CRANFIELD UNIVERSITY

DR. NIVEDITHA M.S

RE-ENGINEERING THE OUTPATIENT PROCESS FLOW OF A MULTI-SPECIALITY HOSPITAL

SCHOOL OF AEROSPACE, TRANSPORT
AND MANUFACTURING
Health Administration

MASTER OF SCIENCE
Academic Year: 2014 - 2015

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This thesis is submitted in fulfilment of the requirements for the degree of Master of Science in Health Administration.

ABSTRACT

Manufacturing concepts such as Just-in-Time, Lean and Six-Sigma, Japanese 5S, Materials Requirement Planning, Scheduling and Capacity Management have been applied in the Healthcare industries in the West for the last decade and has yielded positive results. In this study, these concepts and philosophies have been applied to an Indian Multi-speciality Hospital to improve its OPD process flow and increase patient satisfaction.

The Outpatients Department (OPD) is usually the most crowded sector in a hospital. The frequent problems encountered include the waiting period for consultation, an unpredictable number of Walk-in patients, insufficient and operationally deficient OPD reception staff and unattended appointment patients. This study aims at, identifying methods to standardise OPD operations management. It has made the process more efficient through optimum resource utilisation. This will increase patient satisfaction by meeting and exceeding their expectations while maintaining quality of care.

This research was conducted by mapping the process flow and using the data that was collected through an observational, cross-sectional, non-interventional study. Though there were a comprehensive set of recommendations at the end of the study, only a few could be implemented due to the introduction of a new Hospital Information System (HIS) software putting the implementation plan on hold.

ACKNOWLEDGEMENT

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LIST OF ABBREVIATIONS

A:W – Appointment to Walk-in Ratio

CQI – Continuous Quality Improvement

DNA – Did Not Attend

EDC – Electronic Data Capture

ERP – Enterprise Resource Planning

ExP – Existing Patient

HAI – Hospital Acquired Infections

HIS – Hospital information System

IT – Information Technology

JCI – Joint Commission International

JIT – Just in Time

MRP – Materials Requirement Planning

MRP II – Manufacturing Resource Planning

OPD – Out Patients Department

OPT – Optimised Production Technology

OT – Operation Theatre

PI – Process Improvement

PRD – Patient Relations Department

PRM – Patient Relations Manager

SD – Standard Deviation

TAT – Turn Around Time

TPM - Total Productive Maintenance

UHID – Unique Hospital Identity Number

VSM – Value Stream Mapping

WHO – World Health Organisation

LIST OF DEFINITIONS

- ***Appointment Patient*** – is an Outpatient who books a consultation slot before coming to the hospital for consultation.
- ***DNA*** – is an Appointment patient who does not attend the consultation after booking an appointment slot.
- ***Existing Patient (ExP)*** – is an Outpatient who is registered in the hospital and holds a UHID number.
- ***First Visit*** – is a New or an Existing Outpatient coming for consultation the first time or the third time within 7 days for the same consultant and is billed for consultation.
- ***Follow up*** – is an Existing Outpatient who comes for a follow up consultation within 7 days from the date of billing his first consultation, to the same consultant and is not billed for the consultation.
- ***New Patient*** – is an Outpatient who is not registered in the hospital and does not hold a UHID number.
- ***Walk-in Patient*** – is an Outpatient who comes for consultation without booking prior appointment slot.

1. INTRODUCTION

Health was defined in the Constitution of the World Health Organisation (WHO) for the first time in 1946 as: *"a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity"*. The preamble further states that "the enjoyment of the highest attainable standard of health is one of the fundamental rights of every human being without distinction of race, religion, political belief, economic or social condition."(WHO 1946, *p1315*). Although Health is a universal need, needs for health care provision is largely involuntary, varied, and idiosyncratic (Hodgson 2009).

Increasing knowledge and awareness about health has brought the importance of healthcare and the provision of the required care and treatment and the facilities available to support the ill to the forefront of people's minds. Healthcare organisations aim at providing essential sets of healthcare facilities and services to meet the needs of an individual's health. With the advancement of technology and growth in the world economy, there has been improvement in the quality of people's lives, with more resources being diverted into the healthcare industry. In most countries, due to limited resources, the cost of health care is becoming increasingly difficult to afford. As a result, there has been an increasing number of studies in the field of operations research globally, using theories such as simulation, scheduling and queuing modelling to solve these problems (Cheng-Hua, Yuan-Duen et al., 2006). The application of Operations Research brings greater versatility and variety to the management of healthcare organisations (Sweeney et al., 1989; Ginter et al., 1998). The two most important aspects of all healthcare organisations are quality of service and overall cost. Higher quality of care at a lower cost increases patient satisfaction and thereby the competitiveness of the organisation (Cheng-Hua, Yuan-Duen et al., 2006). The healthcare industry is fast becoming the most important industry, impacting everyone in society because of its broad-based inclusive and extensive nature of functioning. An efficient and proficient healthcare system is inextricably linked to national economic performance. Its delivery is a complex endeavour (Sheffield, 2008) as it involves

emergencies which are non-deferrable and hence should be devoid of ambiguity or error (Shortell and Kaluzny, 2000). There is evidence to suggest that the increasing cost of healthcare is putting pressure on access to, and quality of, healthcare delivery (Blumenthal, 1999). Thus, healthcare is consuming an increased percentage of our economic product and its rising cost can in part be attributed to the inefficiencies in healthcare delivery according to Hall (2006).

Ovretveit (2000) believes that quality in a healthcare organisation is three dimensional-

a) Patient quality: which includes necessary needs of the patients.
b) Professional quality: which includes the needs of patients according to the conjectures of the professionals.
c) Management quality: which comprises the resources to deliver the wants and needs of the patients without waste, errors or delay, and within policy and legal regulation.

India is a developing country, with the second largest population in the world. Even though 20% of the global disease burden is borne by India alone, ample numbers of people are deprived of basic healthcare facilities (as shown in Table 1). India's hospital bed density is only 0.86 beds per thousand populations. In the west, Germany has the highest with 8.3beds per 1000 people, with the US and UK both having 3.1 beds per 1000 people. Brazil, which is at a similar stage of economic development to India, has 2.3beds per 1000 population. The Indian Government does not recognise healthcare as a top priority, with only 6% of GDP being spent on its requirements, which is amongst the lowest globally. The biggest challenge is to keep "in sync" accessibility with the quality of patient care (Üsou, Shetty et al., 2012).

Per Capita Income	**Rs 60,950/£750**
Doctor Density	**1:1722**
Hospital Bed Density	**0.86/1000 population**

Table 1 : India and its Healthcare Scenario (Üsou, Shetty et al., 2012).

Healthcare provision in India is arranged as follows:

- The Government Sector
- The Private Sector
- The Public Private partnership

The Government Sector – largely comprises of the Primary Health Care centres that are mainly situated in rural areas and are scattered across the nation. They provide basic healthcare facilities for the rural population, usually free or at a minimal cost.

The Private Sector - this is also spread across the country and ranges from small polyclinics to bigger multi-speciality hospitals. It caters mainly to the urban population or those referred from the primary setups for more advanced care and treatment. The cost of healthcare here is quite high and thus, people with low purchasing power cannot afford it.

The Public - Private Partnership – its existence is an outcome of a contract or agreement between Public authorities and private companies to run a hospital in unison.

The provision of corporate hospitals is relatively recent in India. It's only in the last three decades that such hospitals have started to be established in the country. Some of the top hospitals in India are:

- Apollo Group of Hospitals
- Fortis Hospitals
- Wockhardt Hospitals
- Colombia Asia Hospitals
- Manipal Hospitals
- Narayana Hrudayalaya Cardiac Hospital

These hospitals not only provide services for the Indian population but also serve a large percentage of international patients through what is commonly called Medical

Tourism. Equipped with state of the art technology and proficient doctors, these hospitals are of international quality. Most of them are JCI (Joint Commission International) accredited which is the gold standard for quality in the healthcare industry (Üsou, Shetty et al., 2012). The high quality of service delivered by them has influenced the rapid growth in Medical Tourism, bringing in overseas patients seeking top class healthcare facilities at a reasonable cost.

In India, the provision of healthcare services and healthcare workers, including doctors, nurses and pharmacists, is highly concentrated in urban areas and the private sector. Urban residents, constitute 28% of India's population and have access to 66% of the country's available hospital beds, while the remaining 72% who live in rural areas have access to just one-third of the beds. Over the past 25 years, both rural and urban patients have increased their use of private service providers over public options. This is due to gaps in the quality and availability of facilities, long waiting times and the absence of diagnostic equipment in public setups (Yip and Mahal, 2008).

Recent reforms in healthcare have shifted the focus of health organisations to streamline their processes to deliver high quality care whilst reducing the cost (Miller, Kochut et al, 2003). The patient's choice of healthcare service provider is usually influenced by its reputation, resources, service provided, waiting period and relative price. Healthcare providers can reduce costs by more effective and efficient utilisation of the available resources and capacity, with minimal length of patient stay and improved patient services. All this can be brought about by standardising and optimising the processes, with the joint outcomes of cost optimisation and reducing patient waiting times. With a thorough knowledge on the relationship between the resources, utilisation and patient throughput, major managerial issues can be resolved to further improve hospital operations (Hutzschenreuter, Kristine, 2010). Ultimately, the end goal of all hospitals is to have continuously increasing revenue without affecting quality of patient care, whilst preserving patient satisfaction. To fulfil patient satisfaction quality of service management is of prime importance in every health organisation (Miller, Kochut et al., 2003).

1.1 : Problems in Healthcare

Where access to healthcare exists, the biggest problem in healthcare across the world is "long waiting times" (Tolbert 2014). Appointment waiting time and time spent by the patient waiting at the facility, defined as "*provider waiting time*", are among the top 10 causes of patient dissatisfaction as indicated by the findings of Gesell and Gregory in 2004. Healthcare is an industry that is strained with surges in demand from its customers (patients). When patient numbers spike, everything from management of amenities to personal care shifts into overdrive (Littmann 2014). Another concern is the rising healthcare cost pressurising the healthcare providers to have more effective resource management to enable reduction in cost (Smith-Daniels et al., 1988, Sweeney, D.R. 1996). This trend for the efficient use of resources is critical in an era of rapidly escalating costs has continued. Wright, Bretthauer et al., in 2006 noted that healthcare managers face increased pressure to reduce costs while delivering high-quality service.

Common problems faced in Healthcare (Binder 2013) –

1. Long Waiting Times: - due to improper scheduling and process flow – a result of demand outstripping supply.
2. Too Much Unnecessary Care: – advising needless investigations and tests.
3. High Cost: – is an outcome of incorrect resource and material planning, strategy planning, unnecessary care.
4. Lack of Transparency: – Lack of information to choose the right health care.
5. Medical Negligence: – on the part of hospital, staff or the patient.
6. Mishandling of infectious waste: - improper disposable of infectious waste may lead to spread of infections.
7. Data Management: - Managing large sets of confidential data of the patients and the Health Organisation.
8. Avoidable Harm to Patients: - one in four Medicare beneficiaries admitted in the US suffers some form of harm during their stay (often hospital acquired infections).

Hospitals aim to provide quality service and treatment at reasonable cost, yet patients complain about the increasing health costs, hospital charges, doctor's fees, poor service quality, long waiting times etc. This has lead health organisations to employ methods that improve patient care, efficiency and reduce costs (Shivaji, Subramanian, 2009). Omaswa, Burnham et al (1997) discussed the problems faced by the outpatients in the Masaka Hospital (Uganda), where patients frequently left without treatment due to indefinitely long waiting times. An Ishikawa diagram identifying causes of these delays that were responsible for dissatisfaction of both patients and staff was plotted. Subsequent examination of outpatient records, observations of patient flow, and discussions with patients and staff revealed the following problems: low morale among health workers, shortage of supplies, inadequate supervision by hospital management, poor coordination of patient flow, and inefficient dispensing of drugs. However, this would be a hospital at the extreme of operational inefficiency, nonetheless, there are similar, if not as extreme, problems faced in the developed world's hospitals.

Conversely, some researchers have noted that chasing operational efficiency may not have the best outcome for the patient. Koning, Verver et al., (2006), identified that operational efficiency has significantly increased the cost of healthcare. Operational insufficiencies are associated with administrative, logistical, medical service delivery process and healthcare delivery systems. Efforts to reduce inefficiency and quality improvement has made better healthcare affordable by a large percentage of population. However, "as health systems consist of many interacting activities, improvements in one segment of patient flow will have unpredictable effects on other segments" (Haraden and Resar, 2004). This is highlighted out by Goldratt's Theory of Constraints (1984) whereby eliminating one bottleneck will result in moving the bottleneck to another part of the process.

Emphasis on preventive medicine and short length of inpatient hospital stay has made outpatient services a vital component in health care. In this fast-growing industry, hospitals that fail to have cost effective outpatient services find themselves financially unviable (Goldsmith, 1989). Right decision making at strategic and operational level helps achieve cost-effectiveness in outpatient services (Cayirli and Veral 2003).

Development in the field of Medical Science, Medical Engineering and Technology has improved treatment methods cutting down on the time needed to treat an illness, thus comforting patients who dislike staying in hospital for long to complete their course of treatment. The latest technology has paved the way for several Day-Care procedures and Outpatient treatment making it possible to treat the patients more efficiently with in-patient procedures being replaced by day case procedures. The increasing demand for treatment on OPD basis has shifted the attention of the operations team from the Inpatients to the Outpatients Department as the Outpatients generate more revenue than the Inpatients on a daily basis. Consequently, there have been a number of studies conducted in the Outpatients Department to improve the quality of service provided, increase patient satisfaction, reduce the waiting time and attain cost effectiveness.

1.2 : Risks in Health Operations

The healthcare industry is becoming more focused on benchmarking and measurement (Hall 2014) as means to improve efficiency during times of economic crisis and political austerity measures. It is vulnerable to several risks related to health care reform, which, if not managed correctly, will cause long lasting damage to its reputation. A Healthcare Risk Management Week is held every year during the third week in June by the American Society for Healthcare Risk Management (ASHRM) (Hall 2014). Some risk factors in healthcare are –

1) Patient's Safety Risk – when a disease is wrongly diagnosed or an incorrect treatment is advised.
2) Fraudulent Risks – administering unnecessary investigations which not only burden patient's expenses but also exhaust laboratory resources.
3) Documentation Risks – error in billing or prescribing incorrect dosage of medicine.
4) IT Risk – increasing use of technology has its own complexity

a) Security breach – confidential information and sensitive data can be hacked or altered and illegally used for financial gain.
b) System failure - doctor will be unable to view patient's record in time to make critical decisions about treatment in case of system failure.

5) Ethics and Integrity Risk – due to internal corruption within the organisation staff.
6) Environmental and Health Risk - waste management forms a very important part of the health industry. Safe waste disposal, proper hygiene and sanitation standards if not followed will have a devastating effect on the environment. The commonest risk to patients during a long hospital stay is of Hospital Acquired Infections (HAI).
7) Social Media Risk – these may expose the organisation to potential irregularity, legal and reputational risks ranging from privacy violations, to data abuse and theft.

Effective risk assessment and management requires understanding the perceptions of involved stakeholders and how their beliefs can influence risk management decisions (Wood, Bostrom et al., 2012). Risk management can be brought about by inducing disciplines to reduce the incidence of organisational loss, which may be proactive, endeavouring to prevent or mitigate a loss or reactive, in order to control damage. Health care providers need to manage risk by profoundly understanding the industry's issues and requirements. The challenge lies in finding a metric that measures risks effectively and efficiently (Hall 2014). A Metric Stream (a system that provides an integrated and flexible framework for documenting and assessing risks, defining controls, managing assessments and audits, identifying issues, and implementing recommendation plans) approach of identifying risk, analysing risk, evaluating risk, controlling risk, monitoring risk, reporting risk and managing the risk will provide centralised framework for the Risk Management (Watson 2012).

1.3 : Work Culture

It is important to consider the differences between the Western Culture and Eastern (Asian) Culture. This is because many of the management and operational concepts and techniques have been developed in the West. Cultural differences may therefore affect the effectiveness of the applied techniques. Thus, a brief understanding and recognition of the differences in the work culture between the East and the West will help to evaluate the degree of adaptability to the changes introduced. In the western system, importance is given to working within the system, delegation of work, control, direction and manipulation of people. Whereas, the Eastern system give their employees freedom and autonomy to work more enthusiastically as they believe in creativity and growth (Fine 1983). Eastern culture favours comprehensive thinking while the Western culture favours analytical thinking. Eastern culture emphasises collectivism and group consciousness while Western culture emphasises individual benefits (Peng Luo 2008). When dealing with challenges, westerners solve problems directly and quickly with little emotional fuss but Asians give great importance to emotions and find consensual solutions that do not offend anyone. Time is money in industrialised countries, however in Asian nations, interpersonal relations and traditions are given higher value. In Western society, there are fewer hierarchical levels and the manager considers himself to be part of the team. The subordinates are expected to ask questions that challenge the leader's instructions and purpose. They promote individualism and the supervisor assures that opinion of every staff member counts. Asian and Indian companies have well-defined hierarchical structures where each person understands his/her position in the organisation and the staffs follow every instruction of the manager without asking for clarification or questions. The West believes that a professional relationship should not become overtly personal; hence they are direct and clear in their instructions and comments to others, whereas, the Asians perceive directness to be rude and offending so they use phrases that are diplomatic and polite while making agreements. Technology places a very important role in developed countries as all work is computerised and accessed electronically,

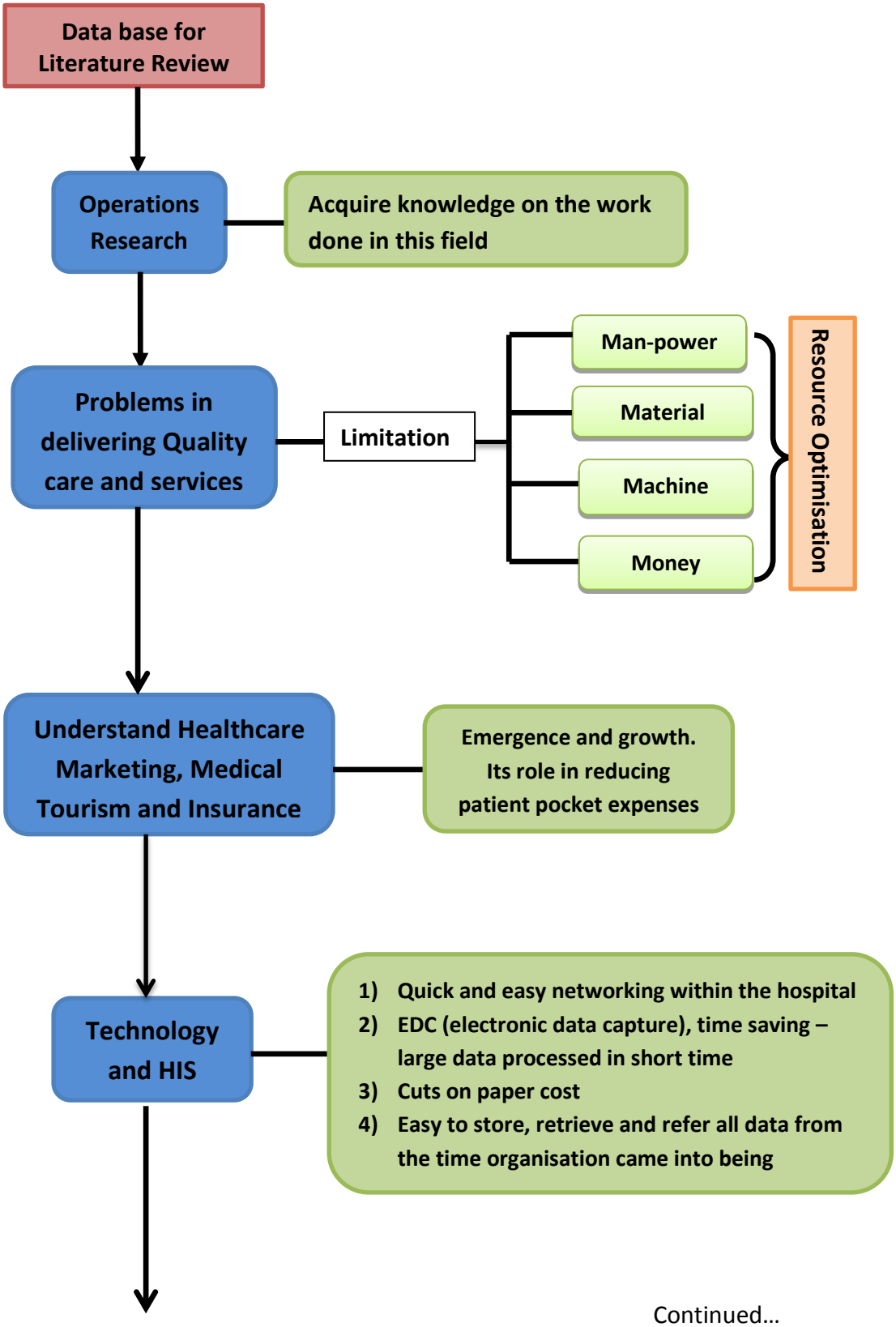
but in developing countries most of the work is done manually as the people are not much oriented to technology.

Thus, while adapting Western and industrialised nation's ideas in Asian nations and developing countries their differences in work culture should be considered to rely on the effectiveness of the concept being implemented.

2. LITERATURE REVIEW

This chapter deals with a review of the relevant literature, to acquire in-depth knowledge of the study to be conducted and to understand the various studies conducted in the field of healthcare. Under-pinning knowledge for the present study comes from the Manufacturing Strategies such as – JIT, Lean, TQM, TPM, MRP, ERP, OPT, capacity planning, scheduling, Process Mapping etc.

To begin with, a strategy was planned for Literature Review as in Figure 1. Literature sources include: ABI/INFORM, Scopus, ProQuest, Elsevier and Google Scholar. Literature search identified 685 plus articles which were narrowed down to 392 articles and from which 176 of them have been cited.


