common management. With the establishment of the post of the Executive District Officer Health, all the required steps in this regard are gradually being implemented now.

2.8.6 Private Health Services

The Private Sector plays a major role in provision of health. In absolute terms, private sector is by far the most important provider of health services, accounting for up to 60% of total expenditures on health. The recently completed census on Private Sector Health Facilities (1989) shows some 42,700 private facilities out of which 69% are clinics and chemist shops, 27% medical stores, including 550 private hospitals. Pakistan has a large pharmaceutical industry with 33,000 registered drugs produced by over 343 licensed manufacturers. The existence of a large network of small chemists shops, estimated at 11,500, permits relatively high consumption of drugs[1]. In addition a large number of unregistered practitioners are also in the market. These heavily outnumber registered personnel including dispensers, nurses, midwives and LHVs. These establishments are located overwhelmingly in urban areas, and hence not accessible. Taking all establishments together, only 27% are in the rural areas[1].

The traditional system of medicine is still actively providing health care especially in rural areas. There are about 55000 Tabbibs with 31 Unani institutions awarding diploma and 3 universities awarding degree[37]. Nine hospitals in private sector are attached with teaching institutions. In addition there are 135 Homoeopathic teaching institutions in the private sector. Presently all Homeo colleges are awarding diploma while six Homoeopathic Colleges affiliated with different universities are awarding degree (BHMS)[37].

2.8.7 Human Resource Analysis

The current output of medical graduates both in public and private medical colleges is around 5,000 per annum. There are presently 107,835 doctors registered with the Pakistan Medical & Dental Council (PMDC) i.e. one doctor for 1475 persons, while the desired ratio is considered to be one doctor for 1000 population. On the basis of one doctor for 1000 population almost 170,000 doctors are required. The number of dental surgeons at 7446 makes for the ratio of one dental surgeon for 21,362 persons[38].

There is a big gap of manpower requirement mainly at First Level Care Facilities (FLCF's) i.e. BHUs and RHCs, especially of female staff. Despite higher female enrolment in medical colleges, they do not opt for rural services for obvious reasons of security and non-availability of civic amenities. Similarly, low number of female paramedics i.e. LHVs, Female Health Technicians, Community Midwife, Nurses etc. is also one of the main reasons for vacant positions of female paramedics in the BHUs, RHCs in rural areas.

There are almost 43,646 registered nurses and almost 83 schools of nursing, 92 schools of midwifery and 6 colleges of nursing in the country. Every year almost 5,000 nurses/midwives are awarded 3-years diploma[39]. During the course of the study nurses are provided stipend for living expenses.

There are almost 72,000 beds in health facilities in Public Sector. However, out of this number 17,000 beds are in rural health facilities and 55,000 beds are available in the hospitals in urban location[37]. Also, the nurse/bed ratio is 1:2.3 (According to WHO standards nurse/bed ratio should be 1:3) that is not in line with the international standards[21]. The status of nurses has recently been upgraded in the public sector facilities from BPS 14 to BPS 16 through a Federal Government notification. This serves as an incentive for the educated girls to join the nursing profession.

2.8.8 Future Plans for Health Care in Pakistan

The aim of any country's health ministry or related people is to make sure that the health care infrastructure is up to the standards and develop and implement strategies to protect people against dangerous diseases; promote public health; and upgrade curative care facilities.

For this purpose various policies have been for improving health care facilities and infrastructure like the National Health Policy etc. The federal government plays a

supportive and coordinative role in key areas like Communicable Disease Control Program, Maternal and Child Health services including Family Planning, Nutrition, Health Manpower development Health Systems Research, Control/Prevention and Treatment of cancer and other catastrophic diseases.

According to the **Medium Term Development Framework (2005-2010)** the vision is a healthy population with a sound health care system practicing healthy life style, in partnership with private sector including civil society, which is effective, efficient and responsive to the health needs of low socio-economic groups especially women in the reproductive age. It aims for future plans that will insure improvement in health care facilities[21]. These plans include:

1. Strengthening primary health care with back up support in rural areas
2. Establishing centers in neglected urban slums
3. Trainings and Re-trainings of medical staff
4. Establishment of health boards to improve hospital management
5. Implementing new strategies of DOTS/Roll back malaria for T.B./Malaria Control
6. Enhance Health Education through skill development of health staff in communication techniques at all levels
7. Vigorous following of plan for substance abuse by Narcotic Control Division

According to the **Millennium Development Goals (MDGs)** Pakistan has set some goals for the 21st century. These goals include:

1. Goal 1: Reduce child mortality
   Target: Reduction of infant mortality by three quarters, between 1990 and 2015.
2. Goal 2: Improve Maternal Health
   Target: Reduce by three-quarter, the maternal mortality ratio between 1990 and 2015.
3. Goal 3: Combat HIV/AIDS, malaria and other diseases
   Target: Have halted by 2015, control the spread of HIV/ AIDS by 2015 and begin to reverse
   Target: Control the incidence of Malaria and Tuberculosis by 2015.

Some other programs that will also be implemented according to MTDF include:

1. Health Manpower Development
2. National Acute Respiratory Infections (ARI) Control Program
3. Environmental Health
4. Health System Research
5. Basic Development Needs Program (BDN)
6. National Program of Family Planning and Primary Health Care for Maternal and Neo-Natal Health
7. Health Insurance and Employees Social Security
8. Public-Private Partnerships in Health

The aim of all these is to ensure that utilization of the health facilities will improve along with quality and affordability.

2.9 Issues Faced by the Services Sector

In services sector things happen on the spot. There are no pre-recorded events that can be corrected and refined later on. Hence issues related to services cannot be discussed in a static context, i.e. as a formal list of impediment, accessibilities and constraints.

Healthcare services just like many other service industries in Pakistan experiences demand and capacity lag. Certain issues are always coming in the way of provision of service and dealing with them is crucial for improving not only our healthcare system but also the rest of services sector.

To solve this problem, a series of focus group meetings were conducted by SMEDA[7]. Feedback received during these meetings threw interesting light on the issues of service delivery. These issues are reflected below.

2.9.1 Lack of standardization

Services are not standardized. Legislation protecting consumers is still at a very early stage and there are no strong traditions to support customers seeking recompense or damages from a services deliverer. International quality certifications are systems-based requiring a lot of documentation, besides being expensive. There is a need for a simple but effective mechanism, at the level of the sectoral or professional associations, to certify the quality of services and thereby ensure adherence to a consistent set of quality standards.

2.9.2 Free Entry and Unemployment

With rising unemployment, services businesses requiring a minimum level of skill, a small capital outlay and virtually no registration are an easy option for investment to

earn a living. With scores of people entering the lower end of the market, competition is high and the range of pricing limited. Therefore, livelihoods are squeezed from the thin margin left after meeting all costs and overheads. Expecting such a market to be quality conscious is an illusion.

2.9.3 Deficiency of Trained HR

Apart from a few organized sub sectors, like banking, medicine and engineering, there are no credible training institutions offering courses in the skills required for the services sector. Resultantly, most of the artisans in trades like electricians, mechanics, drivers, tailors, barbers, cooks, masons, etc, are trained on the job. The level and quality of skill acquired by them is inconsistent and uneven depending on the source and environment of learning.

2.9.4 Informational Asymmetry

In the absence of professional and quality certification, the customer doesn't have adequate information about the pricing structures for various grades of services. Nor is she/he fully aware of their availability.

2.9.5 Lack of IP Protection

Informal and open services markets are not conducive to intellectual property protection, particularly as protection through copyrights, trade marks, etc, are not yet much in vogue in the developing world. This has multiple consequences, such as:

1 Hindering brand development
2 Discouraging innovation
3 Frequent copying and plagiarism discouraging competition and progress and availability of services to people at lower cost.

2.9.6 Constrained Access to Formal Finance

In the absence of tangible assets to mortgage as security, and a lack of tradition for valuation of intangible assets and their use as security for borrowing, services businesses find themselves further excluded from the domain of formal finance.

2.9.7 Lack of International Gateway

International gateway provides the back up support for Internet based transactions. Absence of an international gateway in Pakistan hinders potential for e-business. Export of services also suffers in this context.

Despite our general habit of talking about services in a structured manner, the truly dynamic spirit of the sector needs to be understood. Services are a mix of a few

formal and many informal establishments. The economics of these markets is defined within a situation where the market doesn't have backward linkages with standardized skill development institutions. Assurance of quality is lacking and awareness about IP issues is still thin. All these factors shape the context of exports in services and our expectations in this regard.

In short we may summarize our findings from the above discussion that services and their maintenance is crucial for a growing and profitable business. Service industries are maturing and have become more competitive, and there is a growing need to increase efficiency, productivity and competition[40]. This requires adequate management of the available capacity to achieve maximum and / or optimum utilization at all times, if possible; a not at all simple task.

CHAPTER 3

CAPACITY MANAGEMENT IN SERVICE INDUSTRY: AN INTRODUCTION

3.1 Introduction

Fitzsimmons and Fitzsimmons[9], explain that capacity is the ability to deliver service over a particular time period. For services the time horizon can vary from decades (e.g., the decision to build a resort hotel) to hours (e.g., staffing a fast food restaurant during a lunch hour). One thing that has been found in the literature is that the resources available to the organization determine the capacity. These resources could be of any form like facilities, equipment and labor. The main thing here to understand is how to implement an organizations strategic business plan with the available types and amounts of resources. Thus researches argue that strategic capacity management is to determine the appropriate level of service capacity by specifying the proper mix of facilities, equipment and labor that is required to meet anticipated demand.

Some researches suggest that when speaking of capacity management, the aim is to minimize customer-waiting time and to avoid idle capacity, with the goal of attending to demand in time and in the most efficient way possible. Different authors have defined capacity of a service differently. Lovelock[10], defines it as 'the highest possible amount of output that maybe obtained in a specific period of time with a pre – defined level of staff, installations and equipment.'

Slack[41] et al., give a more basic definition of the capacity as 'the maximum level of value – added activity over a period of time that the service process can achieve under normal operating conditions'.

Hence we may argue that capacity management is the ability to balance demand from customers and the capability of the service delivery system to satisfy the demand. This places emphasis on understanding first, the nature of demand by forecasting[42] and second, the options for managing capacity to meet the expected demand. Main focus of capacity management is on controlling and eliminating demand and supply side variability. Variability of all kinds decreases capacity available and can cause shifting bottlenecks[20].

Both supply side and demand side techniques have been developed to cope with uncertainty[43]. This has resulted in a multitude of capacity management

recommendations. Some of the better-known recommendations developed by Sasser[44], and Schemenner[20], include:

1. Using part time employees during peak demand periods.
2. Sub contracting (outsourcing).
3. Process analysis to refine the service delivery system.
4. Increasing customer participation.
5. Sharing capacity.
6. Pricing to shift demand to non-peak periods.
7. Developing non-peak demand.
8. Developing complementary services.
9. Creating reservation system.

Thus as explained by Johnston and Clark[45], "There is no one way of managing capacity. The capacity management must be aligned with the underlying business model."

Service firms have one commonality. For each day a service is not put to profitable use, it cannot be saved[46][47]. Services generally cannot be inventoried as tend to be consumed as they are produced[48]. This perishability suggests a need for careful planning and management, as idle capacity due to slack demand, as well as turning away customers due to insufficient capacity, are serious problems critical to the success of many service firms[49].

Thus in the particular case of services, the capacity management is made more difficult by the impossibility of making an inventory of the service for its subsequent use, as occurs with the production of goods. The impossibility of synchronizing supply and demand produces a loss in opportunity to attend to certain customers when demand is higher, and supposes high costs due to loss in income when demand is insufficient and the fixed available capacity is not put to good use[44]. In this sense capacity management has a considerable impact on the quality of service perceived by customers[50].

Another problem occurring due to seasonal demand has to be resolved in service activities. This provokes the need to have models for forecasting the demand for a certain period of time. The ideal situation for a service enterprise would be the possibility of reducing its capacity in the periods of low demand and increasing it in the high season[51]. Typically the objective of many service firms is to develop a capacity profile to such an extent that it matches its demand profile and yet retains its

economic viability. However, despite an optimum choice of capacity to the extent that there maybe a close fit to the demand profile, demand forecasting is a skill rather than an exact science[52]. Also not all firms are able to fit capacity to their demand profile. This is because services can rarely achieve constant utilization of their capacity – unless they operate through appointments[52]. There exists a certain amount of debate with respect to identification of a valid measurement of capacity. Some of the causes of imprecision in the measurement of capacity as summarized by Elmaghraby[53] are:

1. Problem of product mix.
2. Problem of set-up time.
3. Problem of varying efficiency.
4. Problem of semi-finished items.
5. Problem of scrap / dropout.
6. Number of social / cultural / economic considerations.

Other considerations must also be taken into account before planning capacity. In the long term capacity is linked to installations and related to their expansion and contraction in the organization. All this is intimately connected to the concepts of economies of scale and scope. On the other hand, the major barrier for capacity in the short term is to be able to deal with unexpected demands. To do so Meredith[54], proposed different alternatives:

1. Increase resources.
2. Improve the use of resources.
3. Modify the product.
4. Modify demand.
5. Not supply demand.

3.2 Capacity Strategies

Literature suggests three different basic strategies; although a mix of all the three strategies is usually employed in most of the organizations. These are[45]:

3.2.1 The Level Capacity Strategy

Maintaining the scarce or expensive resources at a constant level and the organization must manage the consequential issues for service quality.

3.2.2 The Chase Strategy

Service organizations try to match supply to demand as much as possible by building flexibility into the operation. The prime objective is to provide high levels of service availability or fast response, in the most efficient manner.

3.2.3 The Demand Management Strategy

Rather than change the capacity of the service operation, the organization influences the demand profile to 'smooth' the load on the resources.

3.3 Capacity Management Framework

Johnston and Clark[45] proposed a simple framework (Figure 3.1) that allows the operations manager to identify key issues to understand and manage capacity more effectively.

Service output: indicates the overall capacity of the service operation, often expressed in units of output over an appropriate period. E.g. calls per day in a call centre.

Service resource: Here we identify the principal resources required to carry out the operation, paying attention to those, which are critical or near critical.

Service demand: Analyze the impact on capacity of changes in the demand mix or promotional activity.

Service capacity management: This looks at the effectiveness of various techniques to increase or 'flex' capacity.

Capacity leakage: Here we understand why capacity is less than anticipated.

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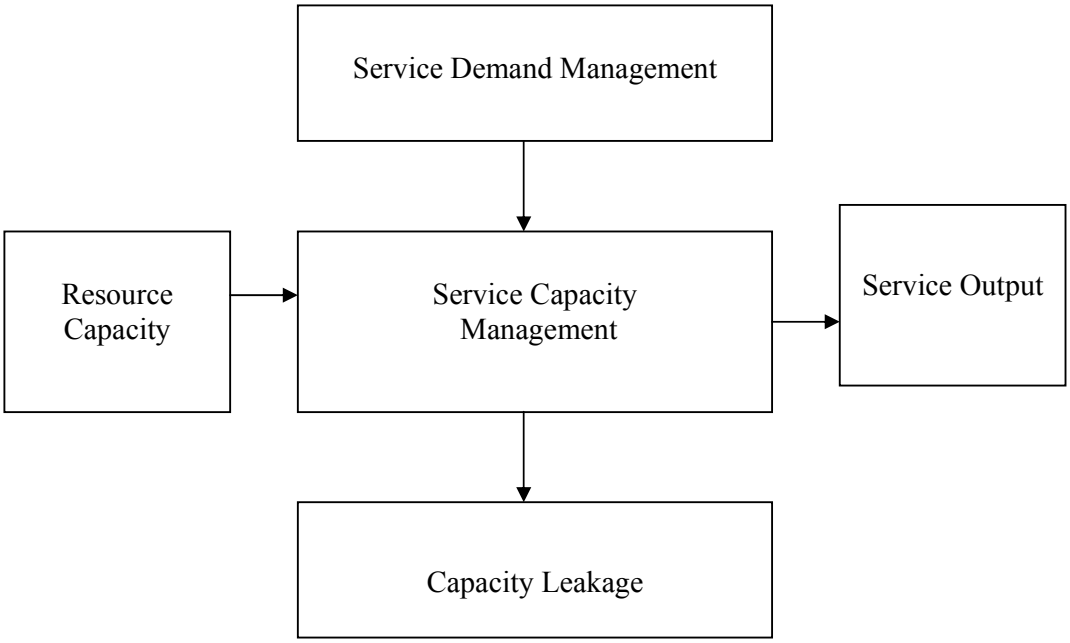


Figure 3.1. Capacity Management Framework

Source: Johnston and Clark, 2001

CHAPTER 4

REVIEW OF SERVICE CAPACITY MODELS

4.1 Introduction

This chapter summarizes the contents and main findings of capacity models that have been considered. Our main focus here is only on how the researches address a specific issue concerning the capacity problem in service industry and what conclusions they draw from their study to overcome these capacity problems.

4.2 Model 1: A Capacity Management Model in Service Industries (Adenso-Diaz and Gonzalez-Torre, 2002)

In this paper the researchers have followed a quantitative approach building up a model that could be used to solve the problem of determining the minimum staffing level for a particular service. Maintaining an expected level of quality is an important issue in the service industry. Keeping this factor in mind the authors here believe that this particular approach allows the calculation of minimum staff needed to carry out all the functions within a service and the expected customer service quality level is maintained at the same time. Since, human resources planning is related to assignment of the right number of people at the right place and time to perform efficiently the job to be done so when a minimum number of resources must be distributed this model could be used to determine the lower limits that should be maintained. The authors here suggest that this model could help to establish minimum capacity levels below which quality maybe affected, so as to be able to assign short – term resources on the basis of demands that arise. In short, such model could help to perform better distribution of staff among the different units and thus a better use of available resources.

Figure 4.1 below gives an idea of steps involved in this model. To better understand the working and logic behind the model it was applied as an example of implementation in two real environments: the internal medicine unit of a hospital belonging to the Spanish National Health Service, obtaining values that were coherent with the usual practice at the Hospital, and in a catering company, where it is currently being implemented.

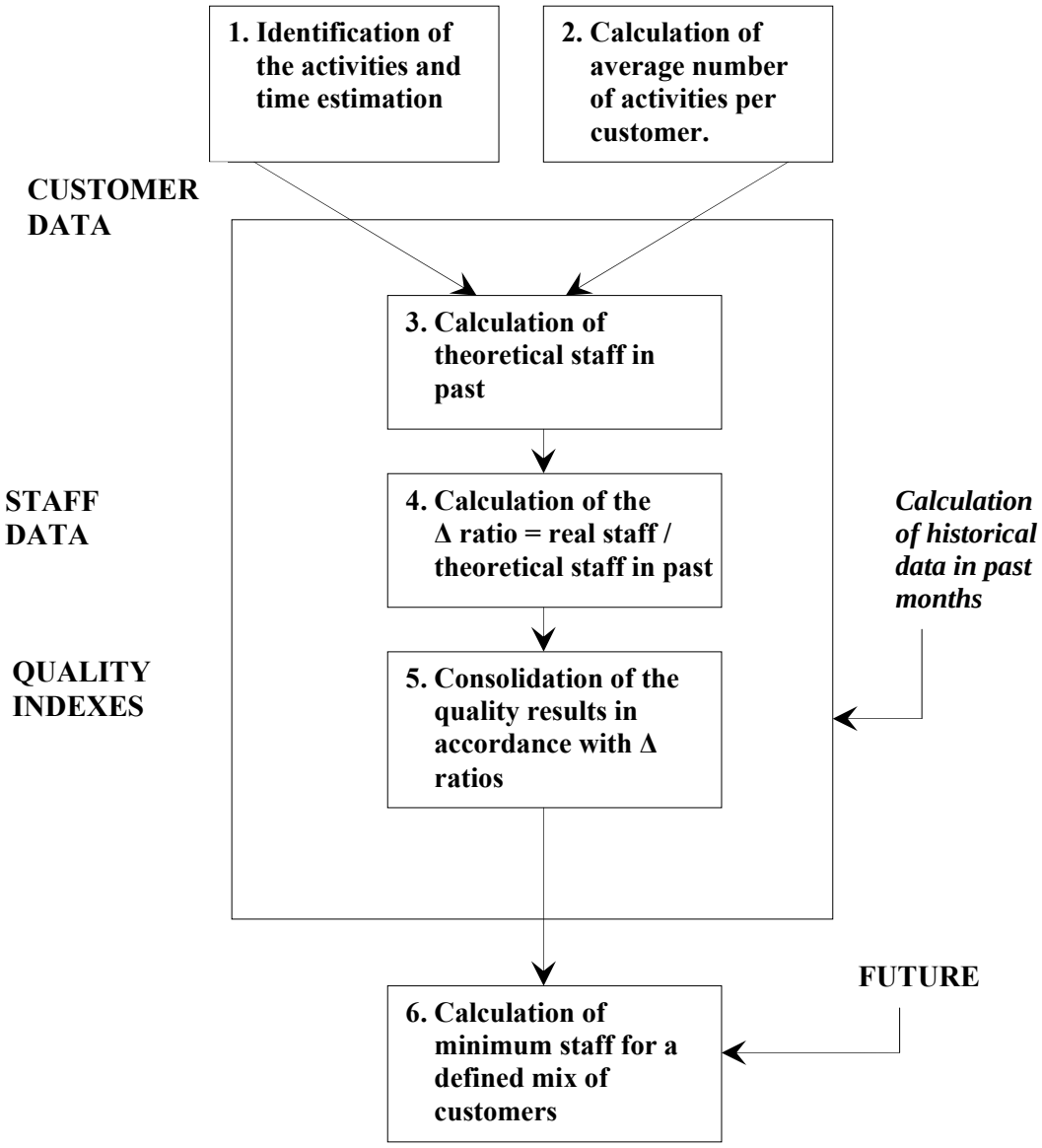


Figure 4.1. Schematic Representation of the Proposed Methodology

(Adenso-Diaz and Gonzalez-Torre, 2002)

After going through this research we may conclude by saying that, if we have pre – defined level of quality set for a customer by a particular service industry this model is very helpful in determining the minimum staffing levels on the basis of historical data.

4.3 Model 2: Demand and Capacity Management Decisions in Services, How They Impact on One Another (Klassen and Rohleder, 2002)

4.3.1 Introduction

Balancing customer demand and service capacity has always been a great issue for service managers[55] [56] [57] [58]. In this particular research authors have tried to explore the issues concerning demand and capacity management in service industry by developing a model that addresses the following issues:

1. How demand management options affect one another.
2. How capacity management options affect one another.
3. Whether some options are more effective than others.
4. To what degree various options must be implemented in various scenarios.

But as stated by the authors there are challenges in developing a certain general model of how capacity and demand work together. These are:

1. Differences among service demand patterns.
2. Differences between the customers and,
3. Customers' reaction to management issues.

An extensive review of the literature suggests the following available capacity management options (CMO's) and the demand management options (DMO's) grouped in Table 4.1.

4.3.2 Model

This study focuses on a multi – server environment where demand and capacity are managed hourly and represents the customer service aspect of many services, which is basically service by human servers (e.g. bank tellers, supermarket cashiers). Arena simulation environment (Systems Modeling Corporation, 1995) has been used which provides a user-friendly approach to model and validate such complex environments with variety of decisions, their uncertain outcomes and their relationships, all in the context of various uncertain environments (including uncertain demand patterns). The

Table 4.1. Demand and Capacity Management Options

CMOs	DMOs
Required CMOs	***Explicit DMOs***
Schedule employees Hire employees Layoff employees	Reservations/schedule customers Yield management
Optional CMOs	***Implicit DMOs***
Part-time employees Temporary employees Allow customer waiting	Price differentials Service differentials (quality changes depending on time or week) Complementary services Substitute services (if service requested is not available) Inform and educate customers Seek subcontract work when slow Advertise to increase demand Advertise to achieve a certain demand level (if capacity is limited)
Allow customer balking Allow overtime Allow idle time	
Rent capacity from other businesses Share capacity with other businesses Turn away customers Hire subcontractors when busy	
Cross train employees Change allocation of resources Change work speed (employees temporarily work faster	
Options which can either be CMOs or DMOs	
Change hours or days of operation Use automation Provide off-site access (phone-in, internet) Change level of customer participation Partition customers (by status, by length of transaction, etc.)	

Source: Klassen and Rohleder, 2002

uncertainties can be summarized as different environmental and decision factors, each of which has been tested at different levels. While developing the model the individual hours have been modeled instead of modeling individual customers that requires a long run time (to test all factors), which is infeasible. Thus in this macro level approach each entity represents an hour using arrival rates instead of inter – arrival times.

We may conclude that with this type of study the authors have tried to gain insight in a general sense using a large number of demands and capacity management options because as suggested it is always important to determine which levels of which demand and capacity management options contribute most to the profitability. Sometimes, as we see from this study that not implementing a particular option is more profitable. And also as the situation changes over time, the importance linked to certain options also changes and the not so important options become more important some times. Since flexibility is an important concern it is always important for an industrial service to work on developing various demand and capacity management options, since this would help improving flexibility, increasing the chance that one will cover for the lack of another, and in turn increase profits.

The various adjustments that could be possible for options found lacking are summarized in Table 4.2:

Table 4.2. Summary of How to Adjust for an Option that is Lacking

If there is less opportunity or flexibility in…….	***The service should consider more……***
Automation	Customer participation Price differentials Inform/educate
Maximum number of staff scheduled	Price differentials Customer participation Cross training (Inform/educate)
Minimum number of full time staff	Inform / educate Advertising to increase demand Complementary services Calling on customers Seeking subcontract work

Source: Klassen and Rohleder, 2002

Figure 4.2 below gives an overview of the model logic.

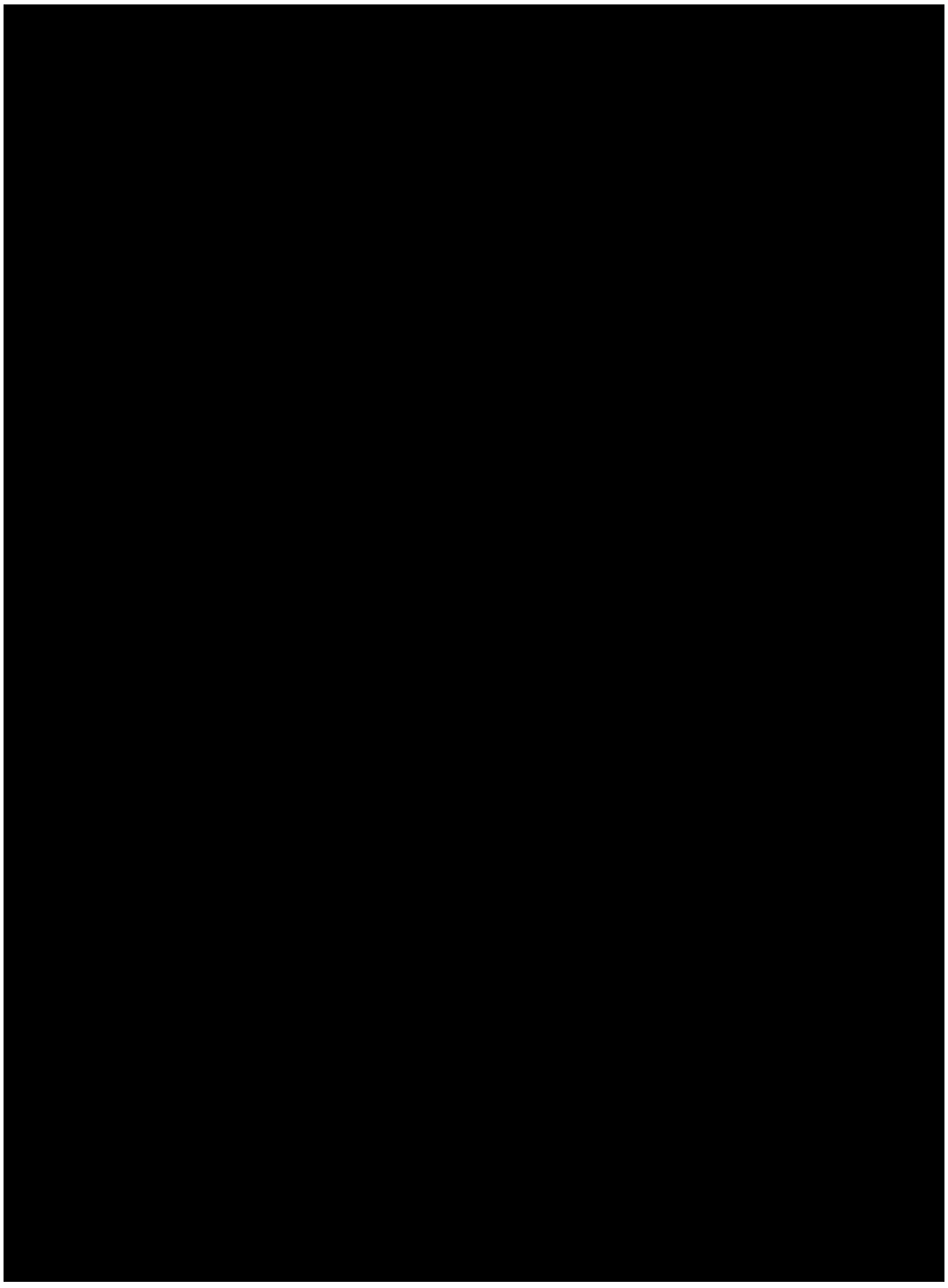


Figure 4.2. Model Logic (Klassen and Rohleder, 2002)

4.4 Model 3: Call Center Capacity Management (Betts, Meadows and Walley, 2000)

Technological developments have allowed the introduction of remote service delivery using telephone or Internet communication systems as means of service delivery [59]. It helps the customers to access the process more immediately. This particular research based study is an important resource in which the authors have tried to assess the capacity management practices of 12 telephone financial service operations, performing a range of tasks. As stated all these 12 call centers belong to the same parent banking organization but operating completely independently. It helps us to understand the methods used to achieve high service levels without unnecessarily compromising operating efficiency. Call centers often experience large fluctuations in demand over relatively short periods of time and most of the time most centers also need to maintain short response times to these demands [60] [61]. Thus a great emphasis has been placed upon capacity management practices within call centre operations.

In this study we find some important characteristics making the call centre capacity management a difficult task. These include:

- Demand seasonality over yearly, monthly and daily time horizons, with many call centers experiencing short – run surges or spikes in demand. The reasons for these demand spikes are often different for each call centre, such as responses to television advertising.
- Short time span to respond to call.
- Expectation to operate under an almost unique set of circumstances, so that the levels of performance achieved by the call centers can be expected to vary.

Literature suggests three broad management strategies namely level capacity, chase strategy and demand management. These have already been discussed in section 3.2 in detail but as we find in the literature authors propose that in some cases the desirable capacity management options might not be feasible because of specific constraints [62] [63] [64].

The research model that has been proposed in this particular study is shown in Figure 4.3 below showing the perceived links between different parameters.

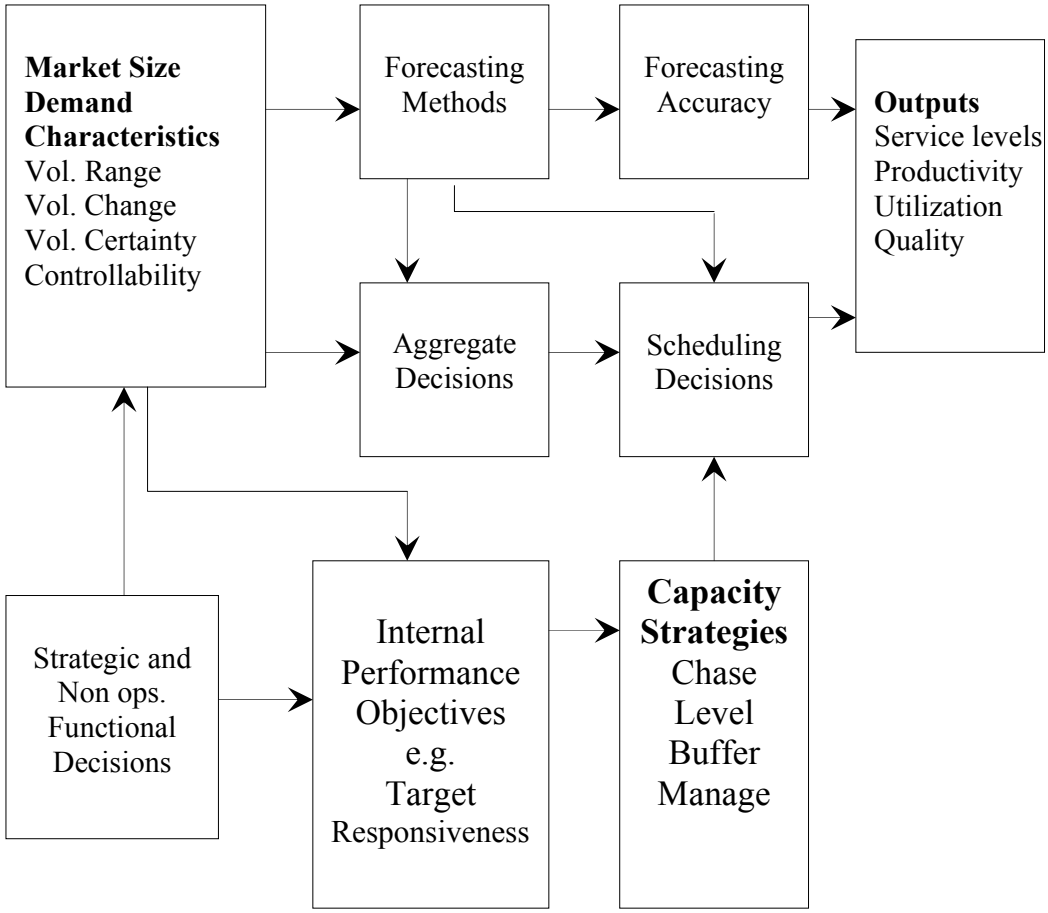


Figure 4.3. A Capacity Management Model in Call Centers

Betts, 2000

From this study we can conclude that call centers face a number of challenges. One of the main problems faced by the call centers studied here is related to short – term peaks in demands and thus creating difficulty to resource adequately. Some times or even most of the time these centers are also required to respond to the customers in a very short period of time, without the ability to buffer the operation from these demand surges. There is also always trouble with the resources provided since call centers providing an excess resource can suffer from operator dissatisfaction and boredom; however, a shortage of resource can put staff under a stressful workload at times.

4.4 Model 4: Outsourcing to Increase Service Capacity in a New Zealand Hospital (Renner and Palmer, 1999.)

As found in literature demand side variability and supply side variability are the two key issues that need to be controlled by using different capacity management strategies. Outsourcing strategy is another important tool in this regard. Using the case analysis of a New Zealand hospital the researchers in this particular study have tried to provide an extensive analysis to identify the positive and negative effects of outsourcing strategy while planning additional capacity in services. In literature there are different available definitions but more generally we may say that outsourcing is defined as 'a contractual relationship between external vendors and an enterprise in which the vendors assumes responsibility for one or more business functions of the enterprise'[65].

Here a case study methodology[66] was used to study the impact of outsourcing on one organization. The specific service that was outsourced and chosen for the study is Lithotripsy. The Lithotripsy service under study is operated as a partnership arrangement between a hospital (Hospital X), consulting urologists, and a New Zealand-wide organization providing mobile Lithotripsy technology (MLT). The urologists use the MLT facilities, together with the support staff and facilities of the hospital, to carry out kidney stone treatment.

The research process and data collection took place in several steps that helped the authors to analyze the case study and review the literature and come up with a set of propositions listed below:

P1. Increased service variability (both demand and supply uncertainty) will be caused by the outsourcing of Lithotripsy, and this will have an impact on the overall service system.

P2. The outsourcing of Lithotripsy will increase available capacity within the hospital.

P3. The outsourcing of Lithotripsy will increase other areas of uncertainty within the hospital system.

It was important during the research process as to if this set of propositions is coherent with the reality or not. For this we find an extensive analysis done by the authors and we see that findings of all the interviews, questionnaire, and observational exercises clearly supported the three propositions.

The analysis led to different supply side and demand side recommendations. Supply side recommendations include,

1. Faster and more accurate information flows.
2. Layouts rethink.

Whereas on the other hand as investigated by the authors the demand side recommendations are,

1. Give the hospital greater control over patient arrivals.
2. Develop better predictions of variability.
3. Improve handling practices.

We may conclude that this study helps us to understand both the negative and positive impacts that outsourcing might bring about to a non – core health service. It would definitely help increasing available capacity, saving additional capital outlay, and access to sophisticated technology. But, at the same time from above propositions we can say that out sourcing would magnify the uncertainty within the existing service system. There would be problems like increased delivery delays and bottlenecks later in the system which are clearly related to communication delays earlier on. Thus, the bottom line that could be for the management is, to be always aware of the downstream effects of these outsourcing decisions.

CHAPTER 5

FAUJI FOUNDATION'S ORGANIZATIONAL PROFILE

5.1 History of Fauji Foundation (FF)

An ex-serviceman who spends his life in an atmosphere of discipline and fair play finds it rather difficult to adjust to the civilian conditions. A large number of these simply cannot adjust to the non-egalitarian environments and some are simply baffled and disillusioned. It is unfortunate that the economic conditions and monetary environments in the country do not permit full social benefits to these otherwise potential human resources.

Hence, the need day was of an organization resourceful and capable enough to address this issue through a planned coordinated and efficiently monitored effort of its own. It is here that the Fauji Foundation was established for providing ex-servicemen and also general public social security and facilities such as education for their children and health coverage.

Fauji Foundation (FF) was established as a charitable trust in 1954 set up for the welfare of ex-servicemen and their dependents. It is incorporated under The Charitable Endowments Act, 1890. Its aim and structure of governance is given in the Scheme of Administration as notified by the Government of Pakistan. Although the current name dates from 1967, the origin of the Foundation lies in the Military Reconstruction Fund (later known as the Post War Services Reconstruction fund) established in 1942 by the Government of British India for the post-war welfare and rehabilitation of ex-servicemen and their dependents, defined as beneficiaries. It is operating on a completely self sustaining basis, channels approximately 80% of the profits from commercial ventures into social protection programs that serve a beneficiary population representing approximately 7% of the country's population [67].

The Foundation, spending more than Rs. 23.8 billion on welfare, since inception provides services in the areas of healthcare, education, educational stipends, technical and vocational training.

FF has its own organization and administration; however it is attached to the Ministry of Defence of the Government of Pakistan considering it renders its services to ex-servicemen.