Data base for Literature Review
Operations Research
Acquire knowledge on the work done in this field
Problems in delivering Quality care and services
Limitation
Man-power
Material
Machine
Money
Resource Optimisation
Understand Healthcare Marketing, Medical Tourism and Insurance
Emergence and growth. Its role in reducing patient pocket expenses
Technology and HIS
1) Quick and easy networking within the hospital
2) EDC (electronic data capture), time saving – large data processed in short time
3) Cuts on paper cost
4) Easy to store, retrieve and refer all data from the time organisation came into being

Continued…

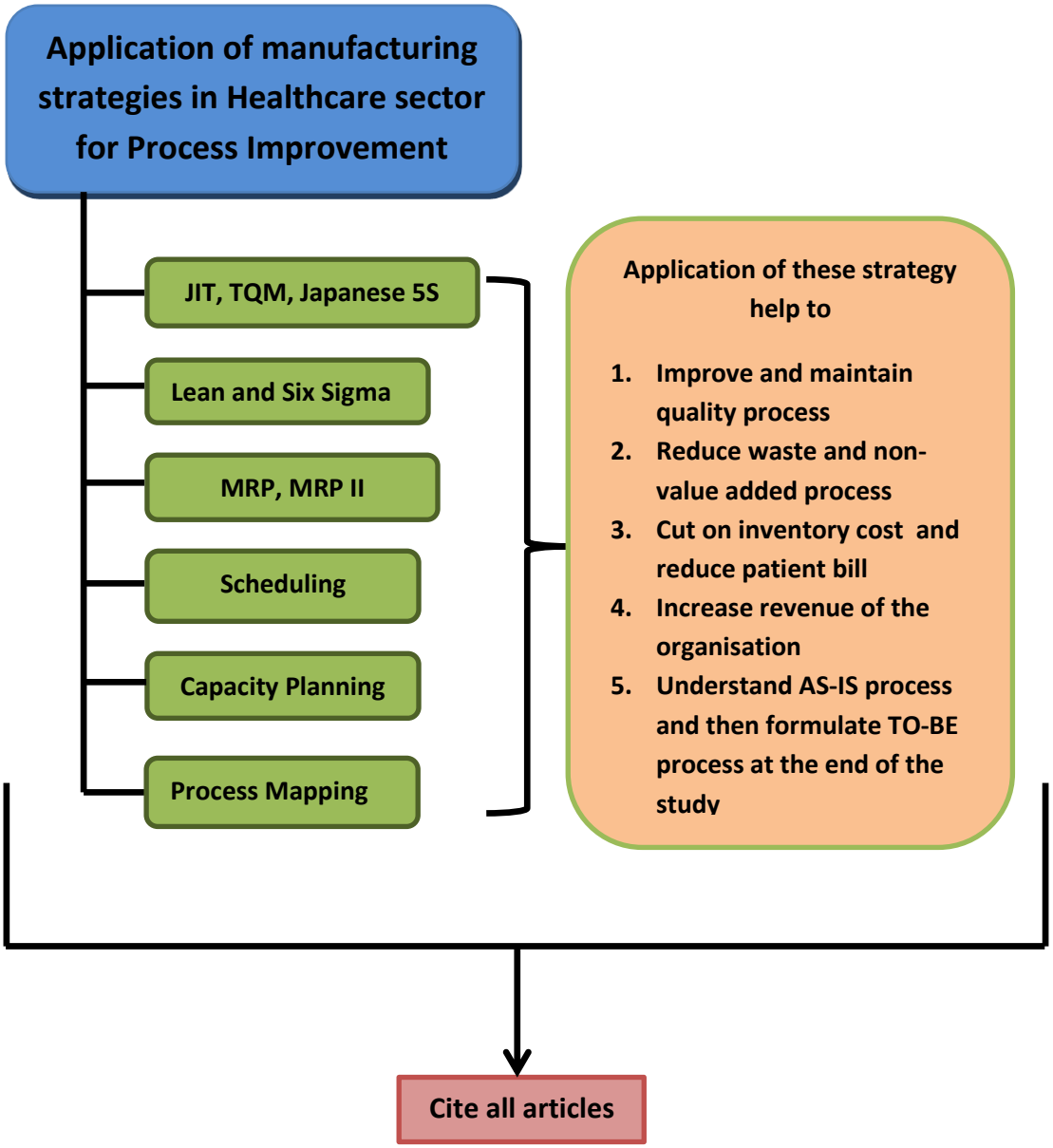


Figure 1 : Search Strategy for Literature Review.

Operations Research and optimisation techniques have gained importance in healthcare. Attention has gradually expanded from resource allocation and strategic planning to include operational issues such as resource scheduling and treatment planning. (Rais, Viana et al., 2011).

In recent years, healthcare marketing has further expanded the scope of healthcare by spreading its importance and awareness amongst its populations. Most of the well-established healthcare organisations have their marketing team, which promote the organisation's goals and attract its customers, drawing unpredictable number of patients. Many companies are now linking up with health organisations to provide health facilities to their employees and their dependents, thereby bringing in additional customers.

Hospital Information System (HIS) is an advanced technology outcome which helps easy and quick networking of patient data within the hospital. It allows all permitted staff to access the information in the system, making it effortless to share information between departments. For this very reason, it should be user friendly so that anyone accessing the system can do so without complications. Prior to the advent of HIS, paper was the material used to store all information, thus bundles of paper occupied large storage space and at the same time were subjected to risks such as fire, misplacement, theft, damage etc. In case of any such accidents there was no back-up information available that could be restored, hence any information lost was permanently lost.

Development in the field of technology and the introduction of HIS has had a considerable and significant impact. Some of its benefits are –

a) Large amounts of manual and paper work can be reduced to a great extent.
b) Minimum space is required to store huge amounts of data.
c) All information entered can be accessed, processed and transferred easily.
d) Manual errors are reduced to a great extent.
e) Back-up of all data is possible and it can be retrieved easily in case of any mishap.

f) Information accessed electronically hastens the process.
g) Information is secured and cannot be accessed by everyone.
h) It is reliable, less time consuming and cost effective.

Along with its advantages some of the drawbacks with the HIS are –

a) System breakdown: this halts the entire process until an alternative is set-up.
b) Security breach – confidential information and sensitive data can be hacked or altered.
c) Can be accessed only by skilled employees.
d) Training demands on workforce.
e) Maintenance of records and system software and hardware can be expensive.

Even though HIS has been used for a long time in developed nations, India has adopted this technology only over the past few decades. As a developing country, the majority of the population is not technically oriented and thus finds it difficult to adapt to the new era. However, the corporate hospitals are trying to keep in line with the Western technology and the smaller private healthcare centres have now started implementing and adapting to the new technology. Nevertheless, primary health centres and the other government set-ups still continue to use the paper method.

2.1 : Manufacturing Strategies

Buffa, (1984) and Wheelwright, (1984) identified four magnitudes of manufacturing strategy: (1) cost, (2) quality, (3) flexibility and (4) dependability. Boyer et al., 2005 confirm that these magnitudes are still recognised as the key components of competitive priorities in manufacturing strategy. In the 1970s and early 1980s, Japan entered world markets by competing on cost, coupled with high quality of conformance and built a loyal customer base. According to Daniel et al., 2009 the Japanese captured significant market share in global markets with a cumulative

philosophy that there need not be a trade-off between cost and quality. Some researchers have tried applying manufacturing strategies in healthcare to improve process flow, to improve and maintain quality with advancing technology, to optimise usage of available resources and ultimately, to lower the cost without compromising the quality of services provided. Over the past few decades, these methods have been successfully implemented in the healthcare industries of the West and of late, are now being applied in Indian healthcare (Indian Medical Society 2013).

2.1.1 : Just-In-Time

The Just-in-Time philosophy will be explored in this section.

2.1.1.A : Introduction to JIT

The essence of JIT manufacturing is the timely provision of materials, components and sub-assemblies as need arises in the manufacturing process (Daniel et al., 2009). JIT involves making, only what is needed, when it is needed and in the amount it is needed. It aims to meet demand instantly with perfect quality and have no waste. Global competition has forced manufacturing companies to explore techniques for reducing their costs, without conceding customer satisfaction. Thus, Lean manufacturing, particularly, just-in-time (JIT) is considered a powerful tool to reduce waste and inefficiency, speed up production processes, and increase delivery performance (Danese, Romano et al., 2012). JIT has five basic techniques: set-up time reduction, equipment layout, pull system production, daily schedule adherence, and JIT delivery by suppliers. The first four concern the JIT production area while the last one refers to JIT supply (Cua et al., 2001).

JIT philosophy as initiated by Toyota Production Company (1956) identifies and eliminates all waste and emphasises continuous improvement in productivity (Brox and Fader, 2002). More widely, non-value adding activities are identified and removed in order to reduce cost, and improve quality and delivery (Hall, 1983; Brox and Fader,

2002; Zelbst et al., 2010). The objective of JIT is to maximize a firm's profit and customer value (Chen, Tan et al., 2011). From the 1980s, JIT has been propagated all over the world. In the past three decades, the experience of JIT mainly came from developed countries like USA, UK and Japan (Hall, 1983; Spencer and Guide, 1995; Huson and Nanda, 1995; Yasin and Wafa, 1996; Sakakibara et al. , 1997; Nakamura et al. , 1998; Brox and Fader, 2002; Shah and Ward, 2003; Matsui, 2007), however, there is also an increasing trend for experience to come from other developing countries, especially from Asian-Pacific countries such as Singapore (Hum and Ng, 1995), New Zealand (Upton, 1998), Egypt (Salaheldin, 2005), India (Wakchaure and Venkatesh, 2006), Turkey (Aydin et al. , 2008), etc.

2.1.1.B : JIT Implementation

Research conducted on JIT has shown that, its implementation has benefited manufacturing firms in consistently improving quality, satisfying customer requirements, minimising levels of inventory and improving relationships with suppliers (Aghazadeh, 2003). Reduction in materials handling costs and maximum use of space can be achieved by the JIT approach provided there is continuous arrival of correct material and backup of necessary inventories (Petersen, 2002). Salaheldin (2005) surveyed the benefits of JIT implementation in the Egyptian industrial sector, which included cost reduction, quality improvement, lead time reduction, inventory reduction and increase in resource utilisation. He further argued that the effect of JIT is not the same in all manufacturing environments. It is more effective where there is repetitive production with fairly stable demand. The management philosophy, world class manufacturing, is about emphasising external and internal customers' needs and expectations with the importance of doing things right in order to meet corporate objectives. Research (Farsijani, Fard et al., 2012) has shown that implementation of a world class production technique such as JIT is not unique in all times, places and circumstances. JIT implementation varies from one company to another and the approach, whilst recognisable as JIT will not be identical. However, key concepts of JIT, such as minimising inventory levels will be identifiable.

Continuous improvement, process control and reliability form important principles of JIT which help improve process efficiency, ensure product quality, and reduce costs (Greb, 2009). Tom van Laar, head of global technical operations at Novartis says low throughput time helps a manufacturer respond quickly to sudden increases in demand, which sometimes occur after launching a new drug. On the other hand, long throughput times require a company to create a large inventory of a product before launch to rapidly satisfy a potential increase in demand. Thomas cautions that a drug producer may not essentially achieve the same level of success as a carmaker with the JIT approach because financial and manufacturing concerns differ in the pharmaceutical and automotive industries and the challenges faced are different. Laar admits, although technology varies in manufacturing industry, that the basic methodology, concept, and approaches are the same (Greb, 2009).

Inman, Green, Kenneth et al., (2011), in their study conducted on Agile manufacturing indicated three things – firstly, JIT-purchasing has a direct positive relationship with agile manufacturing while the positive relationship between JIT-production and agile manufacturing is mediated by JIT-purchasing; secondly, agile manufacturing has a direct positive relationship with the operational performance of the firm and operational performance of the firm has a direct positive relationship with the marketing performance of the firm, and; thirdly, the positive relationship between the operational performance of the firm and the its financial performance is mediated by its marketing performance. Mackelprang and Nairs (2010) concluded that the relationship between JIT practices and performance is significant and positive when considering operational measures such as manufacturing costs, inventory costs, cycle time, speed and on-time delivery. Mistry (2005) in his interviews conducted in an electronics manufacturing company found that, besides inventory reduction, a further important benefit of the JIT supplier delivery program was the simplification of receiving activities for the manufacturer.

JIT and MRP are currently the two most implemented manufacturing technologies/approaches. Based on 246 Chinese companies' survey, it was found that

the degree of the MRP and JIT implementation and integration has a positive relationship with the manufacturer's performance (Chen, Shang et al., 2008). The hybrid MRP and JIT system synergy created is widely accepted in China as it attains better performance.

(Mazanai, 2012), revealed that due to the impeding challenges such as lack of reliable supplier networks, lack of capital and lack of knowledge of immediate financial gains in the application of JIT principles, the majority of SMEs manufacturing sector were not implementing JIT. However, statistically positive correlations between the application of JIT inventory management principles and cost efficiency, quality and flexibility were found, inferring that JIT inventory management application can benefit SMEs significantly in terms of improved quality of products, increased operational cost cuts and increased flexibility.

A successful implementation of the JIT approach in St James' Hospital in Leeds, UK, helped reduce costs, contain inventory and improve service (Slack, Chambers et al., 2009). Some of the reforms brought about were; 1) Single sourcing of suppliers, that helped the hospital negotiate for lower prices 2) Streamlining the admissions process in Urology Department, resulted in a faster, cheaper and more reliable process 3) Introduction of the Kanban system facilitated inventory control and cost saving.

2.1.1.C : Pull System

JIT concept is based on Pull systems (a system where the production of inventory items commence when there is a demand for it) work on a daily schedule and aim at synchronising production activities to fulfil customer demand. Pull systems use Kanban cards or other pull signals to control the flow of production throughout the factory by manufacturing and shipping only what has been consumed downstream (Monden, 1981). According to Sakakibara *et al.* (1997) the term "JIT production system" originally identified the pull production logic, described as "only the necessary products, at the necessary time, in the necessary quantity" (Danese, Romano et al., 2012). In contrast to the push system (a system where the production of inventory items is determined

by a pre-existing schedule), JIT is centred on the pull system, where product is manufactured in response to actual consumer demand. The goal of JIT manufacturing is to generate products only when they're needed and in the quantities necessary to satisfy the demand.

2.1.1.D : JIT Limitations

Singh, Ahuja et al (2013) concluded that implementing JIT is not an easy task and is restricted by organisational, financial, cultural, behavioural, operational, technological and departmental barriers. Ideal JIT is theoretical as true JIT does not exist. This is because, at some point in the supply chain inventory needs to be stocked. In the manufacturing industry, the manufacturers do not hold stock as the requirements for inventory is pushed on to the suppliers who store and supply it only when the need arises. Not holding the stock entirely depends on the response time.

Matson and Matson (2007) identified 20 issues or problems encountered by automotive companies in Tennessee and Alabama when implementing JIT in their businesses. Whilst some of these may or may not be appropriate in a healthcare implementation of JIT, nonetheless some are valid. For example, one of the most significant problems was motivation of the workforce to change, and another was the lack of a suitable working space to enable a JIT layout. These can be translated into the healthcare scenario in India since workers are very conservative in their working practices and many hospitals have limited space and scope to change floor plans.

The healthcare industry is very different from the manufacturing industry as any negligence potentially, could have more serious and immediate consequences, for example, the loss of life. Critical resources like life-saving drugs in Emergency Department and blood for transfusion in the Blood Bank are essential and need to be stored at all times. Their immediate need cannot easily be predicted and lack of such stock especially blood products and drugs will lead to clinical complications, ultimately damaging the hospital’s reputation. In the case of epidemics or natural disasters, lack of medical stock can cost many lives, thus reputable hospitals hold stock of essential

medicines, instruments and other items that are required for treatment. However, the optimum number of drugs, swabs, gauze, dressing sets etc. can be stocked in the nurse station on every floor and Kanban system approach can be applied to replace the used ones. Also, the JIT approach can be applied when a significant high demand can be accurately predicted (Leblanc, Jones, et al 2012) in the Outpatient Department and Day-care centres**.** JIT idea allows administrators to amend the duty schedule and shift staff, to make available increased man power at the counters during the peak hours to meet the rising demands of the patients, so that they are attended to at the right time leading to dissolution of the peak demand.

2.1.2 : Lean Approach

This section discusses the Lean concept and its applications.

2.1.2.A : Introduction to Lean

Lean is an integrated system of principles, practices, tools and techniques focused on reducing waste, synchronising work flows, and managing variability in production flows. Lean focuses on the customer and the entire value chain. While Lean's strength lies in its set of standard solutions to common problems, it is weak on organizational infrastructure, deployment plans, analytical tools, quality improvement and control (Koning, Verver et al., 2006). In the US, Lean methods were adopted in service industries and later by the healthcare industry with an attempt to increase efficiencies and reduce costs (Shivaji, Subramanian, 2009).

The Lean approach is best suited to the optimum use of resources to produce high quality service at low cost. Lean involves moving towards the elimination of all waste in order to develop an operation that is faster and more dependable, producing higher quality products and services and above all operating at low cost. Lean manufacturing was introduced by Toyota nearly 50 years ago (Trebilcock, B., 2004). It isn't a process or a technology but a philosophy aimed at reducing waste by optimising processes

across an enterprise, from the point of order to the point of delivery. Taichi Ohno, the father of Lean manufacturing, identified "seven deadly wastes" that prevent the value-added flow from raw materials to finished goods, says Doug Bonzelaar. They are: 1. overproduction, 2. waiting, 3. downtime, 4. unnecessary product movement, 5. excess inventory, 6. unnecessary motion, and 7. defective products (Trebilcock, B., 2004).

To be globally competitive, every industry must emphasise on speed, efficiency, and customer value. In business, incorporating Lean principles have helped achieve significant economic benefits by improving quality, costs, and cycle time. For best outcome of integrating Lean principles, the organisation must look for new opportunities. Lean supports the idea of "delighting the customer through a continuous stream of value adding activities" (Womack and Jones, 1996). Lean is not about doing better than competitors (Hartwell and Roth, 2006); but about going beyond and being the best in every process and product.

The idea of Lean flow is to deliver products and services of the right quality, in the right amounts, at the right place (JIT) to meet the demands of the customers signalled in the form of a purchase. Thus, a well-planned lean system can effectively respond to fluctuating customer demands and requirements. Lean manufacturing tools used to eliminate waste are: value stream mapping (VSM), standard work, 5S housekeeping, single minute exchange of die (SMED), and visual management. (Cudney, Elrod et al., 2011). The five core principles of lean are: value, value stream, pull, flow and perfection. The success of Lean always relies on the important concept definition of Value. The first part of the Lean principle implementation starts with identifying value from the point of all the stakeholders to the organisation (Shivaji, Subramanian, 2009). “Lean is about making value flow at every step where value is what a customer is willing to pay for and waste is what a customer would not pay for”. Young and Mc CLean (2008) define value from a patient point of view as, the route patients take from entry into hospital until he leaves; i.e. designing pathways around creating value to patients at each step. To map a value added process all people who “touch” the patient pathway (receptionist, paramedics, nurse, specialist doctors and departmental

managers) should be included, excluding the steps like waiting for bed availability, the consultant, sample collection or medication which are non-value adding to the patient (Burgess and Radnor 2013).

2.1.2.B : Lean Implementation

Lean is a process improvement methodology, which is based on continuous improvement focusing on value, flow and waste reduction. To be effective at delivering sustained and continuous service improvement, Lean implementation should be aligned to organisational strategy, where Lean becomes part of the organisational culture (Davies and Walley, 2000; Corbett, 2007; Ben-Tovim *et al.*, 2007; Hines *et al.*, 2004; Hines *et al.*, 2008). In the last two decades, the Lean concept has largely been used in manufacturing processes, but now it is also being applied to a wide range of service operations. It is important to understand the difference between the manufacturing sector and service sector before implementing Lean. Also, healthcare industries have a different customer orientation than the other service industries (Shivaji, Subramanian, 2009). Alsmadi, Almani et al (2012), analysed the difference in Lean practices and their relationship to firm performance between manufacturing and service sectors in the UK. Though the study proposed Lean application in the service sectors, Lean practices needed further adaption to ensemble service operations. The study outcome clearly stated that service firms are concerned with the soft practices of Lean, such as people and customer involvement, while in manufacturing-related practices such as total productive maintenance, set-up time and supplier feedback they are found to be underperforming. Moreover, the results showed a positive relationship between Lean practices and firm performance in both sectors and the degree of effect on performance was found to be identical between the two sectors.

The literature reports several successful implementations of Lean in hospitals. Applying Lean techniques (combined with six sigma) at Stanford Hospital and Clinics (George, 2003) describes the achievement of a 48% reduction in mortality rate from coronary

artery bypass graft surgery with a 40% reduction in the costs of running the cardiac unit and a reduction of $25 million in yearly material cost. On the other hand, process simplification shortened the average length of stay in the emergency room from 247 to 139 minutes in 2005 (Weinstock, 2007). Lean has also helped public hospitals, examples are: the British National Health System (NHS) adopted Lean and issued a report on Lean thinking for the NHS (Jones & Mitchell, 2006), New York Technology Development Organisation (TDO) developed a program for healthcare organisations based around lean-manufacturing principles (Tampone, 2005), Chalice discussed steps to control healthcare costs using Lean methods (Chalice, 2005). A team of 15 people at University of Iowa Health Centre used a Lean methodology and eliminated non-value added activities in Radiology CT scanning resulting in increased revenue by approximately $750,000 per year (Bahensky, Roe, & Bolton, 2005).

Extending Lean implementation to the supply base was a bigger challenge as it affected the social as well as technical systems of the organisation (Abdulmalek and Rajgopal, 2007). For example, Textron Defence Systems obliterated functional groups and restructured around core processes to support Lean implementation (Klein and Maurer, 1994). Warner Robbins Air Logistics Centre (WRALC) agreed on changing many of its internal systems, such as the technical system, the behavioural system, and the management system, to support Lean implementation (Dickmann, 2005). Furthermore, Lean execution requires linking with the extended supply chain. In the case of Lockheed Martin Aeronautics Company (LMAC) a system-of-systems approach, recognising their interactions with both upstream influences and downstream customers was applied (Ferdowsi and Stanke, 2002). Thus, a context-specific viewpoint and a systems viewpoint that covers the extended supply chain is required for employing the Lean approach. Various researches on adopting Lean thinking in support functions indicated that Lean philosophy is not limited to manufacturing industry alone and can be relevant in any business domain. Awareness of the external and internal advances of a company enables it to incorporate changes and survive. Ahlstrom (2004) investigated the possibilities of applying Lean in service companies and found that

perhaps Lean is better suited for service rather than manufacturing companies depending on the nature and characteristics of the services.

Lean thinking has great power in helping organisations to think out of box and gain new insights for their process improvement (Shivaji, Subramanian, 2009). Lean Methodology intends to streamline the processes and the improvements accomplished are evident more quickly compared to other methodologies enabling the employees to appreciate the results instantaneously (Towne, J., 2006). Eckelbecker (2012) studied cases where medical administrators were adapting "Lean" or "Six Sigma" in Worcester and other locations, to exclude waste and save money, but this notion was not accepted by nurses and labelled unsuccessful, according to experts. It can be a turning point in hospitals as employers, insurers and government pushed to control medical spending. This involved the separation of patients in the emergency department showed faster flow of care reducing patient waiting times by more than 5 percent and another, concentrating on billing for radiology procedures, reduced denials from insurers by more than 80 percent, bringing in additional payments to the hospital. One of the first projects involved tapering down a 23-step discharge process to a nine-step process, reducing the time taken to send the patients home. Another was “just in time” that included organising supply rooms to order bandages and culture bottles only when supplies were low. On the other hand, some nurses were unhappy with the Lean method as they spent less time with the patients. Frequent failures are faced by Lean adopters. Lean experts have estimated that only 20 percent of Lean efforts in health care persist and succeed, because; top executives do not make it an on-going priority, organisations are not willing to adapt to change in work culture, improvements occur in isolated departments rather than whole entire organisation.

2.1.2.C : Six-Sigma

In the ***mid-1980s, Motorola developed the Six Sigma concept*** that focused on improvement and significant reduction of process defects. Quality is specifically

measured in terms of defect rates and is assessed from the customer's perspective. More formally, Six Sigma has been defined as "an organised and systematic method for strategic process improvement and new product and service development that relies on statistical methods and the scientific method to make dramatic reductions in customer defined defect rates" (Linderman et al. 2003). To approach a problem, Six Sigma deploys a five phase strategy (**DMAIC**); **D**-Define: identify/define the problem and set the goals, **M**-Measure: gather data, measure inputs and outputs, **A**- Analyse: develop problem hypotheses and identify root causes, **I**-Improve: develop improvement ideas and establish solution, **C**-Control: establish performance standards and deal with any problems. Six-Sigma offers a structured, analytic, logically sound approach to problem solving and a strong organisational framework for its deployment yet one weakness of Six Sigma is its complexity (Koning, Verver et al., 2006). In the case of simple problems where easy solutions can be implemented, observance of Six Sigma may be considered "overkill" and inefficient (George 2003). While, Lean focuses on doing the right things (value-adding activities), Six Sigma focuses on doing things right (with no errors). Critics of both Six Sigma and Lean highlight that these quality techniques focus on processes rather than the systems where the processes operate (Stamatis 2000).