5.2 FF's Objectives

The objectives laid down by FF are as follows[67]:

- PROVIDE and arrange medical care to all the beneficiaries.
- PROVIDE artificial limbs to the beneficiaries and ex-servicemen.
- IMPROVE financial strength and profitability through strong investments.
- ENSURE operational excellence of all the existing investments.
- SATISFY stakeholders' genuine expectations.
- ACHIEVE best of benchmark standards comparable to reputable organizations.
- ENHANCE skills, know-how and competence at all levels.
- ENCOURAGE innovation, creativity and excellence.
- INCREASE efficiency and productivity in our systems through adoption of best practices.
- INCULCATE a culture conducive to continuous improvement.
- EMPOWER and recognize each employee's outstanding contribution.
- MAINTAIN lean and efficient organization.
- ENSURE safe and environmentally conscious organization.

FF generates its own income from its multidimensional operations such as investments in well-regulated sectors. Every year brings new challenges that need to be addressed through a combination of meticulous planning, optimal utilization of resources and sound financial management to maintain a financially viable posture.

5.3 Core Lines of Business

Fauji Foundation is for the welfare of its beneficiaries by law. Therefore, strong commercial operations are a must to fund the welfare for an expanding beneficiary base, on a sustainable basis. Thus it has a number of industrial & commercial concerns, (generally known as the Fauji Group); half of them are fully owned by the Foundation and in the remaining it controls the boards, through major investment & shareholding. The core businesses in which it has currently invested are fertilizer, power, oil & gas exploration & distribution, oil terminal operations, financial services, cement, sugar, cereals, employment services, and security services. The businesses where FF is a holding entity include:

- Mari Gas Company Ltd.
- Fauji Cement Company Ltd.

- Pakistan Maroc Phosphere, S.A
- Fauji Fertilizer Company Ltd.
- Fauji Fertilizer Bin Qasim Ltd.
- Foundation Securities (Pvt.) Ltd.
- Fauji Kabirwala Power Company Ltd.
- Fauji Oil Terminal & Distribution Company Ltd.

And the businesses that are fully owned by FF are:

- Fauji Cereals
- Foundation Gas
- Fauji Sugar Mills
- Fauji Corn Complex
- Foundation University
- Fauji Security Services
- Overseas Employment Services
- Experimental & Seed Multiplication Farm

5.4 Welfare Services

Fauji Foundation provides welfare services to approximately 10 million individuals on a completely sustainable basis. The welfare services are provided, free of cost or on a subsidized basis, to individuals who meet the qualifying criteria defining its beneficiaries **(Annexure A)**. With the aim to bring about social uplift, opportunities are provided for education through FF Education System up to the College level, vocational training to empower females with not only income generating skills but self-confidence, and technical training to males thereby providing marketable job skills allowing them to contribute positively to the maintenance of their families and households.

The welfare services also extend into the realm of healthcare. The FF Healthcare system provides free healthcare to all beneficiaries at facilities across the country. For those who may not be able to find their way to one of the facilities, mobile health units are operating in remote areas bringing doctors and medicines to those who otherwise may never receive even basic healthcare.

The Artificial Limb Center is the only one of its kind in the region and provides services not only to the local population but exports to neighboring countries as well.

Although FF is known for its presence in the commercial / industrial sectors, it is the provision of welfare services to our beneficiaries that drives its investment decisions.

5.4.1 Education

5.4.1.1 Model Schools and Colleges

The Fauji Foundation Education system over the last 20 years has matured into a progressive and a well-rounded system of Model Schools and Colleges, offering quality, English-medium education both in the urban and rural areas. Starting from 34 Model Schools in 1988, the Fauji Foundation Education System has now grown to over 101 institutions located throughout the country. These institutions include 6 higher secondary, 78 secondary and 15 middle & primary schools and two colleges.

FF Education system has faculty strength of over 1700 and an annual budget of over Rs. 850 million for over 41,000 students so, it can rightfully be proud of its contribution for promoting the cause of education in the country.

5.4.1.2 Foundation University

The Foundation University was granted the Charter by the Federal Government in 2002[67]. The University has been established as a center of excellence to provide quality education of international standard to the talented students.

The university took under its wings three Fauji institutions that were already functioning in Rawalpindi namely

- Foundation University Institute of Management and Computer Sciences (FUIMCS)
- Foundation University Medical College (FUMC)
- Foundation University College of Liberal Arts and Sciences (FUCLAS)

5.4.2 Vocational Training Centers

System of Vocational Training started with a Vocational Training Center (VTC) at Jhelum in 1975. By 1991 Fauji Foundation had established a network of 66 VTCs. Table 5.1 shows how the VTCs are distributed across the country. The Centers impart training to the females including wives and daughters of ex-servicemen. The training is aimed at equipping them with basic skills for self-employment and learning the household skills. On the average, 4000 students are trained annually. Up till now 75663 students trained in Basic courses and 51258 trained in Short courses.

Table 5.1. VTCs Distribution Across the Country

Provinces	No. Of VTCs
Punjab	42
NWFP	9
Sindh	3
Baluchistan	1
Azad Kashmir	7
Northern Areas	4

Source: FF Headquarters, Rawalpidni

5.4.3 Technical Training Centers

First Technical Training Center (TTC) was established in 1981 at Rawalpindi. Presently 9 TTCs i.e. 7 in Punjab and 1 each in NWFP and AK are imparting technical training in basic skills to ex-servicemen, their sons and serving personnel to facilitate their rehabilitation after retirement. On the average, approximately 2000 students are trained annually. Until now 23725 students trained in Basic courses and 9867 trained in Short courses.

5.4.4 Student Stipends

Fauji Foundation Educational Stipend Scheme is the oldest welfare measure of Fauji Foundation. The scheme benefits beneficiaries studying in Schools, Colleges, Universities, as well as those undergoing professional and technical education. Introduced in 1954, with the award of 1,586 awards, the scheme today supports over 71,000 individuals and disperses over Rs. 120 million per year.

5.4.5 HealthCare System

Fauji Foundation (FF) Healthcare System, started operations with the establishment of a 50 bed TB Hospital at Rawalpindi in 1959. Over the years, it has grown into the largest Non-Governmental Healthcare System in Pakistan, providing exemplary medical treatment ranging from primary to tertiary level. For beneficiaries, healthcare is provided free of cost.

Figure 5.1. Snapshot of FF Health Care System

Source: Fauji Foundation Website

FF's extensive Mobile Dispensaries Coverage System carries the healthcare to the doorsteps of our patients living in the remotest areas of Pakistan. Provision of Artificial Limbs to beneficiaries and non-beneficiaries is a unique distinction of FF. FF Artificial Limb Center is also running a program in collaboration with International Committee of Red Cross (ICRC) to reach out the amputees/handicapped for providing Prosthesis and Orthosis. The integrated and progressive healthcare system is also equipped to diagnose and treat medical, surgical, obstetric and gynecology, eye, ENT, pediatrics, psychiatry and disabled patients.

5.4.5.1 Hospitals

Fauji Foundation has established hospitals at District and Tehsil levels. The FF Healthcare system comprises 118 projects, 11 of which are hospitals - 4 Urban, 4 Semi Urban and 3 Rural. These hospitals provide accident and emergency medical care, primary to tertiary health care as well as Mobile Health Care at doorstep of beneficiaries.

5.4.5.2 Medical Centers

A large number of Fauji Foundation beneficiaries live in remote areas of the country thereby limiting their access to basic healthcare services. To cater for this Fauji Foundation has established 24 Medical Centers across the country providing primary health care services. The Centers are also running mobile dispensaries five days a week which are equipped with a doctor and paramedic, carrying sufficient medicines to provide basic healthcare. Each Center has 3 Doctors (2 Male and 1 Female) with basic facilities such as Lab tests and X-ray. The future plans include inclusion of an ultrasound machine and ECG machines, for proper & prompt diagnosis. In the year 2007, the number of patient treated in FFMCs topped 712,000, bringing the total treated since inception to over 3.0 million.

5.4.5.3 Dispensaries

Fauji Foundation endeavors to provide even the most basic healthcare services to its beneficiary population regardless of geographic location. Where cost / benefit considerations do not allow for the establishment of a hospital or medical center, Fauji Foundation has established Dispensaries. Located in the remote areas, they are equipped with an MBBS doctor along with qualified paramedic staff and provide daytime consultation and treatment. These dispensaries provide basic health care to approximately 400,000 patients.

Figure 5.2. FF's Hospital's Spread over Pakistan

Source: Fauji Foundation Website

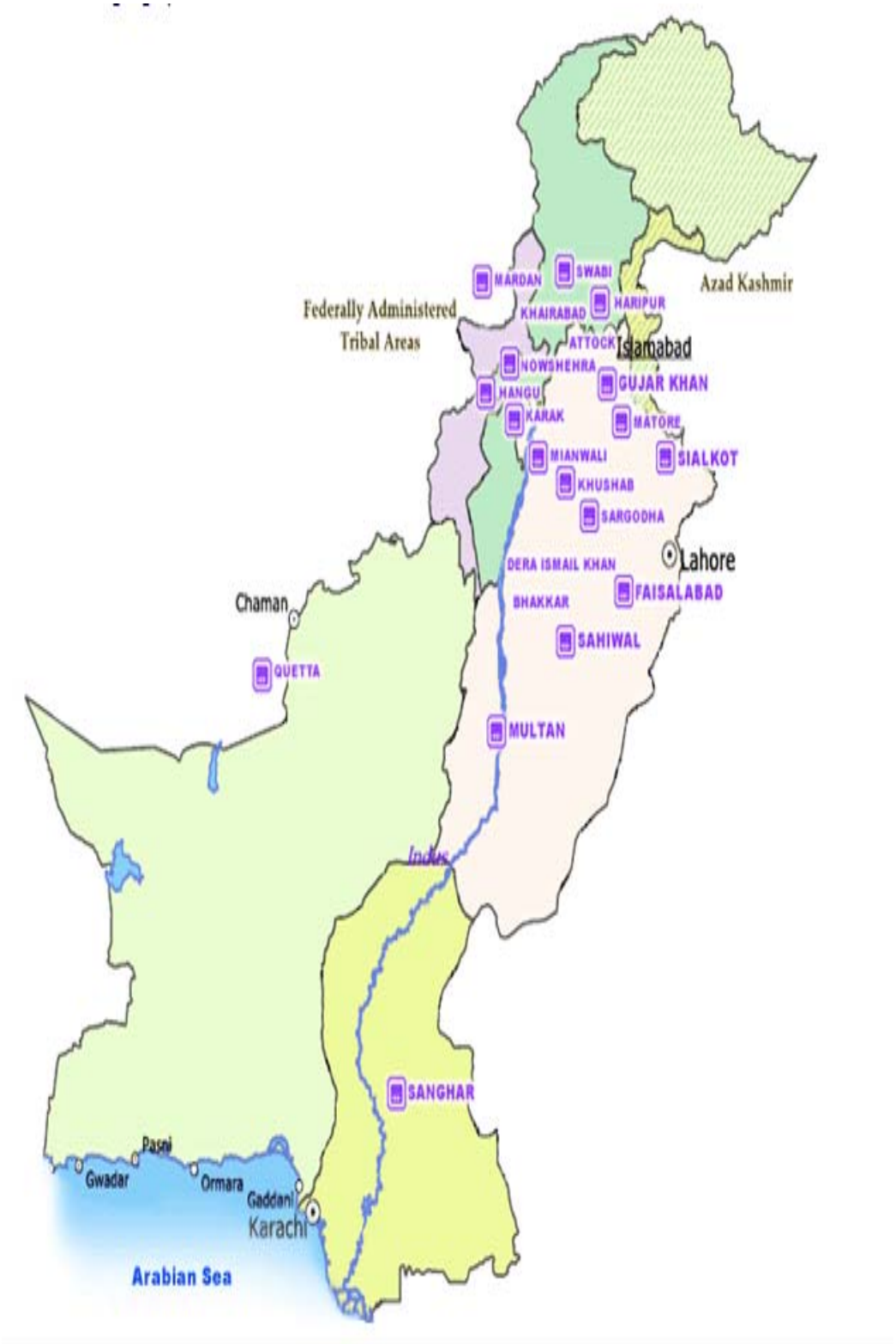


Figure 5.3. FF's Medical Centers Spread over Pakistan

Source: Fauji Foundation Website

Figure 5.4. FF's Dispensaries Spread over Pakistan

Source: Fauji Foundation Website

5.4.5.4 Mobile Units

To reach the beneficiaries in mountainous terrains of Azad Kashmir 2 Mobile Health Units located at Kotli and Rawalakot are providing primary health care services. A doctor and a paramedic man the mobiles.

5.4.5.5 Artificial Limbs Center (ALC)

ALC is the first center of its kind in the sub–continent. It was set up in 1911 at Pune in India, in anticipation of the likely causalities in impending wars. Later it was moved from Pune, first to Sialkot in 1936 and then to Lahore in 1946 where it functioned under the Pakistan Army. Following the 1965 war, due to casualties in northern part of Pakistan, it was shifted to Rawalpindi. Since 1966 it is working under FFH Rawalpindi. The ALC is also the largest such center in the country. On the average it provides over 7500 artificial limbs and supporting appliances every year, approximately one-third of which go to non-beneficiary on a cost price basis.

In collaboration with the International Committee of Red Cross **(ICRC)**, over 50 patients have been provided with artificial limbs and supports through a special outreach program.

5.4.5.6 Nursing Training School

Fauji Foundation School of Nursing, located in the premises of FFH Rawalpindi, was established in 1978 with the aim to produce trained and competent nurses through improving nursing education. Pakistan Nursing Council (PNS) recognized the School of Nursing in 1979, within one year of its establishment. It is associated with FFH Rawalpindi for practical training in General Nursing Course of 3 years, and Federal Government Services Hospital (Polyclinic) Islamabad for their training in Midwifery for one year.

Not only has this training improved healthcare services but has also provided the opportunity to employ daughters of beneficiaries of FF, who are offered employment in the FF Healthcare System after the completion of the course.

Figure 5.5. FF's Mobile Units in Azad Kashmir

Source: Fauji Foundation Website

Table 5.2. Performance of ALC since 1966

Since 1966	
Artificial limbs provided	**Artificial limbs repaired**
177,426	66,000

Source: FF Headquarters, Rawalpindi

5.5 Resources

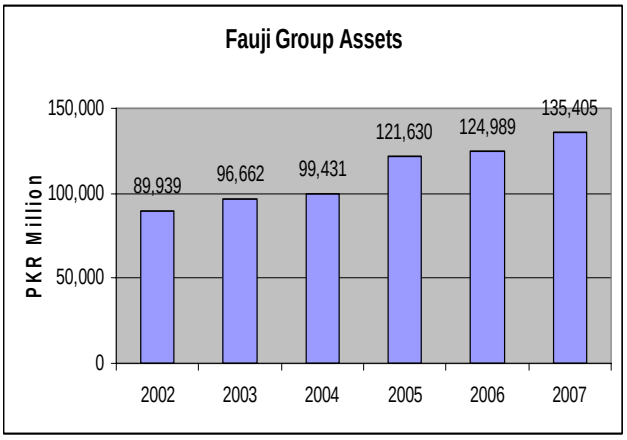
5.5.1 Human Assets

The Fauji Group currently employs approx. 12,411 employees and as such also has a rich skill mix of experienced and dedicated individuals in various sectors including Fertilizer, Cement, Natural Gas, Power Generation, Oil Terminal Operations, Financial Services, Healthcare, Education etc. The human inventory majorly consists of retired personnel, a few serving Armed Forces officers and regular FF employees.

5.5.2 Financial Assets

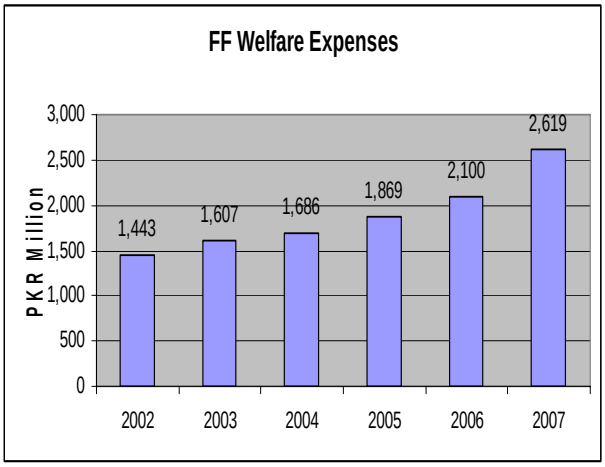
Fauji Foundation, holding entity of the Fauji Group of Companies, has grown to become one of the largest, autonomous business conglomerates in the country. Profits from its ventures are channeled into social protection programs that serve a beneficiary population. Fauji group's total assets are worth $ 2,100 million.

The welfare expenses of Fauji Foundation are of interest as our study is related to Fauji Foundation Hospital (FFH), Rawalpindi that comes under the umbrella of welfare services. FF's expense on welfare services is worth USD 42 million.



Year	Total Assets
2002	USD 1,477 million
2003	USD 1,587 million
2004	USD 1,633 million
2005	USD 1,990 million
2006	USD 2,053 million
2007	USD 2,100 million

Figure 5.6: Fauji Group Assests
Source: Finance Division, FF Headquarters, Rawalpindi



Year	Total Assets
2002	USD 24 million
2003	USD 26 million
2004	USD 28 million
2005	USD 31 million
2006	USD 34million
2007	USD 42 million

Figure 5.7. FF Welfare Expenses
Source: Finance Division, FF Headquarters, Rawalpindi

5.6 FF's Mission

Provide / facilitate quality education and medical care to the beneficiaries through investment in ventures ensuring earning growth compatible to our demands for providing high quality services[68].

5.7 Executive Management at FF

There are two tiers of management at the Executive level: the Committee of Administration and the Central Board of Directors.

- The Committee of Administration (COA) is the policy board of the organization consisting of nine members **(Annexure B)**. It is responsible for defining the strategic direction of the Foundation without its involvement in the day-to-day functioning.
- The Central Board of Directors (CBODs) functions as the management committee consisting of 10 members, which is responsible for the day-to-day fiscal and management control of the organization within the broad policy mandate. It ensures that policy objectives are met through adherence to best practices and good corporate governance. Secretary, Ministry of Defense, is the ex-officio Chairman of Fauji Foundation, whereas Vice Chairman and Managing Director oversee the day-to-day operations of Fauji Foundation with requisite direction to the functionaries.

5.8 Assistance During Earthquake – 2005

FF's hospitals, schools and training cent played a major role in providing assistance during and after the deadly earthquake in year 2005. Its hospitals provided health care services for the wounded and also the rehabilitation services for the emotionally scarred people. After the great earthquake of 8 October 2005, the ALC played a major role in the provision of prostheses and orthoses to the injured. By fitting approx 260 prostheses, it made largest single contribution to this effort. Also as part of its relief operations technical and vocational trainings were carried out along with providing quality education in its schools so as to train and facilitate the people of earthquake affected areas.

5.9 Case Study: Fauji Foundation Hospital (FFH) - Rawalpindi

The Fauji Foundation Hospital was established in the year 1959 standing on 53 acres of land. The hospital acts according to the acts formulated by the Ministry of Health, Pakistan. It is also an abode of medical education accredited to the Foundation

University of Management and Computer Sciences. The Fauji Foundation Hospital is situated in Rawalpindi, Pakistan. Health in Pakistan is very poor and so effective measures are taken to curb the problem.

The hospital has made great developments over the years. It is now a tertiary care teaching hospital that shelters **600 beds**. It aims at increasing the number of beds to eight hundred and fifty. The hospital inherits all the modern facilities according to the pros and cons of Pakistan Medical and Dental Council. The hospital is also a base for two mobile dispensaries being operated across **22** localities within a 60 km radius of the hospital. Primary healthcare is provided to approximately **18,000** patients annually[69]. The Fauji Foundation Hospital extends its services to the retired personnel and their family members. Besides the hospital caters to the other patients also.

The hospital provides outpatient and inpatient services. The outpatient consultation / treatment is provided during working hours while Emergency / Trauma services are provided to patients **24** hours a day whereas the inpatient facility has bed occupancy of **98%** and a **1:11** nurse to bed ratio[69].

The hospital employs certified medical personnel specialized in their respective fields and is equipped with the modern medical equipments. Currently the hospital has 1087 employees. The details of these are shown in Table 5.3.

The hospital has **12** wards, each of them further divided into sub-units. For surgeries there are two well-equipped operation theatres, which are coupled with six operating rooms for serious cases and emergencies.

The hospital patient breakdown for Oct 2007 - Sep 2008 is shown in Table 5.4.

Some other statistics about the hospital are shown in Table 5.5.

Table 5.3. Employee Status at FFH, Rawalpindi

Employee Category	Strength
Specialist Doctors	41
Registrars	40
Post Graduate Officers	32
Medical Officers	59
House Officers	37
Administrative Staff	12
Operation Theatre (OT) nurses	30
Staff Nurses	177
Support staff	659

Table 5.4. Hospital Patient Breakdown For Oct 2007 - Sep 2008

Patient Category	Strength
Female Patients	**53%**
Male Patients	**26%**
Children	**21%**

Table 5.5. Hospital Statistics compared to Oct 2006 - Sep 2007

Health Statistics for Oct 2007 – 2008	
Patient admissions	**20,436**
Mortality rate	**859 (4.2%)**
Increase in Patient Admissions	**3%**
Decrease in Number of Deaths	**0.1%**

Source: FFH, Rawalpindi

The Fauji Foundation hospital is an abode of medical teaching for the students aiming to be doctors. The hospital imparts post graduation and undergraduate education in the field of medicine. Besides it also trains the students in the arenas of Medicine, ENT, Surgery, Eye and Anesthesiology. The hospital also grants a scholarship named as the FCPS (Fellowship of College of Physicians and Surgeons) in the fields of General Surgery, Urology, Paediatrics, General Medicine, Orthopedic Surgery, Anesthesiology, Otorhinolaryngology, Gynae/Obs, Psychiatry and Haematology.

The Fauji Foundation Hospital has been effectively serving the inhabitants of Pakistan with their care and devotion

For our analysis to develop a generic model for service capacity in health care services we will take up the female medical ward of Fauji Foundation Hospital as a case study. The results and methodology used here can be applied to the whole hospital in future studies.

5.10 Strategic Direction of FF

FF aims to become a welfare organization that provides excellence in Healthcare, Education and Industry so as to contribute to national development and also achieve customer satisfaction. However, the strategic objectives of FFH include:

- Establishment of an efficient and productive welfare organization via operational excellence, implementation of current practices and employee feedback.
- Support and promote the compliance of Ministry of health and PMDC (Pakistan Medical and Dental Council) conventions in the interest of Pakistan.
- Use latest technology and medical developments to establish benchmarks for healthcare standards in the country.
- Maintain an organization that directly or indirectly manages the welfare, in terms of healthcare, of ex-servicemen and their dependents in Pakistan.
- Expand the area of its services to other parts of the country by establishing a couple more tertiary care hospitals (preferably in Lahore and Karachi).
- Introduce programs such as workshops and training sessions for all employees so as to achieve a quality service standard.

CHAPTER 6

ANALYSIS, RESULTS AND DISCUSSION – FEMALE MEDICAL WARD, FAUJI FOUNDATION HOSPITAL

6.1 Organizational Analysis

The Chairman Fauji Foundation is the Chief Executive of the hospital. The Director Welfare Div (Health) deals with all the planning, administrative issues and induction processes of the hospital with the help of two General Managers. The operational layout is shown in Figure 6.1. FFH has pioneered in providing quality health services by establishing a state of the art hospital with ample facilities to cater for its beneficiaries. The hospital is the only tertiary care hospital under the umbrella of Fauji Foundation providing health care services in various different fields.

FFH has a medicine department comprising of female and male wards. These are further divided into 6 sub-units, out of which 4 are Female Medical Wards and 2 male Medical Wards. For our study we are undertaking the Female Medical Ward comprising of 132 beds. The wards are under the administrative control of specialists that is 1 specialist for each ward. A team of Registrars, Post Graduate Trainees, Medical Officers, House Officers, Nursing staff and support staff has specific areas of responsibility so as to manage the affairs of the female medical ward.

The female medical wards serve several tasks:

- Handling indoor female patients from general medicine, urology, neurology, oncology etc.
- Arranging outdoors to cater for as many female patients as possible.
- Record of patient admission and discharge.
- Provide information regarding patients at the Patient Information Desk and waiting area for patient attendees.
- Carrying out of tests of patients in supervision of a qualified staff nurses.

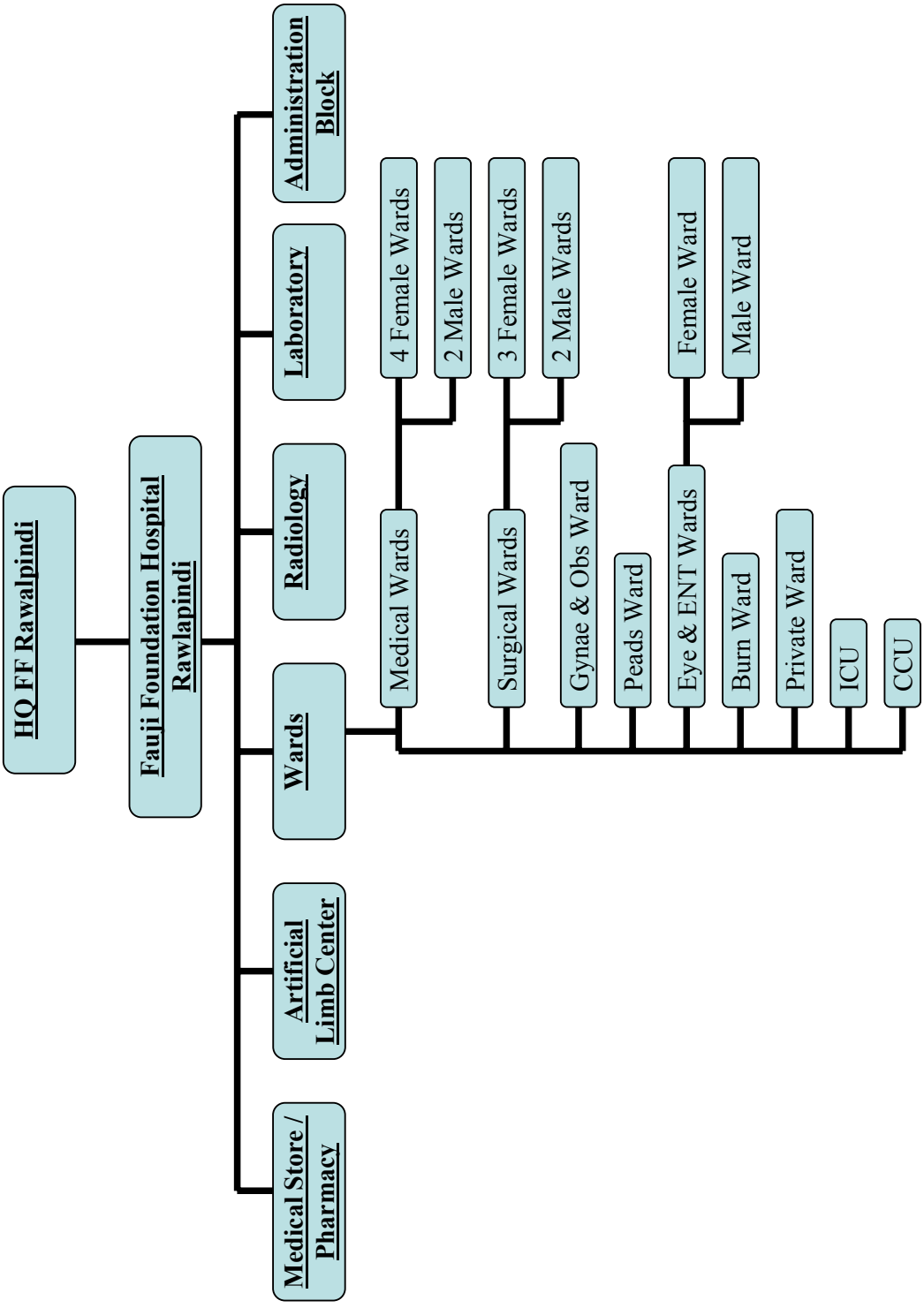


Figure 6.1. Hierarchy of Fauji Foundation Hospital
Source: Headquarter FF Rawalpindi

FFH Rawalpindi extends it services to all its beneficiaries spreading all over Pakistan. It is also providing private patients with equally good service. The female medical ward has its own parking sufficient to cater for the patient vehicles along with a staff parking lot. The ward comprised of 132 beds subdivided into 4 wards each having 44 beds. The Out Patient Ward (OPD) area has one hall meant for waiting purpose with three checkup rooms where the on call doctor resides. The OPD area has the capacity to hold about 95 patients at one time. The private patients are also treated in the same area. A separate area for private patients can increase efficiency, decrease workload and also generate revenue. The use of automated techniques has improved operational efficiency however the system needs backup support to avoid chaos and mismanagement in case of load shedding.

6.2 Human Resource (HR) Analysis

FFH Female medical ward consists of persons of various categories. The total manpower presently held by this ward is 80 persons against the authorization of 92 (This authorization was re-approved in Sep 2007). The details of manpower held in different categories are shown below in Figure 6.2. Since then no new inductions have been made even though the patient influx has increased by 3%over the next year.

The administration staff comprises of 100% Retired Army personnel. The doctors are inducted on merit basis but retired doctors are preferred. The support staff is 43% enrolled staff and 57% retired army personnel[70]. The House Officers and Post Graduate Trainees (PGTs) are both inducted on merit basis however; PGTs that have done their house job from FFH are given preference. The staff is appointed on either contract basis or permanent basis as per FF rules. In case the position is permanent the staff can be transferred to other FF hospitals present all over the country. The Welfare Div (Health) at FF Headquarters, Rawalpindi makes the transfer decisions. The pay packages for the House officers and lower staff aren't as rewarding as compared to the top management, which results in demoralization. Therefore, the FF needs to review its pay structures to facilitate its entire staff. In addition FF should not accept the incompetent individuals.

The enrolment of staff is not purely merit based, but at the desire of the concerned officers, who wish to fit in their relatives before leaving the organization.

There is a human resource department present at FF but it doesn't have any formal planning for the development of human resource. The HR decisions aren't made by

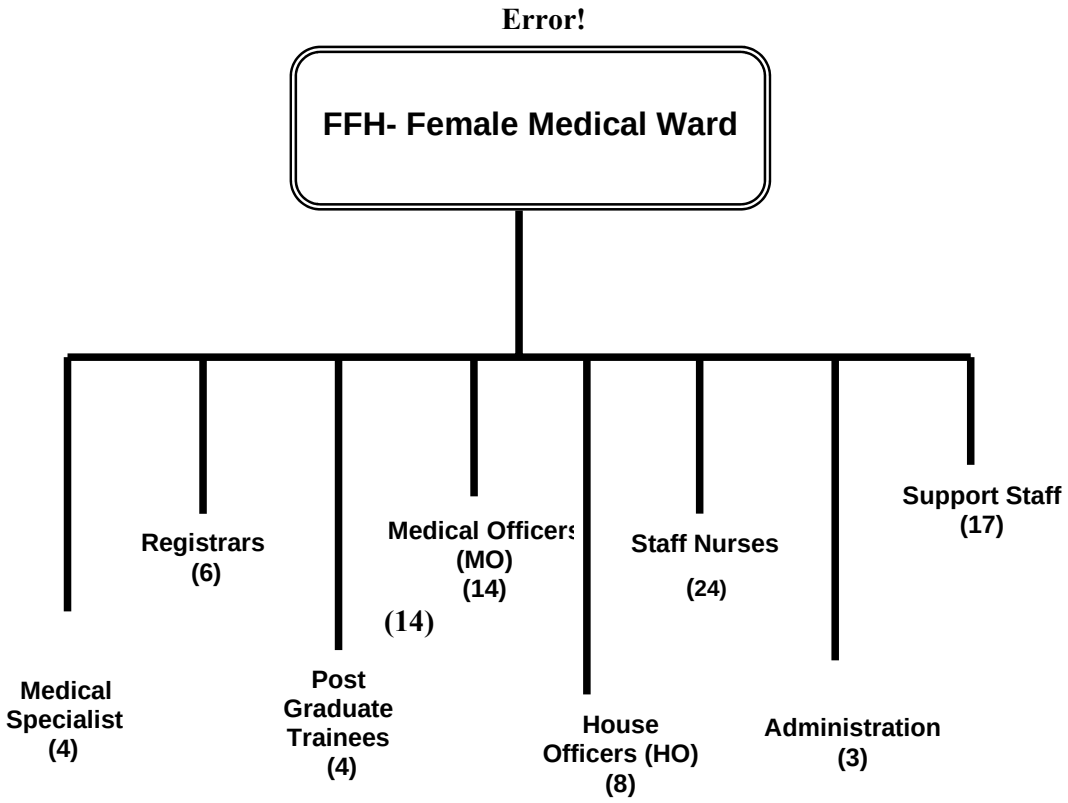


Figure 6.2. Held Manpower Details

Source: Data collected from Headquarter FF Rawalpindi

people who have specialized in this field rather the work is done by staff which is incompetent and has no understanding of induction process. A nursing school is present in the premises of FFH, which is recognized by PNS, that imparts education to prospective nurses but still on job trainings need to be planned so as to achieve quality nursing services that meet international standards. Similarly, trainings and seminars for doctors must also be planned so that they can keep up with the medical advancements. Also, the employees must be acknowledged for their good performance and work ethics.

The communication gap exists in the all tiers of management. The flow of information is not smooth. Often the support staff and administration people tamper with information causing problems.

The organization needs to take concrete steps towards the merit-based enrollment, reducing the communication gap among employees, training of employees on frequent basis and reward and punishment measures.

6.3 TECHNOLOGY ANALYSIS

In any medical project the Electro medical equipment that comes under the umbrella of technology is a lifeline. With rapid development of medical sciences, necessity of Electro medical equipment keeps on occurring with the entry of new generation of equipment.

The FFH is the hub or all the FF hospitals across Pakistan. Hence, it should be equipped with all the latest medical equipment necessary for running a tertiary care hospital. This research sheds some light on the adequacy, utilization, maintenance, training and the induction of technology at FFH.

6.3.1 EQUIPMENT ADEQUACY

A technology inventory survey **(Annexure D)** was carried out at FFH, Rawalpindi premises. The aim was to identify the present status of electro medical equipment present at the hospital. Moreover, the adequacy of the equipment along with its operational state was also analyzed.

The list of held electro medical equipment at the FFH, their quantities and operational state is mentioned in the Table 6.1 below.

Table 6.1. Equipment Status At FFH

S No.	MACHINE	YES	NO	IF YES, NUMBER	OPERATIONAL	
					YES	NO
1.	X-Ray Machines	√		3	3	0
2.	Ultrasound Machines	√		3	3	0
3.	Dialysis Machines	√		8	6	2
4.	MRI Machines		√			
5.	CT SCAN		√			
6.	Auto Analyzers	√		6	6	0
7.	Color Doppler	√		1	1	0
8.	Echo	√		1	1	0
9.	Chlonoscopy	√		1	1	0
10.	Mammography		√			
11.	Fluoroscopy	√		1	1	0
12.	ETT	√		1	1	0
13.	Holter Monitor	√		1	1	0
14.	Gastroscopy	√		2	2	0
15.	Bronchoscopy	√		1	1	0

Source: Survey conducted at FFH, Rawalpindi

It is interesting to note that the FFH, Rawalpindi, which was established almost 50 years ago and being the only tertiary care hospital under the umbrella of FF still doesn't hold any CT and MRI Scan machines. Moreover, the Mammography facility is also not available. The patients who need to under go these tests have to be referred to various other facilities like Military Hospital (MH), Combined Military Hospital (CMH), Abrar CT / MRI Scan etc.

A couple of ambulances are assigned for transporting the patients from FFH, Rawalpindi to these facilities. The hospital can earn great profits by installing these machines at its own facility. Installing these machines on contract basis with the installing firms at FFH, Rawalpindi can do this. The idea is to offer space to the firm for installing the machines to carry out tests. The firm may carry out tests on slightly higher rates however; the FFH beneficiaries maybe offered reduced rates for these tests. This will increase the influx of civilian patients (in the surrounding vicinity of FFH) coming to FFH to have their tests done resulting in financial gains and also increase the satisfaction of its beneficiaries by reducing the hurdles faced by them in order to get the tests performed at other facilities and eventually resulting in increased capacity. Also the designated ambulances will be free for other important functions like transporting critical patients from their homes to the hospital etc.

Another important issue that came to surface after the survey was the operational state of the machines. Out of the 8 dialysis machines present only 6 were operational. The FFH has a maintenance department at the facility and yet no effort was being to done to effectively fix the problem and make the machines running. This shows a clear lack of responsibility on part of both the management and maintenance department. A check should be kept to ensure the operational status of the machines. The more the number of operational machines the higher will be the capacity to treat the patients.

6.3.2 EQUIPMENT UTILIZATION

When discussing the capacity, it is important to discuss the effective utilization of equipment. It would show a lack of capacity management if the equipment is present at a facility and is not effectively used or is over used. A solution needs to be achieved in order to address this problem.

The survey carried out focused on the utilization of the machines too. The Table 6.2 gives an idea of the daily utilization of the machines.

Table 6.2. Equipment Utilization at FFH

S No.	MACHINE	DAILY UTILIZATION	TIME / TEST	TECHINICAINS / MACHINES	ACTUAL RUNNING HOURS
1.	X-Ray Machines	230	2 - 4 mins	2	12 Hours
2.	Ultrasound Machine	50	10-15 mins	1	10 Hours
3.	Dialysis Machines	7 – 10	4 Hours	1 per 2machines	8 Hours
4.	Auto Analyzers	500-600	-	1	Depends
5.	Color Doppler	3-4	15-20 mins	1	2 Hours
6.	Echo	20	15-20 mins	1	6 Hours
7.	Chlonoscopy	3 / Week	45 mins	4	3 Hrs/Week
8.	Fluoroscopy	2-3	10-15 mins	3	1 Hour
9.	ETT	1	45 mins	1	5 Hours
10.	Holter Monitor	1	24–48 hours	1	24-48 Hours
11.	Gastroscopy	4	40 mins	3	2 Hours
12.	Bronchoscopy	2 per Week	1 Hour	3	2 Hrs/Week

Source: Survey conducted at FFH, Rawalpindi

A closer look on the statistics show that none of the machines is being under utilized as compared to patient to time ratio. However, a number of machines are being over utilized. For example, if we take the x-ray machines, their daily utilization is 230 tests. If on average each machine takes 3 minutes, each machine runs for about eleven hours.

Therefore, overall the x-ray machines operate for almost 11 hours per day. Interestingly, the operation hours of the hours of the hospital are 7 hours. Clearly the x-ray machines are working more than their capacity. Hence, in order to overcome this problem of overtime, one new machine needs to be installed. This will not only decrease the overtime running but also increase the output of the x-ray machines by increasing the daily utilization of the machines.

Similarly, the ultrasound machines are also operating over the running time of the hospital. Each machine is operating for more than three hours and overall working for 2 hours more than the hospital running time.

The hospital management must look into this matter as overtime running not only cost more but also causes the wear and tear of the machines, which would result in decreased lifetime of machine and eventually loss to the organization. Also the technicians working are over stressed and this causes loss in performance and reduced capacity.

6.3.3 EQUIPMENT MAINTENANCE AND STAFF TRAINING

Maintenance of technology at any service organization is of utmost importance for efficient flow of operations and high output(s). Similarly, for any hospital it is compulsory that its electro medical equipment is working properly as it has to render its services to a large number of patients.

FFH, Rawalpindi has its own maintenance department that works along with the firms which install machines / equipment at the facility. The equipment's maintenance phase is by going through either preventive or scheduled maintenance.

The Table 6.3 gives an idea of how the equipment's maintenance is carried out.

Machine maintenance at FFH is the responsibility of the maintenance department, which is headed by the Bio medical officer and the installing firm. Generally, 2 year contracts are signed where the firm provides free of cost maintenance. After that

period a new contract is established where the hospital pays the firm for its maintenance requirements.

From the data above, mostly the maintenance of equipment is done when the machine presents some problem i.e. corrective maintenance. However, the standard should be carrying out preventive maintenances so as to avoid any the equipment going out of order. The maintenance department should carry out scheduled weekly maintenances to ensure the proper working of the equipment. This would not only reduce the costs incurred but also enhance the operational capability.

Another important issue is the training of staff operating the equipment. According to the policy of FFH, the staff is trained free of cost by the representatives of company installing the machine.

The survey carried out for technology analysis yielded the same. The details are shown in Table 6.4 below.

Although the operating staff is trained to operate the equipment, still there was a consensus that the need for further training will always be there except that in case of auto analyzers. Another important observation that was made by the doctors and staff at FFH was that the training of operating the equipment should not only be provided to the minimum number of people required to run that machine, but also to a few other staff members so as to have backup support in case the normally working operators are not available. This would not only make the staff more competent but also reduce demand and capacity lags in case of non-availability of technicians normally assigned to operate the machines.

Table 6.3. Equipment Maintenance at FFH

S No.	MACHINE	MACHINE MAINTENANCE		MAINTENANCE DONE AT		
		PREVENTIVE	SCHEDULED	AT FFH	LOCAL SERVICE CENTER	PARENT SERVICE CENTER
1.	X-Ray Machines	√	√	√		
2.	Ultrasound Machines	√		√		
3.	Dialysis Machines	√		√		
4.	Auto Analyzers	√		√		
5.	Color Doppler	√		√		
6.	Echo	√	√	√		
7.	Chlonoscopy	√		√		
8.	Fluoroscopy	√		√		
9.	ETT	√		√		
10.	Holter Monitor	√		√		
11.	Gastroscopy	√		√		
12.	Bronchoscopy	√		√		

Table 6.4. Staff Training

S No.	MACHINE	IS THE STAFF TRAINED FOR OPERATION		NEED FOR FURTHER TRAINING
		YES	NO	
1.	X-Ray Machines	Yes		Yes
2.	Ultrasound Machines	Yes		Yes
3.	Dialysis Machines	Yes		Yes
4.	Auto Analyzers	Yes		No
5.	Color Doppler	Yes		Yes
6.	Echo	Yes		Yes
7.	Chlonoscopy	Yes		Yes
8.	Fluoroscopy	Yes		Yes
9.	ETT	Yes		Yes
10.	Holter Monitor	Yes		Yes
11.	Gastroscopy	Yes		Yes
12.	Bronchoscopy	Yes		Yes

Source: Survey conducted at FFH, Rawalpindi

6.3.4 TECHNOLOGY PLANNING FOR FUTURE

One of the most important issues is the technology planning for future. For any hospital it is necessary to plan for future expansion and improving its facilities.

FFH is not only just a hospital but it is also a teaching hospital as it is affiliated with the FUMC. Hence, the technology planning is done in accordance to the needs of the FUMC, its beneficiary base and also the rules and regulations set by Pakistan Medical and Dental Council.

The Central Equipment Selection Committee is responsible for this planning. It keeps in mind the patients equipment demand and also the standard requirements.

6.3.5 PROCESS FOR INDUCTION OF TECHNOLOGY

The equipment / machines are inducted in to the hospital after going through long process. The induction is generally done in three forms:

- ***New Induction*:** The new induction refers to installing a machine which was previously not available at the hospital premises
- ***Replacement*:** The replacement is done when an existing machine goes out of order and is not repairable or its repair is not cost effective.
- ***Upgradation*:** The concept of upgradation is associated with the machines that have the capacity to re module via some software enhancements or can be integrated with new hardware, which is state of the art.

The process of induction of any kind at FFH, involves the participation of four major entities. These include:

- Hospital (referred to as the project)
- Welfare Division (Health)
- Procurement Department
- Finance Division (Health)

The hospital's role is in providing the demands that are selected during the meeting of Medical Superintendent (MS) and the Electro medical Selection Committee (ESC). Also at the hospital is the CESC, which vets the demands and prioritizes the equipment according to the needs of the hospital.

The welfare division health (WD (H)) is responsible for forwarding and receiving all the communication done between various departments and playing a major role in generating the final equipment demand list and price negotiations that is done by the finance division.

The procurement department (CPO) is responsible for floating the ITs (Invitation of tenders), preparing the comparative statement (CST) and finally placing the purchase orders as approved by the Central Board of Directors.

A detailed process flow chart technology induction is shown in Figure 6.3.

The induction process is the same for all three types of induction. However, when the demand list is being made, first priority is given to replacement of an existing flawed machine, second to the upgradation and third priority to the new induction.

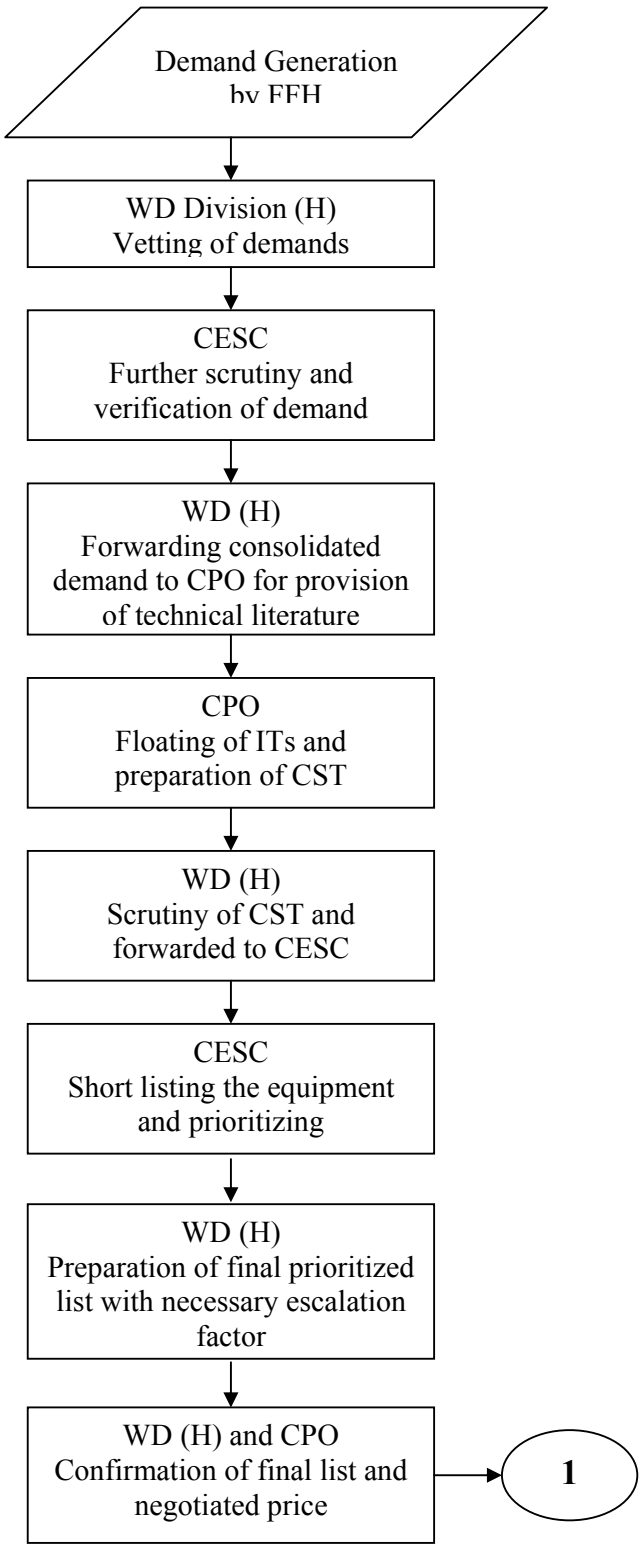

Demand Generation
by FFH
WD Division (H)
Vetting of demands
CESC
Further scrutiny and
verification of demand
WD (H)
Forwarding consolidated
demand to CPO for provision
of technical literature
CPO
Floating of ITs and
preparation of CST
WD (H)
Scrutiny of CST and
forwarded to CESC
CESC
Short listing the equipment
and prioritizing
WD (H)
Preparation of final prioritized
list with necessary escalation
factor
WD (H) and CPO
Confirmation of final list and
negotiated price
1

Figure 6.3. Contd

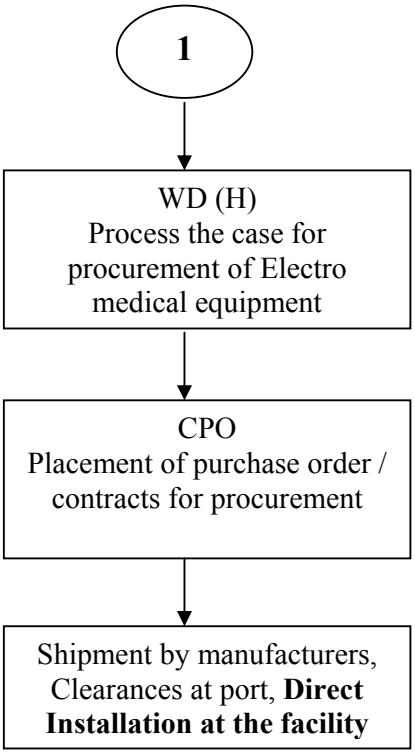


Figure 6.3. Process Chart for Technology Induction

Some important issues concerning the induction process are discussed below:

6.3.5.1 INDUCTION PROCESS TIME

The whole induction process is done annually and the process takes about three and a half months time to complete from demand generation to machine installation. As the induction process is carried out annually, it is often the case that if a machine runs out of order during a period where the demand cannot be generated it remains unreplaced. This result in low levels of output, customer dissatisfaction and eventually prolonged demand supply gap. No methodology is yet in order to cater for this problem. Efforts should be made to ensure the availability of generating periodic demands and machine inductions.

6.3.5.2 COMPARTIVE STATEMENT

The comparative statement that is made by the CPO is based upon the analysis of technical specifications, price, price validity, model and country of origin.

6.3.5.3 VENDORS

The selection of vendors is not specific but is generic. The vendor is selected on the base of the offer that is made in the tender. Normally, preference is given to the company which provides the best specification, warranty and whose hardware backup support is available.

6.3.5.4 REPLACED EQUIPMENT

The equipment that is replaced goes through a life cycle assessment process before being replaced. Initially, its working is monitored. If the working is up to the mark, the machine is given extension.

Secondly, the machine / equipment is improperly working but has some capability to perform it is down classified. Once if its down classified, its demand is raised i.e. its priority is raised.

Thirdly, if the machine is beyond repair or operation then it is condemned and is then auctioned at FFH, Rawalpindi.

6.4 Qualitative Analysis

The qualitative analysis was done to get an idea of how the doctors, staff and patients react to the services provided by FFH's Female Medical Ward. A survey was conducted (**Annexure C**) in both indoor and out door female medical wards. The survey was conducted Thursday, 12 March 2009 at 11:00 am local time in both indoor

and outdoor wards simultaneously. The survey was designed to determine the capacity issues in light of peoples opinion. The targeted masses were that of doctors, staff, patient attendants and pateints.

The analysis of the survey responses and results are discussed below.

6.4.1 Doctor / Staff Analysis

The FFH Female medical ward has 36 doctors and nursing staff of 24. Out of these 4 are specialist, 6 registrars, 4 PGTs, 14 MOs and 8 HOs.

6.4.1.1 Indoor Patient Ward

Considering the Indoor Patient wards which have a capacity of 132 beds meaning it can cater for a maximum of 132 patients at a single time the number of Patients per doctor can be deduced as shown in Table 6.5.

The number of Patients / Doctor was also calculated via a survey conducted at the FF Female medical ward. The results from that survey were slightly different from that of theoretical results. The surveys showed the number of patients / doctor was more than that in theory. The results of the survey are shown in Table 6.6.

The comparison of theoretical and survey results show that most of the doctors handle more patients in comparison to the number of patients they are assigned. This clearly shows that there is some discrepancy in the way the system works. Only the registrars are managing fewer patients than they are assigned. This was because almost all the registrars were not committed to performing their duty and made the administrative work duty an excuse for underperformance. Also the PGTs, MOs and HOs suggested that their duties go beyond the normal working hours and proper scheduling of duties is needed.

Theoretically, there are 24 nurses for the 132 bed female medical ward. The duties of nurses are divided into three shifts. The nurses work in groups of eight per shift. That means that there is a 1:16 nurse to bed ratio, which is not in accordance with the WHO standards i.e. 1:3. The nurse to bed ration is even higher than that stated by FFH (1:11) itself. 1 nurse for 16 patients clearly states that the nurses are overworked which affects their work and efficiency resulting in poor provision of services and reduced capacity. Employment of more nurses is a must to cater for this problem. Moreover, the tasks the nurses perform like catheter change, drip injection and monitoring, patients' stats etc. need to be standardized. Proper trainings / workshops

are required to help nursing staff master the tasks and standardize the time they take to perform these tasks.

Table 6.5. Theoretical Results of Patients / Doctor

Doctor's Category	Number of Patients / Doctor 2008	Number of Patients / Doctor 2007	Number of Patients / Doctor 2006
Specialists	33	36	38
Registrars	22	27	24
PGTs	33	36	37
Mos	9	12	11
Hos	17	21	22

Table 6.6. Survey Results of Patients / Doctor

Doctor's Category	Number of Patients / Doctor
Specialists	33
Registrars	12
PGTs	37
Mos	15
HOs	31

Source: Survey conducted at FFH, Rawalpindi

6.4.1.2 Outdoor Patient Clinic

The average patients that visit the Outdoor clinic is 7007 patients / week. For every Outdoor Patient Day (OPD) there is 1 specialist, 1 MO, 1 PGT and 3 HOs available. The OPD is in operation for 7 hours (7:30 – 2:30) six days a week.

A survey **(Annexure D)** was conducted in the medical OPD to get an idea of how the doctors function there and whether there is a need to build on OPD capacity.

The survey results showed that 58% of the doctors had to manage 100-150 patients per day whereas only 5% had to mange 50 or fewer patients per day. The OPD Patient load on doctors is shown in Figure 6.4.

The standard number of patients to doctor per day stands at 75-80[3]. In comparison, the graph above clearly shows that the doctors are overworked which affects their efficiency resulting in capacity lag. The doctors present in order to cater for as many as patients as possible need to manage their OPD time and also the strength of doctors for a single OPD needs to be increased. The staff has to make sure that not only that they manage as many patients as possible but also provide quality health service to all patients and make sure that they follow the work ethics.

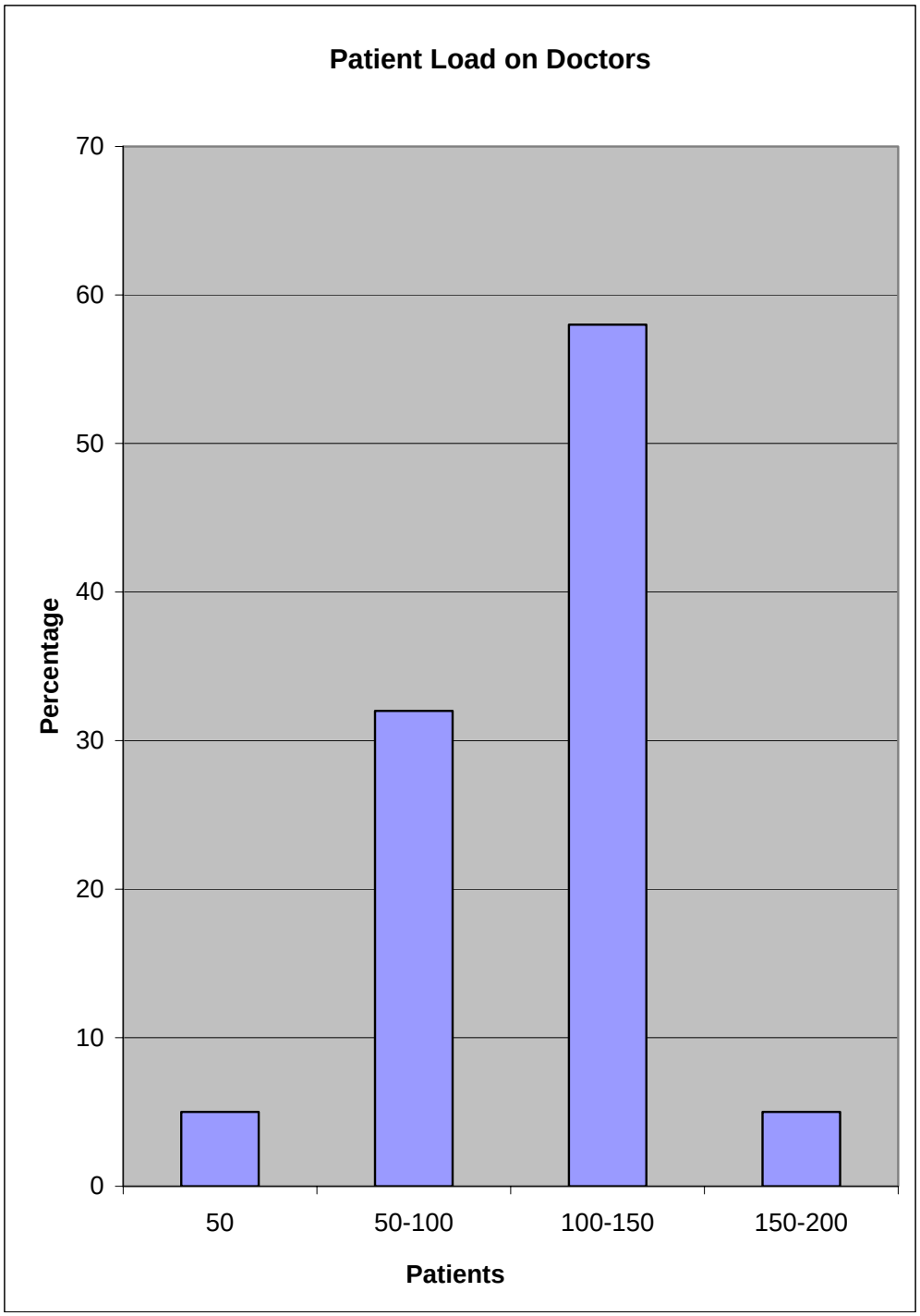


Figure 6.4. Patient Load on Doctors

Source: Data collected from Survey conducted at Fauji Foundation Hospital

The average time consumed by a single patient is shown in Figure 6.5.

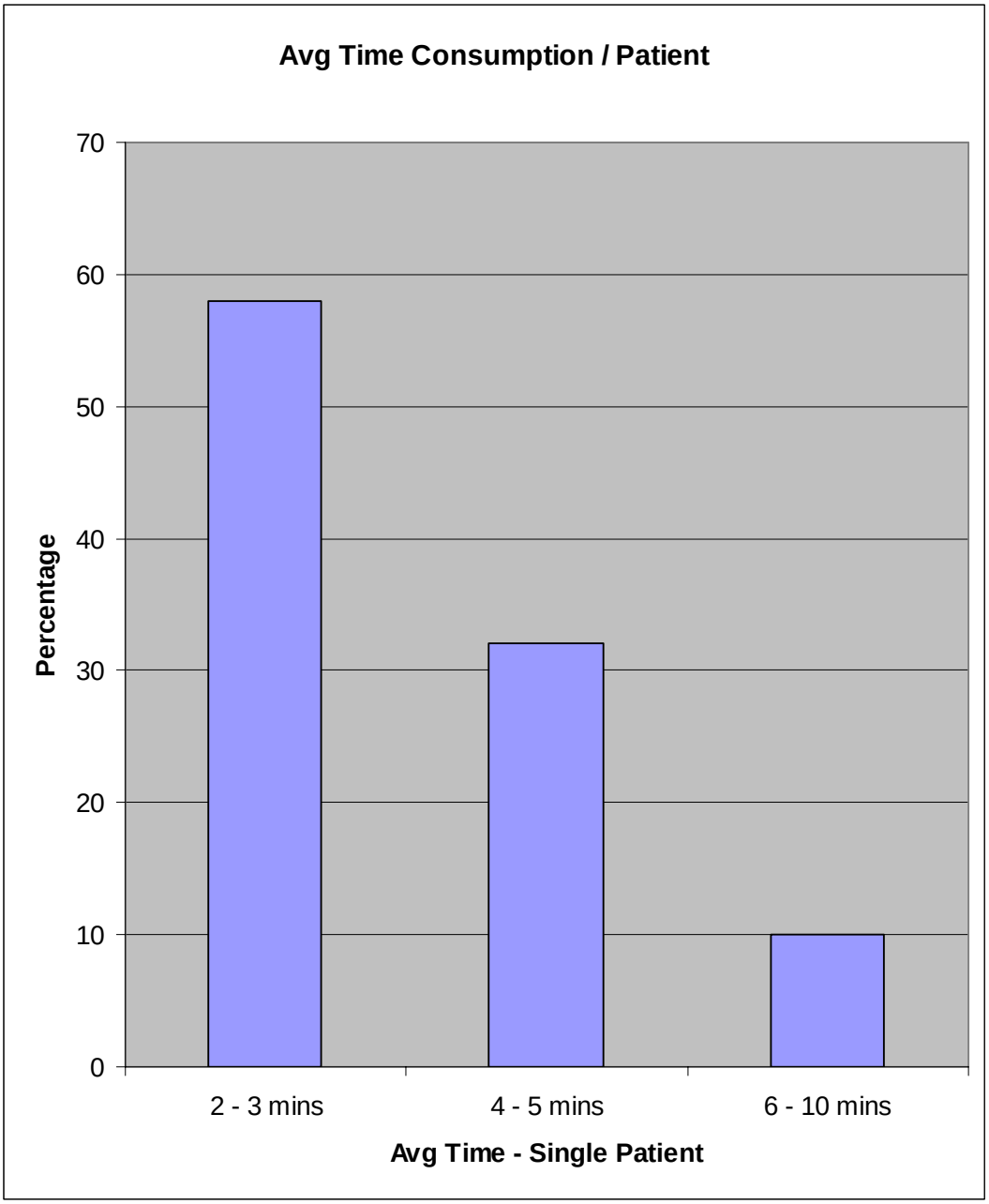


Figure 6.5. Average Time Consumption / Patient
Source: Data collected from Survey conducted at Fauji Foundation Hospital

Out of all the patients that visit the OPD, 58% of the patients consume 2 - 3 minutes whereas only 10% patients take over 5 minutes.

The survey also yielded that 67% of the doctors believe that the strength of doctors is insufficient for a single day in OPD while 33% of doctors considered the strength to be sufficient.

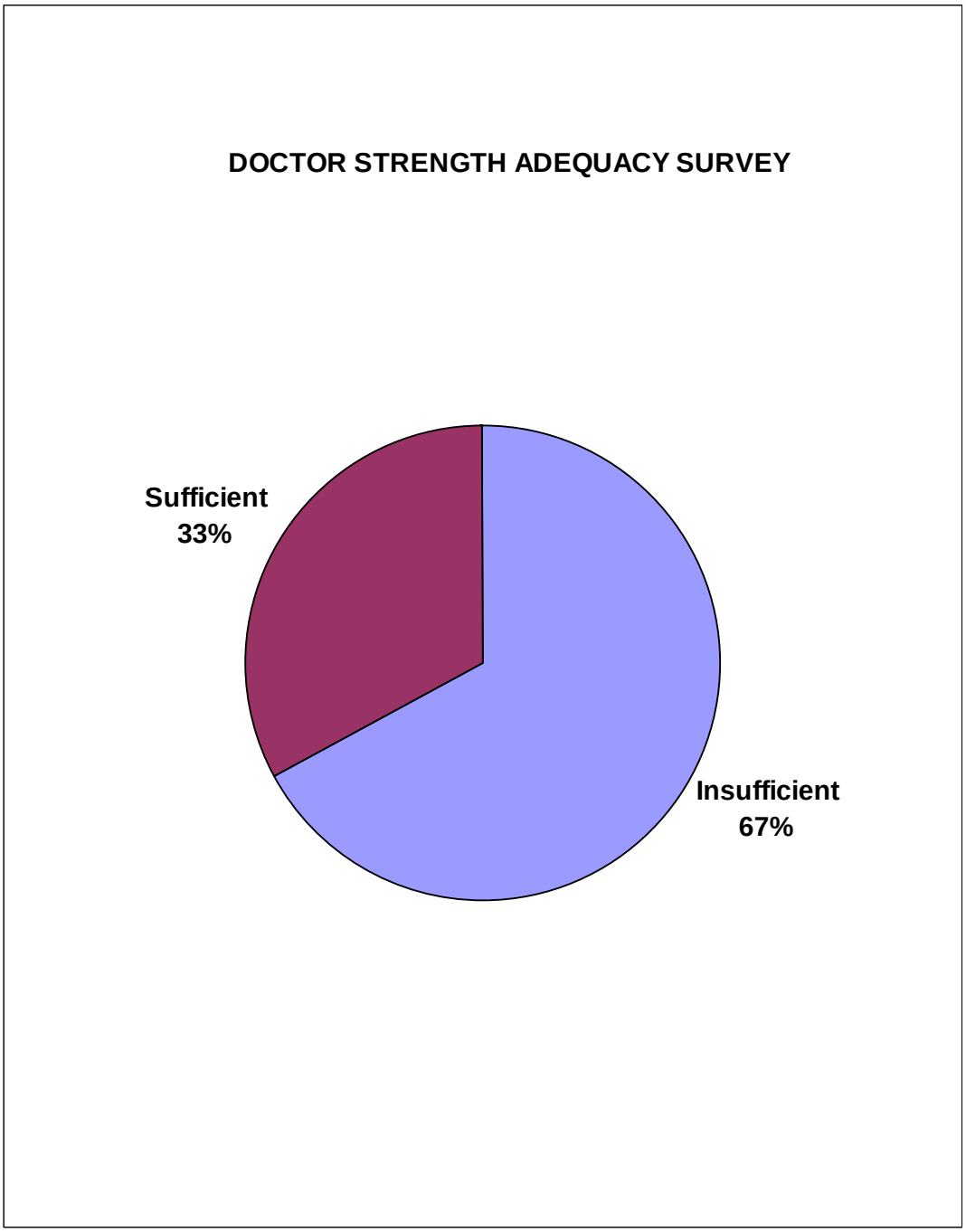


Figure 6.6. Doctor Strength Adequacy Survey

Source: Data collected from Survey conducted at Fauji Foundation Hospital

On the question of training of nursing and support staff present in the medical OPD the results were quite different from that of doctor strength adequacy survey.

Nearly 76% of the doctors agreed that the nursing and support staff was inadequately trained as shown in Figure 6.7. An emphasis was made to make the on job trainings mandatory. Also, the staff should be monitored so as to make sure that their performance matches the needed standard.

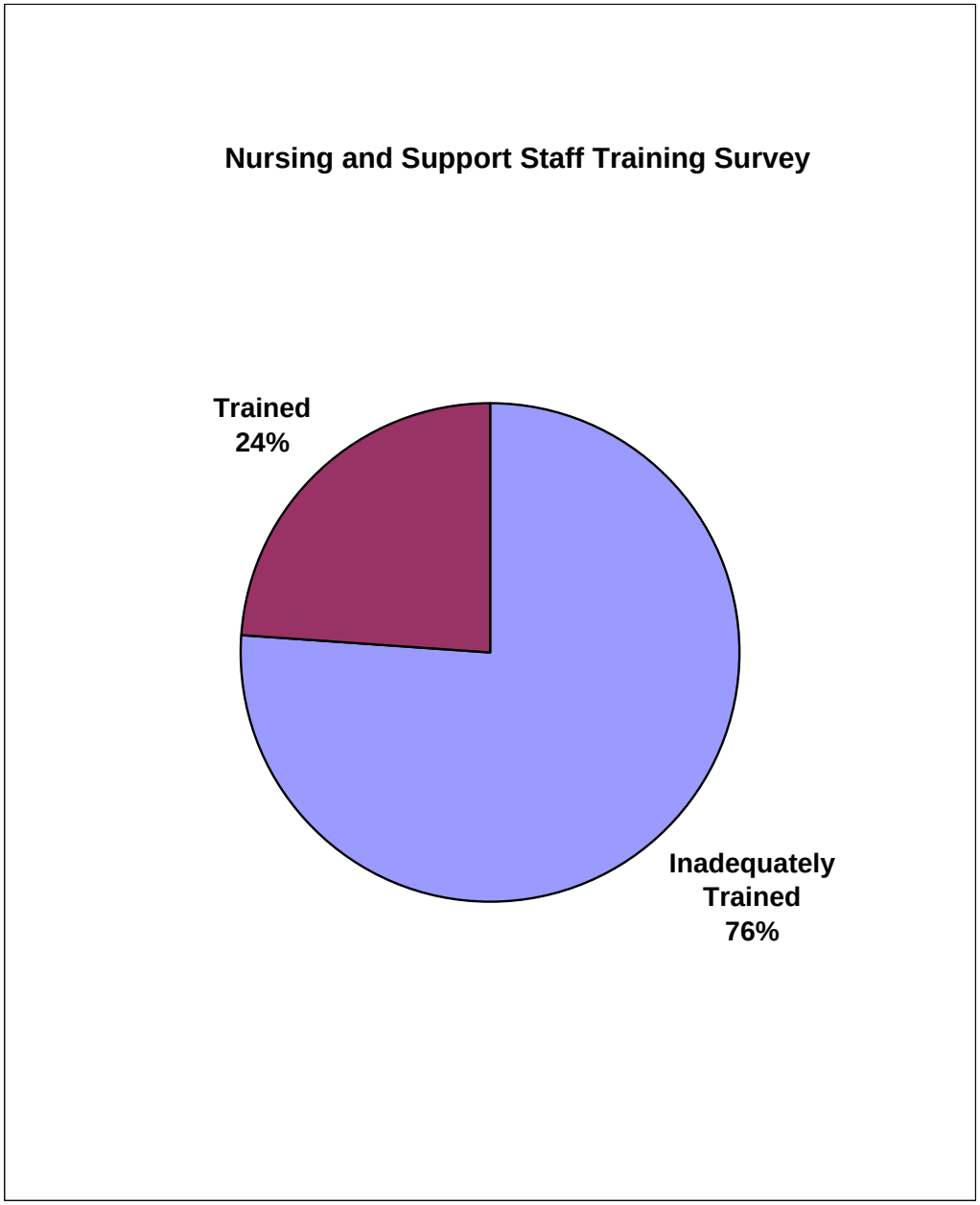


Figure 6.7. Nursing and Support Staff Training Survey

Source: Data collected from Survey conducted at Fauji Foundation Hospital

The survey also showed that 100% of the doctors admitted that even on OPD days they had to handle indoor and emergency patients. Also the OPD duties a re scheduled irrespective of the fact that the doctor has served a night duty. This results in exhaustion of doctors and their work is adversely affected.

The frequency of OPD duty was also deduced from the survey. This OPD duty ratio is shown in Figure 6.8. According to 63% of the doctors they had to perform the OPD duty more than three times per week. 27% of the doctors suggested that OPD duty was assigned to them twice a week.

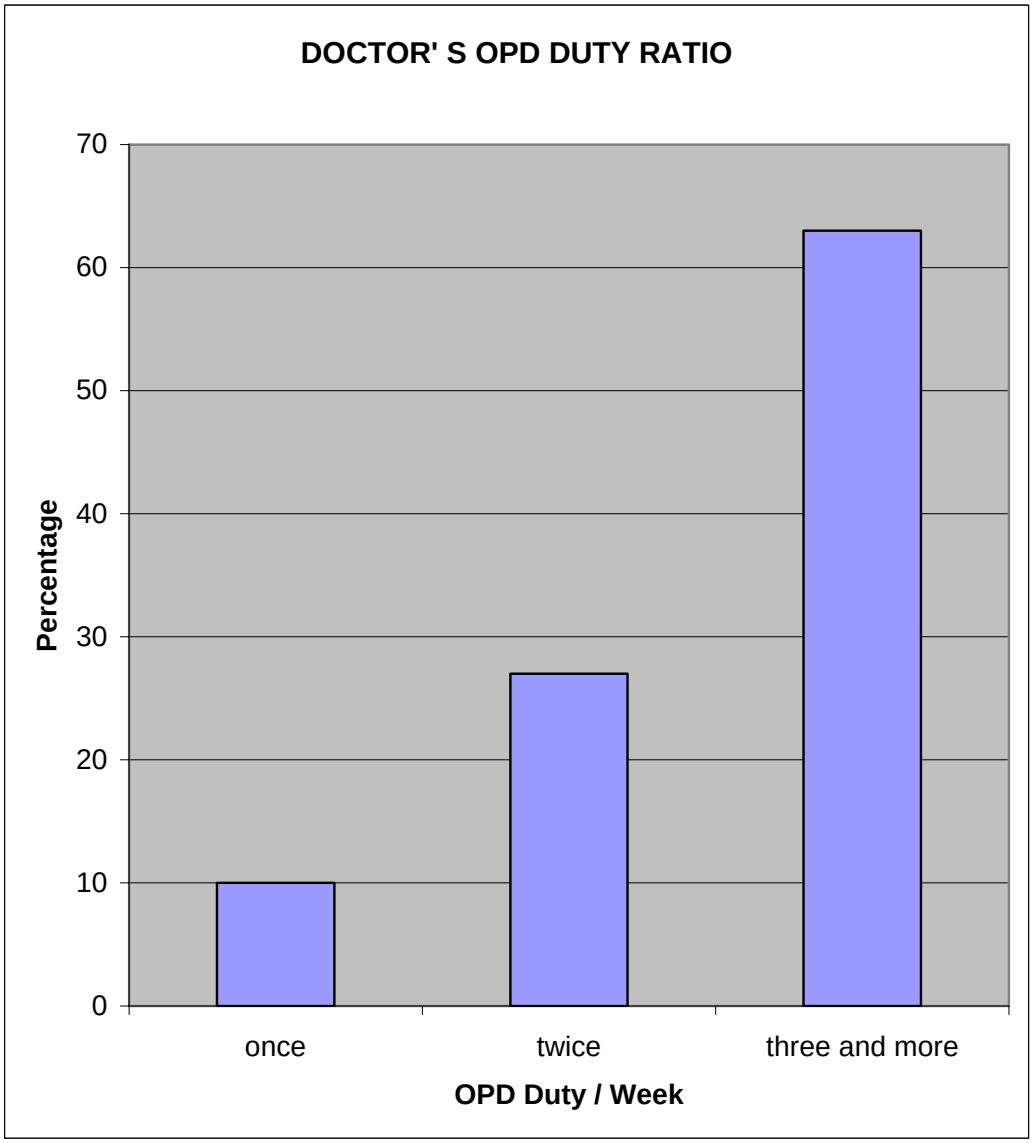


Figure 6.8. Doctor's OPD Duty Ratio

Source: Data collected from Survey conducted at Fauji Foundation Hospital

Clearly, the doctors at FFH Female medical ward are over-worked and although theoretically the workload is distributed among all the doctors but practically it isn't the case. Most of the junior doctors are covering up for senior doctors in their absence. Proper scheduling should be done so as to divide the workload in order to avoid exhaustion on part of junior doctors and improve efficiency. Also, feedback should be taken from the staff on frequent basis that will give an insight into problems faced by them. Proper training of staff should be catered for. Special on job trainings and seminars should be held to achieve standard health care services.

6.4.2 Patient Feedback Analysis

6.4.2.1 Outdoor Patient Clinic

Similar to the survey conducted amongst doctors, a survey was conducted in the medical OPD to get an idea of how the patients react and respond to the services provided to them. The results of this survey will serve as an input to the service capacity model. Nearly 54% of the patients suggested that they visit the OPD twice a month and only 2% visited the OPD more than 5 times. The frequency of patients OPD visit can be seen in Figure 6.9.

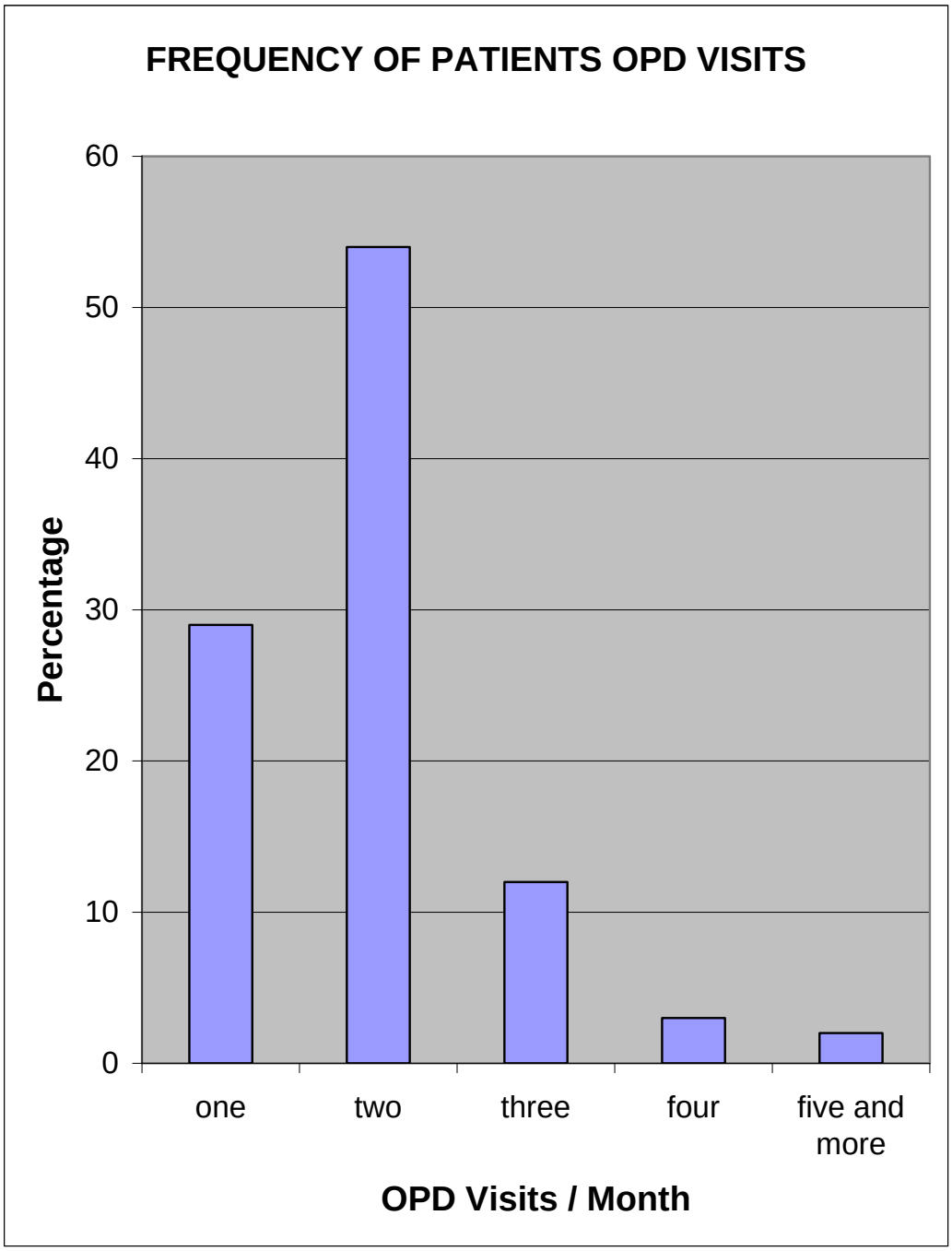


Figure 6.9. Frequency of Patients OPD Visits

Source: Data collected from Survey conducted at Fauji Foundation Hospital

Most of the patients were of the opinion that due to the large number of patient attendance at the OPD the waiting times were too long and even some patients had to return back due to unavailability of doctors or time shortage.