In Towne (2006), the Virtua Health Centre, in Marlton, NJ, U.S.A., had relied on the Six Sigma methodology for six years to achieve organisational goals of excellent service, caring culture, clinical quality and safety, best people employment and resource stewardship. Virtua then turned to the Lean Methodology, which complemented Six Sigma and allowed for quick turnaround. For any organisation attempting transformation, the main obstacle is staff resistance to change. The employees need to be motivated and wholly involved in the process so that they feel responsible and are encouraged to work for the betterment of the organisation. GE Healthcare, found that any initiative must come from top management with good communication to the staff so that they understand what has to be achieved and how it has to be done. It can be considered that Lean makes the staff feel more responsible and empowered as their

ideas are utilised to improve the work process. While, Six Sigma accomplishes major changes, Lean focuses on the smaller stuff.

2.1.2.D : Lean Limitations

Liker and Rother (2011) explain the reasons for failure of Lean implementation. Firstly; Lean activity fades away with time and its effects decline. Secondly; Expecting immediate results. Thirdly; Top Managers are either not willing to embrace the philosophy or do not understand it wholly. Fourthly; Lack of motivation and continuity of the employees. Lean is a slow, steady and continuous improvement process that takes time before results are evident. If the process is adopted and continued with the same commitment, after a few months employees can look back and realise how much has been accomplished. It is not a one-time process but an unceasing attempt towards continuous improvement, thus the organisational leader should fully understand the concept and constantly motivate his employees to retain their interest.

Shivaji and Subramanian (2009) highlighted certain constraints encountered by Jefferson County Hospital during Lean implementation. 1) Waning of management interest in Lean due to problems of funding, designing and building a new hospital facility 2) Initial training provided by the Lean consultant was oriented more to a manufacturing company rather than a hospital 3) Employees were reluctant to participate in Lean training sessions or to study the current system, etc., in addition to their usual daily activities 4) Lack of incentives for employees to make suggestions that helped improve operations and cuts costs. Lean effectiveness increases when the focus is on the process and not on the people.

Liker and Morgan (2006) outlined and illustrated that Lean can be applied beyond manufacturing to any technical or service process and must be adopted as a continual, comprehensive, and coordinated effort for change and learning across the organisation. But, Lean efforts represent “limited, patchy approaches, quick fix to reduce lead time and costs and increase quality, which never create a true learning culture.” Other problems that can interrupt lean implementation are failure to address

fundamental structural issues. Most managers fail to realise that Lean is a management philosophy and not a collection of tools for problem solving. Most leaders are not thoroughly knowledgeable and fail to understand its value or do not have the patience and control to implement it. Lean mainly depends on the employee willingness to adapt to the changed work culture and any resistance to this is the first step towards lean failure.

The primary motive of the Lean concept was to reduce the waiting time of the patients and provide them with timely information and service (Shivaji and Subramanian, 2009). Common problems observed in the Outpatient Department are the waiting queue at the counter, unnecessary movement of the patient from one counter to another, wastage of paper following incorrect print outs, excessive numbers of files and forms occupying the limited space available. All of these can be resolved with the JIT and Lean approach. Waiting queues can be cleared, by relocating and temporarily increasing the manpower at the counter when it is crowded. Unnecessary movement can be cut down by having a systematic flow, for example, registration at front lobby followed by instructing the patient to go to the OPD where the patient ID is acknowledged and billed for consultation, after which the patient is directed to the vital signs check room, after completing which he takes a seat in the OPD premises until called for his consultation. The systems used in the hospital should support a strong HIS network so that, following consultation, any laboratory investigations advised can be billed at the OPD counter and the patient can go directly to the sample collection room with the bill. By keeping a limited stock of paper at the counter, with careful usage, minimal errors and wastage would cut down the cost. Having the required number of well-arranged forms and files at the desk will condense the space occupied by them, thereby providing space to allot the other resources.

2.1.3 : Japanese 5S

This section will now consider Japanese 5S concept and methodology.

2.1.3.A : Introduction to Japanese 5S

“5S is a system designed to prevent items, tools and equipment from being lost or misplaced”. It focuses on creating a workplace that is more efficient, effective and organized (Hogrefe 2013). 5S is the first step towards Total Quality Management and Business Excellence. It was originally developed by just-in-time expert and international consultant Hiroyuki Hirano as an extension of his earlier work on just-in-time production systems. 5S represents a simple good housekeeping approach to improve the work environment coupled with the principles of Lean manufacturing systems. The focus lies in the concept of how the visual workplace can be utilised to drive inefficiencies out of the manufacturing process (Shil, 2009). 5S is a proven method used to systematically organise, standardise, clean and maintain the workplace (Lewis, 2007). The platform for developing an integrated management system lies in merging Total Productive Maintenance (TPM) and 5S Japanese acronym for Continuous Quality Improvement (CQI) (Bamber et al., 2000). 5S stands for – *seiri*, *seiton*, seiso, *seiketsu and shitsuke* (as in Figure 2). Becker 2001, Gapp et al., 2008 explain the 5 steps in the 5S process as –

a. Seiri (Sort) - identify unnecessary work, space, items and remove them. It is most effective when essential items are identified and kept. Clearing the area, allocating space for remaining items by placing, stacking and storing the materials enhances overall safety.
b. The object of Seiton (set in order) is to arrange work place items for quick identification. For this purpose, everything should be organised according to the frequency of use. Concept, such as "first in first out" and color-coding materials can be implemented to organise the workplace.
c. The goal of Seiso (shine) is to make the employees accept that proper workspace maintenance is part of their job and a daily cleaning process will help identified the waste sources. A dedicated tidying routine will inevitably resolve safety concerns.

d. Seiketsu (standardise) formalise procedures to avoid wasted indecision times by determining the best way to complete a task such that the organisation will work towards the best practices.

e. Shitsuke (Self-discipline) form favourable habits and maintaining them in the long term.

Safety can be coined as the sixth "S," but whether unified or not, the natural conclusion of a 5S workplace is a safe, productive environment (Hogrefe 2013).

Figure 2: The Five Steps of Japanese 5S.

2.1.3.B : Japanese 5S Implementation

A framework of applying 5S within a business was first formalised in the early 1980s by Takashi Osada (Ho *et al.*, 1995). The practice of 5S aims to embed the values of organisation, neatness, cleaning, standardisation and discipline into the workplace (Osada, 1991). It benefits both the customer and the employee. In Japan the 5S practice was initiated in the manufacturing sector and then extended to other industries and services sector (Gapp, Fisher et al., 2008). 5S describes how to organise

and lay out a space for maximum efficiency and effectiveness by identifying; sorting and storing the items used, and maintain the area to help sustain the newly organised areas (Mehok, 2011).

Hubbard (1999) studied the implementation of the 5S in the Clarkson Company that yielded an excellent result. They began organising the workplace by using *Red Tags* to identify unneeded items then brought in orderliness by analysing their processes and eliminating wasted motion. Next a cleanliness checklist was introduced and the employees were made responsible for the neatness of the work environment. These three steps resulted in a standardised workplace and lastly the discipline acquired by every employee ensured that they followed the correct procedures developed in the 5S implementation. The red tag program recovered 10 percent of the floor space which was used as a storage area and the colour coding strategy for materials helped to determine where things belonged.

Application of Japanese 5S in healthcare results in a neat and clean healthcare facility, improves productivity, increases patient safety, decreases waiting time and minimizes cost. Medication errors can be reduced to a great extent by; a) labelling drug containers or trays and placing the right drugs in them; b) Disposing expired medications that are no longer used, indeed creating more space to place medicines that are used; c) segregating the medications and placing high risk medicines in cupboards so that it is not used carelessly; d) placing the drugs, medications and other items required in the order of their importance; e) keeping the workplace and the surroundings clean as this will abate the possibility of acquiring hospital acquired infections.

Casey (2013) studied North American organsations that adopted 5S approach and found that disorganisation returns after few months. He reasoned it to be because of the significant cultural differences between Japanese and North Americans. The Japanese live in limited space, hence store just what they want and need whereas, the North Americans are accustomed to wide open spaces. In Japan conformity is cherished but conformity is not always valued by North Americans. Thus, they adopt a

culture of individualism and excess. Casey proclaims that an organisation should start with the standardisation step and know what is expected when standards are in place, next systemize a process to measure orderliness and then consecutively follow the sort, set in order and shine steps. The failure for Japanese 5S implementation by the North Americans could have been for two reasons – 1) Union resistance to change introduced in the work pattern; 2) Bad implementation approach by the management.

2.1.3.C : Japanese 5S Limitations

Oswald (as in Casey 2013) declares that for successful implementation of 5S, teamwork and the winning spirit of the employees is necessary. Application of 5S, helps to continuously improve and maintain the quality in an organisation. By identifying the essential items, arranging them in the order of importance (keeping things used most within easy reach), cleaning the work place, good maintenance of resources will help cut down on non-value added work, thus saving time, space and cost. If the employees are resistant to change and are unwilling to acquaint to changed work pattern then it is nearly impossible to successfully implement 5S approach. For this reason, the manager must induce enthusiasm and interest in the employees so that they agree to adapt to new work patterns and take up the responsibility to sustain the improved process.

Becker (2001); Eckhardt (2001); Zelinski (2005) state that 5S is easy to understand but difficult to realise how it helps improve organisation decision making and performance. 5S is designed for “ordinary, everyday companies” that intend to improve their efficiency and productivity levels. Proper labelling, designated storage spaces, and communication centres are a few ways to incorporate 5S practices into the workplace (Hogrefe 2013). Orderliness in the workplace eliminates three types of waste: searching waste, difficulty of-use waste, and the waste of returning items to their proper place (Hubbard, 1999). Thus, this concept is appreciated by production managers as it focuses on improving productivity and quality, while lowering product costs and enhancing the flexibility of operations (Becker 2001). Lewis (2007) postulates the result of applying 5S in business is; enhanced quality, improved safety, increased

throughput, reduced cost and pride of ownership. Although 5S is predominantly used in the manufacturing sector, it is now deployed in industries such as banking, mining, construction and healthcare.

2.1.4 : Materials Requirement Planning [MRP]

This section explores the MRP concept and its development into MRP II and ERP methodologies.

2.1.4.A : Introduction to MRP

Healthcare industry is subjected to constant advancement and improvement in medications, procedures and equipment. Hospital cost suppression is an important problem challenging the health care administration and the advancement in information technology like Enterprise Resource Planning (ERP), Material Requirements Planning (MRP), and Manufacturing Resources Planning (MRPII) in production processes and supply chains has instilled interest in the administrators (Costa, Lameira et al., 2013). As MRP involves production schedule, inventory records, bill of materials and calculating time-phased material, component and sub-assembly requirements, both gross and net, processing capability and storage capacity has made commercial use of MRP possible and practical. While the prime objective of MRP is to compute material requirements, it proves to be a useful scheduling tool as it employs backward scheduling wherein lead times is used to work backwards from a due date to a start date. As the MRP systems popularity increased, practitioners and researchers realised that the data and information produced by it could be augmented with additional data to meet other information needs like Capacity Requirements Planning module, which could be used in developing capacity plans to produce the master production schedule. Further, manpower planning and support for human resources management were incorporated and distribution management capabilities were added. What started as an efficiency-oriented tool for production and inventory

management has become a cross-functional information system serving diverse user groups (Mcgaughey and Gunasekaran, 2007).

The core principle of MRP is that, if a product or service is composed of several inputs, the demand for these inputs depends upon the amount of product to be produced. Thus, a company can calculate its material requirements if it knows how much of product has to be produced. Some limitations while implementing MRP involve: 1. The production-marketing interface, 2. Invalid scheduling caused by inadequate capacity planning and 3. Lack of data integrity (Piper 1988).

2.1.4.B : Manufacturing Resources Planning [MRPII]

MRP in MRPII stands for manufacturing resource planning rather than materials requirements planning. Manufacturing resource planning is a computer-supported planning and scheduling system that enables management to control: 1. production scheduling, 2. cash flow, 3. manpower planning, 4. capacity planning, 5. inventory, 6. distribution, and 7. materials purchases and offers certain benefits that include: a. low inventories, b. lower prices, c. shortened lead times, and d. increased management productivity. MRP system evolved from material requirements planning to an enterprise information system resource in manufacturing operations.

The need for greater efficiency and effectiveness was common even to non-manufacturing sectors such as healthcare, financial services, aerospace, and the consumer goods sector who adapted MRPII to manage critical resources (Mcgaughey and Gunasekaran, 2007). MRP II anticipates the materials needed, in the quantity needed and the dates on which they will be needed (McLeod, 1995). The objectives of MRP II are to reduce inventory-holding cost, improve customer services and plant-operating efficiency (Wilson et al, 1994). The information management capability of MRP II is particularly relevant when there are unpredictable customer requirements and complex product structures. Key feature of MRP II is its ability to maintain correct priorities so that production can focus on what is really needed (Fogarty et al., 1991).

2.1.4.C : Enterprise Resource Planning [ERP]

The ERP system is an information system that integrates business processes and aims to create value and reduce costs by making the right information available to the right people at the right time in order to make good decisions in managing resources effectively and proactively. The origin of ERP can be traced back to materials requirement planning (MRP) (Mcgaughey and Gunasekaran, 2007). ERP is comprised of multi-module application software packages (Sane, 2005) designed with large automated cross-functional systems that bring about improved operational efficiency and effectiveness through integrating, streamlining, and improving fundamental back-office business processes. Traditionally, the objective of ERP systems was greater efficiency in general and, to a lesser extent, greater effectiveness.

2.1.4.D : Implementation of MRP, MRP II and ERP

Hutchins (1999) formulated seven fundamental points essential for the success of the MRP implementation: 1) Manage the data – eliminate all informal data systems. 2) Changing a company often requires drastic actions and it is important to convince the people that the company will change. 3) Stop measuring the wrong things and start measuring the right things. To make things happen, system implementation needs to be directly tied to compensation. 4) Do not run parallel systems - Users always outsmart programmers. If the old system is allowed to remain, the workers will find a way to let the manager think they are using the new system while actually continuing the old. 5) Project evaluation - Management, vendors, implementation team, and the users who make it happen must be rewarded publically on reaching the finish line. 6) Education and training – Implementation requires knowledge and right understanding of the system if not the users will invent their own process from a part of the system and manipulate it. 7) Monitor the system and project all the way through.

Steinberg, Khumawala, Scamell et al., (1982) reported the problems that healthcare organisations face are similar to manufacturing organisations. In the case of hospitals expired medications, obsolete equipment and short shelf-life drugs lead to excessive

inventory, wastage of space and high operational costs. MRP II for surgical supplies was developed at Park Plaza Hospital, a private hospital in Houston, Texas. The system was used to procure only the minimum levels of inventory needed to support a detailed schedule of surgical procedures. Although application of the MRP II method will not reduce the cost to a great degree, it will help dampen the rising cost of healthcare. The automated inventory management method long used by manufacturers, can be implemented in the healthcare sector to cut down cost by managing the lowest possible inventory level. MRP: 1. ensures that materials required for delivering goods and services are available, 2. maintains the lowest possible inventory levels 3. Plans and integrates service activities, schedules, and purchasing requirements (Hien, Randall, Wells et al., 1989).

Studies on MRP II implementation showed that, MRP II on raw materials inventory levels facilitated in maintaining lower levels of safety stock (Braglia and Petroni, 1999). Tower, Knibbs et al., 2005, asserted that in the MRP II system, orders for raw materials are sequenced to arrive at approximately the same time as each item appears in the Master Production Schedule, resulting in reduced average inventory levels. Thus Plossl (1994), states that reducing average inventory level reduces inventory investments to a minimum.

The application of the MRP approach in Outpatients Department will lead to lower inventory costs, reflected by a reduction in the patient's bill. Resources provided in the consultation room like soap/sanitizer, medications, gels, equipment, bandages etc., should be checked for their expiry dates. Their availability in the rooms should be only what is required, as excess will lead to expired stock piling up with wasted investment on the excess inventory.

Most firms implement ERP with the goal of replacing diverse functional systems with a single integrated system that does the work faster, better, and cheaper (Mcgaughey and Gunasekaran, 2007). In a hospital, responsibility of services is shared between many autonomous units. To implement ERP, acceptance is required by its various stakeholders to bring in organisational and technical changes in the sector. For this

very reason, it is essential to understand the attitude, behaviour and expectations of the physicians and the administrators to reduce friction between the departments (Boonstra, Govers et al., 2009). This can be best done by enquiring about the demands and requirements of the consultants and whilst considering the financial objectives of the hospital.

2.1.4.E : Limitations of MRP, MRP II and ERP

Previous research in the materials management literature has identified how failure occurs in MRP systems. Even well-established companies with excellent MRP implementation plans have failed with no logical explanations Hutchins, (1999). 4 statements with limited foundation in fact are: 1) MRP is an ''either-or'' proposition. 2) MRP is a closed-loop system. 3) There is no such thing as a unique company. 4) MRP is a standardised technology; contribute to the failure of an MRP system if good judgement is not exercised in considering their validity and/or impact.

Hutchins, also expressed certain limitations while implementing MRP. 1) Developing an unrealistic implementation schedule whilst not keeping in check the realistic state of the company would invariably cause failure. 2) There is no perfect system, some changes to the processes needs to be made to accommodate the software. 3) Work problems that no one will be able to anticipate. 4) Need for a contingency plan to switch to when the system fails. 5) A company improves because of its employees input and not because of the system. The users know better what the system can and cannot do. 6) Need for continuous training as it is not a one-time event. 7) Failure to evaluate results.

Wailgum (2009) highlighted some failed implementations of ERP – 1) SAP's R/3 ERP software adopted by Hershey Food’s which prevented it from delivering $100 million worth of Kisses for Halloween in 1999 and caused the stock market price to dip by 8 percent. 2) An ERP, supply chain and CRM project that aimed to upgrade the systems caused a 20 percent stock dip and a collection of class-action lawsuits in 2000 for Nike. 3) In 2004, SAP system ERP implementation caused a huge loss of revenue that was

more than five times the project's estimated cost. 4) In 2004, a computer program introduced at the University of Massachusetts, Stanford and Indiana University was a disaster as the students found it very difficult to comply with the ERP applications that left them at best unable to find their classes and at worst unable to collect their financial aid cheques. 5) "Garbage-disposal" giant Waste Management in 2005 filed a suit and claimed SAP executives participated in a fraudulent sales scheme that resulted in the massive failure. 6) Oracle's master plan to build the next-generation of applications that are completely standard using Fusion Applications in January 2006 did not accomplish. 7) Oracle alleged in 2007 that SAP (via Tomorrow Now a small company) compiled an illegal library of Oracle's copyrighted software code and other materials, forcing the company to shut down in 2008 following a lawsuit. 8) In 2008. CIOs were reluctant to take chances storing the sensitive data (accounting, HR, supply chain) contained in their ERP systems in another company's data centre as they were committed to their traditional ERP systems.

Thus, for a successful implementation of MRP, before introducing any system or bringing any change the organisation needs to understand the impacts of the same and choose a system that would suit the requirements of the company. The manager must have an open discussion with his employees before bringing in changes to assess the acceptance of the new system by the users. Continuous training sessions should be conducted so that the users completely understand the concept and are motivated to adopt the new system.

2.1.5 : Process Mapping

This section discusses the importance of process mapping and its benefits to develop more effective processes.

2.1.5.A : Introduction to Process Mapping

A process converts inputs into outputs (as in Figure 3). To achieve this it may require tools, materials, methods and man-power.

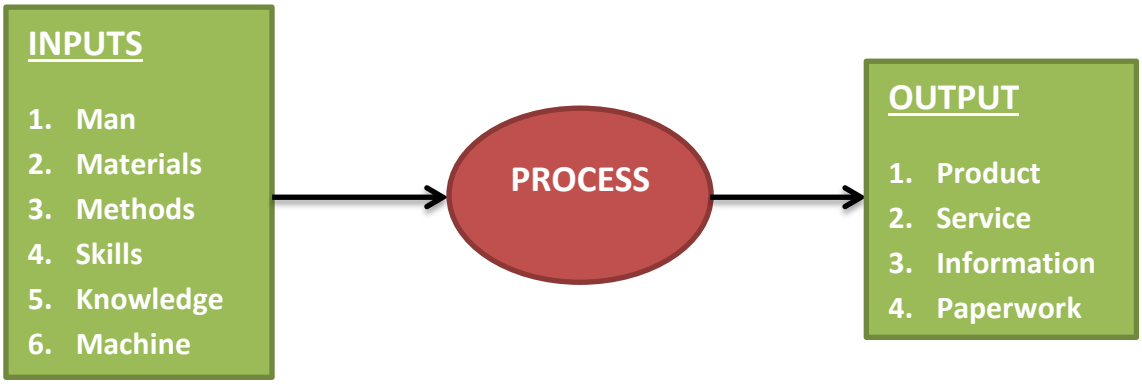


Figure 3 : Inputs Converted to Outputs by a Process

Processes are arguably the most vital area of control for an enterprise as they constitute a substantial portion of organisational costs, and an organisation is only as effective as its processes. An effective method of documenting processes is to map them; this is called Process Mapping. It is an analytical technique used in business to understand processes and procedures by visually illustrating the activities, decision points, timings, precedence, dependencies and the work flows (Figure 4. explains all about process mapping). Process mapping is an excellent tool to establish strong internal controls and to know how the company operates (Pardiso, Cruickshank et al., 2007). This tool is very powerful in defining the current state of operations if done accurately and serves as a road map for isolating and eliminating problem areas. The most important part is to have a well-organised plan with well-defined boundaries ascertaining the beginning and end of the process (Argent 2007).

“A good process map visually represents the work flow, identifies problem areas and opportunities for process improvement and provides understanding of the entire process, specific roles and contributions of process participants” (Deas 2009). Process maps are excellent problem solving tools that streamline activities and eliminate non value-added steps. In the 1970s, after the quality movement took hold in the US, the most widely accepted process mapping tool was the flow-chart until it lost its credibility in recent years, as Continuous Quality Improvement defines this term as being evolved from being managed and controlled by a few experts to being used by all employees. With the introduction of the Toyota Production System, a new process

mapping concept called Value Stream Mapping emerged. Nash, Poling et al., (2009) propose that as many Six Sigma practitioners have adopted this concept that it may very soon become the initial tool of choice for process mapping worldwide.

Figure 4 below, expresses the sequence followed to perform a process map. However, Shivaji and Subaramanian have missed the crucial and vital requirement of validation of the As-Is and To-Be process maps by process owners. This ensures that the process has been captured correctly and is a true reflection of the processes.

Figure 4 : What is Process Mapping? (Shivaji and Subramaniam 2009).

2.1.5.B : Benefits of Process Mapping

A process map helps to increase efficiency, eliminate needless activities, reduce cycle time, and simplify workflow (as in Table 2.). The critical tool in Lean is a Value Stream

Map (VSM) that can be used as a quality improvement activity guide, as it highlights non value-adding steps and bottlenecks in the process (Koning, Verver et al., 2006) by eliminating steps that are redundant, out-dated, or non-value added thus, shortening the process (IOAM's Report 2010). This technique diagnoses and identifies potential and actual blocks in the existing process that prevent a quality service reaching the customer and proposes a re-engineered process to remove the bottlenecks (Akamavi and R.K 2005).

Improved schedule and budget predictability	**Increased productivity**
Improved cycle time	**Increased customer satisfaction**
Improved employee morale	**Increased return on investment**
Improved quality (as measured by defects)	**Decreased cost of quality**

Table 2 : Benefits of Process Mapping (Koning, Verver et al., 2006).