Hence, the patients were asked of their preferred time of visiting. 88% of the total patients present agreed on the fact that they preferred coming early in order to avoid long waiting lines. The patient feedback on preferred visiting time is shown in Figure 6.10.

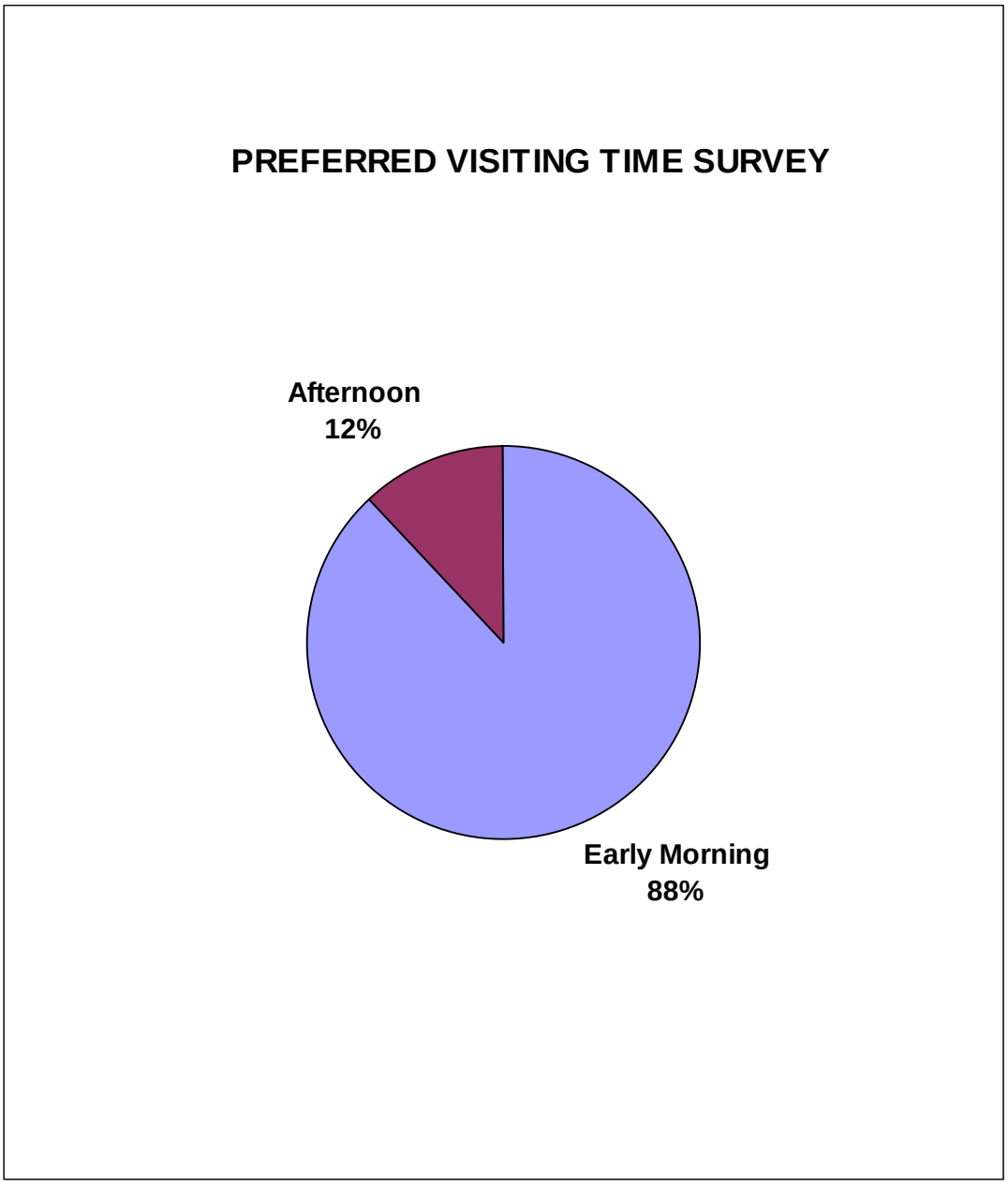


Figure 6.10. Preferred Visiting Time Survey

Source: Data collected from Survey conducted at Fauji Foundation Hospital

Although most patients preferred coming early still they had to wait for a long time for their turn to get checked up.

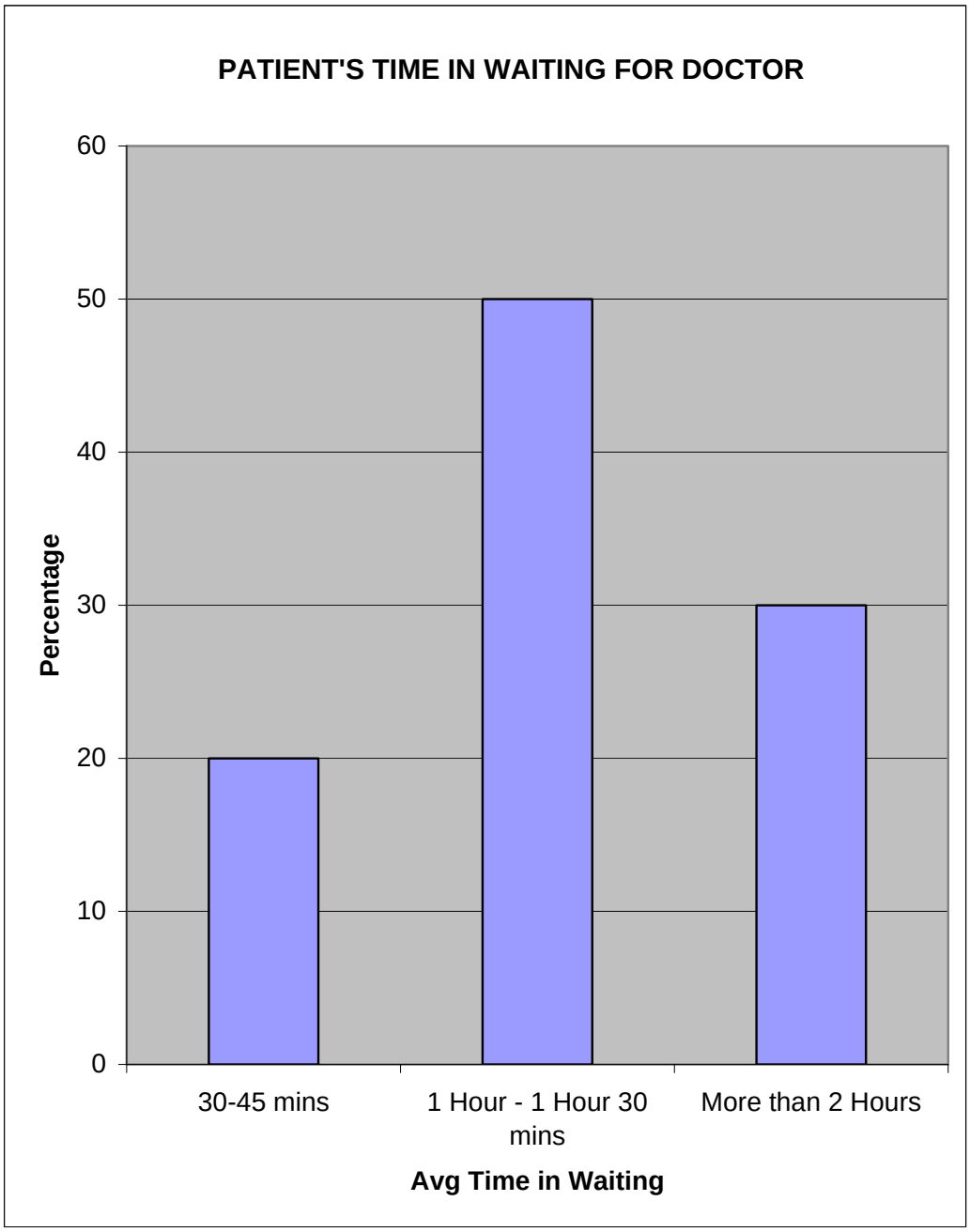


Figure 6.11. Patient's Time in Waiting for Doctor

Source: Data collected from Survey conducted at Fauji Foundation Hospital

On analysis it was found that 50% of the patients had to wait for around 1 hour or more. 30% patients had to wait over 2 hours. The waiting area is normally filled with patients and long waiting times result in overcrowded waiting room and eventually a suffocating environment. This causes them to faint or in need of emergency medical attention.

The survey also yielded that 63% of the patients believe that the strength of nursing and support staff present is sufficient for a single day in OPD while only 37% of patients considered the strength to be insufficient.

The staff adequacy survey results are shown in Figure 6.12.

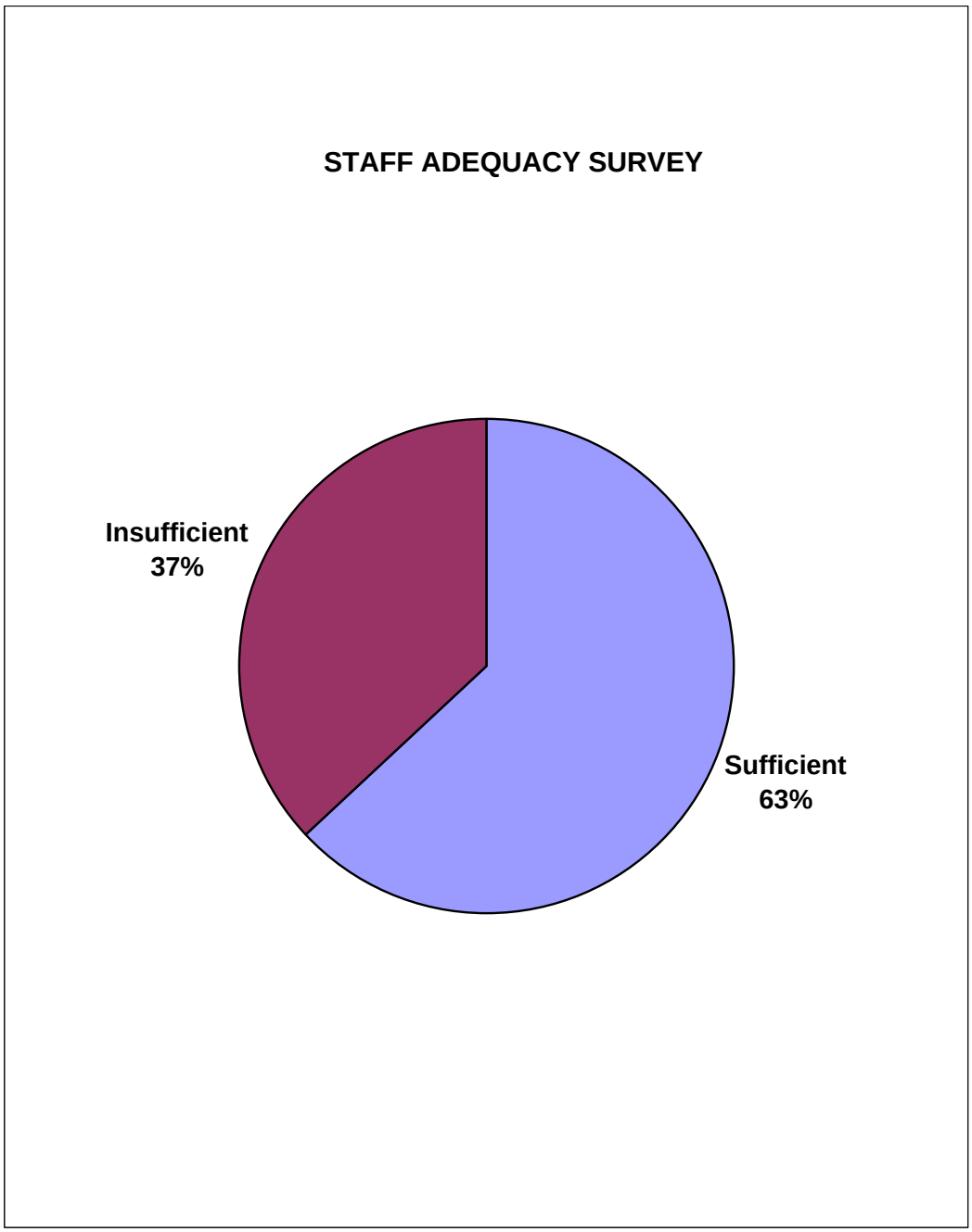


Figure 6.12. Staff Adequacy Survey

Source: Data collected from Survey conducted at Fauji Foundation Hospital

Also, the way the staff handled the patients medically needs more standardization. This would require constant or at least periodic monitoring. The feedback of patients on staff training is shown in Figure 6.13.

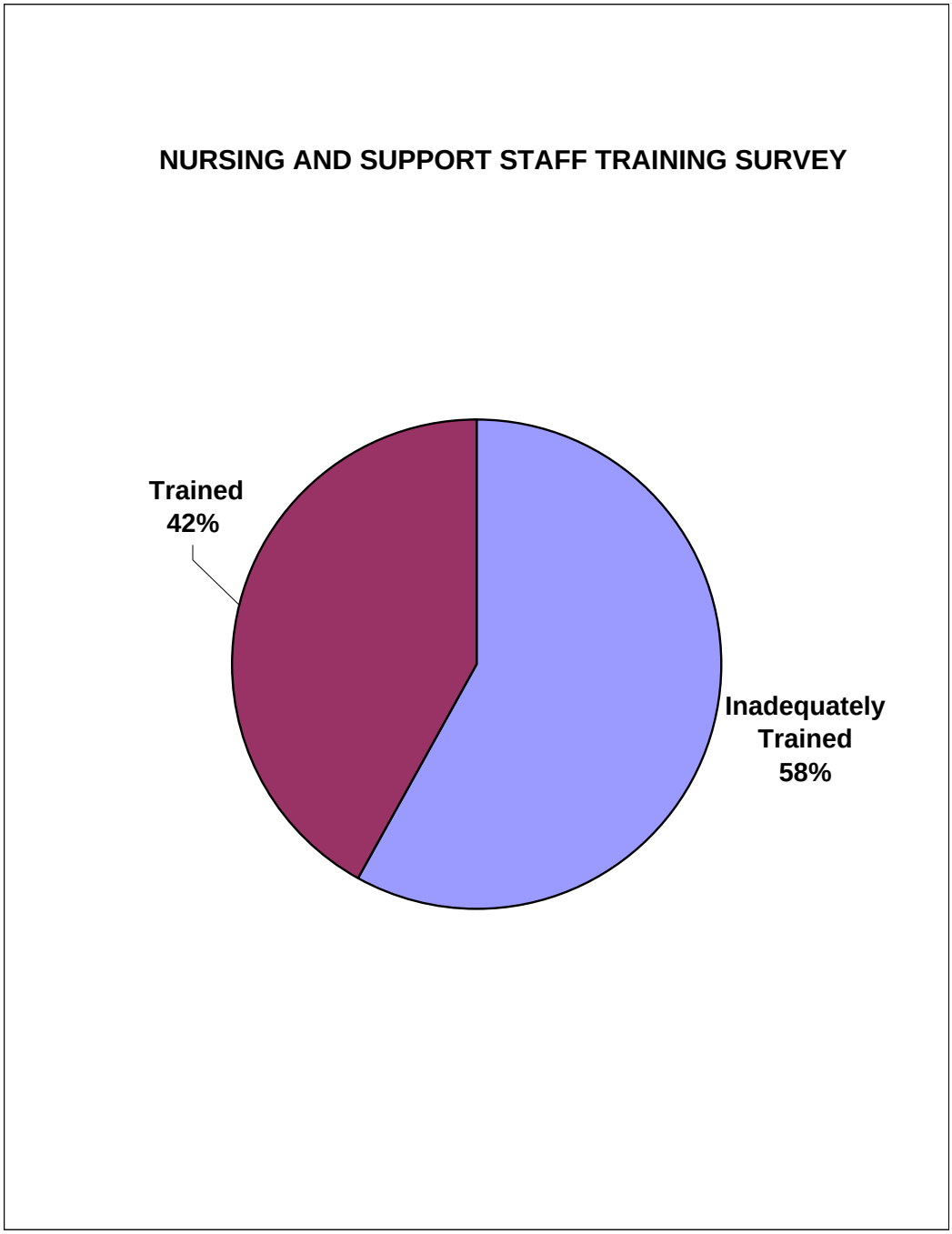


Figure 6.13. Nursing and Support Staff Training Survey

Source: Data collected from Survey conducted at Fauji Foundation Hospital

On the question of training of staff present in the medical OPD the results came out to be quite similar to that of the results from the doctors feedback regarding this issue. 58% of the patients believed that the nursing and support staff was not adequately trained while 42% disagreed. An emphasis was made by many patients to ensure that ethical training of the staff was a must.

The patients were also asked if the space in waiting area of the medical OPD was adequate. Out of total number of patients present 63% were of the opinion that the space wasn't adequate and needed expansion plus proper heating and cooling system should be arranged so as to make the patients comfortable. Figure 6.14 shows the results of space adequacy survey.

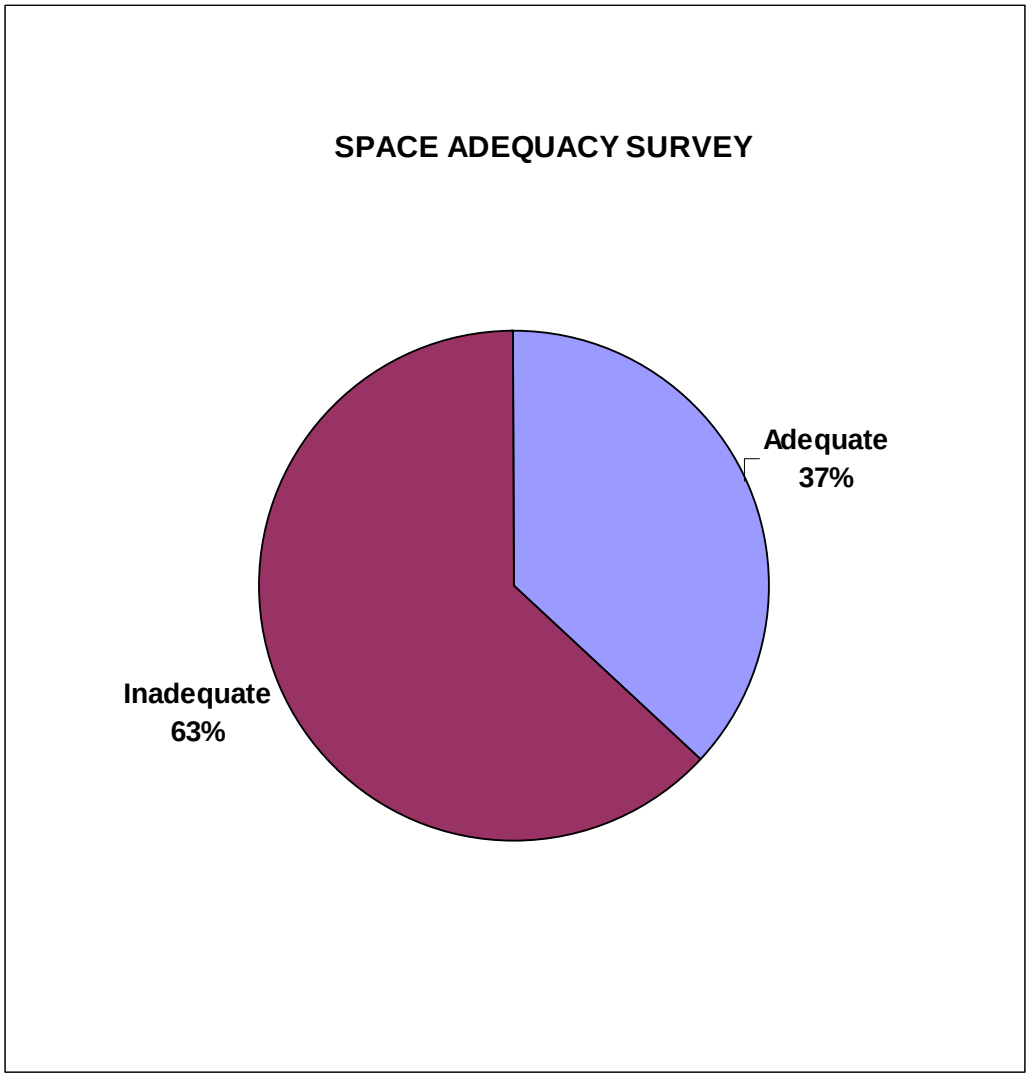


Figure 6.14. Space Adequacy Survey

Source: Data collected from Survey conducted at Fauji Foundation Hospital

The patients were also asked if they were satisfied with the computerized system for slip generation. 100% Patients agreed that the computerized system of issuing patient slips was better than the manual method as that made the system efficient and faster. The female medical OPD space needs to be managed properly. Proper ventilation system should be catered for. A token number system can be installed so as to make the OPD checkup system smooth and increase productivity in terms of providing medical assistance to as many patients as possible. The customer satisfaction can be achieved to some extent if the staff understands the ethics and code of conduct when dealing with patients.

6.4.2.1.1 Medical Store, Laboratory and Radiology

The patients are referred from OPD to either medical store or for laboratory for tests. The feedback was also taken on the time they had to wait at medical store and the laboratory. The FFH medical store caters for over 1000 patients per day[71]. Still a huge number of patients are not entertained. Waiting lines are too long and many patients have to wait for a very long time. The survey yielded that 75% of the patients had to wait for over 2 hours in order to get medicine form the medical store that can be seen in Figure 6.15.

The medical store has only 1 counter where both the prescriptions are submitted and the medicines are issued. This causes over-crowding and long waiting lines. There is some space available around the medical store so as to renovate and expand the facility. Also, separate counters for men and women need to be established in order to evenly distribute the patients.

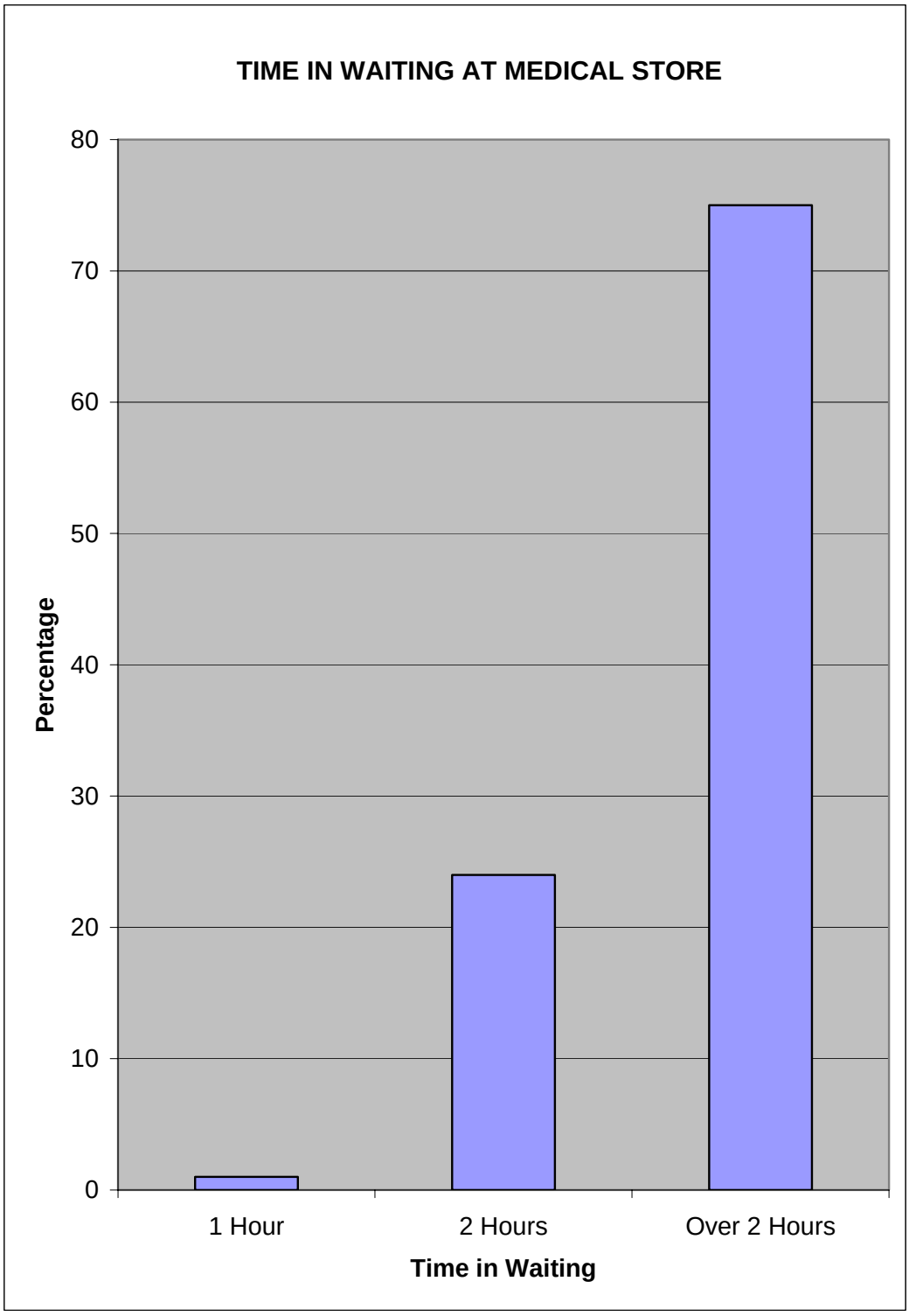


Figure 6.15. Time in Waiting for Medical Store

Source: Data collected from Survey conducted at Fauji Foundation Hospital

Similarly, the time it takes for the patients to get their tests done from the laboratory and radiology department was also reviewed via the survey as shown in Figure 6.16. 53% patients were of the opinion that waiting time for test was 30-45 minutes where as only 3% had to wait over an hour.

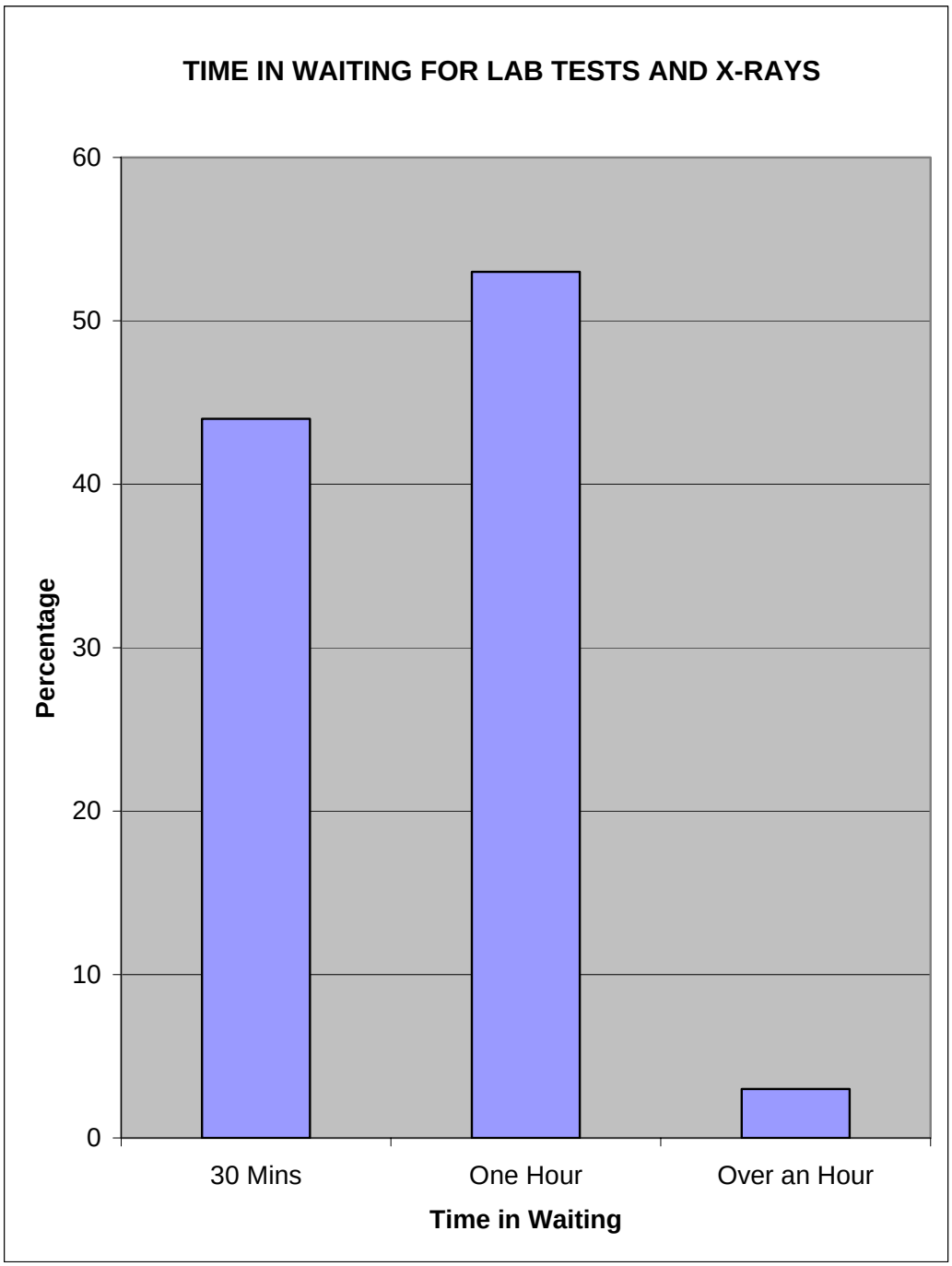


Figure 6.16. Time in Waiting for Lab Tests and X-Rays

Source: Data collected from Survey conducted at Fauji Foundation Hospital

The laboratory and radiology departments are quite efficient as compared to the medical store. Although the number of machines present in for x-ray are only two and that creates a problem when the demand is more. As a result of which the machines have to run overtime for many hours. Still its performance is better than that of the medical store.

6.5 Quantitative Analysis

There are many innovative procedures, calculations and methodologies to carry out the quantitative analysis. These include linear and non-linear programming, analytical modeling and simulation modeling.

In our case we will focus on simulation modeling as it gives the best possible and accurate results. Monte Carlo Simulation was used to analyze the capacity of the female medical ward's indoor and out door units in terms of minimum number of beds and facility needed for the patients. Also, the patients referred to the x-ray department were taken into account to and minimum number of test demand was determined. The Monte Carlo simulation includes data collection, random number assignment, model formulation and analysis.

The basic simulation system and process is illustrated in Figure 6.17.

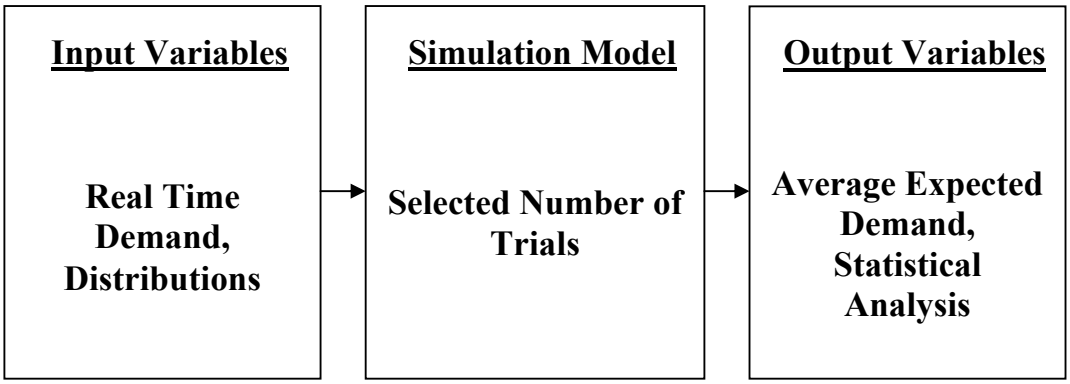


Figure 6.17. The Basic Simulation System and Process

The selected number of trials depends upon the modeler. No specific number is defined for the number of trials. The number of trials however depends on the type of software used, accuracy needed, processing speed of the computer and the importance of achieving 'close to life' results etc. The outputs refer to results obtained which will be having their own distribution depending upon the input distributions. From the outputs obtained the statistical analysis can be performed to provide an insight into rational decision-making.

6.5.1 Indoor Patient Ward

The female medical ward indoor unit has 132 beds allocated to it. To analyze the minimum number of beds that should be there to fulfill demand and use the results to manage / build capacity we carry out the simulation process.

6.5.1.1 Data Collection

The first step was to gather the data required to run the simulation. The input(s) to this model was the real-time demand; in this case the incoming patients per week, and their probability distributions. The historical data of Sep 2006 – Oct 2008 more specifically 100 weeks was gathered is shown in Table 6.7.

The Figure 6.18 shows the trend of incoming indoor patients from Sep 2006 - Oct 2008.

Table 6.7. Indoor Patient Status Sep 2006 - Oct 2008

Month	Total	Week 1	Week 2	Week 3	Week 4
Sep 2006	219			104	115
Oct 2006	474	110	120	131	113
Nov 2006	415	95	104	112	104
Dec 2006	433	127	87	109	110
Jan 2007	444	98	108	117	121
Feb 2007	410	102	98	95	115
Mar 2007	431	115	80	116	120
Apr 2007	411	105	100	99	107
May 2007	414	118	77	98	121
June 2007	461	133	120	98	110
Jul 2007	466	116	121	105	124
Aug 2007	468	130	117	106	115
Sep 2007	428	96	110	97	125
Oct 2007	442	101	132	100	109
Nov 2007	430	96	112	117	105
Dec 2007	410	101	97	92	120
Jan 2008	427	105	117	98	107
Feb 2008	455	118	87	120	130
Mar 2008	415	95	112	100	108
Apr 2008	411	99	102	98	112
May 2008	441	116	100	124	101
June 2008	469	120	131	102	116
Jul 2008	478	124	112	124	118
Aug 2008	436	117	101	103	115
Sep 2008	430	84	127	129	90
Oct 2008	226	115	111		
Total	**10944**				

Source: FFH Rawalpindi

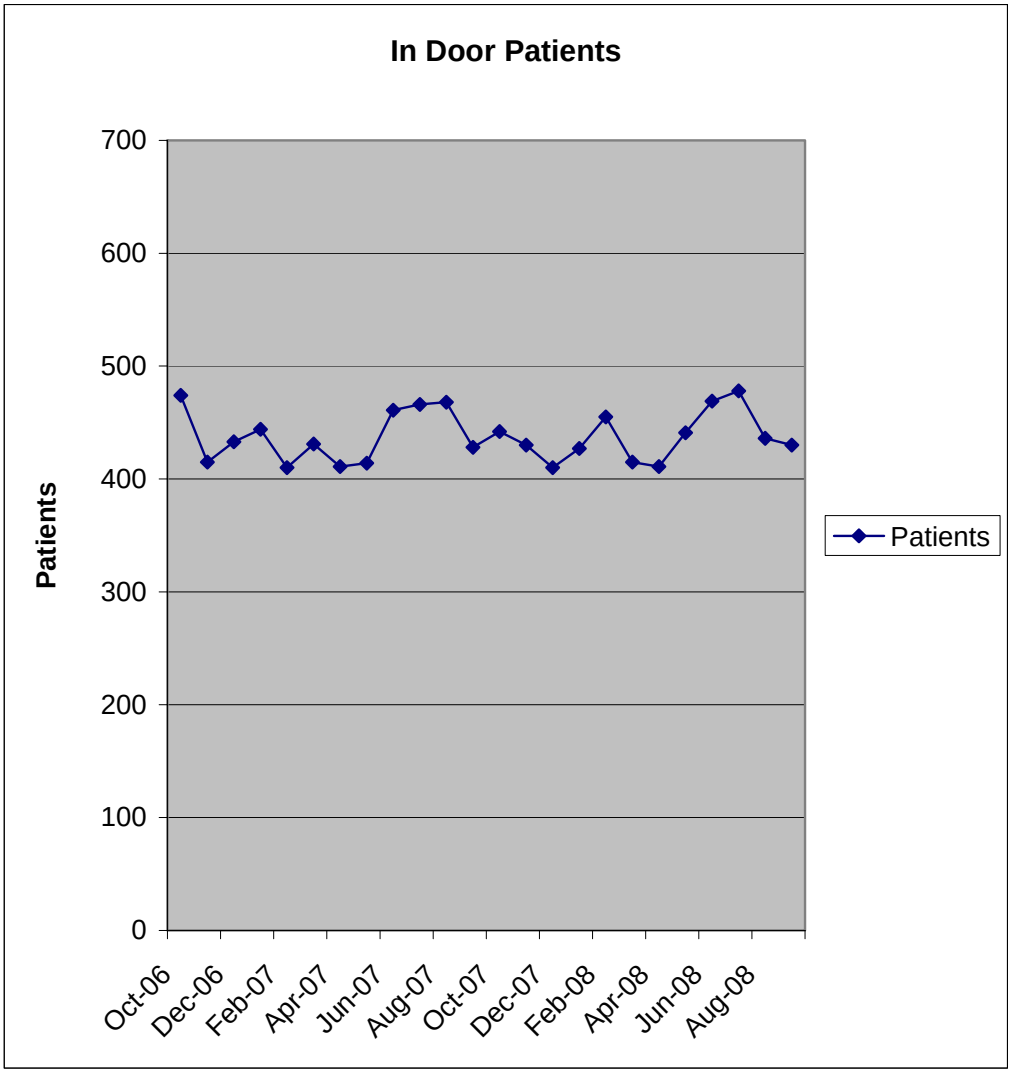


Figure 6.18. Indoor Patients Sep 2006 – Oct 2008

Source: FFH Rawalpindi

6.5.1.2 Probability Distribution

Historical data collected was then grouped into categories from 77 - 133 patients. Probability distribution was then applied to this data as shown in Table 6.8 using the formula:

P (X) = Frequency (X) / Total Weeks

6.5.1.3 Random Number Assignment

Once the probability distribution is done the next step is the random number assignment. The simulation will run for 100 weeks to start with. Depending on the probability the ranges of random numbers are defined. A **random number** is a number that has the same probability of being selected as any other number. (**Annexure E**). The Monte Carlo process generates the random variable, demand, by "sampling" from probability distribution. Once random numbers are generated, their ranges are then assigned to the weekly patient demand in the same proportion as their probability of occurrence as shown in Table 6.9.

6.4.1.4 Simulation Experiment

Random number assignment follows the actual simulation run. The software used for simulation in this research is MATLAB. The random numbers are generated using the formula:

Rands=floor (1000*rand (k,1))

Once the random number is generated the program compares it with the assigned ranges. For example, from the random numbers generated in the first simulation run, we take the first random number generated. It is then compared to the random number assignment table. The number 331 falls in the range 330-339 which corresponds to the 103 patients. By repeating this process of selecting all random numbers one by one from the random number table generated and then determining weekly patient demand from the random number, we simulated demand for a period of time as shown in Table 6.10.

Table 6.8. Probability Distribution of Indoor Patients / Week

Weekly Patient Demand	Frequency of Demand	Probability P (X)
77	1	0.01
80	1	0.01
84	1	0.01
87	2	0.02
-	-	-
100	4	0.04
101	4	0.04
-	-	-
131	2	0.02
132	1	0.01
133	1	0.01
	Total 100	Total 1.00

Table 6.9. Random Number Assignment Table – Indoor Patients

Weekly Patient Demand	Probability	Random Number Range
77	0.01	0-9
80	0.01	10-19
84	0.01	20-29
87	0.02	30-49
-	-	-
-	-	-
100	0.04	220-259
101	0.04	260-299
-	-	-
131	0.02	960-979
132	0.01	980-989
133	0.01	990-999

Table 6.10. The Simulation Experiment – Indoor Patients

Week	RN	Range	Patient Demand
1	331	330-339	103
2	999	990-999	133
-	-	-	-
225	444	440-459	108
226	532	530-579	112
-	-	-	-
1857	523	770-829	111
1858	263	260-299	101
-	-	-	-
2720	771	770-829	120
			Σ = 296480

As the simulation was run for 2720 weeks results from each simulated week were stored and finally average estimated value for 2720 weeks was calculated.

Estimated Average Patient Demand = 296480 / 2720

Estimated Average Patient Demand = 109 Patients / Week

The simulation results in an average value of 109 patients that means that there should be at least 109 beds available in the indoor female medical ward. The management can use this information to determine the number of beds that should be available in the female medical ward so as to manage or build its capacity.

The results can also be calculated analytically using the formula for probability distribution P (X), as follows:

E (X) = (77)(0.01) + (80)(0.01) +…….+ (100)(0.04)+ ……+(132)(0.02) + (133)(0.01)

E (X) =110 Patients / Weeks

The simulation was done first for 100 weeks but the results were not very close to the estimated analytical results. Hence, the simulation experiment was done for 2,720 weeks until a constant result is not achieved. That result which remains constant is called the "**Steady State Result**".

The results of the simulation can be seen graphically as shown in Figure 6.19 and the simulation codes are in **Annexure E**.

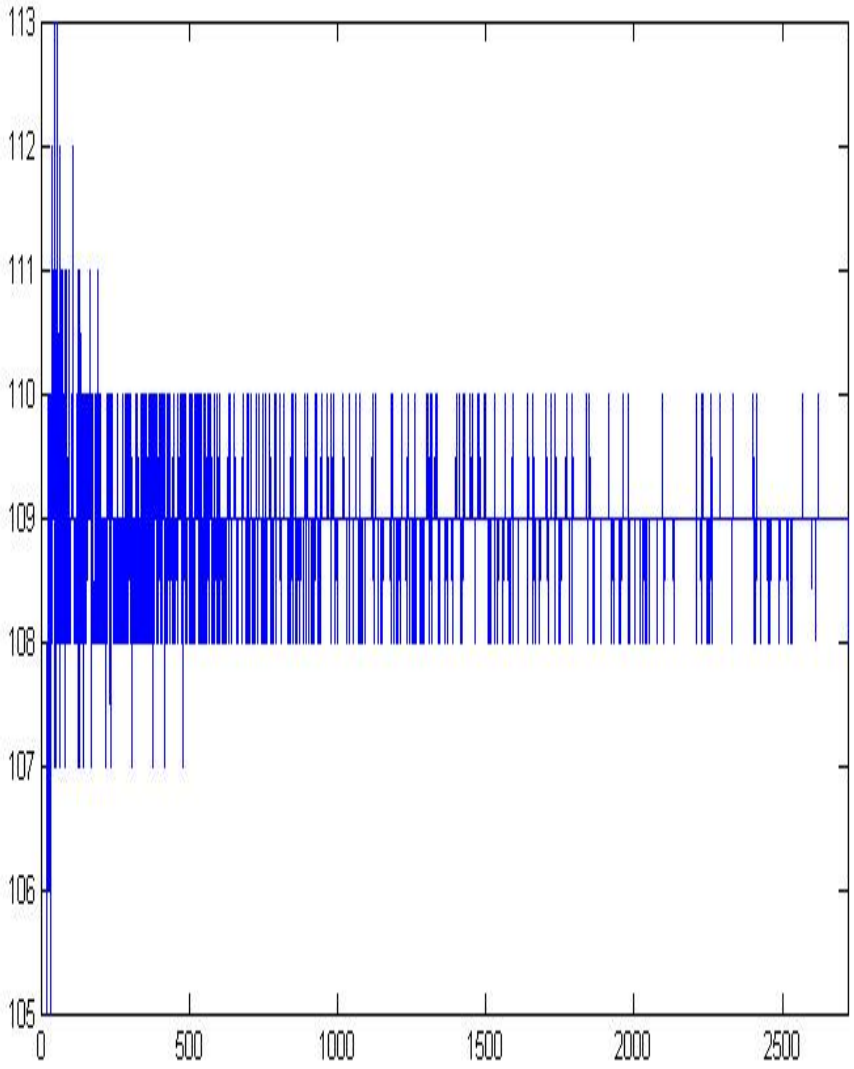


Figure 6.19. Simulation Results for Indoor Patient Ward

The flow chart of the simulation for indoor ward is shown in Figure 6.20.

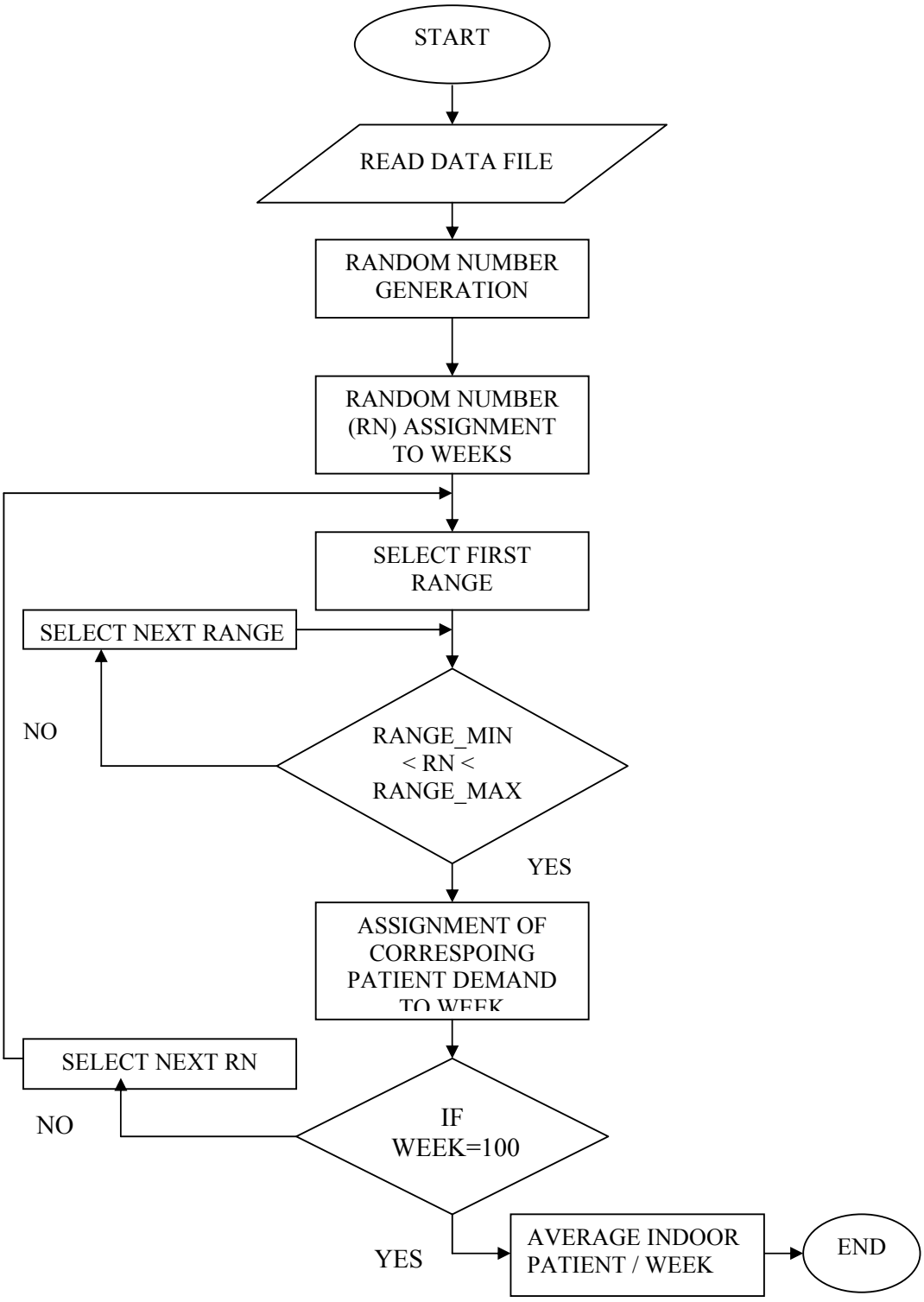


Figure 6.20. Simulation Flow Chart–Indoor Patients(Least Number of Beds Required)

6.5.2 Outdoor Patient Clinic

The female medical ward outdoor unit can cater for approximately 4233 patients per month[72].

6.5.2.1 Data Collection

The first step was to gather the data required to run the simulation. The input(s) to this model was the real-time demand; in this case the incoming patients per week, and their probability distributions. The historical data of previous two years (Sep 2006 – Oct 2008) more specifically 100 weeks was gathered is shown in Table 6.11.

The Figure 6.21 shows the trend of incoming indoor patients from Sep 2006 - Oct 2008.

Table 6.11. Outdoor Patient Status Sep 2006 - Oct 2008

Month	Total	Week 1	Week 2	Week 3	Week 4
Sep 2006	2137			1012	1125
Oct 2006	4542	1270	1095	1134	1043
Nov 2006	4349	1119	1147	1028	1055
Dec 2006	4200	1023	1124	1012	1041
Jan 2007	4342	1152	999	1180	1011
Feb 2007	4495	1029	1038	1230	1198
Mar 2007	4642	1350	1044	1238	1010
Apr 2007	4437	1141	1121	1024	1151
May 2007	4438	1048	1234	1134	1022
June 2007	4416	1256	1080	1098	982
Jul 2007	4365	1044	1129	1140	1052
Aug 2007	4686	1056	1047	1262	1321
Sep 2007	4470	1128	1187	1123	1032
Oct 2007	4371	973	1027	1131	1240
Nov 2007	4665	1102	1399	1123	1041
Dec 2007	4367	1052	1132	1028	1155
Jan 2008	4450	1133	1042	1243	1032
Feb 2008	4575	1060	1137	1057	1321
Mar 2008	4248	1102	1111	1012	1023
Apr 2008	4050	843	1147	1038	1022
May 2008	4252	1021	1052	1044	1135
June 2008	4599	1144	1251	1062	1142
Jul 2008	4393	1057	1139	1141	1056
Aug 2008	4524	1142	1027	1297	1058
Sep 2008	4061	1020	1121	890	1030
Oct 2008	1971	934	1037		
Total	**110045**				

Source: FFH Rawalpindi

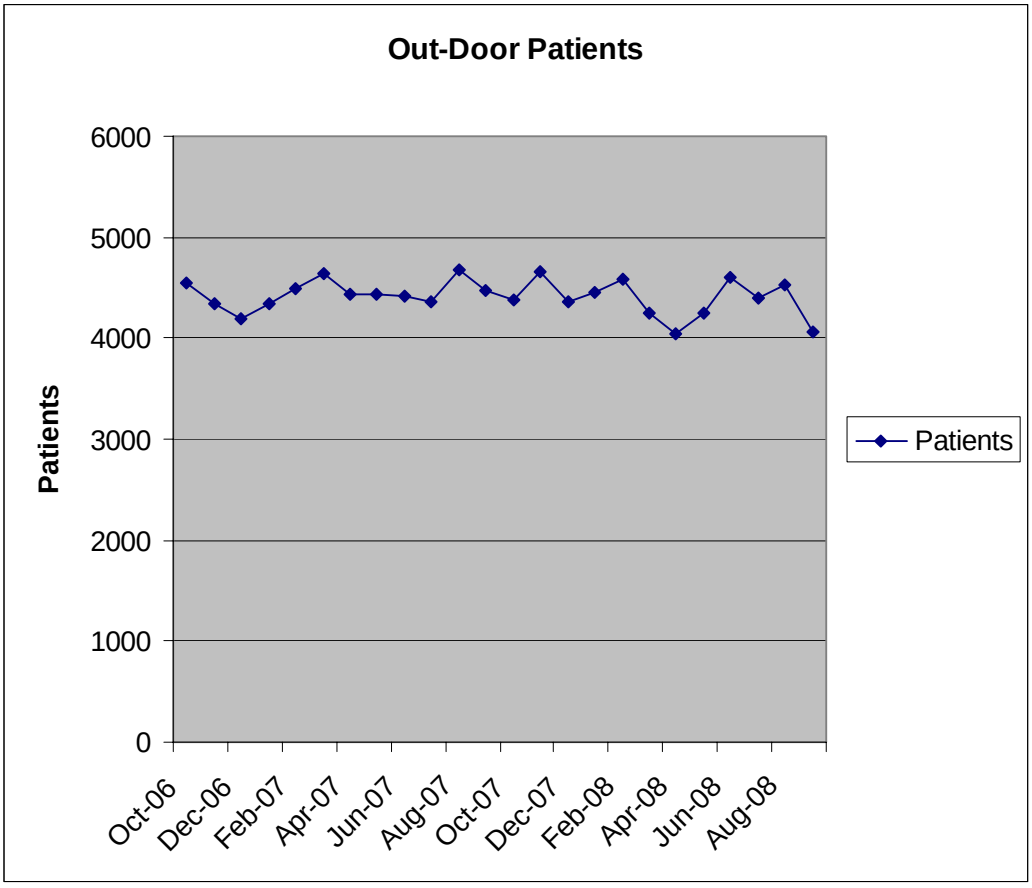


Figure 6.21. Outdoor Patients Sep 2006 – Oct 2008

Source: FFH Rawalpindi

6.4.2.2 Probability Distribution

Historical data collected was then grouped into categories from 843 - 1399 patients. Probability distribution was then applied to this data as shown in Table 6.12 using the formula:

P (X) = Frequency (X) / Total Weeks

6.5.2.3 Random Number Assignment

Once the probability distribution is done the next step is the random number assignment. The simulation will run for 1000 weeks to start with in order to get accurate results. Depending on the probability the ranges of random numbers are defined. Once random numbers are generated, their ranges are then assigned to the weekly patient demand in the same proportion as their probability of occurrence as shown in Table 6.13.

6.5.2.4 Simulation Experiment

Random number assignment follows the actual simulation run. The software used for simulation for outdoor patient ward is also MATLAB. The random numbers are generated using the formula:

Rands=floor (1000*rand (k, 1))

Once the random number is generated the program compares it with the assigned ranges. For example, from the random numbers generated in the first simulation run, we take the first random number generated. It is then compared to the random number assignment table. The number 331 falls in the range 330-339 which corresponds to the 103 patients. By repeating this process of selecting all random numbers one by one from the random number table generated and then determining weekly patient demand from the random number, we simulated demand for a period of time as shown in Table 6.14.

Table 6.12. Probability Distribution of Outdoor Patients / Week

Weekly Patient Demand	Frequency of Demand	Probability P (X)
843	1	0.01
890	1	0.01
934	1	0.01
-	-	-
1038	2	0.02
1041	2	0.02
-	-	-
1321	2	0.02
1350	1	0.01
1399	1	0.01
	Total 100	Total 1.00

Table 6.13. Random Number Assignment Table – Outdoor Patients

Weekly Patient Demand	Probability	Random Number Range
843	0.01	0-9
890	0.01	10-19
934	0.01	20-29
973	0.01	30-39
-	-	-
-	-	-
1038	0.02	270-289
1041	0.02	290-309
-	-	-
1321	0.02	960-979
1350	0.01	980-989
1399	0.01	990-999

Table 6.14. The Simulation Experiment – Outdoor Patients

Week	RN	Range	Patient Demand
1	17	10-19	890
2	999	990-999	1399
3	342	340-349	1038
-	-	-	-
1225	678	670-689	1134
1226	522	520-539	1102
-	-	-	-
5657	743	730-749	1141
5658	186	180-199	1027
-	-	-	-
10000	360	360-369	1047
			Σ = 1101271

As the simulation was run for 10000 times results from each simulation were stored and finally average estimated value for 10000 weeks was calculated.

Estimated Average Patient Demand = 1101271 / 10000

Estimated Average Patient Demand = 1101 Patients / Week

The simulation results in an average value of 1101 patients that means that there should be a capacity for at least 1101 patients / week in the outdoor female medical ward. The management can use this information to build on the capacity and also manage the existing capacity to its best use.

The results can also be calculated analytically using the formula for probability distribution P (X), as follows:

E (X) = (843)(0.01)+(890)(0.01)+….+(1038)(0.02) + …+ (1350)(0.01) + (1399)(0.01)

E (X) =1100 Patients / Weeks

The simulation was done first for 1000 weeks but the results were not very close to the estimated analytical results. Hence, the simulation experiment was done for 10,000 weeks until a constant result is not achieved. That result which remains constant is called the "**Steady State Result**".

The results of the simulation can be seen graphically as shown in Figure 6.22.

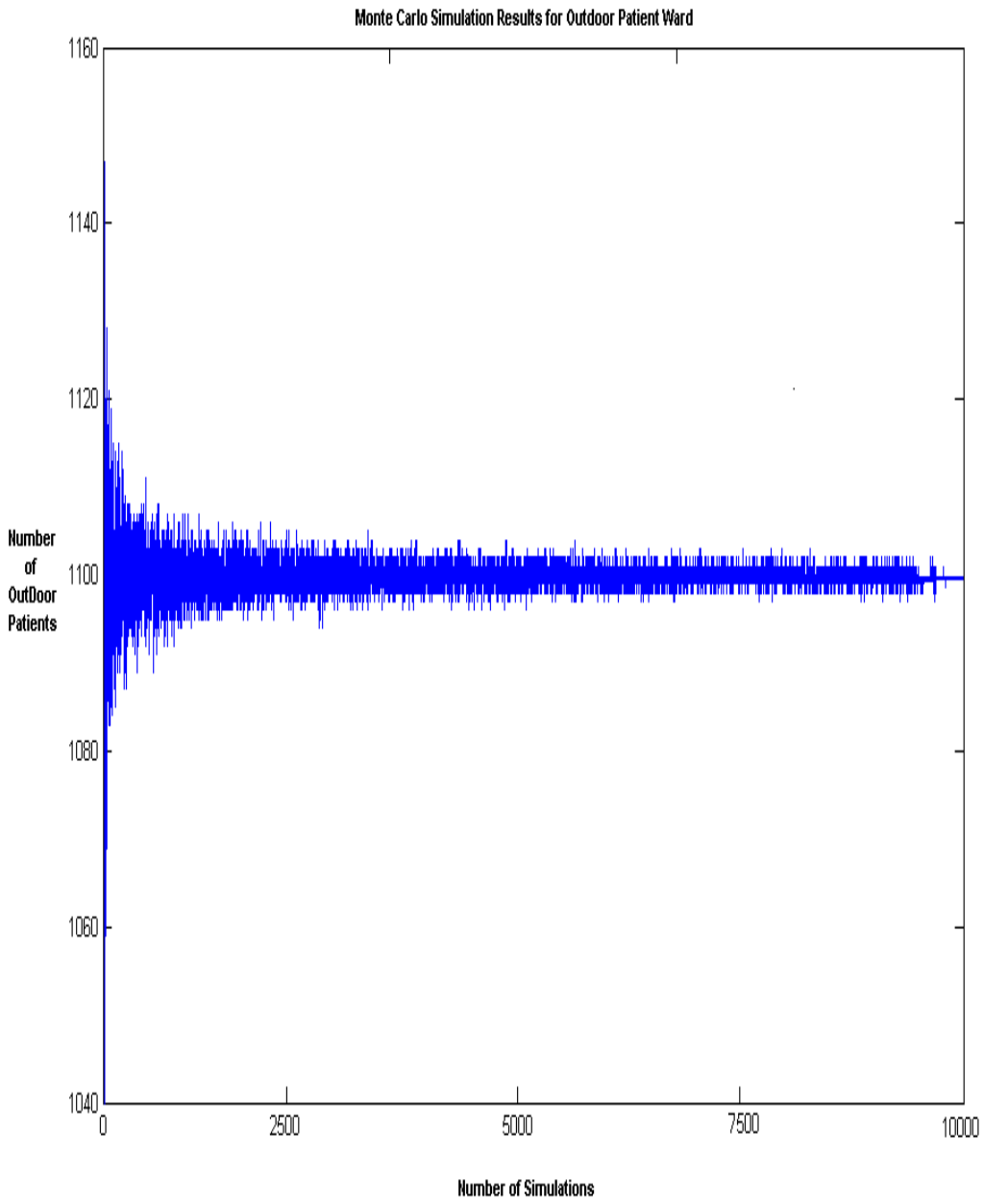


Figure 6.22. Simulation Result for Outdoor Patient Ward

The flow chart of the simulation for outdoor ward is shown in Figure 6.23

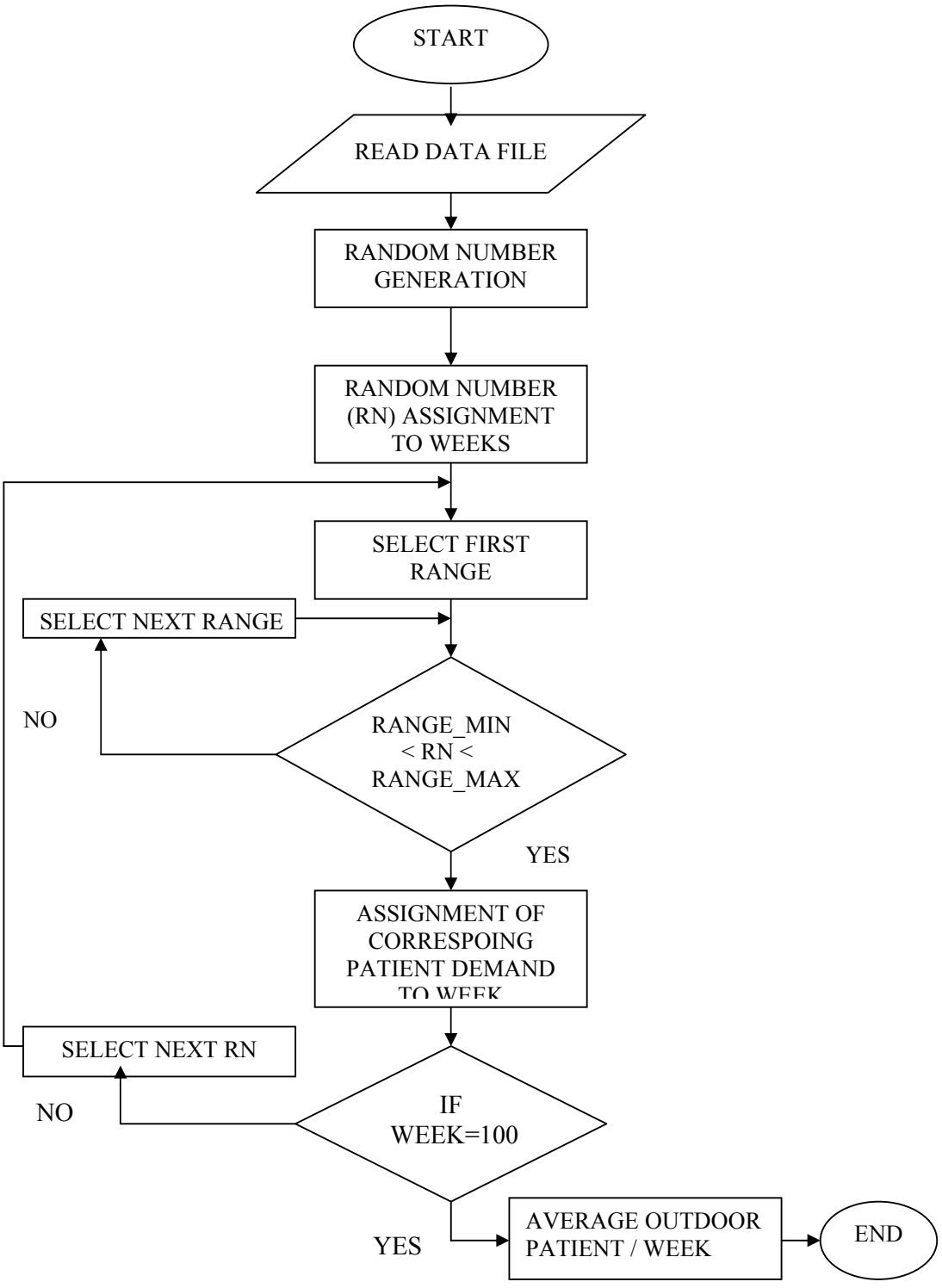


Figure 6.23. Simulation Flow Chart – Outdoor Patients

6.5.3 Radiology Department – (X-Rays)

The patients from the female medical ward (both indoor and outdoor unit) are referred to the radiology department for x-rays test. Three x-rays machine are currently installed at FFH that caters for approximately 431 patients per week[72].

6.5.3.1 Data Collection

The data collection was done so as to run the simulation. The input(s) to this model was the real-time demand; in this case the x-rays tests referrals per week, and their probability distributions. The historical data of previous two years (Sep 2006 – Oct 2008) more specifically 100 weeks was gathered is shown in Table 6.15.

The Figure 6.24 shows the trend of x-rays referrals from Sep 2006 - Oct 2008.

Table 6.15. X-Rays Referral Status Sep 2006 - Oct 2008

Month	Total	Week 1	Week 2	Week 3	Week 4
Sep 2006	798			397	401
Oct 2006	1676	441	398	416	421
Nov 2006	1644	432	412	424	376
Dec 2006	1573	399	411	376	387
Jan 2007	1648	443	395	439	371
Feb 2007	1627	391	430	384	422
Mar 2007	1669	394	410	416	449
Apr 2007	1620	398	411	388	423
May 2007	1681	411	450	421	399
June 2007	1734	445	435	440	414
Jul 2007	1694	399	440	437	418
Aug 2007	1663	427	399	419	418
Sep 2007	1701	437	419	429	416
Oct 2007	1676	431	437	397	411
Nov 2007	1661	417	415	431	398
Dec 2007	1655	399	430	410	416
Jan 2008	1636	426	399	400	411
Feb 2008	1713	398	436	429	450
Mar 2008	1645	396	448	388	413
Apr 2008	1713	448	431	391	443
May 2008	1737	449	445	429	414
June 2008	1787	449	449	439	450
Jul 2008	1754	440	439	431	444
Aug 2008	1709	423	450	399	437
Sep 2008	1727	447	398	435	447
Oct 2008	870	434	436		
Total	**42011**				

Source: FFH Rawalpindi

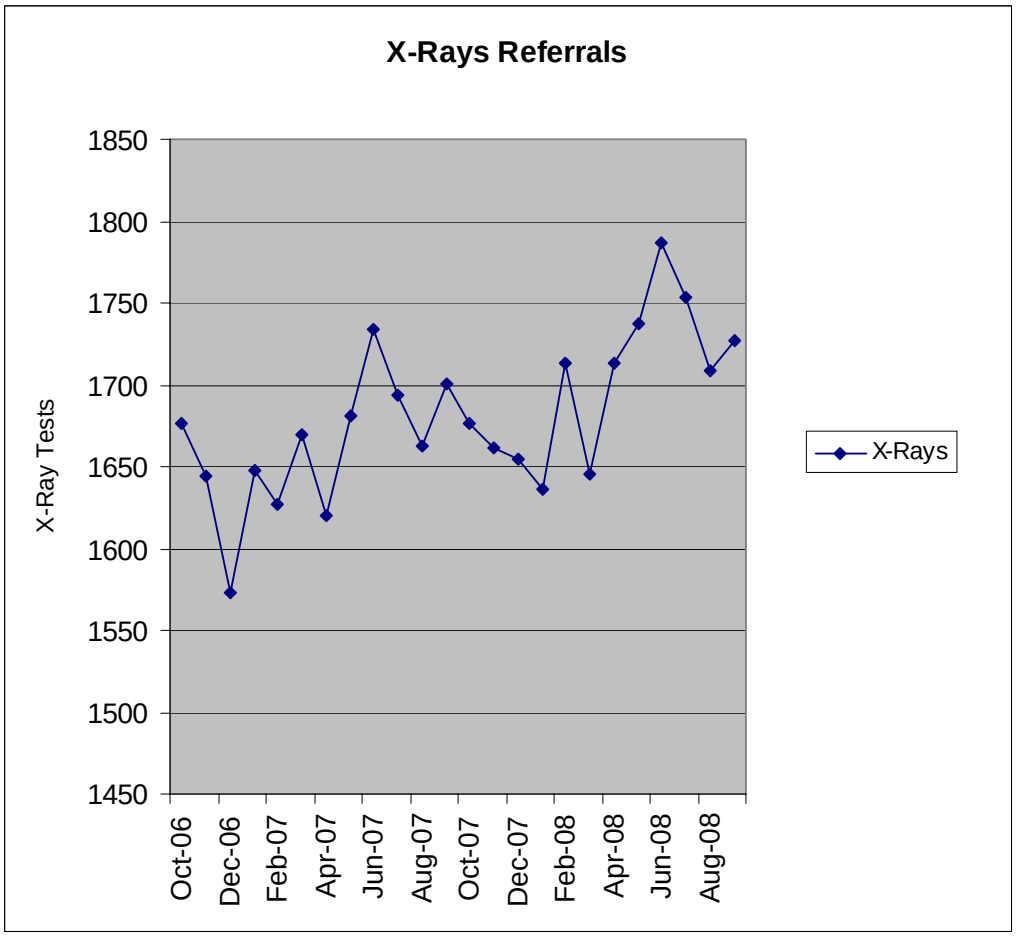


Figure 6.24. X-Rays Referrals Sep 2006 – Oct 2008

Source: FFH Rawalpindi

6.5.3.2 Probability Distribution

Historical data collected was then grouped into categories from 371 – 450 x-rays. Probability distribution was then applied to this data as shown in Table 4.12 using the formula:

P (X) = Frequency (X) / Total Weeks

6.5.3.3 Random Number Assignment

Once the probability distribution is done the next step is the random number assignment. The simulation will also run for 100 weeks to start with. Depending on the probability the ranges of random numbers are defined. Once random numbers are generated, their ranges are then assigned to the weekly x-rays test demand in the same proportion as their probability of occurrence as shown in Table 6.17.

6.5.3.4 Simulation Experiment

Random number assignment follows the actual simulation run. MATLAB is again used for this simulation. The random numbers are generated using the formula:

Rands=floor (1000*rand (k, 1))

Once the random number is generated the program compares it with the assigned ranges. For example, from the random numbers generated in the first simulation run, we take the first random number generated. It is then compared to the random number assignment table. The number 686 falls in the range 680-699, which corresponds, to the 435 x-rays. By repeating this process of selecting all random numbers one by one from the random number table generated and then determining weekly x-rays demand from the random number, we simulated demand for a period of time as shown in Table 6.18.

Table 6.16. Probability Distribution of X-rays / Week

Weekly X-Rays Demand	Frequency of Demand	Probability P (X)
371	1	0.01
376	2	0.02
384	1	0.01
387	1	0.01
-	-	-
410	2	0.02
411	5	0.05
-	-	-
498	2	0.02
499	4	0.04
450	4	0.04
	Total 100	Total 1.00

Table 6.17. Random Number Assignment Table – X-Rays

Weekly Patient Demand	Probability	Random Number Range
371	0.01	0-9
376	0.02	10-19
384	0.01	20-29
387	0.01	30-39
-	-	-
-	-	-
410	0.02	280-299
411	0.05	300-349
-	-	-
448	0.02	900-919
449	0.04	920-959
459	0.04	960-999

Table 6.18. The Simulation Experiment – X-Rays

Week	RN	Range	X-Rays Demand
1	686	680-699	435
2	808	790-819	440
-	-	-	-
125	239	190-259	399
126	189	190-259	399
-	-	-	-
357	234	190-259	399
358	161	140-189	398
-	-	-	-
5000	655	620-659	431
			Σ = 2075000

As the simulation was run for 5000 weeks results from each simulated week were stored and finally average estimated value for 5000 weeks was calculated.

Estimated Average X-rays Demand = 2075000 / 5000

Estimated Average X-rays Demand = 415 X-rays / Week

The simulation results in an average value of 415 tests that means that there should be a capacity for at least 415 tests / week in for female medical ward. The management can use this information to build on the capacity and also manage the existing capacity to its best use.

The results can also be calculated analytically using the formula for probability distribution P (X), as follows:

E (X) = (371)(0.01) + (376)(0.02) +…. + (411)(0.05) + …+ (449)(0.04) + (450)(0.04)

E (X) =420 X-rays / Weeks

The simulation was done first for 200 weeks but the results were not very close to the estimated analytical results. Hence, the simulation experiment was done for 5,000 weeks until a constant result is not achieved. That result which remains constant is called the "**Steady State Result**". The results of the simulation can be seen graphically as shown in Figure 6.25.

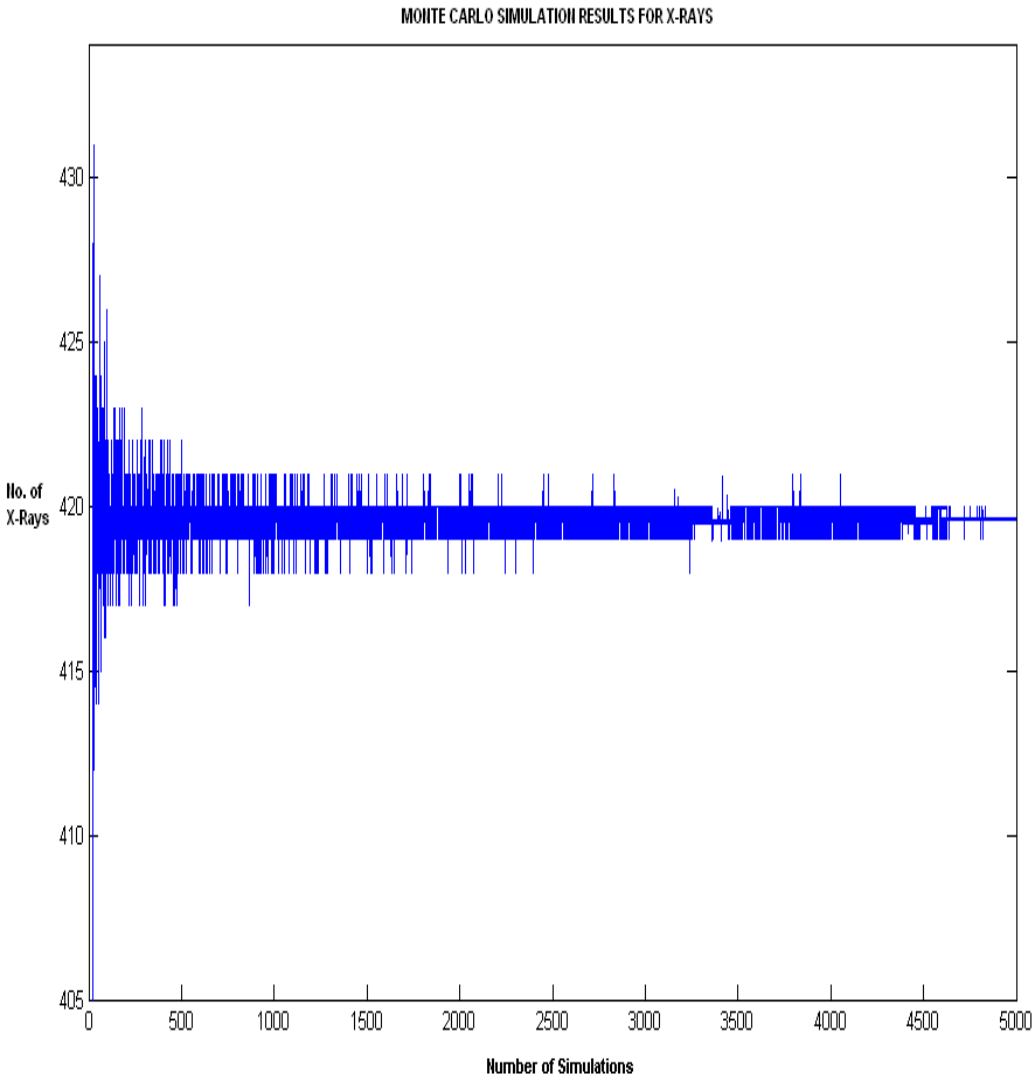


Figure 6.25. Simulation Result for X-Ray Tests

6.5.3.4.1 Simulation for Choosing Alternatives

The staff working in the radiology department works for over 42 hours per week on three machines. However, the number of machines actually operating during any week may or may not be 3. Machines need repair or an operator may not show up at work. Historical records show that actual x-ray tests carried out by 3 machines are distributed as shown in Table 6.19.