Uppal, Wang, Fulton et al (2012) reported that Lean methodology along with other systems engineering tools were adopted to systematically assess, evaluate, and improve an outpatient wound clinic process in order to deliver efficient and patient-centred care. Techniques such as process mapping, spaghetti mapping, and cause-effect diagrams were used to identify the non-value added activities and recommendations were proposed to streamline patient, staff, documentation and information flow, reduce patient waiting time, and increase clinic throughput. The study provided an opportunity for the process owners to understand the Lean concepts and gave a new perspective to their processes.

A well delineated process map exhibits a process framework for continuous improvement (as in Figure 5.)

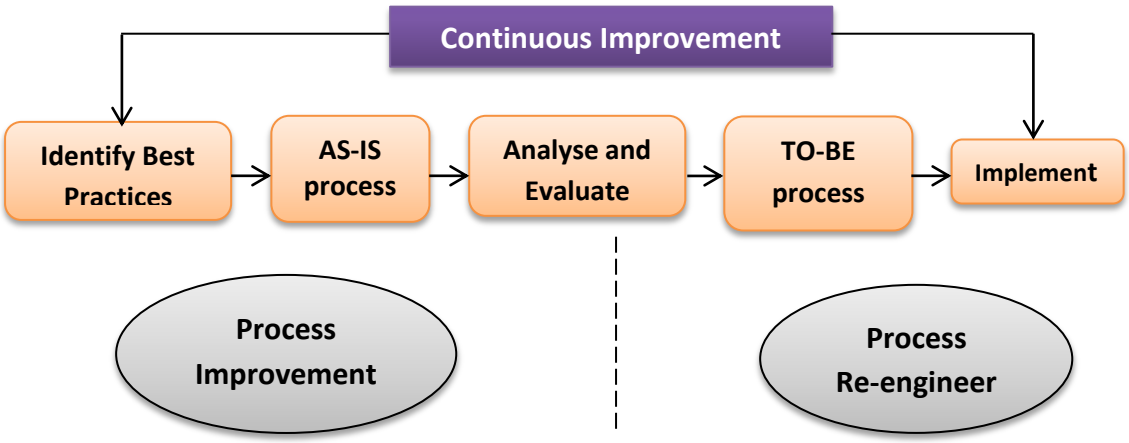


Figure 5 : Process Framework (Subramaniam 2009).

Although, Shivaji and Subramaniam (2009) introduced the process framework, (as in Figure 5) yet again, (as in their description of the stages of mapping in figure 4) they did not recognise the importance of, or mention, validation of the process by the process owner(s). Thus there was no certainty or guarantee if the AS – IS process mapped was complete and correct. Also, non-validation of the TO – BE process map would lead to failure in the acceptance and buy-in by the workforce and the management. Therefore, it is essential that a process map is always validated by the owner(s) to make sure that the process and the role of each stakeholder in the process is rightly understood.

Where a Process Map is a simple workflow diagram that brings a clearer understanding of a process or series of parallel processes, a Process Model consists of a series of steps and decisions involved in the way work is completed. A process model is derived from a process map but has additional information as it looks deeper into the process and ideally a process model can give a better understanding of the organisation and how it functions. IDEF3 is a process model which is used widely in business process mapping. It provides a structured method for expressing knowledge about how an organisation works by collecting and documenting processes and captures the behavioural aspects of an existing or proposed system.

2.1.6 : Scheduling

This section investigates different types of scheduling and the importance of having an effective scheduling system to improve customer satisfaction.

2.1.6.A : Introduction to Scheduling

The goal of effective scheduling systems is to match demand with capacity so that resources are better utilised and patient waiting times are minimised (Cayirli, Veral et al., 2003). The operation of an appointment system depends on the effectiveness of appointment allocation designed to suit the needs of the individuals. Appointment allocation deals with scheduling resources to satisfy demand at the right time and right place. In healthcare, resources could be in the form of machines, staff, space, time or equipment and the demand is the customer order. The prime factors that affect operations of appointment systems are staff scheduling and appointment scheduling (Yedehalli, et al., 2005). Staff scheduling finds its application in many different industries – employee scheduling at a fast food chain, airline crew scheduling, nursing application, scheduling a rotating workforce, military manpower planning, scheduling bus drivers etc. (Bailey 1997). Naidu et al (2005) identified the importance of resource scheduling in healthcare, giving an outline on the various approaches such as linear programming, expert based systems and heuristic approaches for achieving an optimal staff planning that would meet the requirement at the lowest possible cost. Potentially, well-designed appointment systems (AS) can increase the utilisation of expensive personnel and equipment-based medical resources along with reducing patient waiting time according to Cayirli, Veral et al., (2003). In outpatient services, the major reason for patients' dissatisfaction is the excessive waiting times (Huang 1994). Patients expect reasonable waiting times in addition to clinical competence (Jackson 1991).

2.1.6.B : Appointment Scheduling

Appointment Scheduling is defined “as a method of allocating fixed number of resources and service among customers using certain rules and criteria to ensure efficient and quick access to all customers while maximising utilisation or minimising costs” (Salinkar 2010 p48) and this is applied in service industries such as airlines, clinics, restaurants (Denton and Gupta 2003). Appointment scheduling in healthcare is different from other services because problems of resource utilisation and server efficiency are affected by the unpredictability of human nature. The demand for a doctor’s time by two different patients with the same ailment can be very different, unlike the airlines seating capacity which stays fixed and unchangeable (Gupta and Denton 2008). Appointment scheduling becomes challenging because of the unpredictable, non-deterministic and dynamic demand patterns. Walk-in patients with no scheduled appointment necessitate estimation of demand and the associated variability. However, scheduling for surgical procedures is different from outpatient scheduling. Here the operation theatre is booked for different surgeons in blocks, so as to maximize the resource utilisation, which takes precedence over patient and provider preferences. The goal of a well-designed appointment system is to ensure timely and quick access to all customers while maximising server utilisation. (Salinkar 2010).

Appointment scheduling in health care systems is needed to regulate demand (patient appointment requests) and supply (service capacity of health care providers). Appointment systems have two objectives: (i) provide a quality service with short waiting times for patients (ii) protect the system from daily fluctuations in demand leading to an inefficient system, with low utilisation levels on some days and overloads on others. Past research has shown that the longer the appointment is delayed, the higher are the chances of no-show and cancellation (Gallucci et al. 2005). A clinic's choice of a scheduling policy depends on various factors that determine its sensitivity towards no-shows, flexibility in adjusting its physician capacity, willingness to work overtime, and/or willingness to overbook patients depending on the daily workload

(Liu 2009). Denton and Gupta (2003), Robinson and Chen (2003), and Klassen and Rohleder (2004) state that the object is to balance server idling, customer waiting and tardiness (overtime) costs with a focus on determining appointment times for punctual patients with random service times. While, Muthuraman and Lawley (2008) assume that scheduling decisions can be made based on a clinic's past data. They state that this data can identify the correlation between various patient attributes and their no-show probabilities. However, LaGanga and Lawrence (2007) studied how appointment overbooking compensated for patient no-shows so as to improve the overall performance of the clinic. Unfortunately, overbooking is a risky strategy and may not necessarily work in private clinics. For instance, if the no-show rate turns out to be zero or much lower than the predicted rate on a particular day, then the clinic would flood with patients and the appointment patients would not tolerate long waits opting for a refund which would lead to loss in patient number and revenue to the clinic.

The appointment scheduling process can either be *static* or *dynamic*. If the complete demand for a given day is known before the start of scheduling, then the schedule can be optimised in a deterministic manner resulting in a static scheduling process (Gupta and Denton 2008). However, in reality, appointments are usually made over the phone thus appointment requests are stochastic. Scheduling decisions taken in such situations are dynamic scheduling decisions where an appointment request needs to be fulfilled one at a time, and the entire future demand is not known at the time of scheduling each patient (Muthuraman and Lawley 2008). The dynamic scheduling approach attempts to account for demand load variation (Rohleder and Klassen 2002), and thus patient rescheduling due to preferences or cancellations (Hur et al. 2004).

Appointment scheduling considers two queues – the first queue, where patients wait to receive an appointment, and the second queue formed on the day of the appointment to consult. The length of appointment queue can be shortened by increasing the number of patients seen per day. However, the length of the waiting queue increases correspondingly (Salinkar 2010). Designing of an appointment schedule is controlled by three parameters – the block size (one patient or more than one patients scheduled at a time), the block interval (fixed intervals or variable

intervals when patients are called) and the initial block size (one or more patients called at the beginning of the session) (Muthuraman and Lawley 2008). Ideally, an appointment system assigns a consultation time slot with the consultant and a start time of OPD session for the consultant. If every patient is seen by the consultant at the scheduled time and this lasts for the allocated interval, after which the patient leaves and the next patient is immediately consulted, there would be no delays; patients would experience zero wait times and the provider would experience no idle time between appointments. In practice the arrival of walk-ins, lateness of patients or consultant, non-attenders and the difference between the allotted and the actual time taken for consultation disrupts the schedule. Thus designing an appointment schedule needs to consider these parameters to minimise disruption of the schedule. Hence the basic problem of designing an appointment schedule is that of a trade-off between minimizing patient waiting time and maximizing provider utilisation at a given available capacity (Salinkar 2010).

The two complementary criteria for a schedule are minimizing the forfeits for not delivering on time and minimizing the idleness cost (Sourd, 2005). With the increase in healthcare costs and advancing technology, same day procedures are being carried out in outpatient settings with an upsurge in number of patient appointments, thus requiring more effective appointment scheduling (Salinkar, 2010). A characteristic of outpatient practice is the queuing system for scheduling patients to provide a predetermined time interval (Mercer 1973). Thus long appointment waiting times are a chief cause for high no-show rates (Kopach et al, 2007).

There are two different research approaches for tackling the problem of appointment scheduling – analytical approaches and simulation-based heuristic approaches. Analytical approaches include queuing theory, mathematical programming and dynamic programming that focus on the appointment scheduling problem under bounded conditions and do not consider patient or provider characteristics (Salinkar 2010). Fries and Marathe (1981) used a dynamic programming approach to arrive at an optimal number of appointment slots so as to minimize the overall cost function of

the expected patient waiting time and the provider idle time. An approximation method was applied, as the dynamic programming approach required a deterministic value for the total number of appointments to be scheduled. Earlier research, (Mercer 1960 and 1973) disclosed queuing theory was for the steady-state of a system which was more suitable for obtaining estimates of resource requirements and expected waiting times. A time-dependent Markov chain queuing model developed by Brahimi and Worthington (1991) modelled a random arrival rate of patients, and a distinct service time distribution, recognising that complicating factors like patient lateness, preferences, and no-shows require a simulation approach. Denton and Gupta (2003) modelled a two-step linear programming approach to address the appointment scheduling problem which incorporated patient waiting costs, provider idle time costs, and costs incurred by lateness, for a given session length. Advantages of utilising the simulation approach to solve appointment scheduling problems are that continuous service time distributions and the stochastic arrival process can be modelled easily. Simulation modelling techniques befit the inherent stochastic and non-determinate nature of scheduling for outpatient healthcare services (Salinkar 2010). Many studies used simulation approaches as they easily incorporated environmental factors such as no-shows, walk-ins, service time variation and patient sequencing and classification (Cayirli et al. 2008). A recent study has developed an in-depth simulation modelling approach to also include into scheduling consideration the total service time during a patient visit in addition to the consultation time with the provider (Wijewickrama and Takakuwa 2008).

2.1.6.C : Bailey's Rule

Early research in the field of appointment scheduling advocated individual appointment times for every patient over the then prevalent block-appointment scheduling schemes (Bailey 1952) which maximized provider utilisation and minimized provider idle time at the expense of increased patient waiting times. Bailey designed an appointment scheduling rule by which the provider's idle time was kept at a minimum while not compromising the value of the patient's time. Bailey's rule – two

patients are scheduled at the same time followed by one patient at appointment intervals equal to the mean consultation time of the provider. This rule assumes random consultation times fitted into a distribution with a mean consultation time. This rule provides a simple and relatively effective method to schedule patients using an estimate of the average consultation time for a given provider (Salinkar 2010). White and Pike (1964) proposed a modification to the Bailey's Rule to accommodate unpunctual patients in the appointment schedule viz. block scheduling by determining the total patients seen at the clinic and the average consultation time with the doctor. Welch (1964) concluded that patient waiting time, consultation time, and punctuality of patients and providers affect performance of outpatient clinics, dependent on which metrics are used.

Outpatient appointment scheduling has been the subject of scientific investigation since the beginning of the 1950s, when Bailey and Welch wrote about appointment systems in hospital outpatient departments (1952). The objective of appointment scheduling is to have a short waiting time for patient and little idle time for the physician so as to finish on time. Bailey and Welch introduced the first advanced scheduling rule and tested it through simulation (Kandorp and Koole 2007).

2.1.6.D : Application of Scheduling in Healthcare

Scheduling outpatient clinic appointments is a necessity for planning surgeons' activities within a clinical practice (Vissers, 1979). A schedule determines the appointment time and duration of consultation for a patient (Jun et al., 1999). The length of time a patient has to wait for consultation depends on the number of appointments, the availability of the consultant, and the method of appointment scheduling (Meredith et al., 1999). Appointment allocation in outpatient clinics is similar to timetabling in educational institutions which involves assigning a faculty to a course/subject and a room for a fixed time period. Each faculty differs in their skill level (Hinkin, Thompson et al., 2002); there could be many different sections for each course/subject and number of room available (Breslaw 1976, Hinkin, Thompson et a,

2002). Some faculties may prefer to teach more than one course in successive time periods, while others may need a break between two successive lectures. Similar to the educational institutions, clinics scheduling appointments involves scheduling a combination of doctors, nurses, patients and treatments to a time period. Here, doctors perform the function of the faculty members, treatments are considered to act as courses and the patients are the students (Yedehalli et al., 2005).

Effective scheduling systems have the goal of matching demand with capacity so that resources are better utilised and patient waiting times are minimized (Cayirli, Veral et al., 2003). The waiting time for any service is a major concern for customers and waiting for a scheduled appointment can be annoying. However, appointment scheduling is a challenging task, mainly due to the uncertainties associated with service times (Klassen, Rohleder et al., 2004). Muthuraman, Lawley et al (2008) formulated an appointment scheduling policy for outpatient clinics, wherein a schedule was constructed for a single service period partitioned into time slots of equal length. A scheduler assigned a slot for every patient who called for an appointment and each patient booked had a no-show probability thus slots were over-booked to compensate for this.

Rinder, Weckman et al (2010) discussed two types of scheduling methods used in healthcare: work scheduling and staff scheduling. Patients can be scheduled in outpatient clinics as there are a given number of slots available based on the type of work needed to be completed and the number of providers available by hour of the day and the day of the week (Kachhal, 2001). A) Work scheduling includes both resource scheduling and staff scheduling. There are a number of external factors that influence the work schedule, such as no-show appointments and cancellations, emergency appointments, and walk-ins. A smooth patient flow often determines the profitable use of provider and staff time. B) A personnel schedule is prepared once the work schedule is ready after determining the staff requirements. There are two types of personnel scheduling: cyclical and non-cyclical. The cyclical type assigns the same pattern after a certain number of days or weeks and has the advantage that the

personnel know their schedule but there is a lack of flexibility in accommodating demand and worker needs. The non-cyclical type is based on demand and staff availability and generates a new schedule for a short period of time. It is able to accommodate staff needs and change in demand but it requires more planning. Optimisation techniques are used for developing personnel schedules (Kachhal, 2001).

Kaandorp, Koole et al (2007) developed a mathematical model type of scheduling where patient mean waiting time, physician idle time, and tardiness were calculated with the objective of minimizing the sum of the three variables. Since the number of solutions given by this model was huge a search algorithm was necessary. Isken, Rajagopalan et al (2002) used a data mining technique, K-means for clustering, "to help the development of patient type definitions for purpose of building ... simulation or analytical models of patient flow in a hospital". It was based on the idea that each patient has a different need whether it is treatment, consequence of treatment or the resources that need to be allocated to the patients. To solve this problem, patients were classified into groups that had the same needs. The K-means clustering method was used to classify patients.

Gul, Denton et al (2011) asserted that designing a schedule to achieve smooth patient flow in an Outpatient Procedure Centre (OPC) is a complicated task, as it is dependent on a set of co-ordinated activities including patient intake and preparation, surgical procedure, and patient recovery. Uncertainty in the duration of surgical procedures causes long patient wait times, poor utilisation of resources, and high overtime costs. Large numbers of surgical procedures with uncertainty in the duration of activities and a fixed time length of surgical suite availability poses scheduling problems involving multiple, competing criteria. Gul, Denton et al (2011) believed expected patient waiting time and expected surgical suite overtime are performance indicators a manager must consider on a daily basis, although a schedule with small time intervals between procedures will have low surgical suite overtime and high patient waiting times, and vice versa. They proposed a hybrid solution technique mixing a bi-criteria genetic algorithm (GA) with appointment time-setting heuristics to find the (near)

Pareto optimal set of schedules and reveal the trade-off between factors affecting both the patient and the provider. They then tested several commonly used scheduling heuristics against the genetic algorithm to estimate the potential benefits of optimisation-based methods for scheduling system improvements and finally used GA to estimate the potential benefits of optimising daily procedure mix. Chow et al. (2011) built a surgery schedule combining Monte Carlo simulation and Mixed Integer Programming models to reduce variation in bed occupancy in surgical wards. They scheduled surgery block times and determined surgical mix within each block. Cayirli et al. (2006) tested several sequencing and appointment rules for clinic visits using simulation models with regards to patient waiting time, doctor idle time, and overtime. A significant finding of their study was that the impact of sequencing on the criteria is more important than that of the appointment rule.

Pooling referrals on a single appointment list, and scheduling appointments with the first available, not the referral, surgeon has been recommended as a method of reducing time to appointment (Kipping et al., 2000; NHS Modernisation Agency, 2005a). In this method, the patient is referred to an outpatient clinic rather than to a named surgeon (NHS Modernisation Agency, 2005b). The Audit Commission, 2002; Appleby et al, 2003 argue that pooling referrals reduce the uneven distribution of patients over individual waiting lists, contributing to variation in waiting time (Katz *et al* , 1991). Vasilakis, Sobolev et al., 2007 tested three hypotheses on the impact of the pooled-lists method: (a) fewer patients will be waiting for an appointment during weeks with no appointments available, (b) referral to appointment time will be shorter, and (c) appointment to surgery time will increase. They reported the results of their simulation study that compared two methods of scheduling outpatient clinic appointments. In the first method, individual surgeon appointment lists scheduled appointments with the named referral surgeon. The second method used a pooled appointment list to schedule appointments with the first available and not the referral surgeon.

Perfection in process performance is crucial for improving healthcare delivery. In the healthcare system, the demand is the number of patients to be seen every day and the resources are the nurses, physicians, rooms, and instrumentation that are available. The ability to balance the rising demand with the available resources will propose a solution for the scheduling problem (Rinder, Weckman et al., 2010). The last few decades has seen advancement in scheduling methods from manual scheduling to computerised approaches. All the methods developed in recent decades have not only improved the quality of service, but also assisted schedulers to work more efficiently (Chien, Tseng et al., 2008). These new methods aim at staff scheduling as well as patient scheduling – reduction of patient waiting time (indirect and direct waiting time), and total time spent in hospital.

All methods for patient, physician and staff scheduling, mathematical modelling/optimisation, genetic algorithm, local search, and data mining, have common objectives such as: to decrease patients waiting time, reduce physician idle times, increase equipment utilisation, select the maximum number of patients; fairly distribute patients among physicians, and reduce the time and effort to construct the schedule. The variables taken into account for this are: number of open slots per day, number of days in the schedule, length of appointment, and the number of patients to be scheduled every day. Accomplishing these objectives will not only improve the quality of services provided but also reduce its cost (Rinder, Weckman et al., 2010).

Often physicians are not punctual or patients are late for their appointments. A major problem is the missed appointment; when patients do not arrive and do not cancel their appointment in advance. Recent studies concluded that the no-show rates may be around 20% (Bennett, Baxley et al., 2009) and vary between 15-30% in general adult and paediatric clinics (LaGanga, Lawrence et al., 2007). Missed appointments lead to loss in revenue and underutilisation of resources, reduce provider productivity and efficiency, increase health care costs, and limit the ability of a clinic to serve its patients by reducing its effective capacity. Other concerns that require attention are indirect patient waiting time, late cancellation and no-shows, emergency walk-ins and

patient preferences (Gupta, Denton et al., 2008). No-shows and Walk-ins greatly influence the scheduling system; hence managing them is a challenging task. By not arriving for an appointment, a patient denies the appointment to another patient, and indirectly increases the indirect waiting time. Walk-ins occur randomly, increasing patient waiting time and overloading the nurses and physicians. Lastly, patient preferences are not taken into account when scheduling, preferences may differ from person to person and thus clustering of patients with similar preferences can help develop a schedule for that particular group (Rinder, Weckman et al., 2010).

Some limitations imposed by new methods are that artificial intelligence techniques develop rules based on the input and constraints specific to each healthcare facility and thus these models may not be valid for application to a wide range of healthcare facilities. Rinder, Weckman et al (2010) reviewed the use of heuristic models which proved to be successful in improving healthcare scheduling. However, more external variables, such as patient behaviour, needs to be taken into account when developing scheduling methods.

Laganga (2011) conducted a Lean process improvement project to increase the capacity of new patient admission into a healthcare service operation system. The transformation in service processes reported a 27% increase in service capacity to intake new patients and a 12% reduction in the no-show rate as a result of the Lean project. Laganga noted that changes due to Lean methodologies demonstrated the need for a focus on efficient and effective in scheduling techniques. He reported that the maximum benefits from efficiency drives require systematic scheduling techniques.

2.1.6.E : Open Access Concept

Scheduling systems can be designed based on three types of access models – prescheduled (traditional) access, the carve-out model, and the open access (alternatively called advanced access) (Salinkar, 2010). Open access addresses the long appointment waiting times by finishing today's work today (Murray and Tantau 2000).

This implies that when a patient calls an appointment is granted within the next one to three days. Many clinics have adopted open access, although it requires working overtime to clear the backlog from the traditional scheduling model, which is based on a fully pre-scheduled appointment scheduling system. In carve-out models, one half of the total clinic capacity is reserved for prescheduled patients and the second half is utilised for same day appointments (Murray and Tantau 2000). This model may not perform better than the traditional appointment scheduling if it starts compromising or mismanaging the appointment slots allocated for open access in a way that patients start experiencing a non-standardised process of appointment scheduling (Murray and Berwick 2003).

Open Access (OA) proposes a way to reduce no-shows and cancellations by giving patients same-day appointments on the day they call for them. However, OA cannot be a universal solution for all appointment scheduling problems as it will not work in small capacity clinics with a large demand for patient appointment requests (Liu 2009). Open Access can eliminate no-shows as most patients are seen on the next day (Kopach et al. 2007). No shows waste valuable resources when scheduled appointments are missed without sufficient notice to reallocate the appointment. They also provide a source of frustration not only for patients waiting for appointments, but amongst staff. Thus, it is the aim of every healthcare organisation that delivers medical or clinical care, to reduce no shows to zero. Existing literature on Open Access shows that all of Open Access practices are primary care practices, requiring predictable service times. In addition, Open Access is not suitable for scheduling high volume clinics where the demand exceeds the supply. Thus, for Open Access to work, the demand and supply for appointments must be in balance (Salinkar, 2010). Murray et al. (2003), Solberg et al. (2004), Belardi et al. (2004), and Dixon et al. (2006) strongly advocate OA, while Lamb (2002) is strongly against it. Lamb's objections are based around his observation that Open Access can demotivate staff, increase errors and places unnecessary mental and emotional strain on staff. He noted that clinicians and nursing staff were often "bullied" into working overtime to fulfil the demand for appointments. Nevertheless, for OA to work, demand and supply (capacity) need to be

“in balance." However, distributing demand over several days can regulate daily load on the system reducing severity of overloads, but this will consequently increase the no-shows and cancellations (Liu 2009). The carve-out model schedules a varying proportion of patients from the advanced access pool and the prescheduled pool for a given day be based on the optimal proportion of patients that maximizes revenue for the day (Gupta and Wang 2008) or maximizes the percentage of advanced access patients for the day (Qu et al. 2007). Advanced access scheduling, introduced in the early 1990s, significantly improved the performance of outpatient clinics. Its successful implementation required the match of daily healthcare provider capacity with patient demand (Rardin, Williams et al., 2007).

Significant no-show rates and escalating appointment lead times complicate effective management of an Outpatients clinic. Murray and Tantau (1999) proposed a method called Open or Advance access with an essence “do today’s demand today” to avoid wasted capacity due to no-shows. Jonathan Patrick (2011) developed a Markov Decision Process (MDP) model with short booking windows that was significantly demonstrated to be better than open access. The model analysed a number of scenarios that explore the trade-off between patient-related measures (lead times) and physician or system-related measures (revenue, overtime and idle time). Through simulation, Patrick (2011) demonstrated that the MDP model does as well or better than open access in terms of minimizing costs (or maximizing profits) as well as providing more consistent throughput.

2.1.7 : Capacity Management

This section explores the concept of capacity management and its application.

2.1.7.A : Introduction to Capacity Management

In modern work practice, workplace efficiency depends on workplace utilisation. From an office productivity point of view, efficiency is the generation of the

greatest amount of production with the minimum of waste which can be achieved by enabling people to produce the right work at the best quality with the potential to add value or increase knowledge (Davies, 2005). Thus effective utilisation of the workplace is to enable productivity with minimum costs (Khamkanya, Heaney et al., 2012).

Capacity management in healthcare involves decisions concerning acquisition and allocation of three types of resources: workforce, equipment and facilities. Thus selection of a healthcare facility involves decisions on size, location and the general mix of services offered (Smith-Daniels et al 1988). There are many methodologies and strategies to increase productivity of employees through workplace design, the relationship of workgroups, environmental stimuli, etc. (Brill et al, 1984, 1985; Duffy, 1992; Clements-Croome, 2000; Becker, 2002; DEGW, 2005). Under-utilisation of space should be the focus where an organisation is subjected to drive down cost and stimulate a creative workforce (Duffy, 2000). To eliminate under-use of office floor-space, there is an inherent ideal outcome in which all workspaces in a department are fully utilised. However, it is improbable that ideal outcome is achieved in practice but it is worthwhile to investigate feasible ways of efficiency improvement using mathematical stimulations to explore scenarios that would be impossible in practical situations (Fawcett, Chadwick et al., 2007).

A demand forecast is critical for staffing, production planning and managing care, continuity and access. Demand for hospital appointments is determined by the service delivered at the hospital and those obtained by other healthcare providers. Narrowing the gap between demand and capacity is critical to improving access and continuity of care (Davis, Charles, Farmer et al., 2012). Demand uncertainty in the field of health-care pertaining to changes in demand patterns driven by demographics and in delivery of services has become an important issue to be researched (Jack, Power et al., 2009).

2.1.7.B : Capacity Planning for Optimum Space Utilisation

Davis, Charles, et al (2012), in their study, highlighted certain important points; 1) Capacity of a healthcare service depends on – the number of available appointments,

types of appointments, the number of consulting rooms, consulting hours, access to clinical information, patient flow, and availability of staff. 2) While scheduling appointments and staff, demand should be a top consideration. 3) Extending clinic timings beyond business hours can offer appointments to meet demand of patients before and after work and school, reducing the unnecessary burden on the Emergency Department. 4) Patient flow is mostly affected by clinical and administrative information and an efficient and effective support staff. 5) Standardising and defining roles of each member in the team will not only increase productivity but also increase quality and safety. 6) To ensure the successful implementation of staff roles, there should be measures of performance and monitoring to ensure sustainability. 7) Decreasing no shows can increase capacity. Manual or automated reminders such as phone calls, e-mails, or text messages can decrease no shows. The difference in the actual capacity and the demand or demand forecast is the demand/capacity gap which can be narrowed by increasing capacity or decreasing demand. If the gap is large, it creates frustrated patients because there are no available appointments, increases emergency visits, and causes poor patient and staff satisfaction. The goal is to decrease the gap by developing mitigation strategies. If the gap can be reduced to within 5-10 percent, most of the patient needs can be met. Making the gap zero would require over staffing and is not desirable. Another way to narrow the gap is to decrease demand by reducing unnecessary health care utilisation while simultaneously encouraging the appropriate use of health care resources. Also, continuity with the same provider and health care team can alone decrease demand for services.

Systematic studies of systems with variable demand began 100 years ago with Erlan's pioneering work on telephone systems and extensive knowledge has been explored in fields such as operational research and systems engineering (Brockmeyer et al, 1948; Hillier and Lieberman 2001). With sophisticated approaches to space-time management, gain in utilisation and efficiency can be achieved by moving from "full" demand" (where full demand is the historical maximum cumulative demand over a set period of time) to "expected demand". When demand exceeds the full demand, demand can be reduced to the full demand. Though this works by providing each

employee with a non-shared workspace by executing special space-time management (Fawcett, Chadwick et al., 2007). New working practices that reduce territoriality have broadly been discussed in recent years (for example, Worthington, 2005). However, if the transition from current to new space-time management practices is not handled effectively, the new practices may fail (Van der Voordt, 2004). When there is variability in activities, it is exceedingly difficult to move beyond the expected demand and provide enough workspaces to cope with reasonable peaks in demand. This may be reachable by maintaining a continuous queue of people who can be assigned to workspaces as soon as they are vacated (Fawcett, Chadwick et al., 2007).

Tyler et al. (2003) determined the optimum Operation Room (OR) utilisation by analysing important factors such as average patient waiting time and variability of case durations that impact OR utilisation. Guinet and Chaabane (2003) solved the weekly patient-to-OR assignment problem using a primal-dual heuristic. They considered patient satisfaction and resource efficiency with an objective to minimize the number of days patients wait in the hospital and the overtime. Lamiri et al., (2008) aimed to minimize OR utilisation costs and patient-related costs by proposing a stochastic programming model for the assignment of elective surgeries. Uncertainty of demand for emergency cases was solved using a column generation method. Column generation is a statistical method where only the variables which have a significant impact are considered. Traditional linear program methods often require consideration of many variables which can render the solution of the equation potentially irrelevant. Column generation focuses on those variables which are deemed statistically to have the greatest effect. Lovejoy and Li (2002) focused on the trade-off between waiting time, procedure start time reliability, and hospital revenues to expand the OR capacity.

2.1.7.C : Efficiency Measurement in Healthcare

Utilisation is dependent on efficiency. To have an optimum utilisation of space it is necessary that efficiency is measured, but measuring efficiency in healthcare is not an easy task as it depends on a number of variables and risk factors. Burgess (2012) attempts to explain that efficiency in healthcare is significantly related to quality, value

and cost where value is defined as quality/cost. He further states, efficiency could be a concept related to cost (saving or minimizing costs) or related to both cost and quality (some sense of optimisation) or directly related to overall value. In addition to this Burgess concludes that to some extent efficiency is dependent on access to healthcare. Hollingsworth (2003) reviewed a number of studies conducted on measuring healthcare efficiency and identified that measurement of efficiency in healthcare has expanded over the past few years and that non-parametric and parametric methods have been employed to measure and analyse the operational performance of healthcare services. Rahman (2006) conducted a study on managerial efficiency in Bangladesh. This study assessed the status of health care services provided in terms of their technical efficiency, explored the potential cost-savings by eliminating inefficiency and examined what factors contributed to the inefficiencies. Meanwhile, in the USA, Kumar and Nunne (2008) attempted to compare the efficiency of general and specialty hospitals using stochastic frontier regression analysis based on realistic assumptions from the data collected. They concluded that speciality hospitals were more efficient than general ones. However Gomes et al., (2010) proposed a **systematic** approach to measuring, tracking, monitoring and continuously improving efficiency, availability and quality in healthcare by quantifying service effectiveness in healthcare operational setting. One other way of measuring efficiency as suggested by Anderson-Miles (1994) was 'Benchmarking' which was previously applied in other industries and had entered the health sector. He recognised that benchmarking has the potential to improve efficiency, cost-effectiveness, and quality of healthcare services.

This section has considered a range of concepts and techniques all of which are common place in Western manufacturing and service industries. It has noted that since the early 2000s, they have been increasingly applied in Western healthcare, often with great success. Indian healthcare is beginning to take note and attempt to apply some of the same principles as diaspora return from working and studying abroad. However, it was noted, that failures in implementation are often not down to the limitations of the techniques, but can actually be caused by cultural differences in the working methods of Indians when compared to Westerners. It should also be noted that there

is no one system, concept or technology which can provide all the answers. Often, the best solution comes from a hybrid approach combining the most effective bits of each method. Though, it was also noted that the most effective bits of each method/technique may vary when implemented in different settings.

3. RESEARCH AIM AND OBJECTIVES

This chapter deals begins with a research question which provides the relevance of the research to the wider healthcare community. The aim of the study brings this into sharper focus for the hospital at the centre of the research. The primary and secondary objectives will break the aim down into manageable packages which will contribute to achieving the aim. It also highlights the significance of the research.

3.1 : Research Question

To what extent can Western manufacturing management concepts and scheduling strategies be applied in Indian healthcare?

Indian healthcare, as noted in the introduction is under great pressure from under-funding and increasing demand due to India's burgeoning population. India, with the world's second largest population has a massive healthcare burden which is only being addressed by a Government spend of less than 6% of GDP. Thus, this research aims to identify how efficiency can be improved in an Indian hospital by utilising proven techniques from Western manufacturing and service companies. Many of these, as the literature has proven, have been successfully applied in Western healthcare.

3.2 : Aim of the Study

This study aims:

"To apply manufacturing management concepts and methods to achieve improvements in patient retention, by improving the process flow, to optimise the use of resources whilst maintaining high quality care in an Indian Super-Speciality Hospital."

The aim concentrates on several key elements. These are:

- that there are techniques which can be applied, having been successful in Western hospitals, to an Indian hospital.
- that retention of patients is a key objective of the hospital due to the positive effect this will have on revenue through word of mouth and brand recognition.
- that analysing and improving the current processes will identify areas which can generate greater efficiency in working methods, scheduling of patients and ultimately, improve patient satisfaction.
- that maintaining the high standard of healthcare provided to the study hospital's patient base is paramount to the success of the organisation and must not be jeopardised.

Thus, these will be brought about by process mapping to understand the current systems in the hospital. The author will then consider and apply, where appropriate, elements and concepts from some of the strategies used in manufacturing. These strategies, such as, JIT, Lean, Japanese 5S, MRP, ERP, Capacity planning and Scheduling are now being applied in the health and service industries in attempt to attain a flawless process which will improve productivity and flow, increase quality whilst reducing operational costs.

3.3 : Objectives

These following **objectives** were set to accomplish the aim:

Primary objectives –

1) *Analyse and re-engineer the process flow in the OPD* – It is necessary to first thoroughly understand the present methods and process in the OPD and then identify the problems occurring and analyse the root cause.
2) *Standardise OPD operational processes* – Once the root cause for the problems in the OPD is identified and analysed, changes in the OPD process flow will be brought about and implemented to check for the viability of the improved

process. Standardised process flow will thus be more convenient for the patients as well as the staff in all the OPD sectors.

3) *Implement the re-engineered process* – The proposed process is validated by the Operations Manager and then implemented to assess the significance of the changes brought about in the process.

Secondary objectives –

1) *To map the AS – IS process of the OPD in order to obtain knowledge on the present system* – The journey of an Outpatient is observed and noted from the time he/she enters the hospital until he/she leaves after consultation. This will aid in fully understanding the Outpatient process flow.
2) *Analyse all operational factors essential for the study* – Data attributes influencing operational factors and the process flow are selected to be studied.
3) *Prepare a checklist on the necessary resources required in each consultation room and the OPD reception* – In order to have a standardised and regularised OPD, a checklist will be prepared with all the materials and resources needed and implemented to ensure room readiness before the consultant arrives.
4) *Produce a TO-BE process map of the OPD, reflecting viable changes that can be brought about* – After identifying and analysing problems in the present process, changes in the Outpatient process flow are proposed and a TO – BE process is mapped. This is then validated by the Operation Manager and implemented to evaluate the changes.

3.4 : Significance of the Study

The significance of this Research is based on two factors –

- ***IMPORTANCE*** – Across India, the waiting period for consultation has been identified as the prime problem in the Outpatient Department of private hospitals and clinics. This results in cancellation of appointments and refunds which not only causes patient dissatisfaction towards hospital services but also

affects the hospital revenue. In the study hospital, on an average, 0.8% of the total number of appointments booked was being cancelled daily due to prolonged waiting time. This amounted to a considerable loss in revenue. Thus it is essential to understand the process flow of an outpatient in order to find the means by which waiting periods could be reduced. Also, with the increase in total number of outpatients attending the OPD, the study hospital observed a decline in the percentage of booked patients compared to a rise in the Walk-in patient's percentage. This was mainly because those patients who previously booked an appointment for consultation were unhappy with the long waiting time at the OPD which upset their schedule for the day. These patients now preferred walking in for consultation at a time of their own convenience. Thus, this reflected a great need to strengthen the Appointment system.

- ***FEASIBLITY*** – A thorough understanding of all the factors influencing waiting periods of a patient: OPD arrival time of the consultant; average time taken for consultation; number of walk-in patients and overlapping of OT and OPD timing of surgical consultants, were selected as data attributes. These were analysed to arrive at possible methods by which waiting time could be shortened. To have an efficient and effective process flow, it is necessary to understand the present system and all factors influencing it to bring about viable changes to achieve a streamlined process.

4. METHODOLOGY

This chapter begins with the introduction of the hospital where the research was conducted and explains in detail the methods, tools and various techniques used in the study. This project was very challenging and interesting, as it was a live study conducted in a 300 bed tertiary-care multispecialty hospital. The study was conducted with the aim of standardising the processes within the OPD, to expedite the flow of patients and optimise the use of time, space and other resources. Appendix A shows the Project Plan and this highlights the project milestones.

4.1 : Research Setting

The study was carried out in a 300 bed tertiary-care Multi-specialty Corporate Hospital in Bangalore for a duration of 36 weeks. The hospital is Joint Commission Internationals (JCI) accredited, which is the gold standard accreditation for Healthcare organisations around the world. It is well equipped with the state-of-the-art technology and has an excellent infrastructure with some of the best medical fraternity in the country. Established in 2006, the hospital has had continuous growth in the field of healthcare and has emerged as one of the best hospital in India. Along with Indian patients, it draws a large percentage of international patients through Medical Tourism, providing them a vast range of facilities and services with the best possible medical care and treatment.

This research was conducted in the Out Patients Department area of the hospital which includes several specialties like – Internal Medicine, General Surgery, Orthopaedics, Paediatrics, Obstetrics and Gynaecology, Neuro-medicine, Neuro-surgery, Gastroenterology, Dermatology, Endocrinology, Cardiology, Ophthalmology, ENT, Psychiatry.

4.2 : Organization Need

The hospital has faced a number of issues with its Out Patients Department (OPD) for a number of years. These include a significant increase in Did Not Attends (DNAs) whereby a patient with a scheduled appointment fails to attend and notify of non-attendance. At the same time, there has been an increase in the number of Walk-In Patients who have attended the clinic without a pre-scheduled appointment. Walk-In patients pose a number of problems for the hospital including how to actually accommodate them within the consultant's schedule. Proposed solutions have included having consultants treating only Walk-In patients, having Walk-In periods scheduled on particular days and even making all appointments Walk-In. All of these solutions have their own particular set of problems, and outcomes. One outcome already noted are reduced patient satisfaction amongst retained patients as their scheduled appointment times are not being met.

Private Indian Healthcare is expensive relative to the average Indian household income. Additionally, there is ever increasing competition as new providers emerge and existing healthcare groups merge to form stronger, larger rivals. It is therefore very important for the healthcare organisation that operates the study hospital that it maintains its position of market dominance. It recognises that this study may unearth techniques which could be utilised across all its hospitals as with the Üsou, Shetty et al 2011, study.

4.3 : Study Design

It is an observational, cross sectional study in a non-interventional control group, conducted in the OPD area of a multi-speciality hospital that functions between the hours of 0800 to 2000. Data was collected over a span of 8 hours every day for a period of 15 weeks.

The study began with mapping the AS-IS process of the OPD patient flow and collecting retrospective data from the HIS, (Hospital Information System) to fix the sample size

(which is a minimum of 30% footfall for a month, for each consultant of every speciality) and then continued as a concurrent study, wherein simultaneous observation and data collection was carried out at the OPD sector. The entry and exit time of each patient is noted using a digital watch and manually entered into an Excel sheet, following the display of the patient ID number on the screen within the OPD premises. The consultation time for each patient was then calculated from the difference between the timings and the average time taken by each consultant was derived from it. A standardise checklist was prepared to ensure that all required materials and resources are made available in each consultation room, to make their usage optimum.

The study is carried out in three phases –

Phase 1 – Included data collection

a) Retrospective data collection from the HIS to determine the sample size.
b) Concurrent data collection by observation of the required parameters within the OPD processes.

Phase 2 - Involved compilation of the data collected, calculation and data analysis to arrive at the results of the study.

Phase 3 – Was the final phase that involved, discussion of the findings of the study, making recommendations and implementing a pilot to evaluate the effectiveness of this study and its recommendations.

A fundamental layout for the Research to be conducted was planned and a strategy to proceed with the study was agreed between the industrial supervisors, the author and the thesis supervisor. This strategy is depicted in in Figure 6.

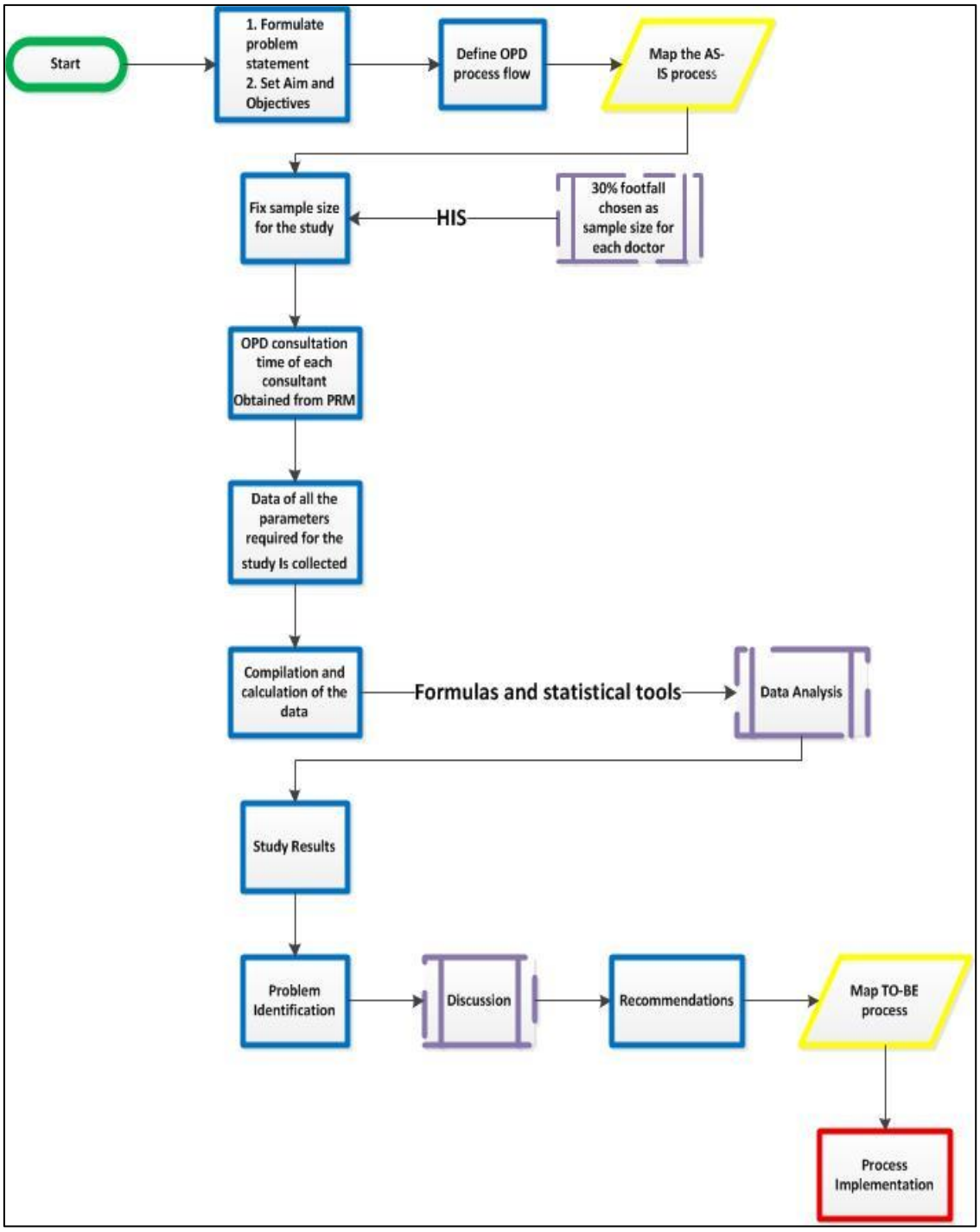


Figure 6 : Research Strategy.

This study's aim is to understand how to "Re-engineer the Outpatient Process Flow" for optimum use of available resources. It does not include the Re-engineering process itself, as the Implementation phase (indicated in the **Red Box**) was not carried out. The

project's scope includes only making the recommendations and proposing a TO-BE process (after validation).

The methodology deals mainly with three obligatory steps to conduct research; which intends to be the blueprint to change: Firstly – Process Mapping, Secondly – Sampling of the population and selecting the sample to be studied and Thirdly – Data Collection and Analysis.

4.3.1 : Process Mapping

The first important step was to conduct the AS-IS process mapping, to understand the present system and identify the problems occurring in the process which helped to decide on the data parameters required for the study. Following data collection and analysis, recommendations on practical changes that can be brought in are made in order to create a TO-BE process map.

For a complete understanding of the OPD system an in-depth knowledge of the Outpatient process flow is essential. This should include the activities occurring at each step and the waiting time and other information which can identify factors which are hindering the process flow. The complete process of an Outpatient Department is discussed in this chapter and mapped using Microsoft Visio 2010.

The study involves observing the **AS-IS Process** in the OPD area of the hospital, to identify the shortcomings and propose a TO-BE Process with an objective of constructing a more efficient process flow which would maintain the quality of care whilst meeting the expectations of the patients and thus increasing their satisfaction. The journey of an outpatient from the time of entry into the hospital till their exit is witnessed and the waiting periods at every step are identified.

4.3.1.A : AS – IS Process

Process flow of an Outpatient begins with the Registration process in the case of a new patient and from Acknowledgement of the UHID number into the system in the case of an existing patient and ends with the patient being advised, either with a prescription for medication/treatment or for laboratory/radiological investigations or with an admission request form where needed.