Table 6.19. Probability of X-Rays Tests Carried out by 3 Machines

Regular Capacity	Probability of X-Rays Tests Carried out by 3 Machines
380 (1 machine)	0.3
410 (2 machine)	0.3
440 (3 machine)	0.4

The average number of tests performed in a week is:

380 (0.2) + 410 (0.4) + 440 (0.4) = **413 x-rays / week**

which is less than the required number of tests.

It is the policy of FFH's radiology department that each week's workload will be completed on schedule even if it requires overtime. The department is allowed to work 20 hours overtime per week. The overtime running of machines costs the company Rs. 750 per hour [73] along with the extra time wages for the employees. Installing one extra machine to the department can solve the problem. To justify adding another machine, weekly savings in overtime costs should be at least Rs. 4000. Hence, an analysis with 4 installed machines was carried out. Management estimated from prior experience that with 4 machines the distribution of weekly capacity would be as shown in Table 6.20.

Table 6.20. Probability of X-Rays Tests Carried out by 4 machines

Regular Capacity	Probability of X-Rays Tests Carried out by 4 machines
410 (2 machine)	0.3
440 (3 machine)	0.3
460 (4 machine)	0.4

Random numbers are assigned to both the X-ray demand and the existing weekly capacity for 3 and 4 machines. Using these random numbers the x-ray demand per week and the capacity for 3 machines and 4 are compared so as to get lead and lag

values in terms of tests for the two cases. The steps involved in this simulation will be:

Step 1. Draw the first random number from the x-rays random number table, find its random number range and associate the number of x-rays for that range to the drawn random number.

Step 2. Draw the first random number from the 3 machines random number table, find its random number range and associate the capacity (number of x-rays) for that range to the drawn random number.

Step 3. Draw the first random number from the 4 machines random number table, find its random number range and associate the capacity (number of x-rays) for that range to the drawn random number.

Step 4. Perform the following logic for both 3 machines and 4 machines

If Capacity **>= Demand, then Lead = Capacity – Demand**

Else if, **Capacity <= Demand, then Lag = Capacity – Demand**

Step 5. Find the time required to perform the tests and the cost they incur in case of a lag situation for both cases.

Step 6. Repeat the steps 1-5 until the simulation is carried out for 5000 weeks

Step 7. Once the simulation is complete, calculate the average overtime costs for both 3 and 4 machines and calculate the savings generated by installation of a new machine.

Table 6.21 contains simulations for two capacity alternatives (3 Machines & 4 Machines) for lag and lead calculations in terms of x-rays.

Table 6.21. 5000-Week Simulation of Alternatives

				3 Machines			4 Machines		
Week	**Demand RN**	**X-Rays**	**Capacity RN**	**Existing Weekly Capacity**	**Lag**	**Lead**	**Existing Weekly Capacity**	**Lag**	**Lead**
1	686	435	983	440	0	5	460	0	25
2	808	440	657	440	0	0	460	0	20
-	-	-	-	-	-	-	-	-	-
354	239	399	73	380	19	0	410	0	11
655	493	421	473	410	11	0	440	0	19
-	-	-	-	-	-	-	-	-	-
5000	971	450	518	410	40	0	440	10	0
				Total	87	22	**Total**	25	81

Once the simulation is completed the cost for both alternatives is compared. In case of 3 machines the overtime cost comes out to be **Rs. 6050** whereas the overtime cost for 4 machines is **Rs. 1838**, resulting in saving of **Rs. 4212 / week** which exceeds the minimum required savings for additional investment. The yearly saving came about to **Rs. 202,176 / year** and this profit is **only** by the x-ray referrals from the female medical ward. The flow chart of the simulation for outdoor ward is shown in Figure 6.26.

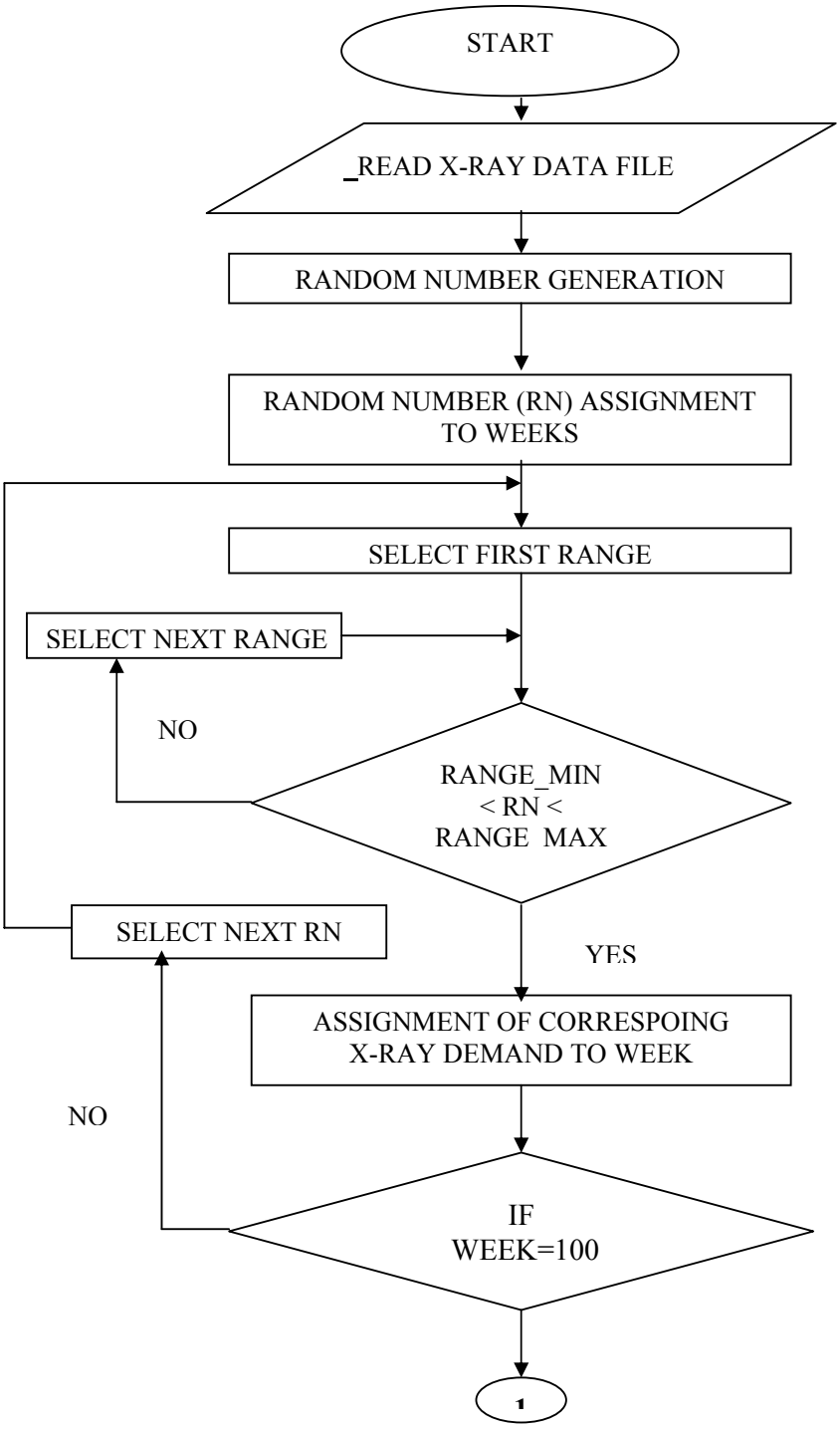


Figure 6.26. Contd.

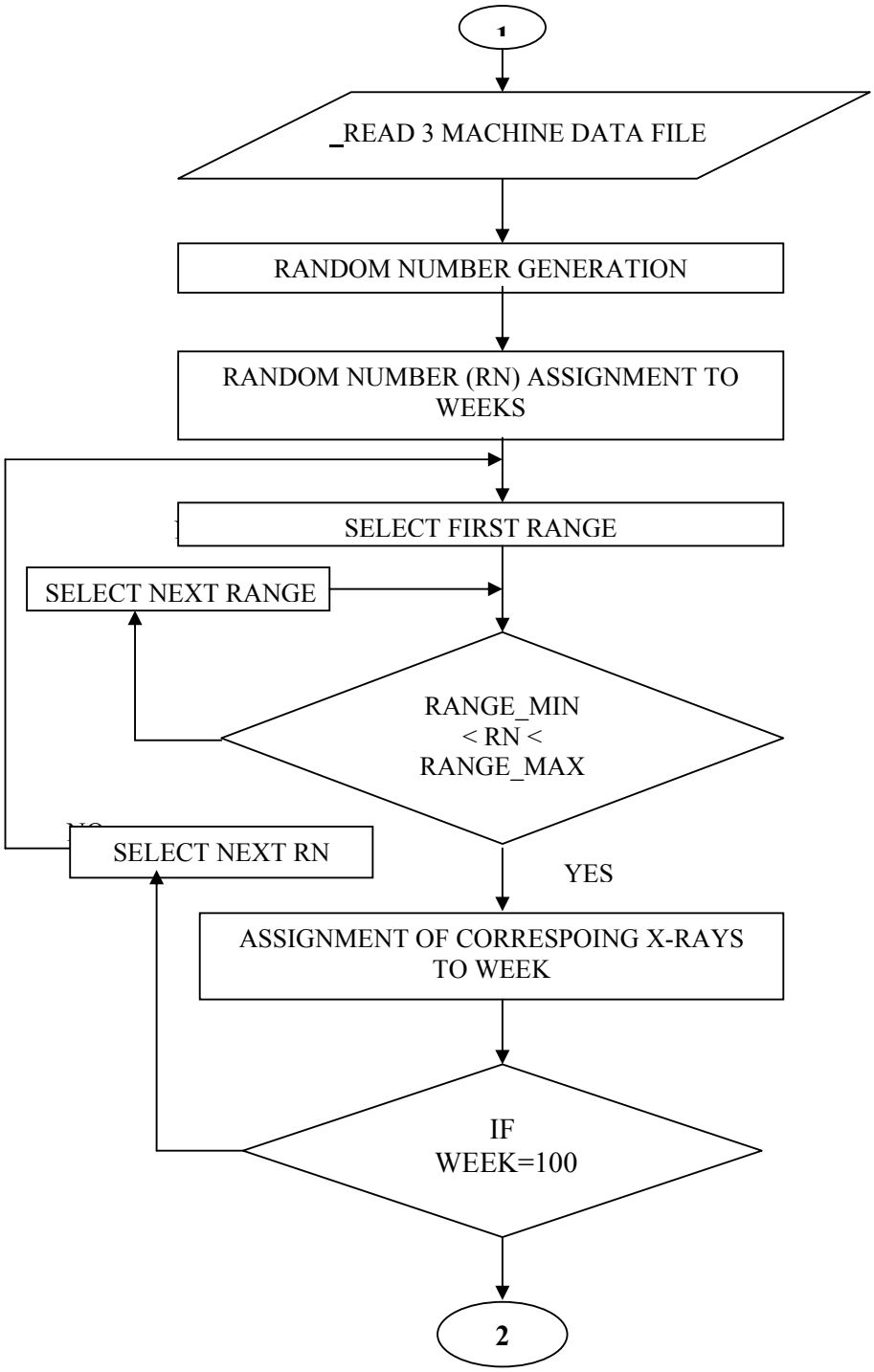


Figure 6.26. Contd.

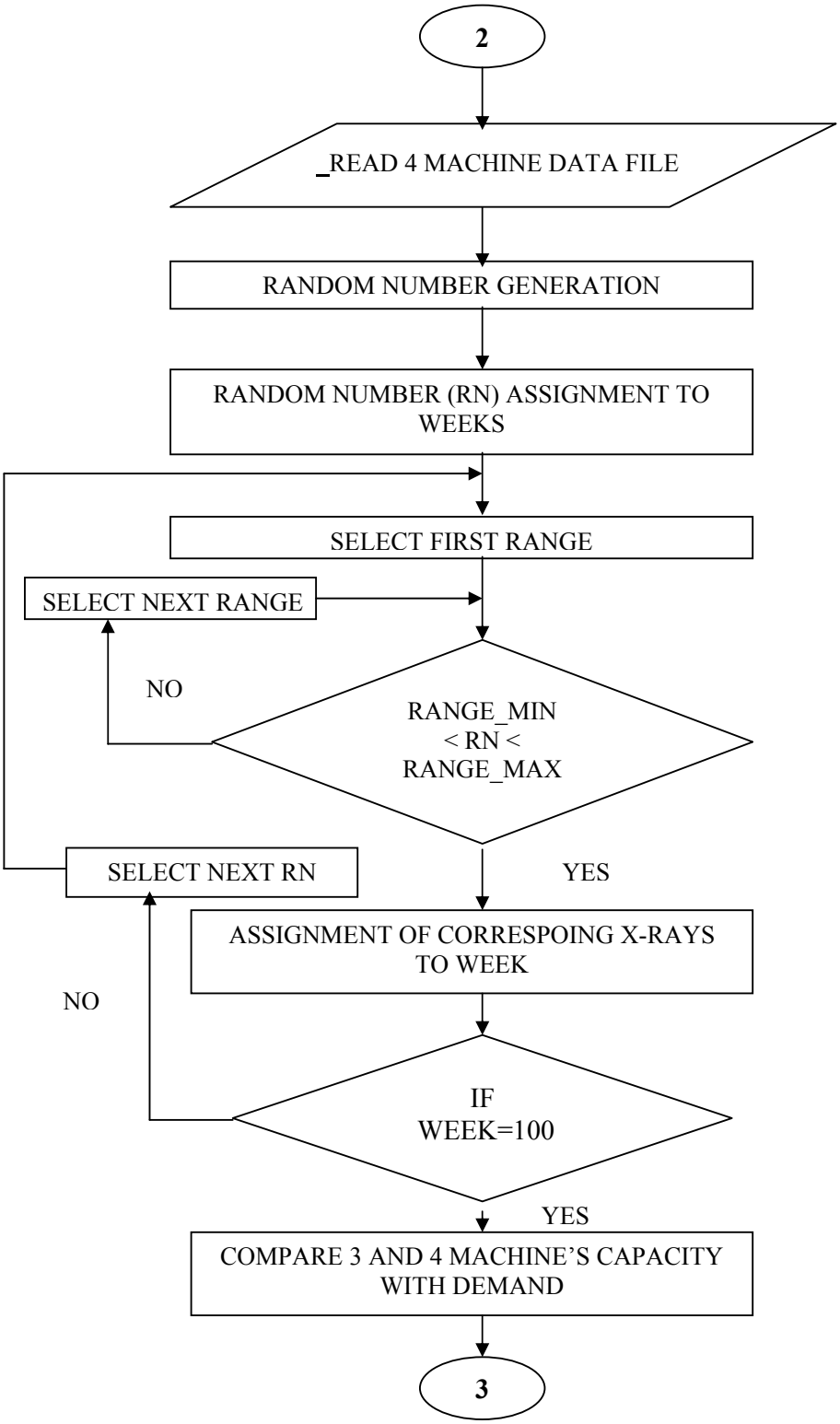


Figure 6.26. Contd.

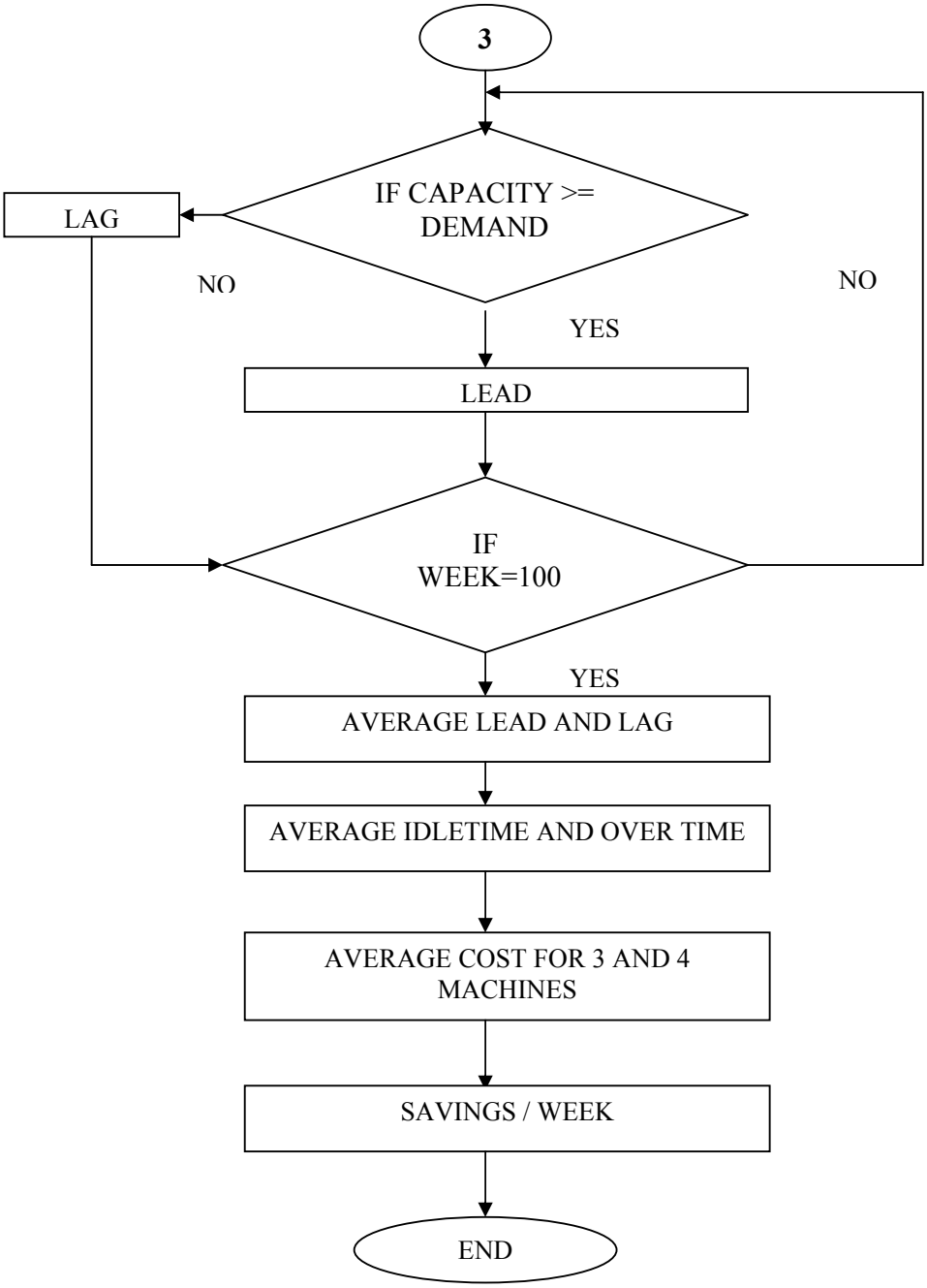


Figure 6.26. Simulation Flow Chart – Radiology (X-Rays)

6.5.4 Radiology Department – (Ultrasounds)

The patients from the female medical ward (both indoor and outdoor unit) are referred to the radiology department for ultrasound test. Three ultrasound machines are currently installed at FFH that caters for approximately 97 patients per week[72].

6.5.4.1 Data Collection

The data collection was done so as to run the simulation. The input(s) to this model was the real-time demand; in this case the ultrasound referrals per week, and their probability distributions. The historical data of previous two years (Sep 2006 – Oct 2008) more specifically 100 weeks was gathered is shown in Table 6.22.

The Figure 6.24 shows the trend of ultrasound referrals from Sep 2006 - Oct 2008.

Table 6.22. Ultrasound Referral Status Sep 2006 - Oct 2008

Month	Total	Week 1	Week 2	Week 3	Week 4
Sep 2006	239			124	115
Oct 2006	479	117	126	117	119
Nov 2006	444	100	107	114	123
Dec 2006	417	98	113	104	102
Jan 2007	418	115	103	102	98
Feb 2007	426	102	110	111	103
Mar 2007	431	115	95	105	116
Apr 2007	426	102	107	112	105
May 2007	432	114	113	99	106
June 2007	450	125	112	104	109
Jul 2007	430	98	107	119	106
Aug 2007	460	117	111	106	126
Sep 2007	420	115	104	108	93
Oct 2007	428	102	113	97	116
Nov 2007	424	99	114	93	118
Dec 2007	414	110	98	104	102
Jan 2008	441	117	102	107	115
Feb 2008	427	102	121	99	105
Mar 2008	436	99	110	116	111
Apr 2008	455	115	107	120	113
May 2008	418	104	96	103	115
June 2008	423	111	97	117	98
Jul 2008	433	98	118	112	105
Aug 2008	440	113	110	104	113
Sep 2008	433	111	98	109	115
Oct 2008	233	117	116		
Total	**10877**				

Source: FFH Rawalpindi

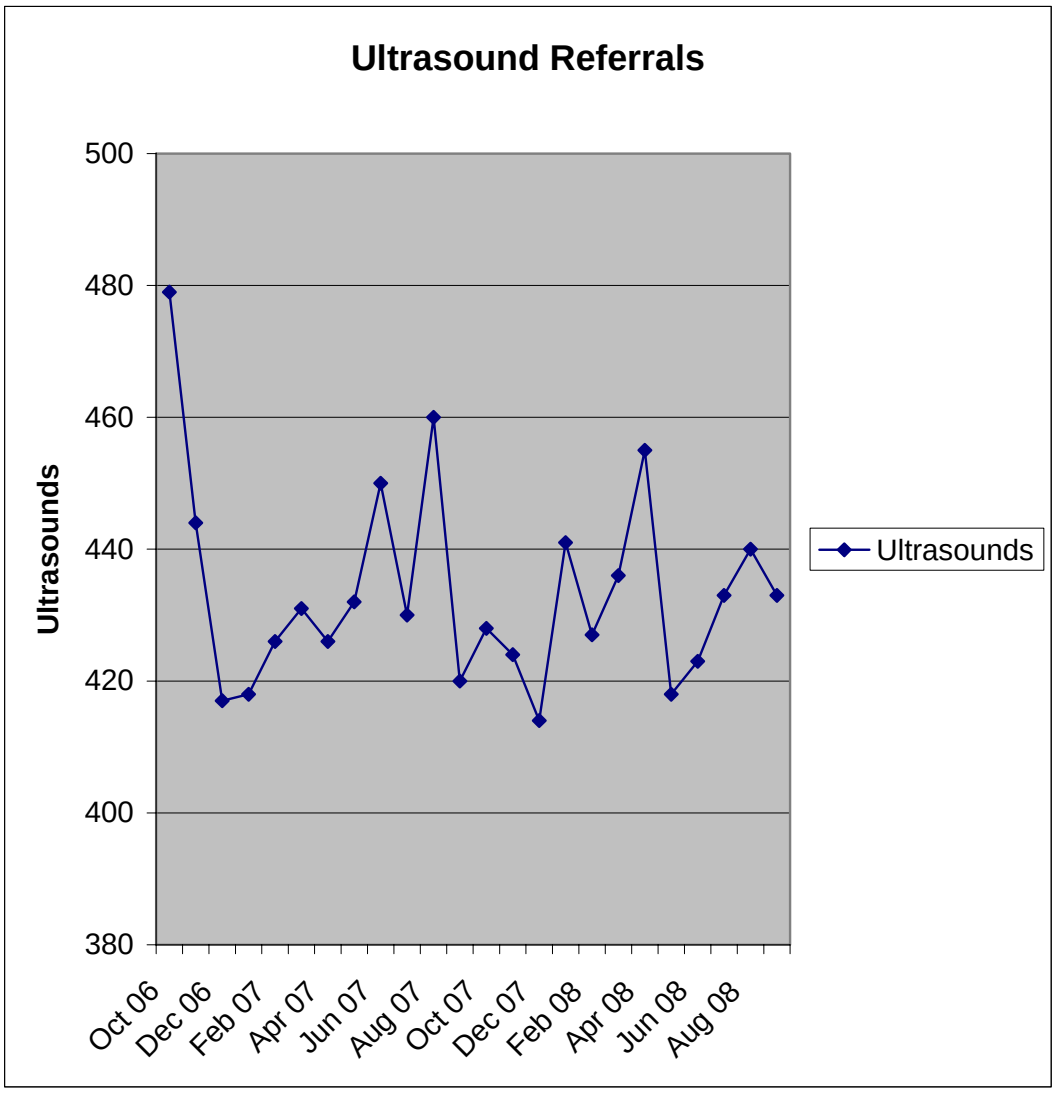


Figure 6.27. Ultrasound Referrals Sep 2006 – Oct 2008

Source: FFH Rawalpindi

6.5.4.2 Probability Distribution

Historical data collected was then grouped into categories from 93 – 126 ultrasounds. Probability distribution was then applied to this data as shown in Table 4.23 using the formula:

P (X) = Frequency (X) / Total Weeks

6.5.4.3 Random Number Assignment

Once the probability distribution is done the next step is the random number assignment. The simulation will also run for 100 weeks to start with. Depending on the probability the ranges of random numbers are defined. Once random numbers are generated, their ranges are then assigned to the weekly ultrasound demand in the same proportion as their probability of occurrence as shown in Table 6.24.

6.5.4.4 Simulation Experiment

Random number assignment follows the actual simulation run. MATLAB is again used for this simulation. The random numbers are generated using the formula:

Rands=floor (1000*rand (k, 1))

Once the random number is generated the program compares it with the assigned ranges. For example, from the random numbers generated in the first simulation run, we take the first random number generated. It is then compared to the random number assignment table. The number 697 falls in the range 690-719, which corresponds, to the 112 ultrasounds. By repeating this process of selecting all random numbers one by one from the random number table generated and then determining weekly ultrasound demand from the random number, we simulated demand for a period of time as shown in Table 6.25.

Table 6.23. Probability Distribution of Ultrasound / Week

Weekly X-Rays Demand	Frequency of Demand	Probability P (X)
93	2	0.02
95	1	0.01
96	1	0.01
97	2	0.02
-	-	-
112	3	0.03
113	6	0.06
-	-	-
124	1	0.01
125	1	0.01
126	2	0.02
	Total 100	Total 1.00

Table 6.24. Random Number Assignment Table – Ultrasounds

Weekly Patient Demand	Probability	Random Number Range
93	0.02	0-19
95	0.01	20-29
96	0.01	30-39
97	0.02	40-59
-	-	-
-	-	-
112	0.03	690-719
113	0.06	720-779
-	-	-
124	0.01	960-969
125	0.01	970-979
126	0.02	980-999

Table 6.25. The Simulation Experiment – Ultrasounds

Week	RN	Range	Ultrasound Demand
1	447	440-449	417
2	808	790-819	440
-	-	-	-
125	105	100-109	395
126	157	140-189	398
-	-	-	-
357	38	30-39	384
358	972	960-999	450
-	-	-	-
5000	655	620-659	431
			Σ = 545000

As the simulation was run for 5000 weeks results from each simulated week were stored and finally average estimated value for 5000 weeks was calculated.

Estimated Average Ultrasound Demand = 545000 / 5000

Estimated Average Ultrasound Demand = 109 Ultrasound / Week

The simulation results in an average value of 109 tests that means that there should be a capacity for at least 109 tests / week in for female medical ward. The management can use this information to build on the capacity and also manage the existing capacity to its best use.

The results can also be calculated analytically using the formula for probability distribution P (X), as follows:

E (X) = (93)(0.02) + (95)(0.01) +…. + (112)(0.03) + …+ (125)(0.01) + (126)(0.02)

E (X) =109 Ultrasound / Weeks

The simulation was done first for 200 weeks but the results were not very close to the estimated analytical results. Hence, the simulation experiment was done for 5,000 weeks until a constant result is not achieved. That result which remains constant is called the "**Steady State Result**". The results of the simulation can be seen graphically as shown in Figure 6.28.

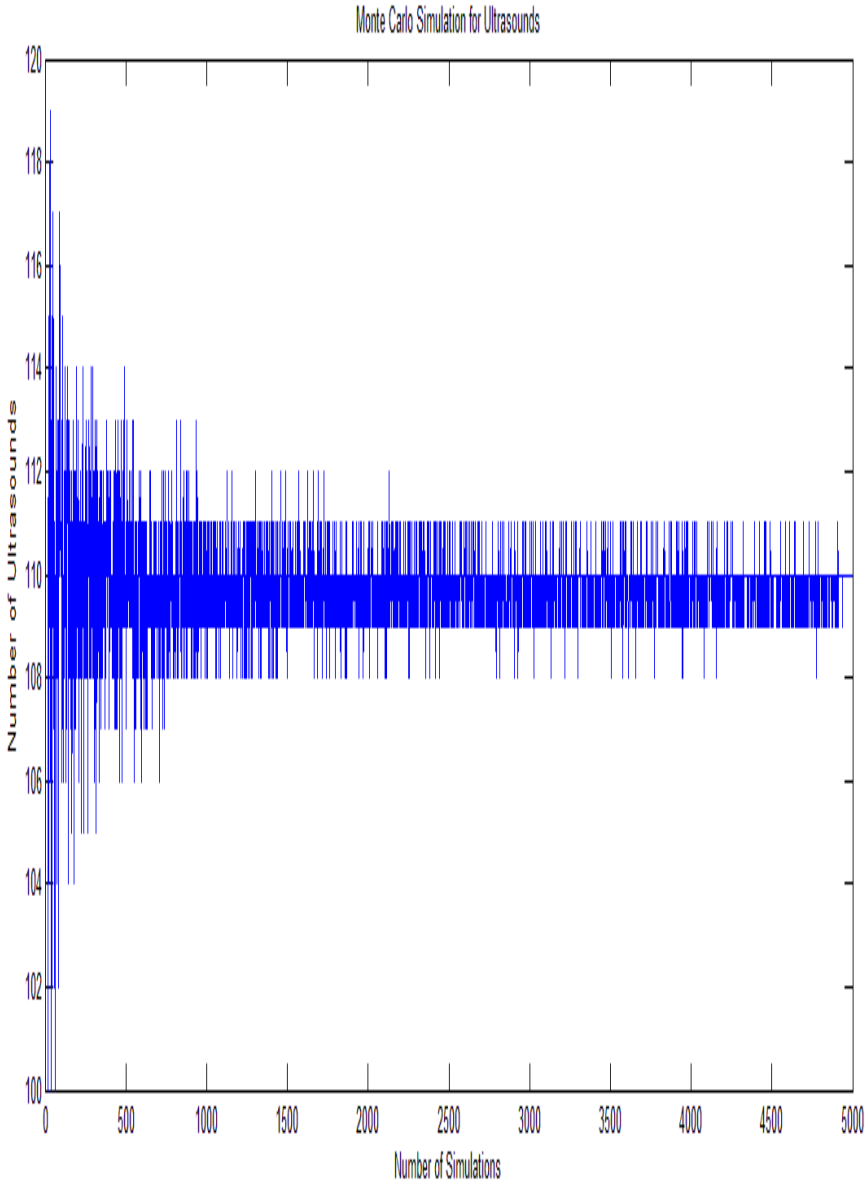


Figure 6.28. Simulation Result for Ultrasounds

6.5.4.4.1 Simulation for Choosing Alternatives

The staff working in the radiology department works for over 42 hours per week on three machines. However, the number of machines actually operating during any week may or may not be 3. Machines need repair or an operator may not show up at work. Historical records show that actual ultrasounds carried out by 3 machines are distributed as shown in Table 6.26.

Table 6.26. Probability of Ultrasound Carried out by 3 Machines

Regular Capacity	Probability of Ultrasound Carried out by 3 Machines
30 (1 machine)	0.3
60 (2 machine)	0.4
90 (3 machine)	0.3

The average number of tests performed in a week is:

30 (0.3) + 60 (0.4) + 90 (0.3) = **60 ultrasounds / week**

which is less than the required number of tests.

It is the policy of FFH's radiology department that each week's workload will be completed on schedule even if it requires overtime. The department is allowed to work 20 hours overtime per week. The overtime running of ultrasound machines costs the company Rs. 400 per hour[73] along with the extra time wages for the employees. Installing one extra machine to the department can solve the problem. To justify adding another machine, weekly savings in overtime costs should be at least Rs. 3200. Hence, an analysis with 4 installed machines was carried out. Management estimated from prior experience that with 4 machines the distribution of weekly capacity would be as shown in Table 6.27.

Table 6.27. Probability of Ultrasounds Carried out by 4 machines

Regular Capacity	Probability of Ultrasounds Carried out by 4 machines
60 (2 machine)	0.3
90 (3 machine)	0.4
120 (4 machine)	0.3

Random numbers are assigned to both the ultrasound demand and the existing weekly capacity for 3 and 4 machines. Using these random numbers the ultrasound demand per week and the capacity for 3 machines and 4 are compared so as to get lead and lag

values in terms of tests for the two cases. The steps involved in this simulation will be:

Step 1. Draw the first random number from the ultrasound s random number table, find its random number range and associate the number of ultrasounds for that range to the drawn random number.

Step 2. Draw the first random number from the 3 machines random number table, find its random number range and associate the capacity (number of ultrasounds) for that range to the drawn random number.

Step 3. Draw the first random number from the 4 machines random number table, find its random number range and associate the capacity (number of ultrasounds) for that range to the drawn random number.

Step 4. Perform the following logic for both 3 machines and 4 machines
If Capacity **>= Demand, then Lead = Capacity – Demand**
Else if, **Capacity <= Demand, then Lag = Capacity – Demand**
Step 5. Find the time required to perform the tests and the cost they incur in case of a lag situation for both cases.
Step 6. Repeat the steps 1-5 until the simulation is carried out for 5000 weeks
Step 7. Once the simulation is complete, calculate the average overtime costs for both 3 and 4 machines and calculate the savings generated by installation of a new machine.
Table 6.28 contains simulations for two capacity alternatives (3 Machines & 4 Machines) for lag and lead calculations in terms of ultrasounds.

Table 6.28. 5000-Week Simulation of Alternatives

				3 Machines			4 Machines		
Week	**Demand RN**	**Ultra sounds**	**Capacity RN**	**Existing Weekly Capacity**	**Lag**	**Lead**	**Existing Weekly Capacity**	**Lag**	**Lead**
1	836	117	983	90	27	0	120	0	3
2	465	105	944	90	15	0	120	0	15
-	-	-	-	-	-	-	-	-	-
354	239	102	73	30	72	0	60	62	0
655	493	106	773	90	16	0	120	0	14
-	-	-	-	-	-	-	-	-	-
5000	971	125	844	90	35	0	120	5	0
				Total	16	8	**Total**	8	21

Once the simulation is completed the cost for both alternatives is compared. In case of 3 machines the overtime cost comes out to be **Rs. 8794** whereas the overtime cost for 4 machines is **Rs. 5318**, resulting in saving of **Rs. 3476 / week** which exceeds the minimum required savings for additional investment. The yearly saving came about to **Rs. 166,848 / year** and this profit is **only** by the ultrasound referrals from the female medical ward. The flow chart of the simulation for outdoor ward is shown in Figure 6.29.

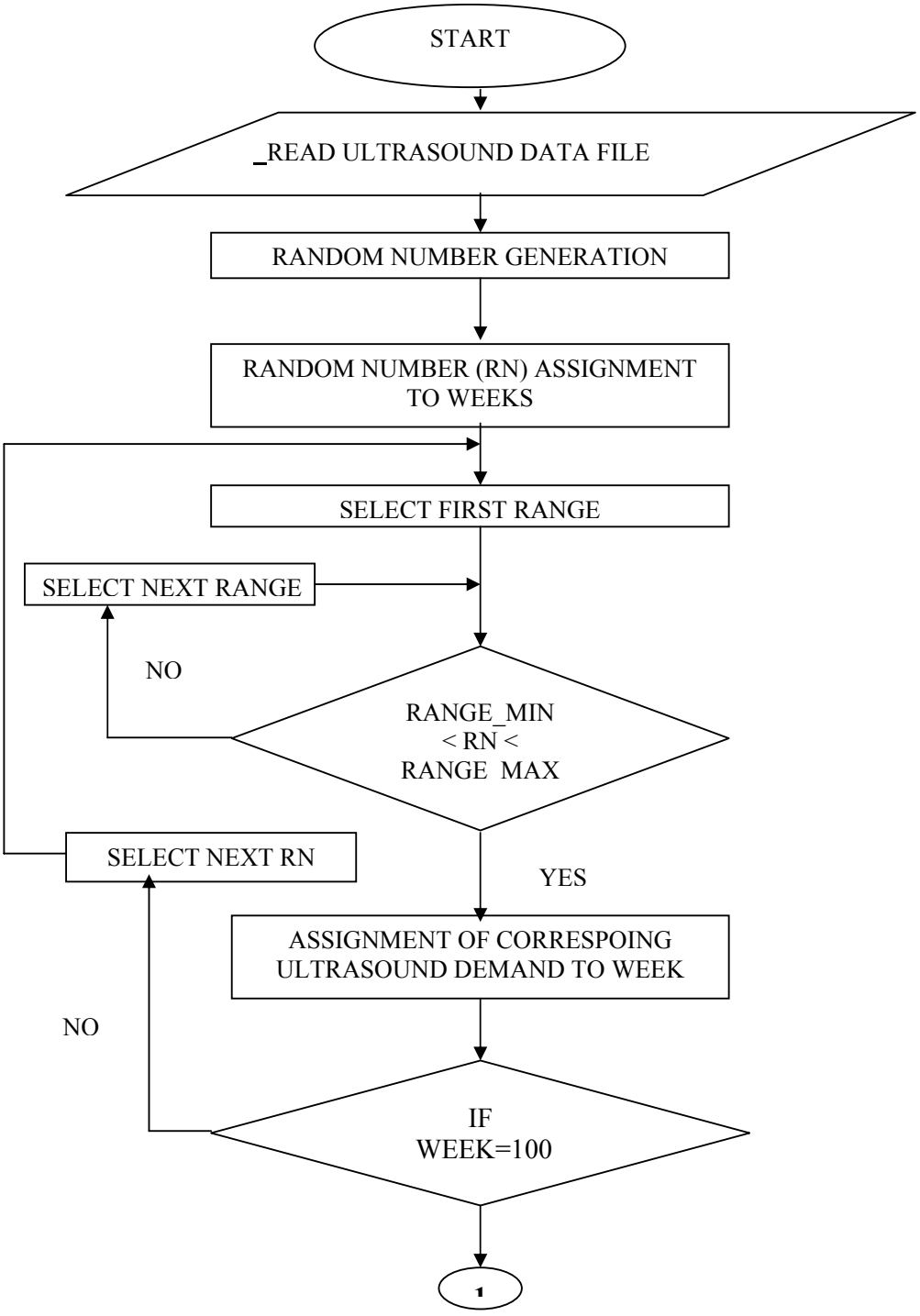


Figure 6.29. Contd.