The various stakeholders involved in the OPD process flow are –

a. Patient
b. Registration Counter staff
c. OPD Reception staff
d. Vitals assessment Nurse
e. Consultant
f. Outpatient Billing staff
g. Sample collection staff
h. Laboratory technicians
i. Radiology Procedure staff and technicians
j. Treatment Room nurse

The series of events occurring in the Process flow of an Outpatient from the time a patient enters the hospital till he exits are as follows –

Step 1 : **Acquiring hospital UHID number**

In the case of a New patient, at the Registration counter, the registration file is completed and submitted following which the registration staff enter the details of the patient into the system and prints the UHID card.

Step 2 : **Acknowledging the patient**

In the case of a new patient, after the registration process is completed, the patient is directed to the OPD for acknowledgement of the UHID number. On the other hand, a known patient who already holds a UHID number proceeds directly

to the OPD for UHID acknowledgement. Once the patient reaches the OPD reception –

a) In case of an appointment patient, the consultation slot is already blocked when the appointment is made. Thus, on arriving at the OPD, the patient confirms his UHID number and the OPD reception staff acknowledge the patient into the system. This gets reflected on the consultant's system confirming the patient's presence in the OPD.
b) In the case of a Walk-in patient, a free slot available in the system is acknowledged with the patient UHID number and this is reflected separately as a Walk-in on the consultant's system.

Step 3 **: Billing for Consultation**

After acknowledgement, the patient is billed for consultation depending on whether it is a first visit or a follow-up. A follow up consultation within 7 days of the first consultation, with the same consultant is not billed and this is confirmed by checking the patient history in the HIS. Once the patient is billed, a printout of the bill is handed over to the patient and an ID band is placed, ideally on the patient's right wrist.

Step 4 **: Vitals Assessment**

After the billing is completed, the patient is directed to the vitals assessment area where a nurse assesses the vitals of a patient and enters the values into the prescription sheet of the consultant for whom the patient has been billed. Here, vulnerable patients and those who are at a high risk for falls are identified and labelled with an ORANGE sticker on the ID band.

Step 5 **: Displaying of patient UHID on the screen**

Following vitals assessment, the patient takes a seat in the OPD lounge and waits till the UHID number is displayed against the consultant's name on the screen mounted on the wall in the OPD waiting area. The UHID number is displayed when the doctor calls the patient for consultation.

Step 6 : **Consultation with the patient**

Once the patient UHID number is displayed, the patient enters the respective consultant's room and comes out after completing his consultation.

Step 7 **: Outcome of consultation**

This is specific to each patient –

a) Patient is prescribed medication – Patient goes to purchase medicines in the pharmacy within the hospital premises or outside.
b) Patient is advised to have an injection/treatment/minor procedure – Patient is directed to the Treatment Room where the patient takes a token and waits for their number to be called for the procedure to be done. Once the procedure is completed, the patient is then billed accordingly at the OPD reception.
c) Patient is advised Laboratory/Radiological investigations –
    i. Laboratory investigation – Patient goes to the front office for billing for the investigation and then is directed to the sample collection area where the sample is collected. The collected sample is sent to the laboratory in batches, where it is processed and the results of the tests are obtained.
    ii. Radiology investigation – Patient goes to the front office for billing for the investigation and then is directed to the Radiology Department, where the patient is called for the procedure (X-ray or Ultrasound). In case of a CT scan or MRI, a separate appointment needs to be taken.
d) Patient is advised admission – Consultant gives an admission request form to the patient which is submitted at the front office to book a room for admission and the patient is admitted.

NOTE : Refer **Appendix B** for the **AS – IS Process Map** of the OPD.

- **Idle Time (Patient waiting time) in the Process flow**

Idle time was observed in the process flow of an Out Patient where **Queuing occurs indicating waited time for patients** are –

1) At the Registration counter to obtain UHID number
2) OPD reception for acknowledgement of UHID number and billing for the consultation fee.
3) At the vitals assessment area
4) Waiting in the OPD lounge to see the consultant
5) Billing of investigations, post consultation
6) At the sample collection area, to collect sample
7) At the Radiology section, patient waits to be called in for the procedure.
8) At treatment room, till patient token number is displayed
9) At report collection desk

4.3.1.B : Validation of the AS – IS Process

A process map should be validated by the process owners to ensure it is the correct representation of the process being examined. It also ensures that process owners understand and are committed to the re-engineering process by offering them greater involvement. Due to the hierarchical nature of Indian Healthcare, individual process owners were not permitted to sign off their processes. Therefore, the AS – IS process was validated by the senior representative of the hospital, Dr. Vinit Samant (Operations Manager) on the 12th May, 2014.

4.3.1.C : Root Cause Analysis for Waiting Time in OPD

Factors identified to be **influencing the waiting time period of a patient** are (as in Figure 7.) –

A. Patient

- A Walk-in patient waits invariably for the consultation depending on the number of Appointment patients present.
- A New patient needs to complete the Registration procedure and hence has a longer process to comply with.
- An Appointment patient who arrives late, after the allotted time subsequently ends up waiting.
- A patient making payment through Debit card takes longer time to be billed than a patient paying cash.

B. Consultant

- Punctuality of the consultant. Late arrival of the doctor delays the consultation of the first appointment, subsequently postponing other appointments.
- In many cases there is an overlap of OT and OPD slot time for surgical consultants.

C. Nursing staff

- The ability of the nurse to complete vitals assessment and treatment procedures more efficiently.
- Availability of adequate number of nursing staff in relation to the number of patients needing to be assessed.

D. OPD reception staff

- Depends on their work aptitude to reduce billing errors and have minimal refunds.
- Being more vigilant about avoiding errors concerning UHID acknowledgement.

E. System

- Systems break down causing delay in the process.

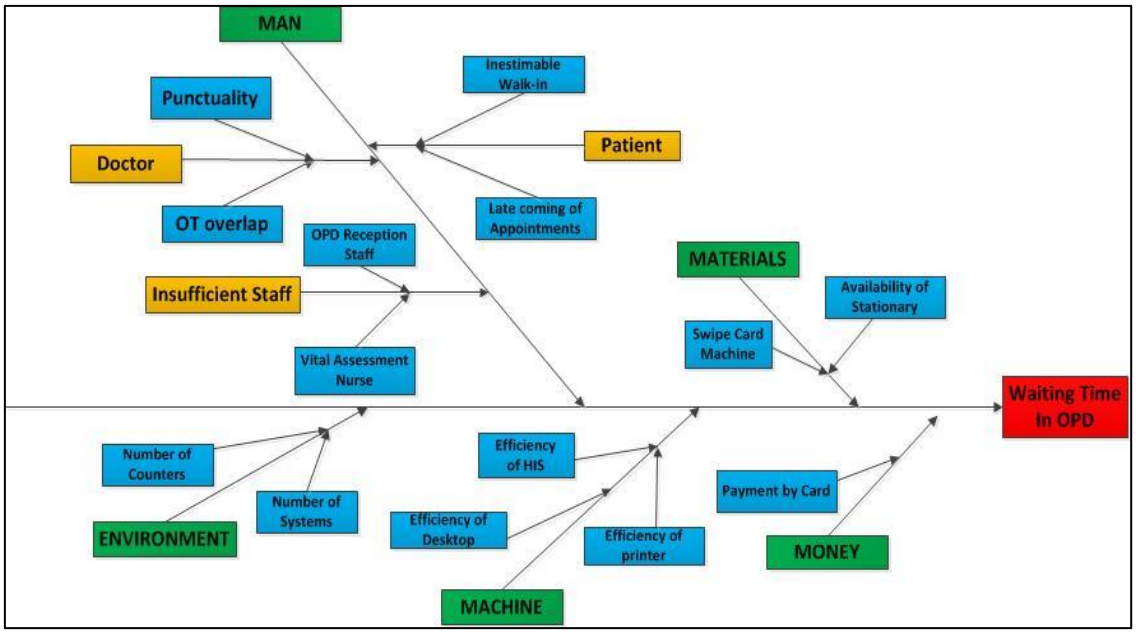


Figure 7 : Root Cause Analysis for Waiting Time in OPD.

4.3.1.D : TO – BE Process

The TO – BE process map which implements the recommendations was created after completion of data analysis and interpretation and can be viewed in the Recommendations chapter.

4.3.2 : Sampling Technique

Sampling is an integral part of the Research Methodology. It is a process used to select a segment of the population to collect the data from and extrapolate the conclusions of a study. Thus the selected sample should ideally reflect the target population.

“Sampling Theory is developed to determine mathematically the most effective way to acquire a sample that would accurately reflect the population under study” (Nalzaro, 2012). A good sample should represent the study population and be of adequate size. It should be reliable, unbiased and yield precise estimates for the whole population. Figure 8. shows the Types of Sampling Techniques.

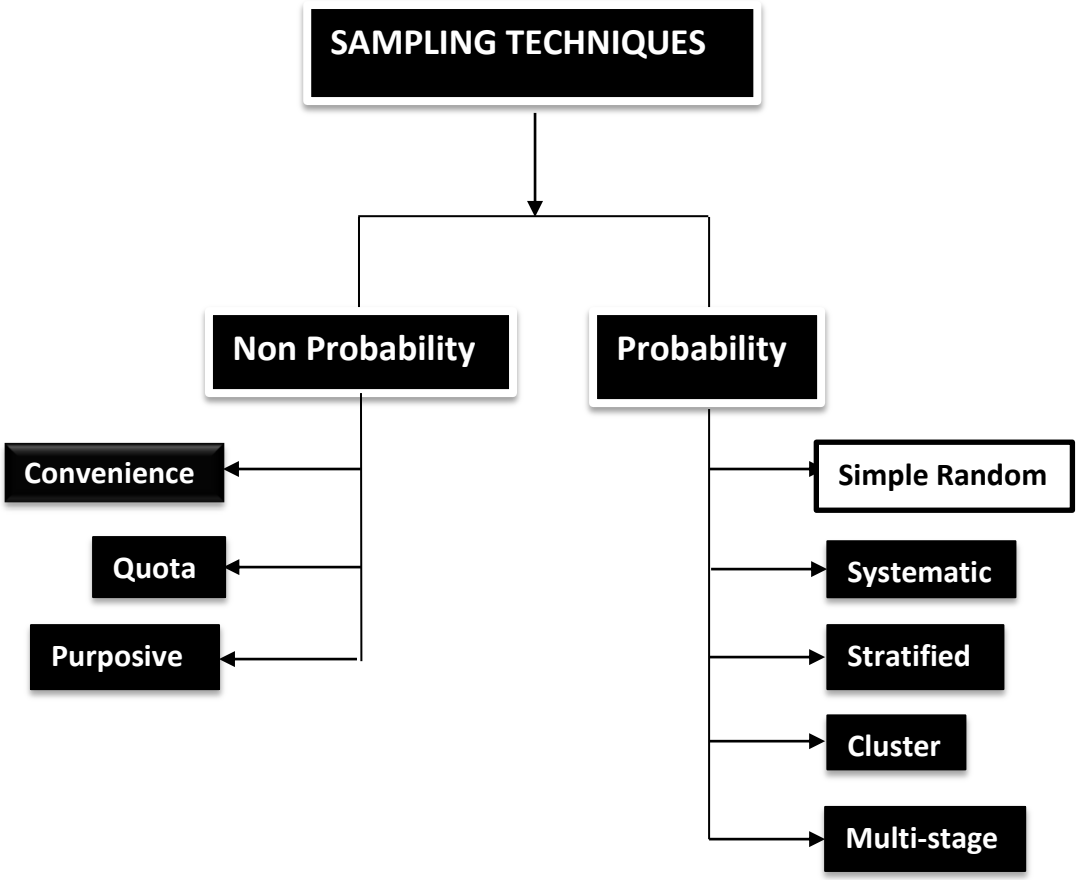


Figure 8 : Types of Sampling Techniques.

The sampling technique used in the study is ***Simple Random Sampling***.

The reasons for choosing this method are –

1) Easy, simple to understand and less time consuming.
2) Chosen sample is homogenous.
3) The findings of the sample chosen will be generalised to the entire population.
4) All the elements in the population have an equal chance of being selected.
5) Amount of sampling error associated with any sample drawn can be computed easily.
6) Does not require prior knowledge of the true composition of the population.

Limitations – Less precise than other methods.

4.3.3 : Inclusion and Exclusion Criteria

The study population includes all patients walking into the OPD for consultation; newly registered or known, including international patients, and those with appointments or attending on a walk-in basis, whether it was their first visit or follow up, post-operative follow up including the health check package customers. The patients excluded were those who came to discuss their reports. From the HIS, the total number of patients seen for a month by each consultant was retrieved and a minimum of 30% footfall for a month was calculated and selected as the sample size, since 30% is seen as statistically significant in any statistical test. The month of January 2014, is chosen to derive this sample size. A random sample from all the departments is then studied, on a two week rotational basis in each OPD and the data is compiled for analysis to arrive at the results.

The specialities included in the study are –

1. Internal Medicine
2. General Surgery
3. Obstetrics and Gynaecology
4. Orthopaedics
5. Paediatrics
6. Ophthalmology
7. ENT
8. Neuro Medicine
9. Neuro surgery
10. Rheumatology
11. Psychiatry
12. Endocrinology
13. Dermatology
14. Vascular Surgery
15. Surgical Gastroenterology
16. Geriatric Medicine
17. Pulmonology
18. Urology
19. Cardiology
20. Paediatric Orthopaedics

These specialties were selected as they were observed during the author's hospital orientation and acclimatisation period to be crowded on all days. They had fully booked appointments and an unpredictable number of Walk-in patients flooding into the OPD area. This resulted in a prolonged waiting period for patients and extended consulting hours for the doctors. Hence these specialities require assistance with

streamlining the appointment system and allotting a fixed number of Walk-in for each consultant to make better use of time, space and other resources available.

On the other hand some specialities excluded were –

1. Clinical Psychology
2. Infectious Diseases
3. Nephrology
4. Oncology
5. Paediatric Surgery
6. Paediatric Endocrinology
7. Medical Gastroenterology
8. Cardio-thoracic vascular Surgery
9. Neuro Anaesthesia
10. Dentistry
11. Hand Surgeon
12. Cosmetology
13. Liver Clinic
14. Infertility Clinic

As they were observed to be relatively free, with a majority of the patients who have appointments and only an occasional patient walking in without an appointment. Furthermore, for these specialities the consultants had their respective coordinators who dealt with allotting appointments to the patients depending on the doctor's availability to attend to his patients in the OPD.

DNA patient sample

A sample size of 200 patients was chosen to study the reason for high proportion of DNA (Did Not Attend) over a span of two months. Patients for all the consultants within those specialities chosen for the study were included. However, patients who arrived late for consultation after the scheduled time were excluded and not considered as a DNA patient.

Sample for overlapping of OT and OPD time

Simultaneously along with other data collection, for a period of four weeks, the coinciding of OT and OPD timing for surgical consultants was studied. This included all the consultants of surgical specialities that were chosen for the research.

4.3.4 : Sample Breakdown

The OPD sector of this multi-specialty hospital is divided into 8 zones – OPD 1, OPD 2, Paediatric OPD, Oncology OPD, Cardiology OPD, Dental OPD, IVF clinic, Nephrology and Gastrology OPD. Each zone has a number of specialities within it. In accordance with the inclusion and exclusion criteria, the OPD zones and the specialities in them which were selected for the research are shown in Table 3. which explains the sample breakdown for the study. A total of 58 consultants from the 21 chosen specialities were planned to be studied.

OPD 1	OPD 2	Paediatric OPD	Cardiology OPD
1. Orthopaedics 2. Internal Medicine 3. Neuro-diagnostics 4. Neuro-surgery 5. Ophthalmology 6. ENT 7. Psychiatry 8. Rheumatology 9. Urology 10. Pulmonology	1. Endocrinology 2. Dermatology 3. Gynaecology 4. General Surgery 5. Geriatric Medicine 6. Paediatric Orthopaedics 7. Surgical Gastroenterology 8. Vascular Surgery	1. Paediatric medicine 2. Neonatology	1. Cardiology

Table 3 : Sample Breakdown in the Study.

4.3.5 : Data Collection

- The entire process of an Outpatient consultation from the time of registration, in the case of a new patient or acknowledgement of the ID number into the system in the case of an existing patient, is witnessed till the patient is called for the

consultation and walks out, either with a prescription for treatment or for laboratory/radiological investigations or with an admission request form if needed.

- Retrospective data was retrieved from the HIS and 30% footfall for the month of January 2014 of individual consultants to be studied was calculated and fixed as the sample size.
- Data was primarily collected by observing the time taken for consultation by each consultant for every patient from a randomly selected sample. Entry time of the patient is noted when the patient UHID number is displayed on the screen.
- HIS provides information on the registration status of every patient and if the patient is a Walk-in or has previously taken an appointment.
- HIS also provides details on the patient history and information to know whether it's the first visit or a follow up case.
- Waiting time for every patient either with Appointment or Walk-in was tracked from the time the patient UHID number is acknowledged into the system till the patient is called in for consultation.
- Information on the OPD consultation hours of each consultant was obtained from the Patient Relations Manager (PRM) and checked if it was followed as per the allotted time.
- Each room was inspected prior to each appointment, to see if it was well equipped with all materials and resources required for that particular speciality. A checklist was prepared and implemented to cross check the rooms regularly.

Although not originally part of the methodology, two other parameters were included in data collection, as they seemed to greatly influence the OPD scheduling system.

i. *Tracking the DNA* patients gained importance, as it was noted during data collection that a prominent percentage of Appointment patients did not arrive for the consultation, denying the opportunity of booking an appointment slot for genuine patients who had to come as Walk-in patients. Tracking involved following up on DNAs where contact details were available and asking the reasons for non-attendance.

ii. *Tracking overlap of the OPD and OT timing of Surgical consultants* became necessary as on many occasions the surgeon was in the OT when an OPD appointment had been scheduled for a patient who had to invariably wait for an unspecified length of time to consult the doctor.

- To track the number of DNA patients, the total number of appointments booked per session and the number of unturned appointments for that consultant was procured.
- A telephone call was made to each of the unturned Appointment patients on the following day to know the reason for not attending their appointment.
- To tap the overlapping of OT and OPD timings for surgical consultants, firstly, the OPD timings of each consultant was noted from the PRM. Secondly, each day's OT lists scheduled, was collected from the OT executive and then the two timings were matched to check for overlapping. This was carried out for a period of four weeks which amounted to 24 days, as there were no elective surgeries scheduled on Sundays.

4.3.6 : Checklist

Initially, the hospital did not recognise the need for a checklist at the OPD even though; it was being used in the In-Patient Department. Here, the house-keeping staff used a checklist to ensure room readiness with all the resources and materials in place before being occupied by a patient. However in the OPD sector, certain materials and resources thought to be necessary were placed in the consultation room and at the reception, but were not replaced even after being emptied, until asked for. During the OPD operating hours, it was often noticed that the consultants called for the OPD house-keeping staff when certain resources were needed. These resources were unavailable or had not been replaced after being used. Occasionally the maintenance staff was requested, during consultation, to check on the electricals that had malfunctioned. On many occasions, the consultants had to walk up to the OPD reception to get extra investigation forms and other request forms. This action

invariably prolonged waiting time which caused delay in consultation. Hence, it was necessary to introduce a *Checklist* in order to have the consultation rooms ready before the consultants arrived.

In order to develop an OPD checklist, the following method was applied:

1) *Interview*: A minimum of two consultants from each speciality were interviewed. This identified the resources and equipment required in their consultation rooms. It also noted which extra materials would aid in providing a quality service to the patients.
2) *Inspection*: a thorough inspection of the OPD reception area and individual consultation rooms was performed to determine the materials/resources required for each consultation and the current level of provision of materials/resources was also noted.
3) *Design*: A checklist inclusive of all materials and resources required was then prepared based on the identified needs of the consultant. It included separating out those materials and resources which were common to all specialties and those which were unique to specialties.
4) *Implement*: Each room was set up to ensure room readiness before the arrival of each consultant.

Thus, by applying the Lean and Japanese 5S philosophies, sources of waste were eliminated and reduced. Having only the required materials and resources present, eliminated idle time spent searching for a required item amidst items which are surplus to requirement. This applies Seiton (order) and Seiri (sort) from the lean philosophy to making sure resources were available and easily selected. The Checklist also applied Shitsuke (sustain) in ensuring equipment maintenance was performed before the day's consultations. Seiketsu (standardise) was utilised by identifying specialty-specific and specialty-unique resources.

5. STATISTICAL ANALYSIS

This chapter deals with data compilation, calculation, analysis and arriving at the results of the study using the appropriate formulae and statistical packages. Data collected in Phase 1 of the study was analysed using the statistical tools included with Microsoft Excel 2010.

5.1 : Data Compilation

During Phase 1 of the study, data collected for each consultant was directly entered into Excel. On completion of data collection, the data was grouped according to speciality. The compiled data was then formulated into a table to arrive at the results.

The data points collected for the calculations were –

1) Consultant name and speciality.
2) Total number of patients (sample size) studied for a particular consultant.
3) Time taken to consult with the sample number of patients by every consultant.
4) Total number of Appointment patients in the sample of each consultant.
5) Total number of Walk-in patients in the sample of each consultant.
6) Appointment to Walk-in patient ratio.
7) Average time taken to consult an Appointment patient.
8) Average time taken to consult a Walk-in patient.
9) Number of patients in the sample who were billed.
10) Number of follow up patients in the sample who were not billed.
11) Percentage of follow-up patients for each consultant.
12) OPD consulting time allocated per week for every consultant of all specialities in minutes.
13) Total number of patients a doctor can ideally consult in a week.
14) Average number of patients, presently consulted by the doctor per week.

15) Average time (in minutes) of the allocated consultation time exceeded by the consultants.
16) Consultation slot time suggested for each consultant.
17) Number of Appointment patients that can be allocated every hour to each consultant.
18) Number of Walk-in patients that can be allowed every hour for each consultant.
19) Percentage of DNA appointments.
20) Additional number of Walk-in patients that can be allowed considering those who DNA.
21) Total number of Walk-in patients that can be allowed per OPD session to each consultant of every speciality.

5.2 : Data Calculation

A set of formulae are adopted as performance indicators to calculate and arrive at a number of parameters that will help to regularise the OPD and standardise the outpatient process flow.

A. To Fix a Consultation Slot Time

a) Time taken by each doctor to consult a patient is calculated by the difference between the entry and exit time of the patient into the consultation room. Expressed as :

$$\text{Consultation time} = \text{Exit time} - \text{Entry time}$$

b) Average consultation time is then derived by calculating the mean consultation time for the chosen sample size specific to each doctor.

$$\text{Average Consultation Time} = \frac{\text{Total Consultation Time}}{n}$$

(where, **n** = sample size for the consultant)

c) Appointment to Walk-in patient ratio (A : W) is determined from dividing the total number of appointments by total number of walk-in patients for each consultant.

$$\text{Appointment to Walk-in Ratio} = \frac{\text{Total Number of Appointments}}{\text{Total Number of Walk-ins}}$$

d) Taking to account the A : W and the average consultation time, the time that needs to be allocated for each consultation is fixed accordingly.