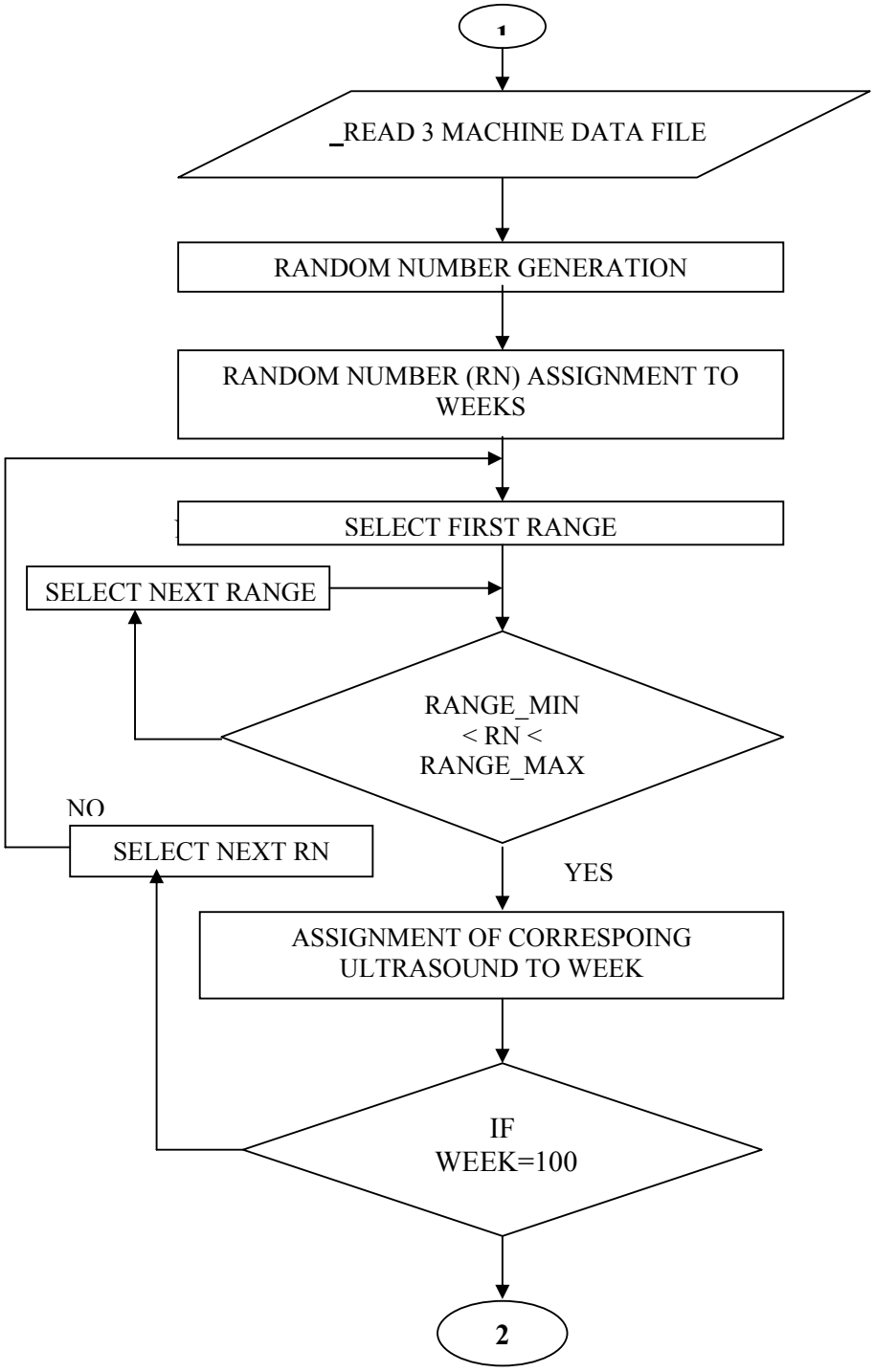


Figure 6.29. Contd.

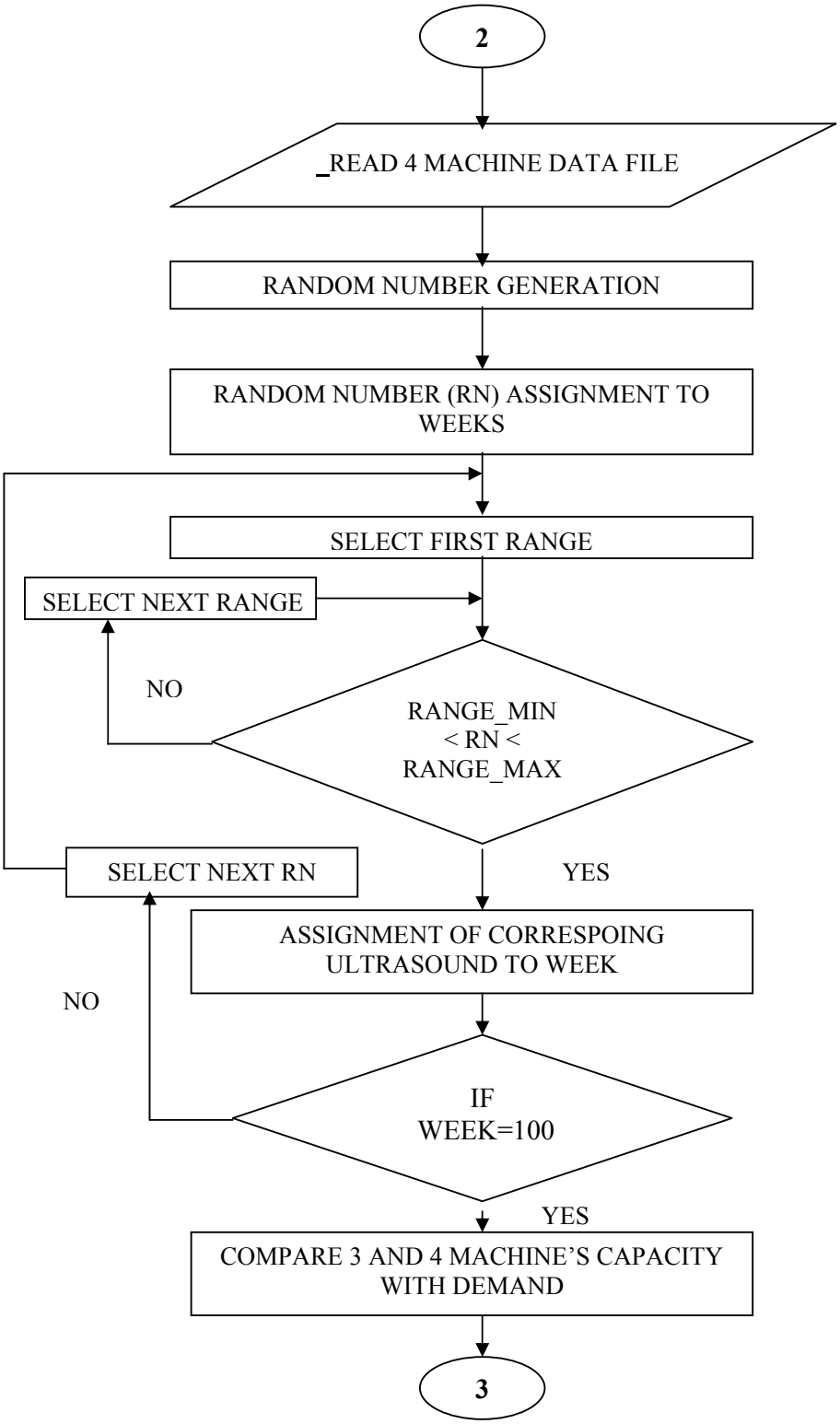


Figure 6.29. Contd.

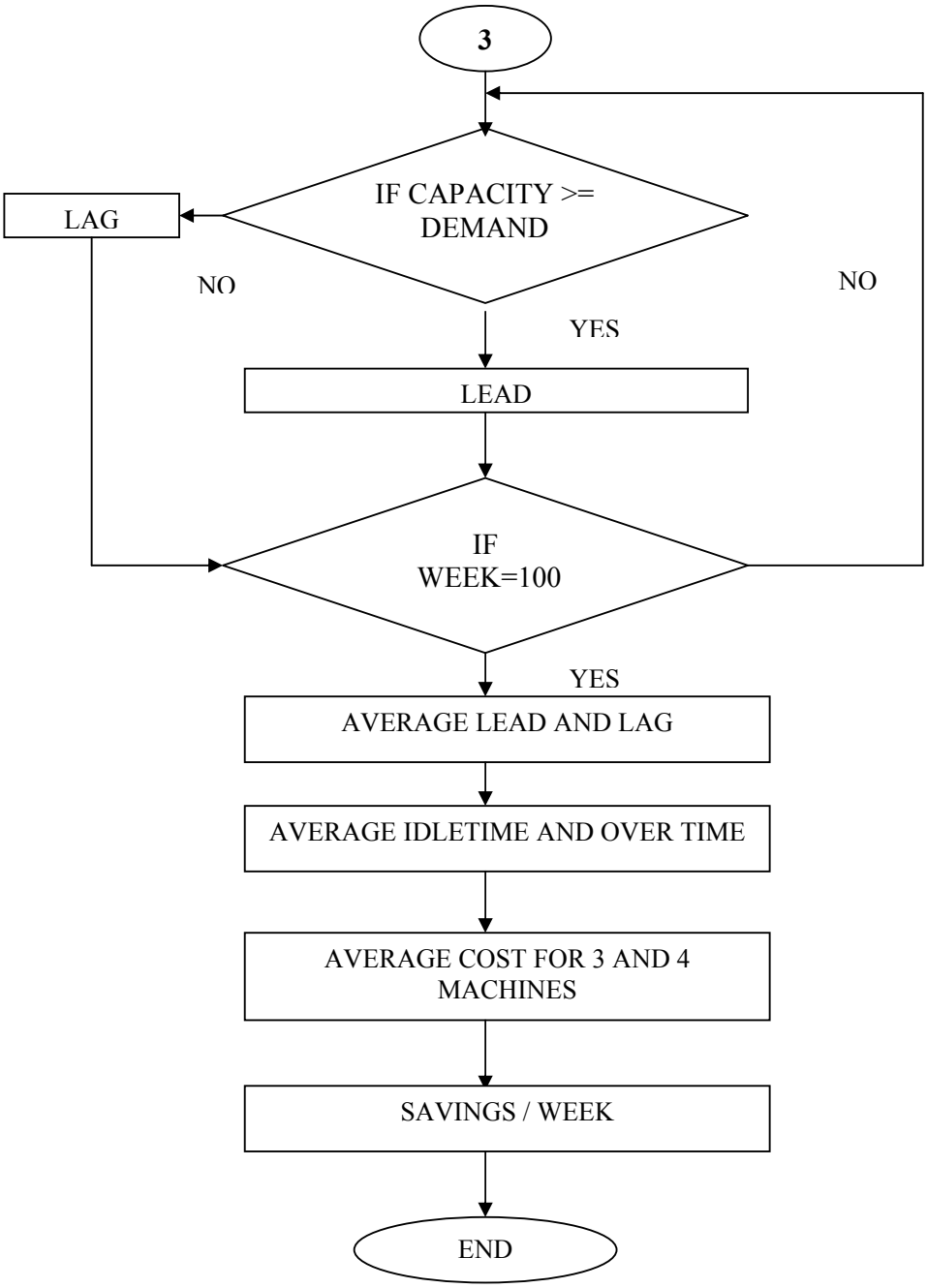


Figure 6.29. Simulation Flow Chart – Radiology (Ultrasounds)

6.6 7S Analysis

The 7-S-Model is better known as McKinsey 7-S. This is because the developers of this model, Tom Peters and Robert Waterman, were consultants at McKinsey & Co at the time it was developed. They published their 7-S-Model in their article "***Structure Is Not Organization***" (1980) and in their books "The Art of Japanese Management" (1981) and "***In Search of Excellence***" (1982). This model is used to analyze the management system of FFH, and is shown in Figure 6.30.

- Strategy The FFH's management does have strategies but not very long-term strategies. Top / senior management makes plan on adhoc basis as per their wisdom and wish. Also, employees don't have any understanding of how the organization works. Information flow from top to bottom is not smooth, lack of coordination, monitoring and no research oriented approach to plan for future are the main reasons for improper utilization of capacity, the delay in operations and lack of standardization in operations.
- Structure The structure is hierarchical with rigid lines of authority.
- System The system is highly centralized; top down, written with extensive post decision verbal communication to seek compliance thus there is an environment of excessive centralization, which results in delayed decisions. The relationships between supervisor and subordinates are too formal and are controlled by hesitance and fear. The employees don't work as a team and are always trying to achieve personal gains by considering co-workers competitors creating a hostile atmosphere that adversely affects the system.
- Skills FFH, Rawalpindi is the largest welfare hospital providing tertiary care to ex-servicemen and their families. Having the largest welfare tertiary care capacity is its core competency.
- Style/Culture ***Organizational culture*** is multidimensional, comprising of retired army personnel and civilians. Timings of individuals are not very strictly monitored, hence no solid way to analyze their output. ***Management style*** is autocratic and coercive. Ex-servicemen appointed at top-level work with their own wish and implement their own ways and rules rather than going for defined SOPs (Standard Operating Procedures). The people

working as their subordinates hence follow their supervisor's orders to satisfy them rather than doing productive and efficient work to benefit the organization. Also, the employees feel that their job is secure so their work is inconsistent and at times inefficient.

- Staff Posting criteria and selection of management and doctors is in the control of management at FF Headquarters. However, all the hiring and recruitment of staff is publicized in various newspapers and websites. Although the jobs are publicized yet many inductions are based on relationships/references. Moreover for civilians there is no job security. Work schedules are defined but they are too hectic and frustrating for the staff causing inefficiency and delay in operations.
- Shared Values/Subordinate Goals The goal of staff working at FFH is to attend to as many patients as possible in other words they strive for quantity not quality. Also, the wards tend to treat and discharge the patients at the earliest, not realizing that early discharge without proper treatment will result in recurring faults.

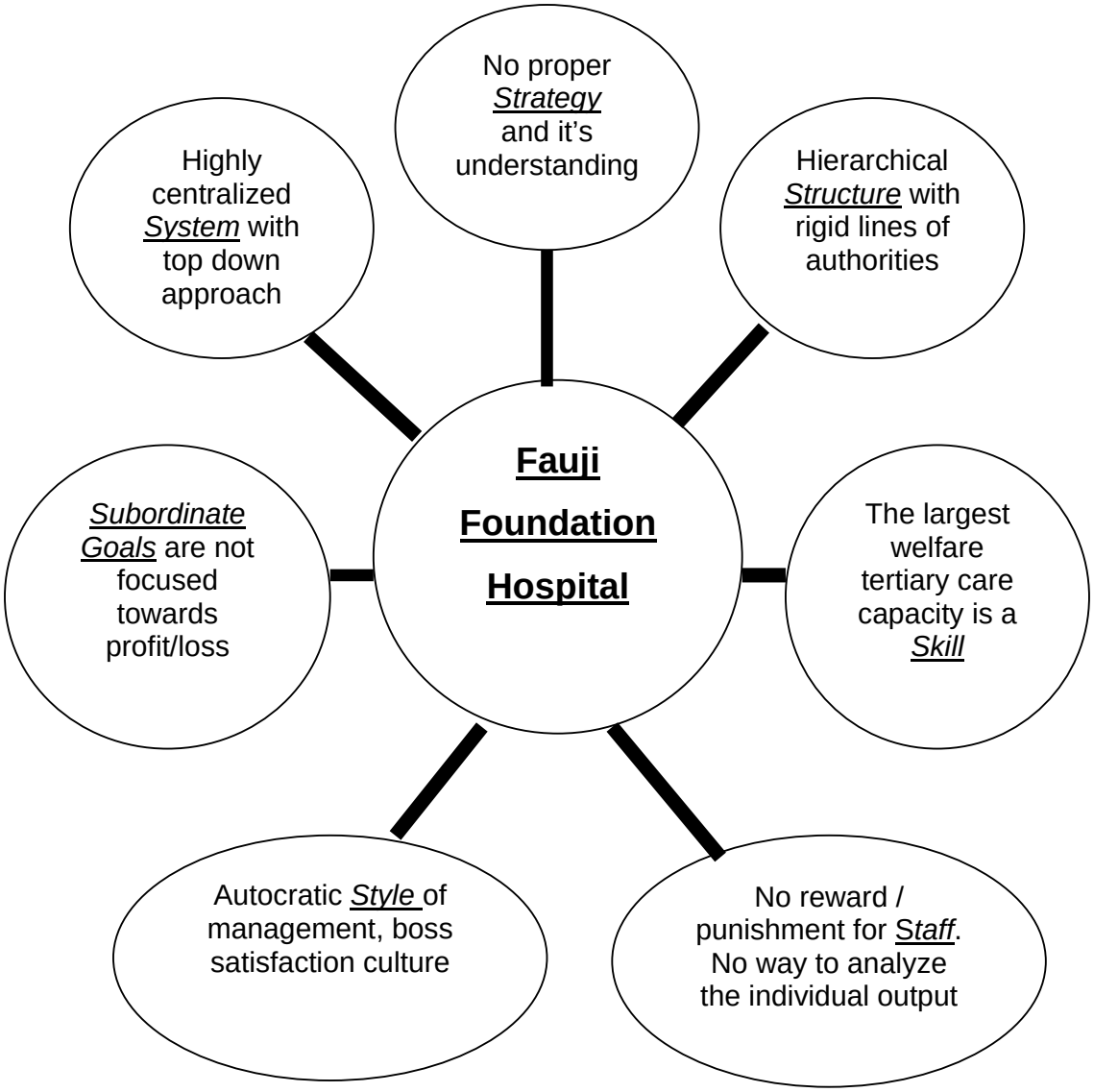


Figure 6.30. 7S Model Customized to Fauji Foundation Hospital

6.7 Generic Model for Service Capacity – Healthcare Services

The analysis done finally leads to the development of a generic model for service capacity model in health care services. Figure 6.31 shows the model that is based on the results and analysis discussed above.

The model consists of 5 major blocks. One is of the input(s), one output(s) block and three blocks are comprised of the various analyses done in this chapter. The input(s) comprises of demand, human resource levels, company's profile and objectives and infrastructure details. The inputs then go into the three analysis blocks namely Quantitative, Qualitative and General Analysis. Each block's analysis is based on different methods and techniques. The qualitative analysis employs surveys, interviews and on ground research and data collection. The quantitative analysis employs data collection and data manipulations using probability distributions and Monte Carlo Simulations in MATLAB. Whereas, the general analysis block covers the HR analysis, organization's strategies, objectives and way of management etc.

The results of all these analysis make the material for the output(s) block. The output(s) block contains ways of utilization of space, beds, staff, improved service levels, patient productivity and smoothness in operations. In short, the model's output(s) gives an idea of how and what to manage in terms of capacity so as to manage and build on the current capacity of the hospital.

CHAPTER 7

CHARACTERISTICS OF SERVICE CAPACITY MODELS

7.1 Introduction

In this chapter our aim is to group sample models under study with our generic model so as to understand the consensus among different authors and researches on issues related to capacity management. This helps the reader to understand some basic approaches that have been recommended by the literature. To make these groupings we first find and learn about major aspects and then see as how they have been treated in all the five capacity models.

Extensive review of the literature and the models led us to develop a set of 14 aspects on which we look to understand how different capacity management issues have been handled the models.

The aspects considered as important are listed below:

1. Literature review
2. Data collection
3. Model logic
4. Focus on good service level
5. Use of particular methodology
6. Applicable areas for the model
7. Capacity management focus
8. Universal versus unique
9. Results of the study
10. Planning available resources only
11. Demand management
12. Use of simulation
13. Handling of un-certainties
14. Forecasting methods

From discussions in chapter 3 on capacity management techniques/recommendations developed by Sasser, (1976) and Schemenner, (1995) we find that the set of 14 aspects we have developed above can be extended. Although these aspects help us to understand capacity management issues from data collection to the nature of results, there are certain more issues that can be added for further investigation in the studies later on, like, affect of customer participation, developing complementary services

etc. It is possible to look at how well different authors tackle the problems related to capacity measurement as listed by Elmaghraby, (1991). What are the solutions proposed to overcome these capacity measurement problems since sometimes as found in literature the capacity in actual is less than as anticipated by any firm.

Thus the problem on classification and grouping is spread on a very huge horizon. But we restrict ourselves here and focus on these 14 aspects only, see and understand the approach and results from the study. As a first step before comparing the models under study we formulate a Table 7.1 as under and see how each of the aspect has been dealt with. This gives us understanding of the major issues under study concerning capacity management for our study.

7.2 Major Aspects of Service Capacity Models

The main aspects listed above are tabulated below in Table 7.1 with the information that we get from each sample model on how these aspects are being treated. The comparisons would follow later on.

Table 7.1. Aspects Under Study

Main Aspects	**Our Model** **Service Capacity Model for Health Care Services**	***Model I*** **Capacity Management Model in Service Industry**	***Model II*** **Demand and Capacity Management Decisions**	***Model III*** **Call Center Capacity Management**	***Model IV*** **Outsourcing to Increase Service Capacity in NZ**
Literature Review	YES, to get an insight how other authors address the issue	YES, to get insight about how other authors address this issue	YES, to find CMO's and DMO's	YES, about queuing theory, erlang theory etc.…	YES, about service variability management issues and outsourcing
Model Logic	Both qualitative and quantitative approach	Quantitative Approach	Quantitative approach, discrete time simulation	Both qualitative research and qualitative approach *(Details Below)*	Qualitative Approach
Use of Simulation	Monte Carlo	NO	ARENA	NO	NO
Data Collection	Historical data collected from the hospital along with surveys and interviews carried out at FFH and FF head office	Historical data associated with quality data (use of Delphi methodology)	Interviews with service managers and customer demand data from different sources, use of available quantitative information and qualitative inferences from qualitative data	Qualitatively exploring nature of demand patterns using combination of informal interviews with management, direct access to operational data from reports and databases to get the quantitative data. Outliers in the original data were discounted	Formal interviews based on set of semi-structured questions. Direct observations of the service delivery process under study *lithotripsy*. Questionnaires used as evidence to support issues raised from interviews
Focus on Good Service Level	YES	YES, works with a pre - defined level of service quality set for a customer	No direct indication by the researchers, but using different DMO's and CMO's always trying to achieve good service	YES, trying to study how high service levels can be achieved without unnecessarily compromising	We may say because by outsourcing a particular service to a specialized party we want the improved

			level.	operating efficiency.	service levels
Particular Methodology Used	YES, Monte Carlo Simulation using MATLAB and surveys.	YES, any of the techniques like GRASP, PRN or Medicus	Arena simulation Software	Regression analysis both linear and exponential. But since exponential patterns did not fit the data better than the linear so linear regression results only reported in this study.	NO
Applicable Areas for the Model	Where demand and capacity is required to be managed continuously and customer satisfaction is desired. Can be applied to almost any sector.	Diverse sector application, whenever there is a flexible workforce with limited staff and variable activities are being carried out	Where demand and capacity are required to be managed continuously, e.g. in a bank	Sectors with Sudden changes in demand, or situations where high customer service level desired by fulfilling customer demands	To almost any service sector industry which can afford to out source a non-core activity to third parties
Capacity Management Focus	YES, minimum capacity levels determined along with feedback to manage workforce and Reduce workload.	YES, determining minimum capacity level below which service quality maybe affected	Continuous capacity management using different CMO's	Using different means of achieving staff flexibility to reduce workforce during quieter periods	Increasing available capacity using out sourcing strategy
Universal Versus Unique Applicability	Unique	Unique type of homogeneous workers considered for the study (of same category)	Unique	Unique, each centre operating under unique set of circumstances so that the levels of performance achieved by the call centers can be	Unique to a particular Non – core activity that is outsourced by a service firm

				expected to vary.	
Results / Findings of The Study	Findings are both of numerical natures and qualitative. The model gives the minimum number of resources required along with what areas need to be improved for better quality and efficiency	Numerical in nature. The model relates quality indices collected in the service to the relationship between the theoretical staff and the actual staff employed to carry out the service	Findings based on percentages and proportions allowing them to be applied to various service environments. Important to choose an appropriate combination of CMO's and DMO's	Results are more qualitative in nature since the number of sites studied was too small for some quantitative analysis. A crucial finding of the study is the strong association between the performance measures & the approach to forecasting	Findings of qualitative nature collected by interviews, questionnaires that formed part of the observational exercise. These findings support predictions made in literature regarding outsourcing a non-core activity in a service firm
Planning Available Resources Only	NO, available resources are planned but new options are also explored	YES, the resources which are considered as constant	NO, could use Different DMO's	YES	NO
Demand Management	YES, trying to adjust the resources on the basis of expected demand / week	NO, only trying to adjust the resources	YES, demand also managed hourly using different DMO's	YES, how different demand Management methods contribute to operating efficiency e.g. chase	Not sure from the information available in the article
Handling Uncertainties Involved	NO	NO	YES, different environmental and decision factors	YES, trying to forecast the uncertainties where results largely depend upon forecasting accuracy	NO
Forecasting Methods	NO	NO	NO	YES, how different forecasting techniques contribute to	NO

				operating efficiency. Shows the strong association between forecasting and performance measures	

7.3 Analyzing the Aspects Under Study

In this section we will look at each aspect listed above, analyze them and see if it is possible to build some relation between the models with respect to these aspects like for example relating the approach used by the researches with respect data collection.

7.3.1 Literature Review

One important aspect of any theoretical research is to go through all the available literature so that one should be clear and focus on the particular issues that he wants to explore. It was the approach by all the models under study. Each researcher has done an extensive review of the literature on general and capacity related issues in the service sector before coming to their own model. With this type of approach it is easy for the reader to follow what the authors want to say and could benefit from the study.

7.3.2 Data Collection

Concerning the data collection we find same sort of approach from all the authors. Usually the researchers are more concerned with the use of qualitative or quantitative (where possible) data available. Qualitative inferences were drawn from the formal or informal interviews, observational exercises, questionnaires etc. If somewhere quantitative data is available it has been put to the best possible use to look at the capacity management issues. Normally, there were no outliers in the available data that different researches came across. But in the special case of article dealing with 'call centre capacity management' issues we find that there were some specific outliers in the available data. These outliers were either due to the loss of incoming calls due to lack of some operational robustness in the centers. Secondly, the outliers appeared due to very rare but extreme forecasting inaccuracy that failed connections in the call centers. But since for the study here regression analysis has been performed so these outliers were discounted. The results which are obtained even after discarding these outliers are still coherent with the reality and it will not be wrong to argue that in

situations like these we can avoid these outliers for the sake of simplicity in our calculations.

7.3.3 Model Logic

In general we find that different researchers have concentrated only one specific approach to deal with the problem of capacity management either, qualitative or quantitative. But, in our model and that of 'call center capacity management' a dual approach towards building some concrete arguments about how to manage capacity has been used. Initially the qualitative inferences drawn from various informal interviews, studying the nature of various demand patterns, and then followed by some quantitative technique to explain the capacity problems. This could help us to conclude that it is better to always focus on one type of logical efforts but where possible different type of approaches could be used to help understand the situation in a larger perspective.

7.3.4 Focus on Good Service Level

As seen from the discussions we find that in general there has been a particular consensus to focus on customer service quality aspect before building some sort of model, which addresses the capacity management issues.

Although only in model 1 the authors clearly indicate that the pre-defined level of service quality is important but if we look at the other models we may argue that others also believe that customer service quality is an important issue. Like for example in the case of outsourcing to increase service capacity there is no clear indication whether or not authors agree to this but we may argue that since we are outsourcing our non – core activity as in the case of a health care unit to some specialist party so this would definitely help improve the service level. So we can say that service quality from the customer point of view has been an important consideration as done by all authors.

7.3.5 Use of Particular Methodology

Normally while defining any capacity management strategy there has been to some extent use of certain mathematical tools or computer software to help better understand the quantitative data available except the model 4 that is a clear qualitative approach and few recommendations have been proposed on the basis of qualitative analysis.

7.3.6 Applicable Areas

As listed in the table above there could be various service sectors, which can benefit from these models. But since each model has some particular characteristics like for example the outsourcing strategy to increase service capacity is very popular in health care services etc. There could be many more areas of application for these models but care should be taken before implementing different capacity strategies in different cases as wrong use could put the service to potential loss of benefits instead of gaining advantages.

7.3.7 Capacity Management Focus

In each model the aim is to better utilize the available capacity or hire capacity from a third party to increase profits for any firm keeping the customer service quality at a pre-determined level. Therefore, we find that each author has clear capacity management focused approach. For example in model 1 the authors have developed a model that allows to find the minimum number of staff to do a certain job keeping the customer service quality at pre-determined level. Similarly in model 4 the authors look at the affects both positive and negative, from industrial services perspective, of hiring additional capacity through outsourcing.

7.3.8 Unique versus Universal

Each model has some constraint like they could only be used under some unique environment and set of circumstances. They are not some universal models that could be applicable to all areas within a particular industrial service.

7.3.9 Results from the Study

Findings from any study are always the most important aspect as these help us to understand the nature of different problems, systems under study and could also lead us to some future work possible. In our study we see that authors have based all their results as either qualitative or quantitative. Some times the results are more numerical as in model 1 but as in model 4 the results are more of qualitative nature collected from various informal interviews etc. But in general the results taken out by the authors from their study are all easy to understand and give clear indication of the authors' intention to be as clear as possible in their approach.

7.3.10 Planning Available Resources

In all models we find that the approach focuses on planning the available resources so as to be able to avoid the capacity problems except the case of outsourcing strategy

where the extra capacity is being made available through acquiring additional resources from the outside/third parties to increase capacity. From this it maybe possible to argue that although out-sourcing of non-core activities is gaining popularity among many industries. In our model though we are proposing on planning for both available resources and considering other options to improve capacity, still many more authors have been focusing on better planning of the available resources as to cut their expenditures and gain the maximum profits.

7.3.11 Demand Management

Another interesting aspect is related to demand management. In our model, model 2 and 3 there has been clear understanding about using different demand management options (or demand management methods as in model 3) but in the other two models there is not explanation on how various demand management options could be employed.

7.3.12 Use of Simulation

Normally there has been no use of simulation technique employed except in the case of our model and model 2 where Monte Carlo simulation (using MATLAB) and ARENA simulation software has been used respectively. Thus these computer simulation software's and such other applications could also be very helpful in determining the nature of service systems and at the same time help service managers to better utilize their available resources. These would definitely help to improve the service level and in turn the profits attained by the company.

7.3.13 Handling of Uncertainties

As suggested in literature uncertainties are an important factor in any capacity related issues. Handling such uncertainties in the best possible way could be very critical. These unforeseen situations are normally associated with things like wrong forecasting, advertisement campaigns etc. Thus while developing such capacity management issues in our particular case we find that in model 2 and 3 the authors have clearly identify the possible solutions on how they can handle uncertainties involved. But in models 1 and 4 and our model there has not been enough explanation in this regard.

7.3.14 Forecasting

Only model 3 employs forecasting techniques. From the results indicated in the study one finds that there is clearly a close association between the forecasting techniques

and the performance measures especially in the case of those service industries that are facing sudden demand changes or demand spikes as these forecasting techniques do contribute to the operating efficiency.

7.4 Comparisons of Models – Aspect by Aspect

Since the main aim of this chapter is to see these available capacity models, study the approach followed by different authors and then try to relate different models as to find if there is some sort of general methodology / thinking common among different authors. So here in this section we would compare models against each other and see in which aspects discussed above these models seem to be having similarity and where the authors disagree from each other. After making this we find which are the models best related to each other to make groupings. These groupings will be done after further narrowing down our analysis to very basic aspects, as suggested from the literature, and compare these models on these few aspects as comparing on a large scale and making groups is quite impossible.

In the Table 7.2 to table 7.5 below we first compare each model against the other. Here in Table 7.2 we take our model as a reference model and then compare the four remaining models on each aspect. In Table 7.3 we have model 1 as our reference model and models 2, 3 and 4 compared to it for different aspects studied. The comparison results for our model against model 1 are taken from table 7.2.

Table 7.4 compares model 2 to models 3 and 4. The comparison results of model 2 to model 1 and our model are taken from Table 7.3. Table 7.5 compares model 3 to model 4. Results for comparison of model 3 to models 1, 2 and our model are taken from Table 7.4.

The findings from this comparison are either indicated as '+' or '-' or '?' in the tables. Here,

'+' means that the models have the similar aspects.

'-' means that the models have different aspects.

'?' indicates that we could not compare the two models due to some lack of information from the authors.

Table 7.2. Comparing Z Model Against Models 1, 2, 3, and 4

Reference: Z Model's Aspects	Model 1	Model 2	Model 3	Model 4
Data Collection	+	+	+	+
Model Logic	+	+	+	+
Focus on Good Service Level	+	+	+	+
Particular Methodology Used	+	+	+	-
Applicable Areas for the Model	+	+	+	+
Capacity Management Focus	+	+	+	+
Universal Vs. Unique Applicability	+	+	+	+
Results / Findings of The Study	+	+	-	-
Literature Review	+	+	+	+
Planning Available Resources Only	-	+	-	+
Demand Management	-	+	+	?
Use of Simulation	-	+	-	-
Handling Uncertainties Involved	+	-	-	+
Forecasting Methods	+	+	-	+

Table 7.3. Comparing Model 1 Against Models 2, 3, and 4 (Our Model Vs. 1 from Table 7.2)

Reference: Model 1 Aspects	Model 2	Model 3	Model 4
Data Collection	+	+	+
Model Logic	+	+	-
Focus on Good Service Level	+	+	+
Particular Methodology Used	+	+	-
Applicable Areas for the Model	+	+	+
Capacity Management Focus	+	+	+
Universal Vs. Unique Applicability	+	+	+
Results / Findings of The Study	+	-	-
Literature Review	+	+	+
Planning Available Resources Only	-	+	-
Demand Management	-	-	?
Use of Simulation	-	+	+
Handling Uncertainties Involved	-	-	+
Forecasting Methods	-	+	-

Table 7.4. Comparing Model 2 Against 3 and 4 (2 vs. 1 and our model from above table 7.3)

Reference: Model 2 Aspects	Model 3	Model 4
Data Collection	+	+
Model Logic	+	-
Focus on Good Service Level	+	+
Particular Methodology Used	+	-
Applicable Areas for the Model	+	+
Capacity Management Focus	+	+
Universal Vs. Unique Applicability	+	+
Results / Findings of The Study	-	-
Literature Review	+	+
Planning Available Resources Only	-	+
Demand Management	+	?
Use of Simulation	-	-
Handling Uncertainties Involved	+	-
Forecasting Methods	-	+

Table 7.5. Comparing Model 3 Against 4 (3 vs. 1,2 and our model from above table 7.4)

Reference: Model 3 Aspects	Model 4
Data Collection	+
Model Logic	+
Focus on Good Service Level	+
Particular Methodology Used	-
Applicable Areas for the Model	+
Capacity Management Focus	+
Universal Vs. Unique Applicability	+
Results / Findings of The Study	+
Literature Review	+
Planning Available Resources Only	-
Demand Management	?
Use of Simulation	-
Handling Uncertainties Involved	-
Forecasting Methods	-

7.5 Model Groupings

To do grouping among the sample models studied and our model it is important to know more precisely what are the most appropriate aspects as suggested by the literature and from the comparisons above. For this purpose we will short list the aspects studied above to the very basic few ones, which are considered, to be the most important in any of the capacity related issues as found in the literature.

It is possible to look at all the aspects described above but in our view these short listed aspects make easier for us to classify and group the models from data collection to results. The aspects that we consider important for classification and groupings from data collection to results are listed below:

1. Data collection
2. Model logic
3. Methodology
4. Planning available resources
5. Results

Now we will look at how different models relate to each other with respect to these very basic characteristics just mentioned.

7.5.1 Our Model against 1

Comparing our model against model 1 on these 5 short listed aspects we found that both seem to be following the same pattern and have the same approach in their analysis of the issues.

7.5.2 Our Model against 2

Here on comparison we found that both models have the same approach in their analysis of issues along with similar concept of planning resources.

7.5.3 Our Model against 3

Here both models seem to be following the same pattern and have the same approach in their analysis of the issues except that of planning of available resources.

7.5.4 Our Model against 4

Comparing these two models we find that both authors are on consensus on all the basic aspects except the methodology used. But we may argue that since with other aspects the authors are in the same sense of handling the capacity issues so these two models could be categorized as similar.

7.5.5 Model 1 against 2

Here on comparison we found that the two authors seem to be following the same pattern and have the same approach in their analysis of the issues.

7.5.6 Model 1 against 3

Here on comparison we found that although initially the authors seem to be having some sort of commonality in their analysis of the situation like data collection and qualitative inferences where required for the analysis but when it comes to final results and conclusion we find a clear difference.

7.5.7 Model 1 against 4

Here the researchers are completely following different path in dealing with the capacity issues and have different logics to build their analysis and the final conclusion. Model 1 is quantitative in nature while model 4 is completely qualitative analysis of the outsourcing strategy to increase service capacity.

7.5.8 Model 2 against 3

Here as well we find difference among the authors in the nature of result they obtain. Model 2 more numerically describe the results while model 3 although gets results from the linear regression analysis but they are more qualitative in nature.

7.5.9 Model 2 against 4

Here completely different logics have been used to analyze the situation.

7.5.10 Model 3 against 4

These two models give us some thing interesting to compare since we find the authors almost in consensus on all the basic aspects except the methodology used. They have difference in the planning of available resources as well since in model 4 the authors try to assess what happens by acquiring additional capacity by outsourcing non-core activity. But we may argue that since with other aspects the authors are in the same sense of handling the capacity issues so these two models could be categorized as similar.

Now the question is how to then make some sort of grouping among these models. We may say that the arguments given above favor the conclusion that there seem to be some sort of coherence between the models 1 and 2. On the other hand model 3 and 4 appear to be approaching the issues under study in almost the same way. So, we may argue to group the models in two basic groups:

Group 1 Model 1, 2

Group 2 Models 3, 4

To further clarify and help reader understand what are the basic similarities among the models considered in each group we enlist few of those below:

Group 1 quantitative analysis, use of particular methodology, results numerical in nature

Group 2 more qualitative approaches in analysis and results description.

However, our model is used both qualitative and quantitative analysis, uses particular methodology, results are both of numerical and qualitative nature it overlaps with both the groups. Hence it uses all the approaches and amalgamates both groups resulting in a model that can be applied to a large number of service industries.