B. To Calculate Maximum Number of Walk-in Patients that can be Allocated to Every Doctor of each Speciality

a) For the sample size of each consultant, the Appointment patients were identified from the HIS noting down their total numbers.

b) Number of Walk-in patients seen was arrived at by calculating the difference between the total number of patients consulted and the number of appointment patients included in this number.

$$\text{Number of Walk-in Patients} = \text{Total Number of Patients Consulted} - \text{Number of Appointment Patients}$$

c) Average consultation times for Appointment patient and Walk-in patients were calculated separately by identifying individual times for each consultant.

$$\text{Average Appointment Consultation time} = \frac{\text{Total Appointment Consultation time}}{\text{Number of Appointment patients}}$$

$$\text{Average Walk-in Consultation time} = \frac{\text{Total time for Walk-in consultation}}{\text{Number of Walk-in patients}}$$

d) OPD consultation time (in hours) allocated for every consultant in a week, was noted down from the PRM Department and was converted into minutes.

e) Total number of patients that can be seen by a doctor during the time allocated in a week for that doctor was then calculated by dividing the product of sample size studied and the total time in minutes taken to consult the chosen sample by the total consultation time in minutes allocated for that consultant in a week.

$$\text{Total number of Patients that can be seen per week} = \frac{\text{Sample size} \times \text{Total consultation time taken for the sample size (in mins)}}{\text{Total Consultation time (in mins) allotted For the consultant per week}}$$

f) Standard Deviation (SD) for Appointment and Walk-in consultation time was obtained separately using the statistical tool in Microsoft Excel 2010.

g) The percentage of DNA appointments for every consultant was determined dividing the number of unattended appointment patients by the total number of appointments booked for the session and multiplying that product by 100.

$$\text{DNA\%} = \frac{\text{Number of unturned Appointments}}{\text{Total number of Appointments booked}} \times 100$$

h) Together with the DNA%, consultation slot time fixed in previous calculation and the Appointment to Walk-in patient ratio for a particular consultant, the maximum number of Walk-in patients that can be allotted to every doctor is determined.

5.3: Data Analysis

The findings of the study following data analysis in Phase 2 are discussed in this chapter.

The study was carried out in four sectors of the OPD – OPD1, OPD2, (refer to the Sample Breakdown in table no. 3 on page 78 to identify the specialities under OPD1 and OPD2), Paediatric OPD and Cardiology OPD. The **Total number of patients** studied was **5550**, from the 58 consultants that were chosen for the study.

Out of the 5550 patients, 1118 fell into the Paediatric group (below 18 years of age) of which 660 were male patients and 458 were female patients and the remaining 4432 were adult patients of which 2127 were males and 2305 were females (as shown in Table no.4 and Figure no.9). Furthermore, the adult patients studied were grouped into 6 age groups as shown in Table 5. and Figure 10.

Group	Number of Males	Number of Females
Paediatrics	660	458
Adults	2127	2305

Table 4 : Number of Male and Female patients under Paediatric and Adult group.

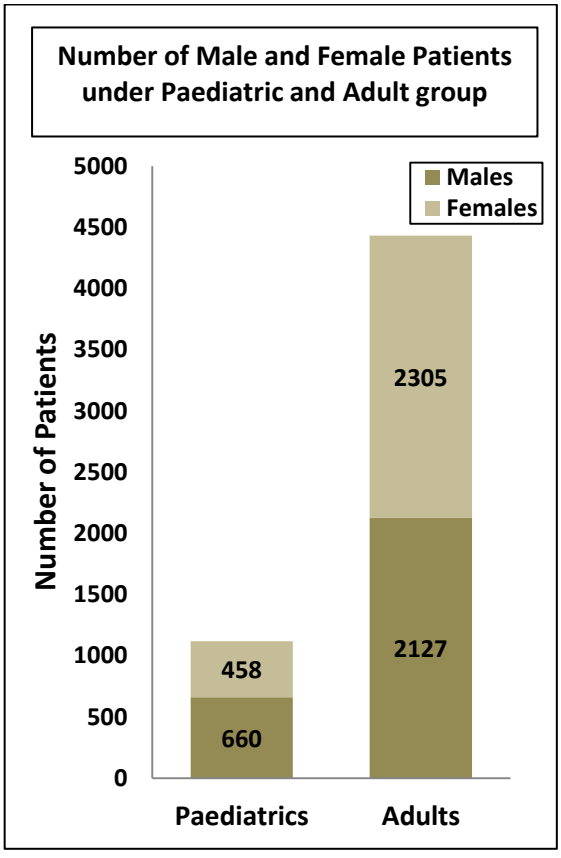


Figure 9 : Number of Male and Female Patients under Paediatric and Adult group.

Age in years	Number of patients
18-27	226
28-37	547
38-47	1828
48-57	1165
58-67	564
68-77	102

Table 5 : Adult patients grouped into Six Age Groups

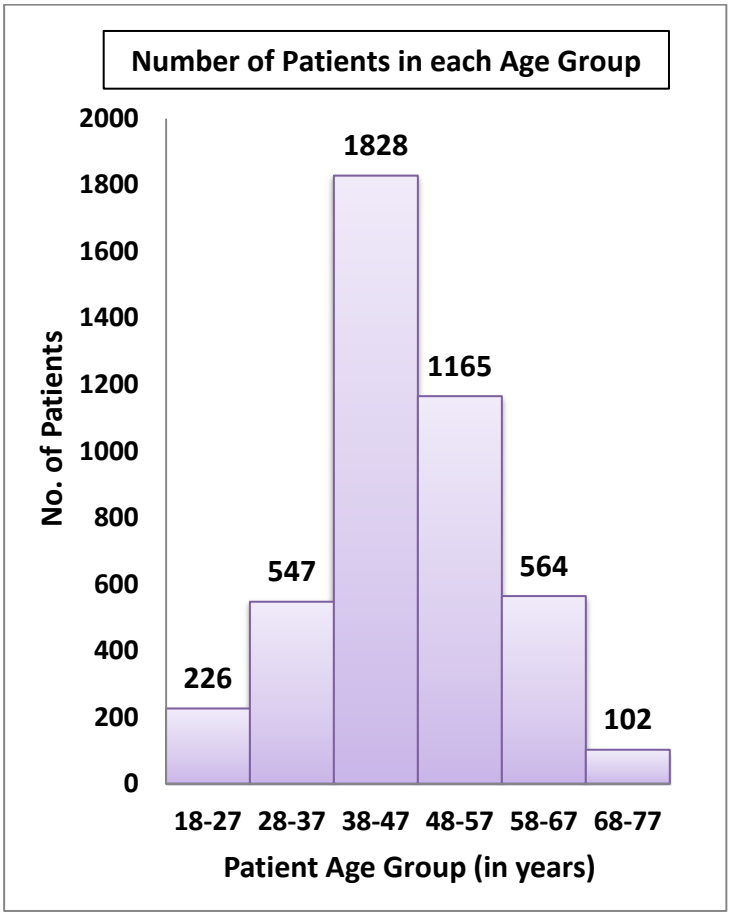


Figure 10 : Number of Patients in each Age Group

5.3.1 : Appointment and Walk-in Patient Analysis

Out of the total number of patients studied, the number of **Appointment patients was 2837** and **Walk-in patients was 2713**, indicating only a marginal difference between the hospital Appointment and Walk-in patients. However, the hospital

received a ***slightly greater number of appointment patients than walk-in*** (as in figure 11.)**.**

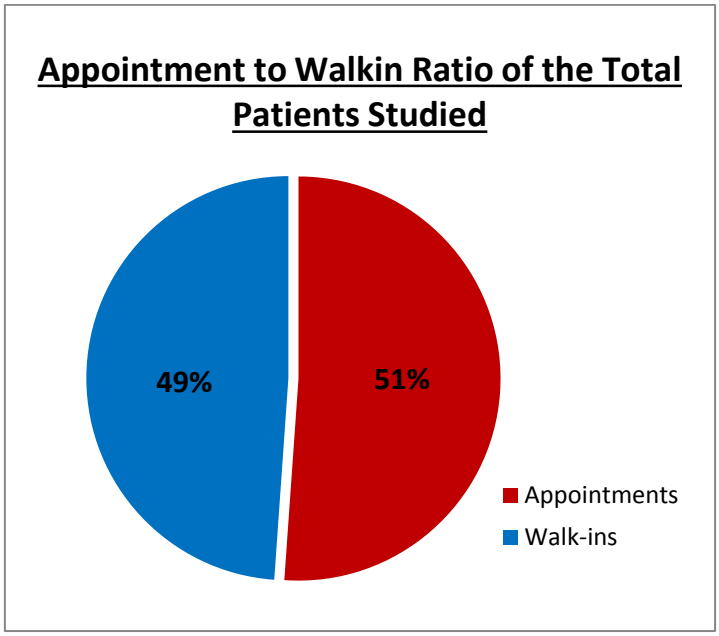


Figure 11 : **Comparison of the Total Appointments to Walk-in Patients Studied.**

Table 6. and Figure 12, 13 show detailed division of the patients based on the OPD sectors studied. It elucidates that the number of Walk-in patients were greater than the Appointment in OPD 1 and Paediatric OPD, whereas in OPD 2 and Cardiology OPD the number of Appointment patients were more than the Walk-in patients.

OPD Sectors	Appointments	Walk-in	Total Patients	Variability
OPD 1	1238	1327	2565	W > A
OPD 2	877	708	1585	A > W
Paediatric	550	600	1150	W > A
Cardiology	172	78	250	A > W

Table 6 : Division of Appointment and Walk-in Patients in the Four OPD Sectors.

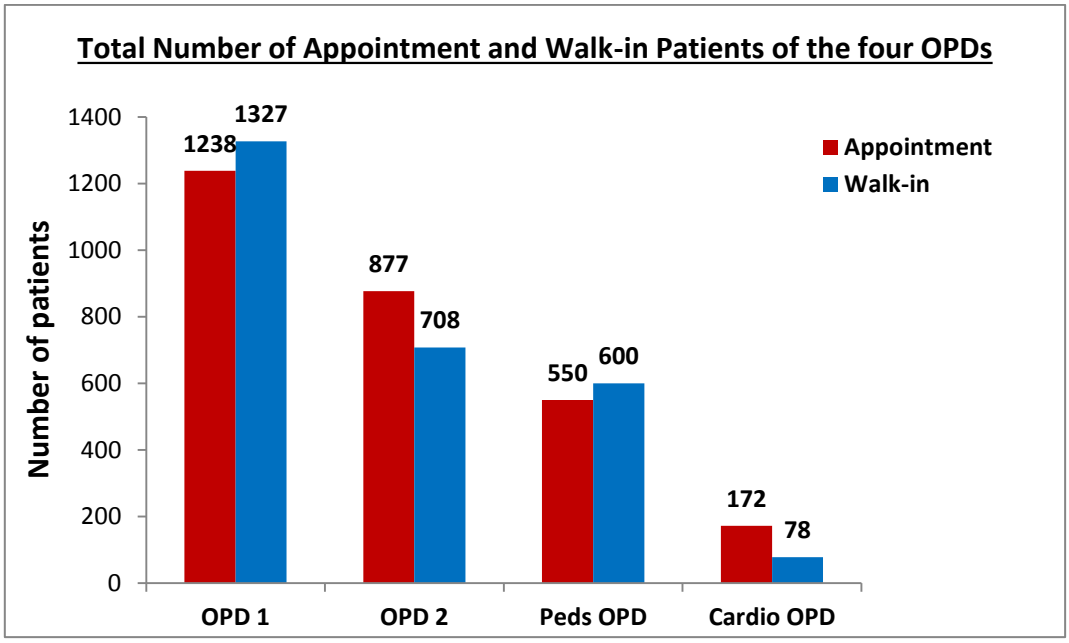


Figure 12 : Comparison of the Total Number of Appointments and Walk-in Patients of the Four OPDs.

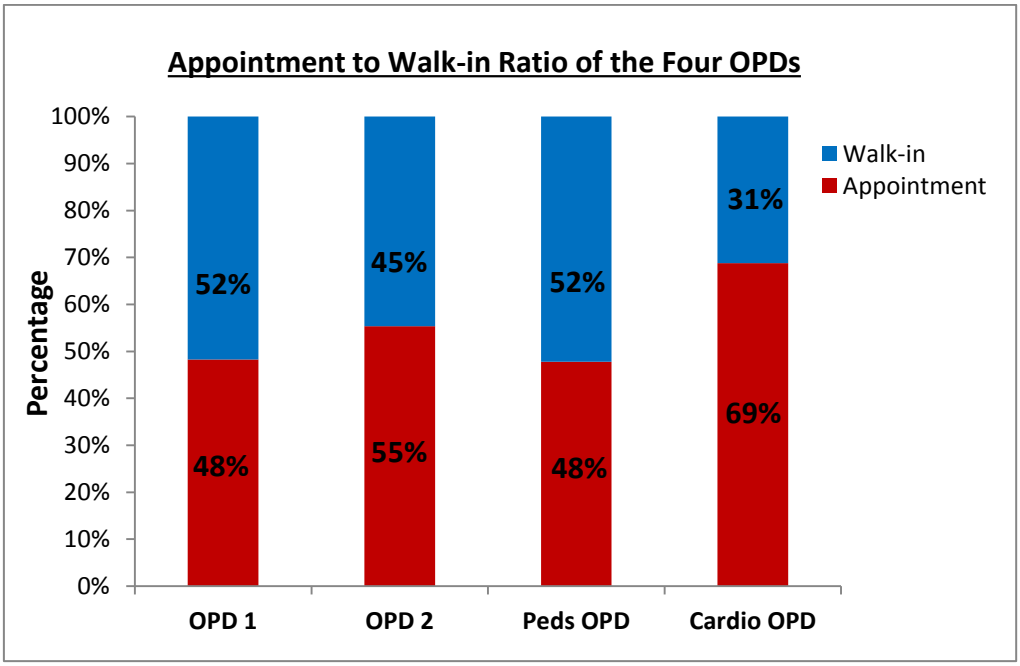


Figure 13 : Comparison of the Appointment to Walk-in Ratio of the Four OPDs.

A comparison made between the Medical and Surgical Specialities, showed that from the total number of patients studied, **3301** patients belonged **to Medical Speciality** and **2249 to Surgical Speciality** (as in Table no 7.)**.** The study further revealed that, the Walk-in numbers were greater than those of the Appointments for Medical Speciality and the Appointments were greater than Walk-in for Surgical Speciality (as in Figure 14 and Figure 15.).

Speciality	No. of Appointments	No. of Walk-in	Variability
Medical	1610	1691	W > A
Surgical	1227	1022	A > W

Table 7 : Comparison of Appointment and Walk-in Patients between the Medical and Surgical Speciality.

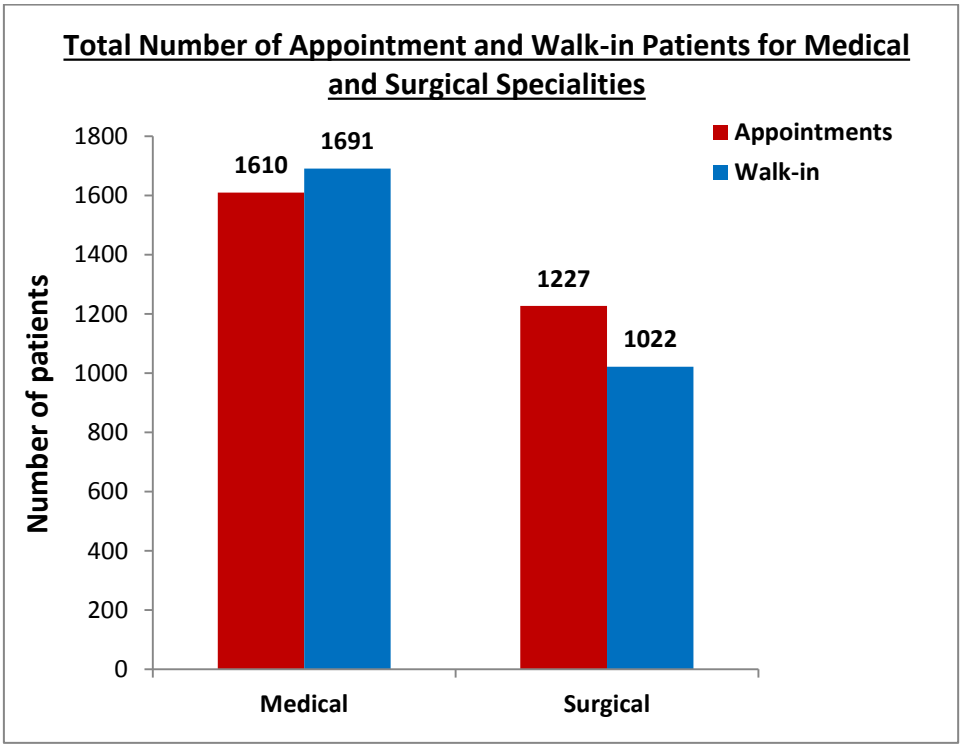


Figure 14 : Comparison of the Total Number of Appointment and Walk-in Patients for Medical and Surgical Specialities.

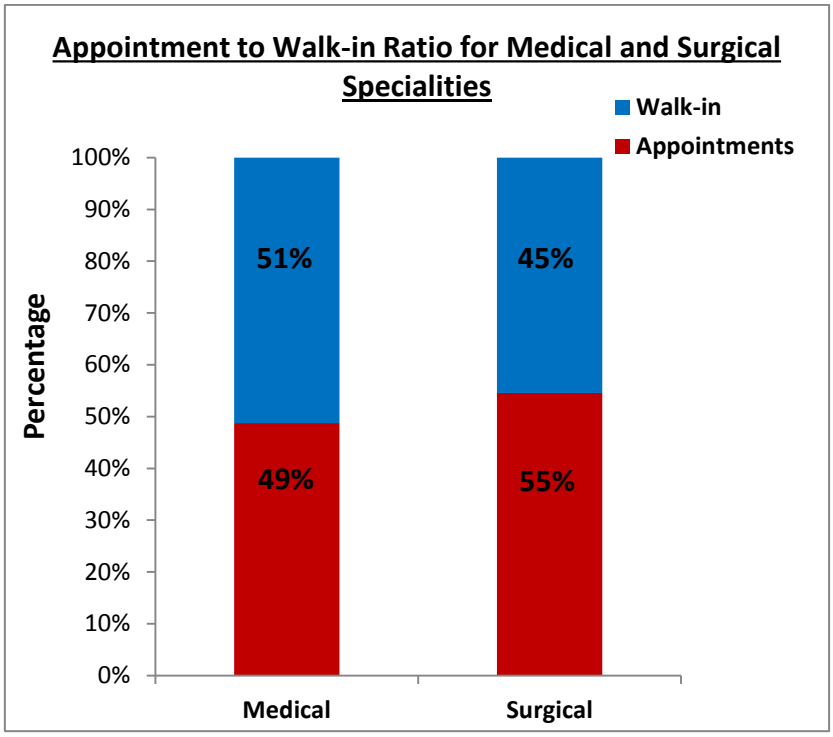


Figure 15 : Comparison of the Appointment to Walk-in Ratio for Medical and Surgical Specialities.

5.3.2 : Waiting Time Analysis

Waiting time for all the Outpatients studied was tracked from the time the patient UHID number was acknowledged into the system by the OPD reception staff to the time patient was called in for consultation.

A. **Waiting Time for Medical Specialties** (as in Table 8. and Figure 16.)

Specialties	Average Patient Waiting Time in minutes	
	Appointment	Walk-in
Internal Medicine	25	75
Neuro-diagnostics	20	35
Psychiatry	20	30
Rheumatology	25	45
Endocrinology	30	50
Dermatology	10	20

Geriatric Medicine	22	30
Paediatrics	25	80
Neonatology	20	40
Cardiology	45	70

Table 8 : Average Waiting Time Period for Appointment and Walk-in Patients of all the Medical Specialties.

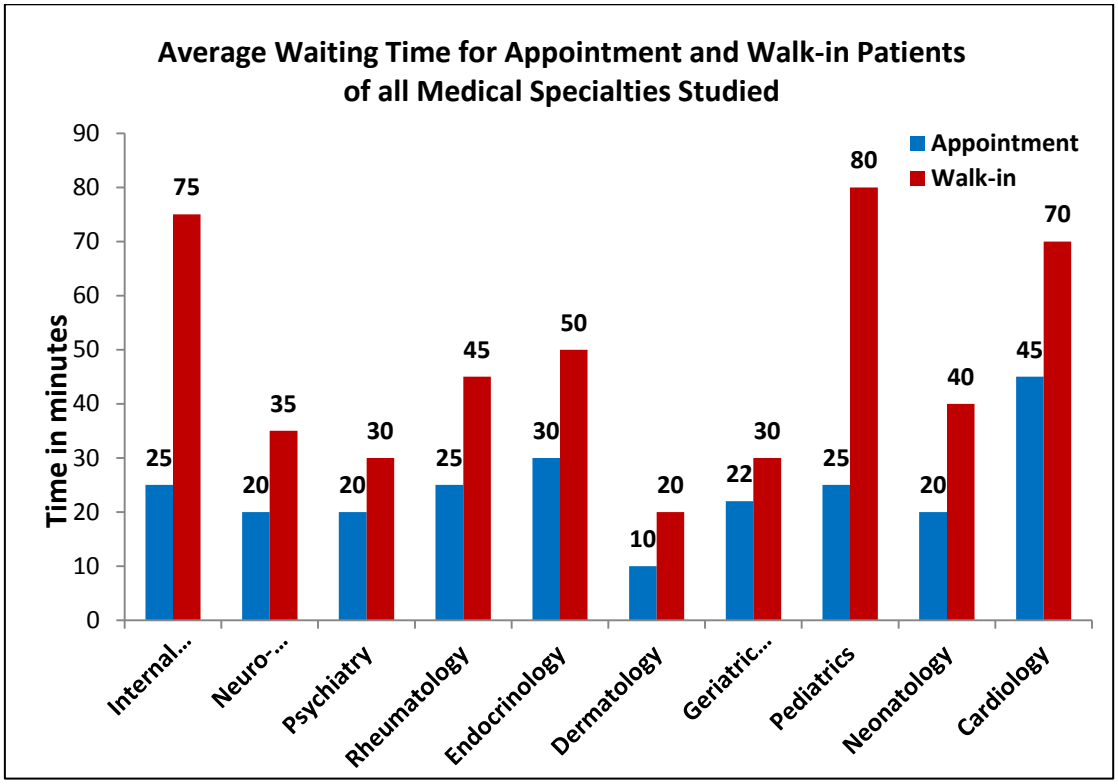


Figure 16 : Waiting Time for the Appointment and Walk-in Patients of all the Medical Specialties.

Appointment patients waited a maximum of 45 minutes for Cardiology, while Walk-in patients waited a maximum of 80 minutes and 75 minutes for Paediatric and Internal Medicine Specialty respectively. However in both patient types the least waiting time was for Dermatology, as this specialty had the fastest turn-around time (TAT) for consultation.

B. <u>Waiting Time for Surgical Specialties</u> (as in Table 9. And Figure 17.)

Specialties	**Average Patient Waiting Time in minutes**	
	Appointment	**Walk-in**
Orthopaedics	25	45
Neuro-surgery	20	40
Ophthalmology	20	35
ENT	20	30
Urology	35	52
Gynaecology	45	80
General Surgery	28	35
Paediatric Ortho	18	25
Surgical Gastroenterology	20	30
Vascular Surgery	26	35

Table 9 : Average Waiting Time Period for Appointment and Walk-in Patients of all the Surgical Specialties.