As stated earlier the aim of this particular comparative study among the sample models is to develop an understanding on how different authors have approached the issue of capacity management in industrial services. Doing so from the comparisons among the sample models on the basic aspects from data collection to results we are able to make two major groups. These groups indicate that there is a general consensus among various authors on issues related to capacity management. The study could be different like qualitative or quantitative approach to the problem but they all agree that capacity management should be done in a way so as to be able to maintain high levels of customer service quality. The comparison also gives us an understanding that how different authors have approached different capacity management techniques like using the available resources or outsourcing to stay coherent with the better-known recommendations as proposed by Sasser (1976) and Schemenner (1995). The study also shows that use of forecasting techniques have great influence on the system performance. But still as commented by Dilworth (1992) forecasting is a skill rather than an exact science. The results from each study are as clear as possible for the reader to understand the problems associated with capacity management.

CHAPTER 8

RECOMMENDATIONS AND CONCULSION

A well-developed hospital system for health care alone can't result in a provision of efficient and quality service. It is also required to be well managed in terms of its capacity related issues. This will play a key role not only in the growth of the health care system but also benefit the country's service sector on the whole in the long run. Fauji Foundation Hospital is one of the most important hospital providing health care services to the huge number of ex-servicemen and their families. It is the only welfare hospital of Fauji Foundation that provides tertiary care to its beneficiaries making it the national hub for patient influx from all over the country. However, the system at FFH is inefficient and can provide better and improved health care services if the management sheds light on managing and building its capacity. Building its capacity via proper research and development and making use of the available resources the hospital can meet its demands, increase the productivity and efficiency and reduce the losses it incurs from poor management.

The services sector has major share in the economy of Pakistan and health care services are an important part of the services sector. To boost the economy and competitiveness of Pakistan there is a need of better health care facilities that are efficiently functioning and provide quality services to its customers. In order to do so implementation of a service capacity model for managing and building on capacity is vital. Therefore there is a dire need to modernize the health care services to facilitate expanding health care demand, overcome inefficiencies and under productivity. Following are the few recommendations to boost the provision of health-care services by managing capacity.

8.1 Recommendations at National Level

8.1.1 PMDC to play as an Active Governing Body

The Pakistan Medical and Dental Council (PMDC) should play as an active governing body in order to improve quality of service at hospitals. Feedbacks should be taken from the customers and staff so as to monitor the hospitals way of operation. Strict rules should be enforced for hospitals all over Pakistan to manage their capacity and build on the existing capacity by setting up R&D cells.

8.1.2 Revision of the National Health Policy

The Federal government has the responsibility to design the National Health Policy. Although a national health policy is in place but it needs to be revised since it was published in 2001 and 8 years have elapsed without bringing any changes to it. There policy should focus on providing parameters and guidelines to health care providers to maintain a uniform standard of health status in line with the international standards, cater for managerial deficiencies and introduce strict regulations for improving quality of service.

8.2 Recommendations for Female Medical Ward - FFH

8.2.1 Operational

The problems related to operations must be prioritized in accordance with their gravity. Following is recommended.

8.2.1.1 Proper Scheduling of Doctors Duties

The doctors are overworked and load of patients in both indoor and outdoor is far more than the expected level of workload. Proper schedules should be made so as to relieve doctors from the overloading. There should be two night duties / week for every doctor along with the provision of no outdoor duties the next day. This will provide job satisfaction to the doctors and make their work more efficient.

8.2.1.2 Reduce Waiting Times

FFH should reduce the waiting times at both the medical store and also in the OPD. The medical store needs to divide its counters for prescription taking and issuing drugs. Also, separate counters for men and women should be established to evenly distribute the patients and reduce waiting times. By increasing the number of doctors and deciding on an average time given to a patient that satisfies him/her can also reduce waiting times.

8.2.1.3 Deploy Employee Monitoring System

Employee monitoring system can monitor the attendance of the staff at FFH. This will keep track of the employee performance and add value to FFH's service and this will transform operations into more predictable and efficient. In addition it will help to reduce the time spent in looking for a doctor for a specific case making it easy to respond to any emergency.

8.2.1.4 Review the Service Provision by Patient Feedback

Frequent feedback from patients visiting the hospital should be taken to review the provision of service from the customer's point of view. This system would create a database of feedback that can be used in future work regarding research and development.

8.2.1.5 Scheduling Machine Maintenance

The maintenance of the electro medical equipment present should be done on regular basis. The maintenance department should develop a schedule for weekly maintenance of the machines. Also, contracts should be made with the installing companies to carry out monthly or quarterly maintenance.

8.2.1.6 Improving the Quality of Service

Hospital management's focus should be on improving the quality and delivery of service to its customers. Improving the ethical conduct of the whole staff can be of great help. Not only the doctors and nurses but also the support staff needs to be trained. The sanitary conditions at the hospital need to be up to standards. The patients' should feel relaxed and not experience unnecessary stress. The medical attention provided should be of high standards. Efficiency in operations needs to be employed to avoid patients of trouble.

8.2.2 Infrastructure

The proper utilization of infrastructure includes the utilization of beds, space and machinery available; to achieve this following is recommended.

8.2.2.1 Utilization of Indoor Ward Beds

The number of beds present in the indoor ward is 132. This research shows that the minimum number of beds that are required to meet the demand of patients is 109. Although currently, the capacity exceeds the demand it doesn't mean that the extra beds could be utilized without proper planning. Frequent simulation runs should be carried out to have an idea of how much demand is expected. In case the demand exceeds the current demand patterns the extra number of beds can be utilized to cater for the extra patients.

8.2.2.2 Expanding Outdoor Ward Area

The number of patients that the outdoor patient ward can handle at one time is 95. From the research we find that the expected number of patients per week is 1150 so an average of 200 patients are expected per day. One patient takes approximately 10

minutes for checkup making it 2000 minutes (33 hours) in all. There are three doctors available other than the 3 HOs that make the doctors over worked and results in long waiting lines of patients. This results in over crowding of the OPD waiting area and hence its expansion is required so as to facilitate the patients.

8.2.2.3 Utilization and Installation of X-Ray Machines

The x-ray machines present in the radiology department should be utilized to properly. As the demand of x-ray tests is quite high the machines need to be operated beyond the time designated for their operation. Installation of some new machines can help reduce the workload and also benefit the hospital economically.

8.2.2.4 Utilization and Installation of Ultrasound Machines

The ultrasound machines present in the radiology department should be utilized to properly. The demand of ultrasounds is higher than the capacity therefore the machines are operated beyond the time designated for their operation. Installation of one new machine can reduce workload and increase profits.

8.2.2.5 Establishing the Patient Information Desk

A patient information desk should be established to help incoming patients find their way within the medical ward premises. Maps of the ward should also be hanged to facilitate the patients and their attendants.

8.2.2.6 Installation of CT and MRI Machines

FFH has been operating for almost 50 years now, still the very demanded machines like CT and MRI have not been installed. Management should make efforts to install these machines at the facility to not only increase patient influx but also reduce the problems faced by the patients, by going to other hospitals, to get the tests done.

8.2.3 Organizational

8.2.3.1 Understanding Organization's Vision

Although the long-term vision is set by FFH however, the people at FFH need to understand it fully so as to respond to the needs of the organization in order to build on strategies that payoff.

8.2.3.2 Frequent Management Changes

The frequent management changes should be reduced by implying long-term contracts with the employees. However, the employee performance should be monitored for a probation period of one year.

8.2.3.3 Improved HR Department

The organization should make efforts and ensure that the hiring is done on the basis of merit and not personal agendas. Also, employees should be rewarded / punished for their work. Most importantly the training of staff should ensure smooth flow of information at all levels of management so as to result in improved decision making.

8.2.3.4 Employee Trainings

The nursing staff should be capable of providing quality health care to the patients. For this purpose workshop, on job trainings and machine trainings should be held. Also, seminars on new medical advancements and technologies should be held to facilitate and educate the doctors. This will improve the treatment methods and ensure customer satisfaction.

8.2.4 Periodic Update of Simulation Results

The simulations should be carried out periodically to update the results so as to manage / build on existing capacity.

8.2.5 Establishing Center of Excellence

In order to benefit various other organizations from the results of the proposed model (simulations) implemented at this hospital a center of excellence should be established. This would require a team of researchers and administrators working constantly to improve their own system and also providing assistance to other parties.

8.3 Future Research Direction

The future research may be in the following areas:

- Extending the proposed model on other departments of the hospital to maximize the efficiency and provision of service capacity.
- Extending this generic service model to other service sectors.
- Feed back analysis of Fauji Foundation Hospital after implementing this thesis.
- Development of user friendly Graphical User Interface for convenience of use for medical staff.
- Development of an online evaluation system for doctors' feedback.
- Carry out linear and analytical modeling to compare with simulation modeling and combine the results from both to develop a more efficient and robust capacity management.

8.4 Conclusion

The service capacity model for health care services is an essential element that needs to be employed so as to efficiently manage / build service capacity of any service organization. Managing capacity at Female Medical Ward, FFH can only be done by strict implementation of the model that includes developing and adopting long term strategy, understanding the common goals, changing the autocratic ways the management works, improving the human resource department, improving the flow of information, scheduling the staff trainings, proper and planned utilization of space, machinery and staff, taking scheduling decisions regarding duties, periodic run of simulations to review the demand and finding the minimum number of beds required, the minimum number of expected outdoor patients, the minimum number of x-ray test demand and choosing between alternatives (with the help of Monte Carlo Simulation), achieving customer and job satisfaction.

The focus of this thesis remained on the Female Medical Ward, FFH; however the research work is equally applicable to all other public, semi-government and the private service organizations regardless of the size and nature. The services sector in Pakistan has 74% contribution to the GDP 2007-08. The health services come under the umbrella of social, community and personnel services, which has exhibited a growth of 78% since 2000 according to the FBS.

Services sector plays a major role in the economic development of Pakistan. Hence, emphasis is needed to bring improvement in the sector so as to enhance its role in the economic development. Efforts should be made for collaboration with other countries to bring in new methods and researches so as to increase the output of this sector along with ability to meet demands. The study relates to the fact that capacity management is not at all a simple task. It requires considerable efforts from the service managers in defining various capacity strategies as according to the underlying objectives of the firm to be able to stay competitive in the global markets.

Implementation of an efficient service capacity model is a pre-requisite for robust, efficient and professional hospital. Hence, the health care services must be modernized by the use of such models and research work to cater for inefficiencies and demand lags.

Annexure-A

Criteria for Beneficiaries

Fauji Foundation Beneficiaries are defined in the FF's Constitution (1972), changes to which can only be made by the express approval of Committee of Administration. The beneficiaries are:

- Wives, sons (up to the age of 18 years) and unmarried daughters of ex-servicemen (JCOs and OR).
- Daughters of ex-servicemen (JCOs and OR) who are widows or divorced and dependent on their parents. However, on re-marriage, such daughters cease to be beneficiaries.
- Sons of ex-servicemen already undergoing treatment for a particular ailment continue getting treatment for that particular ailment if treatment is required beyond 18 years but up to the age limit of 19 years.
- Invalid sons of ex-servicemen irrespective of age (even beyond 18 years of age) are entitled free medical treatment.
- Parents of Shaheeds. (Definition of Shaheed: Those soldiers who attain martyrdom during war or during peace time along the Line of Control due to enemy action in Azad Jammu & Kashmir and Northern Areas).
- Those who have served in or retired from Mujahid Force ex 10 Corps (since 1 Oct 2002), including Shaheeds or Disabled in military action prior to 1 Oct 2002, and personnel of all other Mujahid Battalions activated elsewhere in Pakistan provided that they take part in action during war.

Annexure -B

Committee of Administration

The Committee of Administration (COA) comprises of

1. Secretary Committee of Administration
2. Deputy Chief of Naval Staff (Trg & Pers)
3. Quartermaster General
4. Adjutant General
5. Secretary Defence
6. Ex - MD Fauji Foundation
7. Chief of General Staff
8. Chief of Log Staff
9. Deputy Chief of the Air Staff (Administration).

Central Board of Directors (CBODs)

The Central Board of Directors (CBODs) comprises of:

Chairman	Chairman (ex-officio)
Vice Chairman	Managing Director
Members	Director, Finance Director, Industries Director, Welfare (Health) Director, Welfare (Education) Director, Planning & Development Director, Human Resource & Administration Director, Research Director, Investment
Secretary	Secretary Central Board of Directors, Fauji Foundation

Annexure – C

TECHNOLOGY INVENTORY SURVEY

A. EQUIPMENT AVAILABILITY									
S No.	MACHINE CATERGORY	YES	NO	IF YES, NO.	IF NO, PATEINTS REFERRED TO	OPERATIONAL		YEAR INSTALLED	MACHINE COST
						YES	NO		
1.	X-Ray Machine								
2.	Ultrasound Machine								
3.	Dialysis Machine								
4.	MRI Machine								
5.	CT SCAN								
6.	Auto Analyzers								
7.	Color Doppler								
8.	Echo								
9.	Chlonoscopy								
10.	Mammography								
11.	Fluoroscopy								
12.	ETT								
13.	Holter Monitor								
14.	Gastroscopy								
15.	Bronchoscopy								

B. EQUIPMENT UTILIZATION					
S No.	MACHINE CATERGORY	DAILY UTILIZATION	TIME / TEST	TECHINICAINS / MACHINES	ACTUAL RUNNING HOURS
1.	X-Ray Machine				
2.	Ultrasound Machine				
3.	Dialysis Machine				
4.	MRI Machine				
5.	CT SCAN				
6.	Auto Analyzers				
7.	Color Doppler				
8.	Echo				
9.	Chlonoscopy				
10.	Mammography				
11.	Fluoroscopy				
12.	ETT				
13.	Holter Monitor				
14.	Gastroscopy				
15.	Bronchoscopy				

C. OPERATIONAL STAFF TRAINING AND MACHINE MAINTENANCE									
S No.	MACHINE CATERGORY	IS THE STAFF TRAINED FOR OPERATION		NEED FOR FURTHER TRAINING	MACHINE MAINTENANCE		MAINTENANCE DONE AT		
		YES	NO		PREVENTIVE	SCHEDULED	FACILITY	LOCAL SERVICE CENTER	PARENT SERVICE CENTER
1.	X-Ray Machine								
2.	Ultrasound Machine								
3.	Dialysis Machine								
4.	MRI Machine								
5.	CT SCAN								
6.	Auto Analyzers								
7.	Color Doppler								
8.	Echo								
9.	Chlonoscopy								
10.	Mammography								
11.	Fluoroscopy								
12.	ETT								
13.	Holter Monitor								
14.	Gastroscopy								
15.	Bronchoscopy								

Annexure – D

QUESTIONNAIRE

(STAFF FEEDBACK)

Q1: How many patients do you deal in OPD per day?

a) 50 ☐
b) 50-100 ☐
c) More than 100 ☐

Q2: What is the average time a single patient take?

a) 2 - 3 mins ☐
b) 4 - 5 mins ☐
c) 6 - 10 mins ☐

Q3: Do you think that the staff present is sufficient?

☐ Yes ☐ No

If No how many you suggest
Doctors _____

Support Staff _____

Q4: How many tests do you have to carry out?

a) 50 ☐
b) 50-100 ☐
c) More than 100 ☐

Q5: How many days are you on OPD duty?

a) Once a week ☐
b) More than once ☐

Q6: How many hours do you have to work?

a) 5 hours ☐
b) 5-8 hours ☐
c) More than 10 hours ☐

Q7: After night duty, do you get a day off in terms of OPD?

☐ Yes ☐ No

Q8: Do you think hospital staff is properly trained?

☐ Yes ☐ No

If YES are any trainings carried out?

_____

If NO what do you suggest

_____

Annexure - D

QUESTIONNAIRE

(PATIENT FEEDBACK OUTDOOR PATIENTS)

Q1: How frequently do you visit OPDs?

a) Once ☐
b) Twice ☐
c) Thrice ☐
d) Four times ☐
e) Five times ☐

Q2: At what time of the day do you feel more relaxed to visit OPD?

a) Early Morning ☐
b) Afternoon ☐

Q3: What is the average time in waiting for a consulting doctor? Select the appropriate option:

a) 30-45 mins ☐
b) 1 hour-1 hour 30 mins ☐
c) More than 2 hours ☐

Q4: Average time it takes for the tests?

a) 30 mins ☐
b) More than 30 mins ☐

Q5: Average time it takes at the medical store?

a) 30 mins ☐
b) 1 Hour – 1 Hour 30 mins ☐
c) Over 2 Hours ☐

Q6: Do you think that the staff present is sufficient?

☐ Yes ☐ No

If No how many you suggest
Doctors _____

Support Staff _____

Q7: Do you think hospital staff is properly trained?

☐ Yes ☐ No

If NO what do you suggest

_____

Q8: Do you think the computerized system is better than the manual one?

☐ Yes ☐ No

Q9: In your opinion is the OPD area sufficient for handling the patients present?

☐ Yes ☐ No

Annexure - D

QUESTIONNAIRE

(DOCTORS FEEDBACK)

Q1: How many patients do you deal in OPD per day?

a) 50 ☐
b) 50-100 ☐
c) More than 100 ☐

Q2: What is the average time a single patient take?

a) 2 - 3 mins ☐
b) 4 - 5 mins ☐
c) 6- 10 mins ☐

Q3: Do you think that the staff present is sufficient?

☐ Yes ☐ No

If No how many you suggest
Doctors _____

Support Staff _____

Q4: Do you think hospital staff is properly trained?

☐ Yes ☐ No

If NO what do you suggest

_____

Q5: On a OPD day, do you have to handle the Indoor and emergency patients as well?

☐ Yes ☐ No

Q6: How many days are you on OPD duty?

- Once a week ☐
- More than once ☐

Q7: What is the timing of OPD?

_____

Q8: After night duty, do you get a day off in terms of OPD?

☐ Yes ☐ No

Annexure – E

Random Number

948	451	331	7	165	828	643	322	26	355	743	298
181	415	867	624	55	404	301	152	309	3	437	676
822	755	162	552	525	919	441	44	964	13	552	934
898	617	699	939	452	176	616	518	364	773	828	318
595	781	33	856	682	801	917	388	471	88	925	678
641	995	499	430	829	116	598	221	398	301	633	944
5	816	690	980	69	44	739	819	260	704	296	82
875	77	740	125	443	592	636	532	208	673	241	720
399	394	411	149	878	21	923	632	66	632	753	769
808	543	485	441	626	77	544	209	269	291	822	411
526	920	379	638	173	785	365	776	342	774	147	148
639	93	928	485	163	276	130	23	231	845	726	694
383	479	967	783	409	957	196	529	504	483	377	519
815	208	388	46	304	813	682	882	81	494	430	345
913	160	387	967	66	316	126	115	164	93	532	762
417	835	804	9	644	112	215	909	144	207	850	713
80	818	348	162	539	923	437	540	698	2	836	889
19	98	374	967	619	670	456	838	823	542	92	295
602	182	733	548	156	925	202	8	689	400	379	903
943	473	17	819	57	90	696	147	57	63	722	33
695	221	625	513	575	287	892	92	292	821	994	67
973	922	958	563	950	318	265	61	332	292	402	34
287	219	565	870	254	591	522	129	3	325	360	994
939	434	935	496	971	957	720	647	862	30	365	93
334	815	25	424	33	676	327	560	424	150	64	616
629	176	407	706	429	210	590	837	888	885	962	769
367	68	108	936	511	211	421	829	142	321	817	293
79	928	166	386	486	810	405	795	19	956	854	986

Annexure - F

Monte Carlo Simulation Codes in MATLAB

Code for Indoor Patient Ward

```
% Monte Carlo Simulation for Indoor Ward
clear all
clc
Range_d = csvread ('Indoor.txt');                % no of patients, Range (min, max)
Min=Range_d;
Min (:, 1) = [];
Min (:, 2) = [];
Max=Range_d;
Max (:, 1) = [];
Max (:, 1) = [];
Average=zeros (50,1);
for k=20:5000
Rands=floor (1000*rand (k,1));                   % week no, random, Patients
for i=1:k
   if (Rands (i,1)>=1000)
      Rands (i, 1)=999;
   end
end
Weeks=zeros (k, 3);
for i=1:k
   Weeks (i, 1)=i;
   Weeks (i, 2)=Rands (i, 1);
end
for i=1:k
   for j=1:39
      if ((Rands (i, 1)>=Min(j,1))&(Rands (i, 1)<=Max(j, 1)));
         Weeks (i, 3)=Range_d (j, 1);
     end
   end
```

Annexure - F

```
end
Demand=Weeks;
Demand (:, 1) = [];
Demand (:, 1) = [];
Average (k, 1)=floor (sum (Demand) / k);
end
plot (Average)
total_average=sum (Average) / 4980
```

Code for Outdoor Patient Ward

```
% Monte Carlo Simulation for OPD
clc
clear all
clc
Range_d = csvread ('outdoor.txt');          %no of patients, Range (min, max)
Min=Range_d;
Min (:, 1) = [];
Min (:, 2) = [];
Max=Range_d;
Max (:, 1) = [];
Max (:, 1) = [];
Average=zeros (50,1);
for k=20:10000
Rands=floor (1000*rand (k, 1));             % week no, random, Patients
for i=1:k
   if (Rands (i, 1)>=1000)
      Rands (i, 1)=999;
   end
end
Weeks=zeros (k, 3);
for i=1:k
   Weeks (i, 1)=i;
    Weeks (i, 2)=Rands(i,1);
```

Annexure - F

```
end
for i=1:k
   for j=1:77
      if ((Rands (i, 1)>=Min(j, 1))&(Rands (i, 1)<=Max(j, 1)));
         Weeks (i, 3)=Range_d (j, 1);
      end
   end
end
Demand=Weeks;
Demand (:, 1) = [];
Demand (:, 1) = [];
Average (k, 1)=floor (sum (Demand) / k);
end
plot (Average)
total_average=sum (Average) / 9980
```

Code for Radiology Department (X-Ray Tests and Machines)

```
% Monte Carlo Simulation for X-ray Tests
clear all
clc
Range_d = csvread ('xrays.txt');                %no of tests, Range (min,max)
Min=Range_d;
Min (:, 1) = [];
Min (:, 2) = [];
Max=Range_d;
Max (:, 1) = [];
Max (:, 1) = [];
for k=1:500
Rands=floor (900 * rand (100,1));               % week no, random, x-rays
for i=1:100
   if (Rands (i, 1) >= 1000)
       Rands (i, 1) = 999;
end
```

Annexure – F

```
end
Weeks=zeros (100, 3);
 for i=1:100
    Weeks (i, 1)=i;
    Weeks (i, 2)=Rands (i, 1);
 end
 for i=1:100
    for j=1:48
       if ((Rands (i, 1)>=Min(j, 1))&(Rands (i, 1)<=Max (j, 1)))
          Weeks (i, 3)=Range_d (j, 1);
       end
    end
 end
%3 machines
Range_d1 = csvread ('3machines.txt');
Min1=Range_d1;
Min1 (:, 1) = [];
Min1 (:, 2) = [];
Max1=Range_d1;
Max1 (:, 1) = [];
Max1 (:, 1) = [];
Rands1=floor (900 * rand (100, 1));
for i=1:100
   if (Rands1 (i, 1)>=1000)
      Rands1 (i, 1)=999;
   end
end
Weeks1=zeros (100, 3);
 for i=1:100
  Weeks1 (i, 1)=i;
    Weeks1 (i, 2)=Rands1 (i, 1);
end
for i=1:100
```

Annexure - F

```
    for j=1:3
       if ((Rands1 (i, 1)>=Min1 (j, 1))&(Rands1 (i, 1)<=Max1 (j, 1)))
           Weeks1 (i, 3)=Range_d1 (j, 1);
       end
    end
 end
%4 machines
Range_d2 = csvread ('4machines.txt');
Min2=Range_d2;
Min2 (:, 1) = [];
Min2 (:, 2) = [];
Max2=Range_d2;
Max2 (:, 1) = [];
Max2 (:, 1) = [];
Rands2=floor (900*rand (100, 1));
for i=1:100
   if (Rands2 (i, 1)>=1000)
      Rands2 (i, 1)=999;
   end
end
Weeks2=zeros (100, 3);
for i=1:100
    Weeks2 (i, 1)=i;
    Weeks2 (i, 2)=Rands2 (i, 1);
end
for i=1:100
    for j=1:3
       if ((Rands2 (i, 1)>=Min2 (j, 1))&(Rands2 (i, 1)<=Max2 (j, 1)))
          Weeks2 (i, 3)=Range_d2 (j, 1);
       end
    end
end
%3 machines
```

Annexure - F

```
Lead=zeros (100, 1);
Lag=zeros (100, 1);
for i=1:100
   if ((Weeks1 (i, 3))>=(Weeks (i, 3)))
      Lead (i, 1)=(Weeks1 (i, 3))-(Weeks (i, 3));          %Lead;
   elseif ((Weeks1 (i, 3))<(Weeks (i, 3)))
      Lag (i, 1)=Weeks (i, 3)-Weeks1 (i, 3);           %Lag;
   end
end
Average_Lead=floor (sum (Lead) / 100);
Average_Lag=floor (sum (Lag) / 100);
Idle_time=Average_Lead * 10 / 60;
Over_time=Average_Lag * 10 / 60;
%4 machines
Lead1=zeros (100, 1);
Lag1=zeros (100, 1);
for i=1:100
   if ((Weeks2 (i, 3))>=(Weeks (i, 3)))
      Lead1 (i, 1)=(Weeks2 (i, 3))-(Weeks (i, 3));          % Lead1;
   elseif ((Weeks2 (i, 3))<(Weeks (i, 3)))
      Lag1 (i, 1)=Weeks (i, 3)-Weeks2 (i, 3);           % Lag1;
   end
end
Average_Lead1=floor (sum (Lead1) / 100);
Average_Lag1=floor (sum (Lag1) / 100);
Idle_time1=Average_Lead1 * 10 / 60;
Over_time1=Average_Lag1 * 10 / 60;
Cost_3machines (k, 1)=Over_time * 750 * 3;
Cost_4machines (k, 1)=Over_time1 * 750 * 4;
end
Average_cost_3machines=floor (sum (cost_3machines) / 500)
Average_cost_4machines=floor (sum (cost_4machines) / 500)
Savings=(Average_cost_3machines)-(Average_cost_4machines)
```

Annexure - F

Code for Radiology Department (Ultrasounds)

```
% Monte Carlo Simulation for X-ray Tests
clear all
clc
Range_d = csvread ('xrays.txt');                %no of tests, Range (min,max)
Min=Range_d;
Min (:, 1) = [];
Min (:, 2) = [];
Max=Range_d;
Max (:, 1) = [];
Max (:, 1) = [];
for k=1:500
Rands=floor (900 * rand (100,1));               % week no, random, x-rays
for i=1:100
   if (Rands (i, 1) >= 1000)
       Rands (i, 1) = 999;
end
end
Weeks=zeros (100, 3);
 for i=1:100
    Weeks (i, 1)=i;
    Weeks (i, 2)=Rands (i, 1);
 end
 for i=1:100
    for j=1:48
       if ((Rands (i, 1)>=Min(j, 1))&(Rands (i, 1)<=Max (j, 1)))
          Weeks (i, 3)=Range_d (j, 1);
       end
    end
 end
%3 machines
Range_d1 = csvread ('3machines.txt');
```

Annexure - F

```
Min1=Range_d1;
Min1 (:, 1) = [];
Min1 (:, 2) = [];
Max1=Range_d1;
Max1 (:, 1) = [];
Max1 (:, 1) = [];
Rands1=floor (900 * rand (100, 1));
for i=1:100
   if (Rands1 (i, 1)>=1000)
      Rands1 (i, 1)=999;
   end
end
Weeks1=zeros (100, 3);
 for i=1:100
  Weeks1 (i, 1)=i;
    Weeks1 (i, 2)=Rands1 (i, 1);
end
for i=1:100
    for j=1:3
       if ((Rands1 (i, 1)>=Min1 (j, 1))&(Rands1 (i, 1)<=Max1 (j, 1)))
           Weeks1 (i, 3)=Range_d1 (j, 1);
       end
    end
 end
%4 machines
Range_d2 = csvread ('4machines.txt');
Min2=Range_d2;
Min2 (:, 1) = [];
Min2 (:, 2) = [];
Max2=Range_d2;
Max2 (:, 1) = [];
Max2 (:, 1) = [];
Rands2=floor (900*rand (100, 1));
```

Annexure - F

```
for i=1:100
   if (Rands2 (i, 1)>=1000)
      Rands2 (i, 1)=999;
   end
end
Weeks2=zeros (100, 3);
for i=1:100
    Weeks2 (i, 1)=i;
    Weeks2 (i, 2)=Rands2 (i, 1);
end
for i=1:100
    for j=1:3
       if ((Rands2 (i, 1)>=Min2 (j, 1))&(Rands2 (i, 1)<=Max2 (j, 1)))
          Weeks2 (i, 3)=Range_d2 (j, 1);
       end
    end
end
%3 machines
Lead=zeros (100, 1);
 Lag=zeros (100, 1);
 for i=1:100
    if ((Weeks1 (i, 3))>=(Weeks (i, 3)))
       Lead (i, 1)=(Weeks1 (i, 3))-(Weeks (i, 3));                %Lead;
    elseif ((Weeks1 (i, 3))<(Weeks (i, 3)))
       Lag (i, 1)=Weeks (i, 3)-Weeks1 (i, 3);                      %Lag;
    end
 end
 Average_Lead=floor (sum (Lead) / 100);
 Average_Lag=floor (sum (Lag) / 100);
 Idle_time=Average_Lead * 10 / 60;
 Over_time=Average_Lag * 10 / 60;
 %4 machines
 Lead1=zeros (100, 1);
```

Annexure - F

```
Lag1=zeros (100, 1);
 for i=1:100
    if ((Weeks2 (i, 3))>=(Weeks (i, 3)))
       Lead1 (i, 1)=(Weeks2 (i, 3))-(Weeks (i, 3));          % Lead1;
    elseif ((Weeks2 (i, 3))<(Weeks (i, 3)))
       Lag1 (i, 1)=Weeks (i, 3)-Weeks2 (i, 3);               % Lag1;
    end
 end
 Average_Lead1=floor (sum (Lead1) / 100);
 Average_Lag1=floor (sum (Lag1) / 100);
 Idle_time1=Average_Lead1 * 10 / 60;
 Over_time1=Average_Lag1 * 10 / 60;
 Cost_3machines (k, 1)=Over_time * 750 * 3;
 Cost_4machines (k, 1)=Over_time1 * 750 * 4;
end
 Average_cost_3machines=floor (sum (cost_3machines) / 400)
 Average_cost_4machines=floor (sum (cost_4machines) / 400)
 Savings=(Average_cost_3machines)-(Average_cost_4machines)
```

REFERENCES

[1] Medium Term Development Framework 2005-10, by Planning Commission, GoP

[2] Robert B. Brown (2000), "Capacity Management and Industry", Pearson Education, Essex.

[3] World Health Report 2008

[4] World Health Organization

[5] S. Cooper and Adam Sodelring, Healthcare Management and Operation Research (2006)

[6] Journal on Standard of Living, Sep 2005

[7] Economic Survey of Pakistan 2007-08

[8] Grönroos, C. (2001), "Service Management and Marketing – A Customer Relationship Management Approach", 2nd Edition, John Wiley and Sons, Ltd, Chichester

[9] Fitzsimmons, J. and Fitzsimmons, M. (2000), "Service Management, Operations, Strategy, and Information Technology", 3rd Edition, Irwin McGraw Hill, Inc

[10] Lovelock, C.H. (1992), "Seeking synergy in service operations: seven things marketers need to know about service operations", European Management Journal, Vol. 10 No. 1, March, pp. 22-9.

[11] Lee J. Krajewski and Larry P. Ritzman (2005), "Operations Management - Processes and Value Chains", 7th Edition, Pearson Education, Inc

[12] Roberta S. Russel and Bernard W. Taylor III (2003), "Operations Management", 4th Edition, Pearson Education, Inc and Dorling Kindersley

[13] Albright, S.C., Winston, W.L. and Zappe, F.1999. Data analysis and decision making with Microsoft Excel, Brooks Cole.

[14] Law, A.M. and Kelton, D.W. (1991) Simulation modeling and analysis, McGraw Hill Inc., New York.

[15] Mjema, E.A.M. 2002. An analysis of personnel capacity requirement in the maintenance department by using a simulation method, Journal of Quality in Maintenance Engineering, 8 (3), pp 253-273.

[16] Christer, A.H. and Al-Zubaidi, H. 1997. Maintenance manpower modeling for a hospital building complex, European Journal of Operations Research, 99, pp 603-618.

[17] Duffuaa, S.O., Ben-Daya, M., Al-Sultan, K.S. and Andijani, A.A., 2001, A generic conceptual simulation model for maintenance systems, Journal of Quality in Maintenance Engineering, **7** (3), pp 207-21

[18] Roberta S. Russel and Bernard W. Taylor III (2003), "Operations Management", 4th Edition, Pearson Education, Inc and Dorling Kindersley

[19] Sasser, W.E., Olsen, R. P. and Wyckoff, D. D. (1978) "Management of Service Operations, Text, Cases and Readings", Allyn and Bacon, Inc.

[20] Schmenner, R. (1995), "*Service Operations Management*", Prentice-Hall, Englewood Cliffs, NJ.

[21] Medium Term Development Framework 2005-10, by Planning Commission, GoP

[22] Economic Survey 2007-08: Overview of the Economy, June 11 2008

[23] Appendix to Pakistan Economic Survey 2007-08, p.141

[24] Economic Survey of Pakistan 2007-2008, p. i

[25] Economic Survey of Pakistan 2007-2008, p. xxiv

[26] Economic Survey of Pakistan 2007-2008, p.7

[27] Appendix to Pakistan Economic Survey 2007-08, p.142

[28] Economic Survey of Pakistan 2007-2008, p.8

[29] Forbes 2000

[30] 'Telecom sector has tremendous potential to grow despite world recession', Business Recorder (May 11,2009)

[31] GSM World, February 16, 2008

[32] PIA Annual Report 2005

[33] DAWN NEWS, April 7, 2005

[34] DAWN NEWS, August 20, 2005

[35] 'Pakistan's Post 9/11 Economic Boost', BBC News, 21 September 2006

[36] 0.5 million housing units needed annually to meet shortfall:KCCI Business Recorder, 7 October 2006

[37] Ministry of Health, Pakistan

[38] Pakistan Medical and Dental Council (PMDC)

[39] Register, Pakistan Nursing Council

[40] Wirtz, J., Lee, M.C. and Mattila, A. (1998), "Services in Asia – macro trends", in Monroe, K.B. and Hung, K. (Eds), Asia Pacific Advances in Consumer Research, Vol. 3, Association for Consumer Research, Provo, UT.

[41] Slack, N., Chambers, S., Harland, C., Harrison, A. and Johnston R. (1998), "Operations Management", (2nd edition), Pitman, London.

[42] Lovelock, C.H. (1984), *Services Marketing"*, Prentice Hall, Englewood Cliffs, NJ.

[43] Bowen, D., Chase, R. and Cummings, T. (1990), "Service Management Effectiveness: Balancing Strategy, Organization and Human Resources", Operations and Marketing, Jossey-Bass Publishers, San Francisco, CA.

[44] Sasser, W.E. (1976), "Match supply and demand in service industries", Harvard Business Review, Vol. 54 No. 6, pp. 133-40.

[45] Johnston, R. and Clark, G. (2001), "Service Operations Management", Pearson Education, Essex.

[46] Bateson, J.E.G. (1977), "Do we need service marketing?" Marketing Customer Services: New Insights, Marketing Science Institute Report, pp. 77-115.

[47] Thomas, D.R.E. (1978), "Strategy is different in service business", Harvard Business Review, Vol. 56, July-August, pp. 158-65.

[48] Murdick, R., Render, B. and Russell, R. (1990), "Service Operations Management", Allyn and Bacon, Boston, MA.

[49] Haris, F.H.D. and Peacock, P. (1995), "Hold my place, please", Marketing Management, Vol. 4 No. 2, pp. 34-46.

[50] Rhyne, D.R. (1987), "The impact of demand management on service system performance", The Service Industries Journal, Vol. October, pp. 446-58.

[51] Ng, I.C.L., Wirtz, J. and Lee, K.S. (1999), "The strategic role of unused service capacity", International Journal of Service Industry Management, Vol.10 No.2, pp. 211-238.

[52] Dilworth, J.B. (1992), "Operations Management: Design, Planning and Control for Manufacturing and Services", McGraw-Hill, New York, NY.

[53] Elmaghraby, S.E. (1991), "Manufacturing capacity and its measurement a critical evaluation", Computer and Operations Research, Vol.18 No. 7, pp. 615-27.

[54] Meredith, J.R. (1992), "The Management of Operations", Wiley, New York, NY.

[55] Crandall, R.E. and Markland, R.E. (1996), "Demand management – today's challenge for service industries", Production and Operations Management, Vol. 5 No. 1, pp. 106-20.

[56] Heskett, J.A., Sasser, W.E. and Hart, C.W. (1990), "Service Breakthroughs", The Free Press, New York, NY.

[57] Klassen, K.J. and Rohleder, T.R. (2002), “Demand and capacity management decision in services, how they impact on one another”, International Journal of Operations and Production Management, Vol. 22 No. 5, pp. 527-548.

[58] Showalter, M.J. and White, J.D. (1991), “An integrated model for demand output management in service organizations: implications for future research”, International Journal of Operations and Production Management, Vol. 11 No.1, pp. 51-67.

[59] Anton, J. (1996), Call Center Management by Numbers: Press on Regardless, Santa Maria, CA.

[60] Chase, R.B. (1978), "Where does the customer fit in a service operation?” Harvard Business Review, Vol. 56 No. 6, pp. 138-39.

[61] Mills, P.K. and Margulies, N. (1980), "Towards a core typology of service organizations", Academy of Management Review, Vol. 5 No.2, pp. 255-66.

[62] Lovelock, C.H. (1988), "Strategies for managing capacity-constrained service organizations", Managing Services, Marketing, Operations and Human Resources, Prentice-Hall, Englewood Cliffs, NJ, pp. 163-75.

[63] Northcraft, G.B. and Chase, R.B. (1985), "Managing service demand at the point of delivery", Academy of Management Review, 10, 1, 65-75.

[64] Snyder, C.A., Cox, J.F., Jesse, R.R. Jr (1982), “A dependent demand approach to service organization planning and control”, Academy of Management Review, Vol. 7 No 3, pp. 455-66.

[65] James, B. and White, R. (1996), “The Outsourcing Manual”, Gower Publishing Ltd, Aldershot.

[66] Yin, R. (1994), “Case Study Research, Design and Methods”, Sage Publications Inc., Newbury Park, CA.

[67] www.fauji.org.pk

[68] FF Annual Report 2007-08

[69] MS, FFH Rawalpindi

[70] HR Section, HQ FF, Rawalpindi

[71] GM Medical Store, HQ FF, Rawalpindi

[72] GM Operations, HQ FF, Rawalpindi

[73] Billing-Finance Department, HQ FF, Rawalpindi