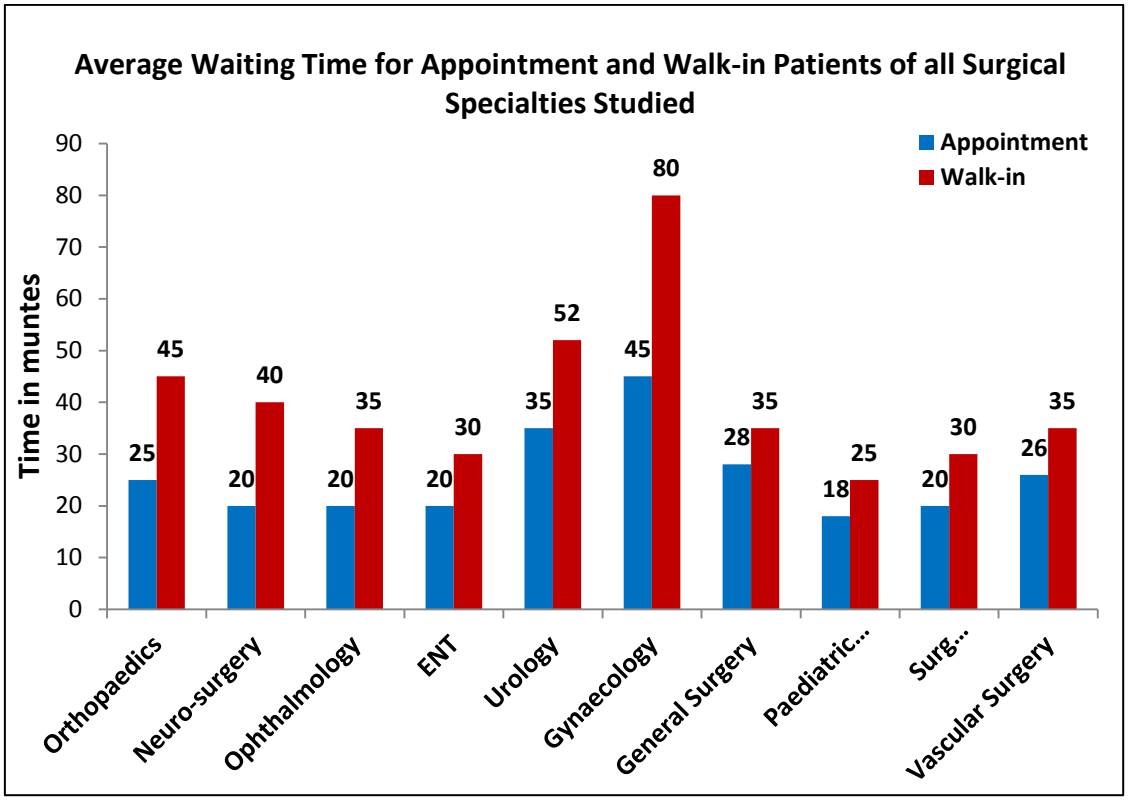


Figure 17 : **Waiting Time for the Appointment and Walk-in of all the Surgical Specialties**.

The highest waiting time for both appointment and walk-in of 45 and 80 minutes respectively was noted in Gynaecology. In contrast, Paediatric Orthopaedics had the least waiting times of 18 and 25 minutes respectively for appointment and walk-in patients.

5.3.3 : Existing versus New Registration Patients and First Visit to Follow-up Patient Analysis

In the duration of the study, the numbers for each of First Visit patients, Follow-up patients, newly registered patients and existing patients for every consultant were tracked.

Among the total patients studied, the number of **New Registration was 1186** and **Existing was 4364,** the number of **First Visit was 4587** and **Follow-up was 963**. Thus,

the hospital saw a considerable percentage of **Existing Patients** at **79%** and **Follow-up** of **17%** (as in Figure 18. and 19.).

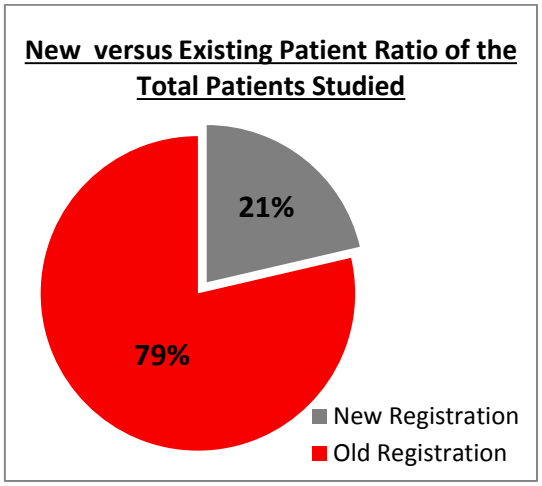


Figure 18 : Comparison between New and Exiting Patients.

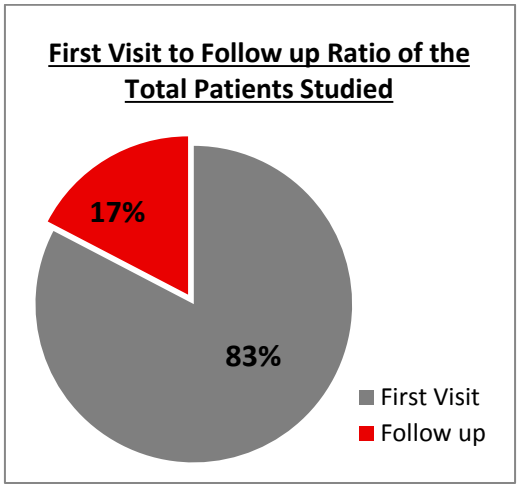


Figure 19 : Comparison between First Visit and Follow-up Ratio of the Total Patients.

Table 10. and Figure 20. show detailed division of the Follow-up percentage in the four sectors of the OPD, which reveals that the **Cardiology OPD** has the **highest** percentage of Follow-ups at **29%** and **Paediatric OPD** has the **least** with **14%** Follow-ups.

OPD	No. of First Visit	No. of Follow-ups	Follow-up %
OPD 1	2140	425	17
OPD 2	1276	309	19
Paediatric OPD	**993**	**157**	**14**
Cardiology OPD	**178**	**72**	**29**

Table 10 : Comparison of Follow up Patient Percentage between the Four OPD Sectors.

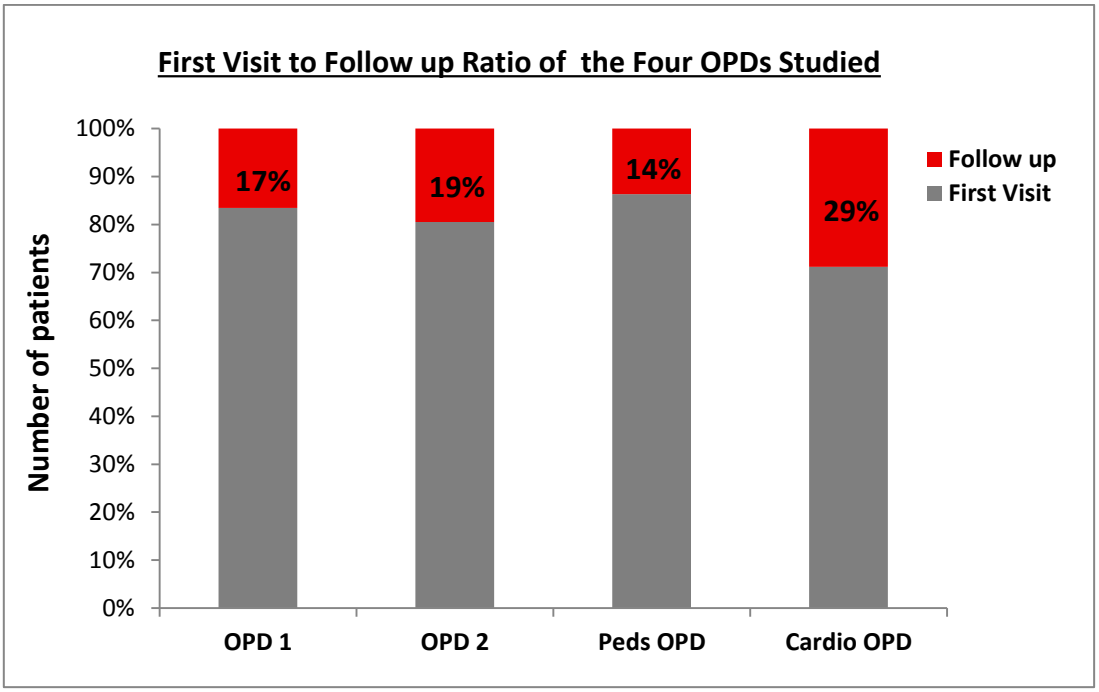


Figure 20 : Comparison of the First Visit to Follow-up Ratio of the Four OPDs.

A comparison between Medical and Surgical Speciality for the Follow-up showed **Surgical Speciality to have a greater percentage of Follow-up patients than the Medical Speciality** (as in Figure 21.).

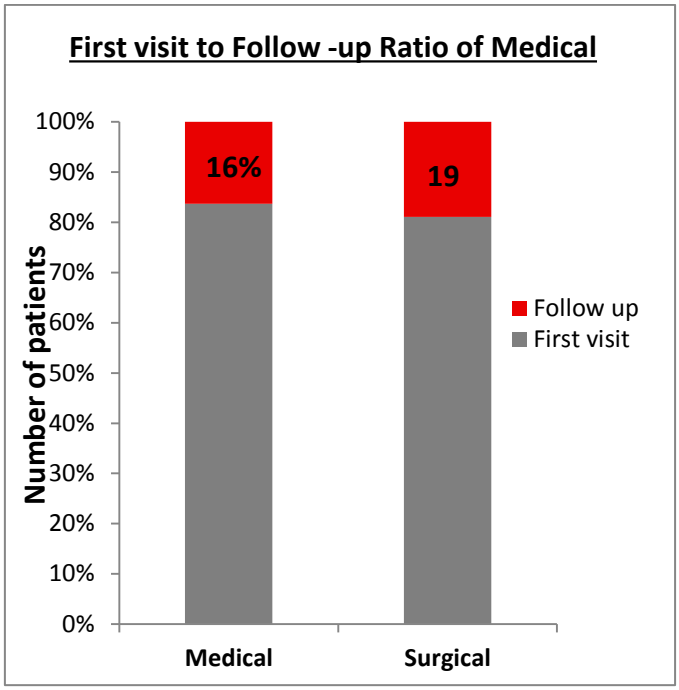


Figure 21 : Comparison between the Medical and Surgical Speciality Follow-up Percentage.

5.3.4 : DNA (Did Not Attend) Patient Analysis

Following data analysis, a prominent finding of the study was the high percentage of appointment patients who did not arrive for the consultation. It was found that the hospital had an **average DNA percentage** of **26.5%** (as in Table 11. And Figure 22.).

OPD	Average DNA%
OPD 1	**28**
OPD 2	**28**
Paediatric OPD	26
Cardiology OPD	**23**

Table 11 : Average DNA Percentage of the Four OPD Sectors.

Table 11., concludes Cardiology OPD to have the least DNA percentage of 23% and that OPD 1 and 2 have an equal DNA percentage of 28%.

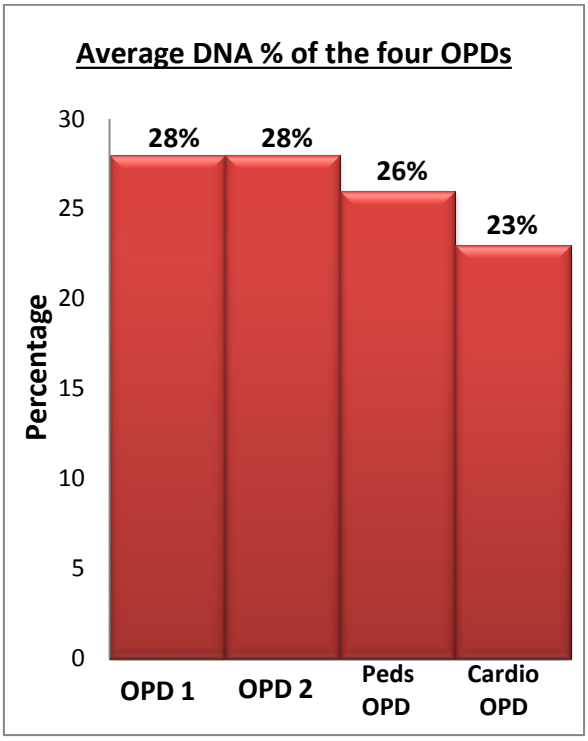


Figure 22 : Comparison of the Average DNA Percentage of the Four OPDs.

From Figure 23, it is clearly visible that **Dermatology** had the **highest DNA percentage of 43%** and **Psychiatry** the **lowest DNA percentage of 16%.**

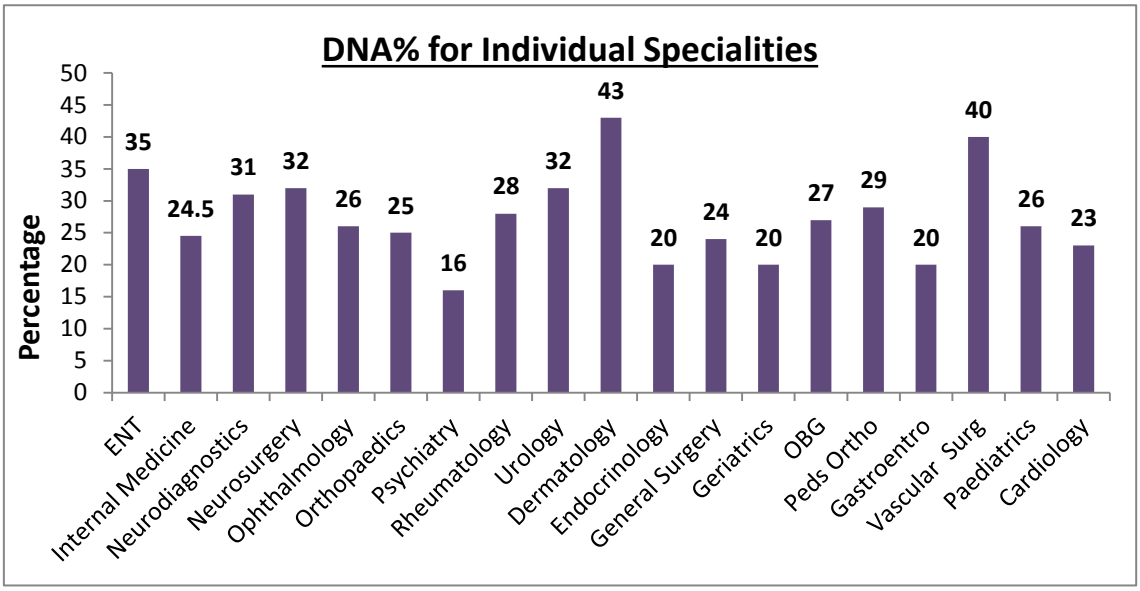


Figure 23 : Comparison of DNA Percentage for Individual Specialities.

Telephone calls made to 200 DNA patients on the subsequent day after not arriving for the consultation revealed the following reasons for not attending the appointment (as in Table 12. And Figure 24.).

Reasons for DNA	Number of Patients	Percentage
Patient was cured	**90**	**45**
Unsatisfied with hospital services	**12**	**6**
Went to a different hospital for consultation	14	7
Failed to remember about their appointment	42	21
High Cost	8	4
Others	34	17

Table 12 : Reasons for DNA Occurrence.

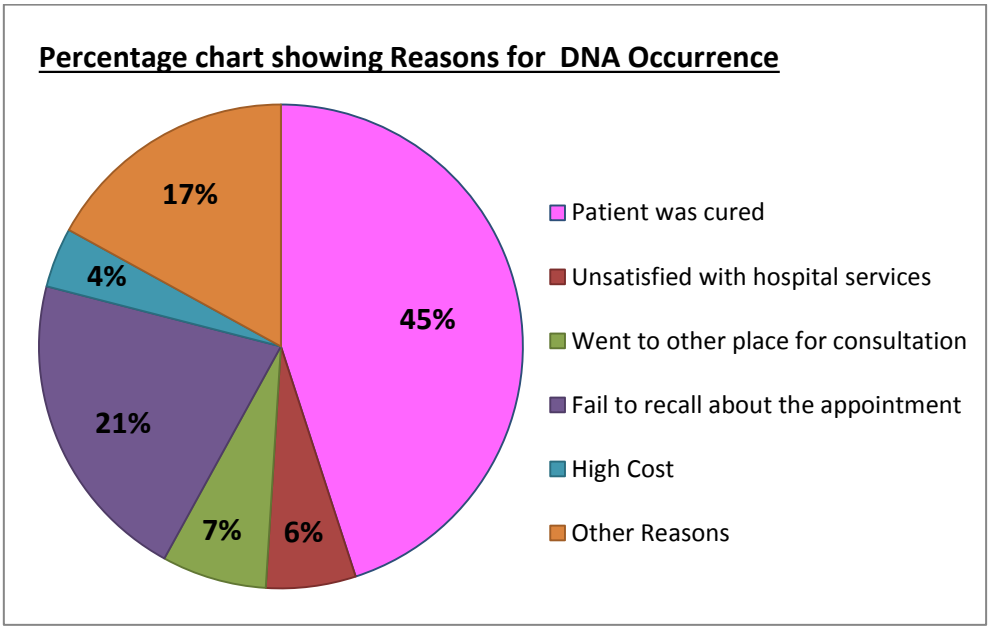


Figure 24 : Reasons for DNA Occurrence.

A high DNA percentage of 45% was a positive feedback as the disease of the patient was cured. However, a small percentage of 4% DNA was because they found the consultation fee to be very high.

5.3.5 : Analysis of OT-OPD Time Overlap

This study also looked into the number of times OT-OPD timing of surgical consultants overlapped. It was found that Urology Speciality has a maximum of 43 overlaps. In contrast ENT and General Surgery speciality had the least number of 8 overlaps over a period of 4 weeks (as in Table 13. And Figure 25.).

Specialities	No. of Overlaps
General Surgery	**8**
Orthopaedics	20
Urology	**43**
Gynaecology	35
Ophthalmology	11
ENT	**8**
Surgical Gastroenterology	9
Vascular Surgery	11
Neurosurgery	21

Table 13 : OT-OPD Time Overlaps of the Surgical Specialities.

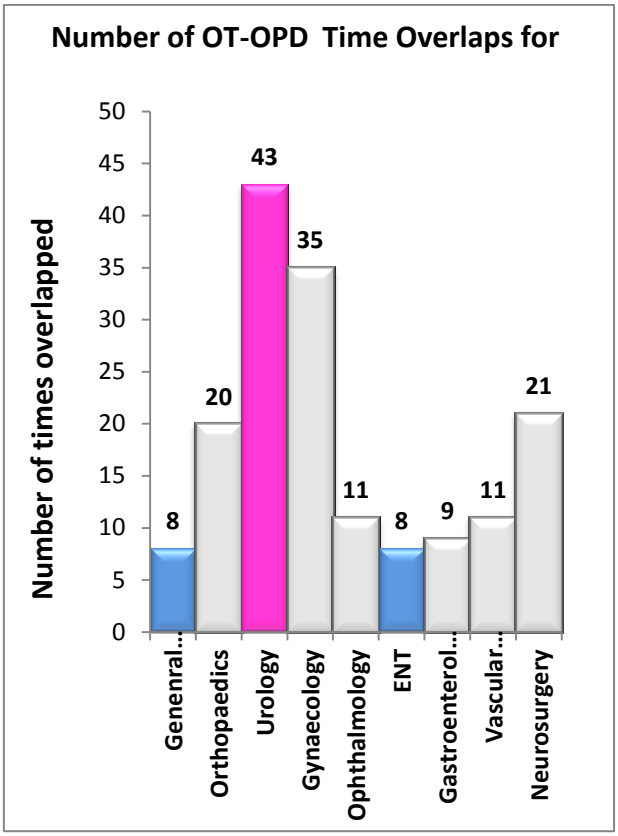


Figure 25 : OT-OPD Overlap Time of the Surgical Specialities.

6. RESULTS and DISCUSSION

The results of the study obtained in the previous chapters are further discussed here. The discussion in this chapter draw an insight into the outcome of the study makes recommendations and supports the conclusions derived.

6.A : Peak OPD Days

During the 5 months of data collection from February 2014 to June 2014, it was witnessed that the OPD had *the highest average footfall on Saturdays* and *lowest average footfall on Tuesdays*, where the average number of patients attending were *795* and *515* respectively (as in Table 14 and Figure 26.).

Days	Average Number of Patients
Monday	705
Tuesday	**515**
Wednesday	605
Thursday	625
Friday	660
Saturday	**795**

Table 14 : Average Number of Outpatients seen on a Daily Basis.

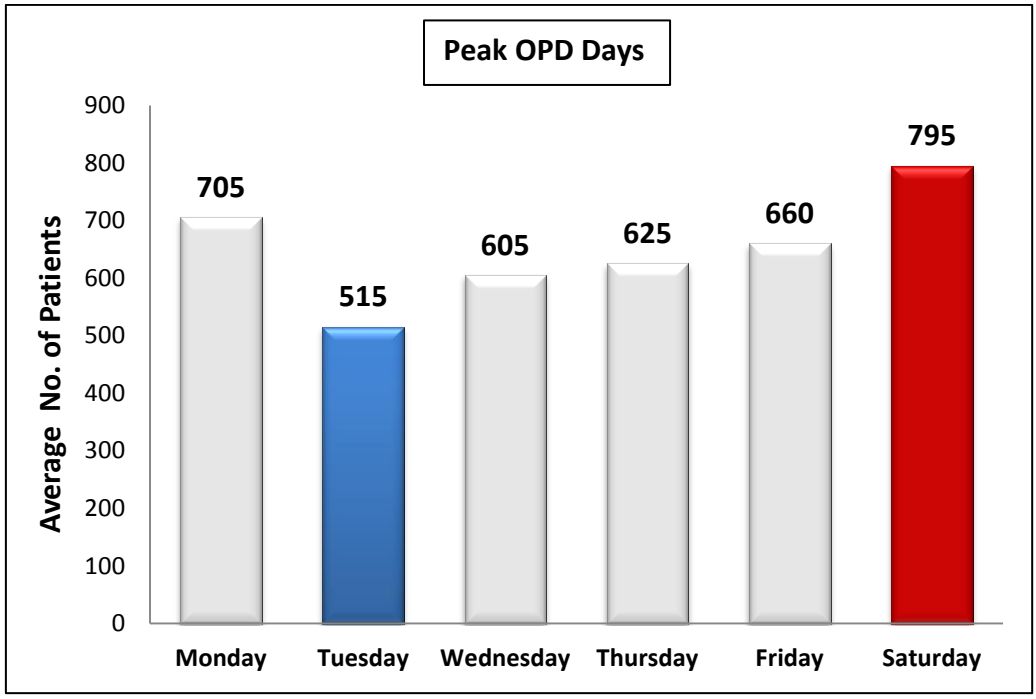


Figure 26 : Peak OPD Days

The observed high footfall on Saturdays is because people were comparatively free from their work as the software companies and schools are closed making it convenient for them to visit a doctor without applying for leave. However, one theory accounting for low footfall on Tuesday could be that Hindus do not believe in initiating anything new or bringing in any changes to their daily routine starting on a Tuesday.

6.B : Peak OPD Hours

The *peak hours* in OPD were between *10:00 AM to 1 PM* during the 8AM to 8PM stretch of the OPD time, where an average of about 389 patients were consulted over a span of 3 hours (as in Table 15. And Figure 27.). The reason for this occurrence was that, the maximum numbers of consultants were present at the OPD during this period.

Time in Hours	Av. No of Patients
0801 – 9000	15
0901 – 1000	55
1001 – 1100	125
1101 – 1200	148
1201 – 1300	116
1301 – 1400	60
1401 – 1500	90
1501 – 1600	60
1601 – 1700	45
1701 – 1800	30
1801 – 1900	22
1901 - 2000	10

Table 15 : Average Number of Outpatients seen on an Hourly Basis.

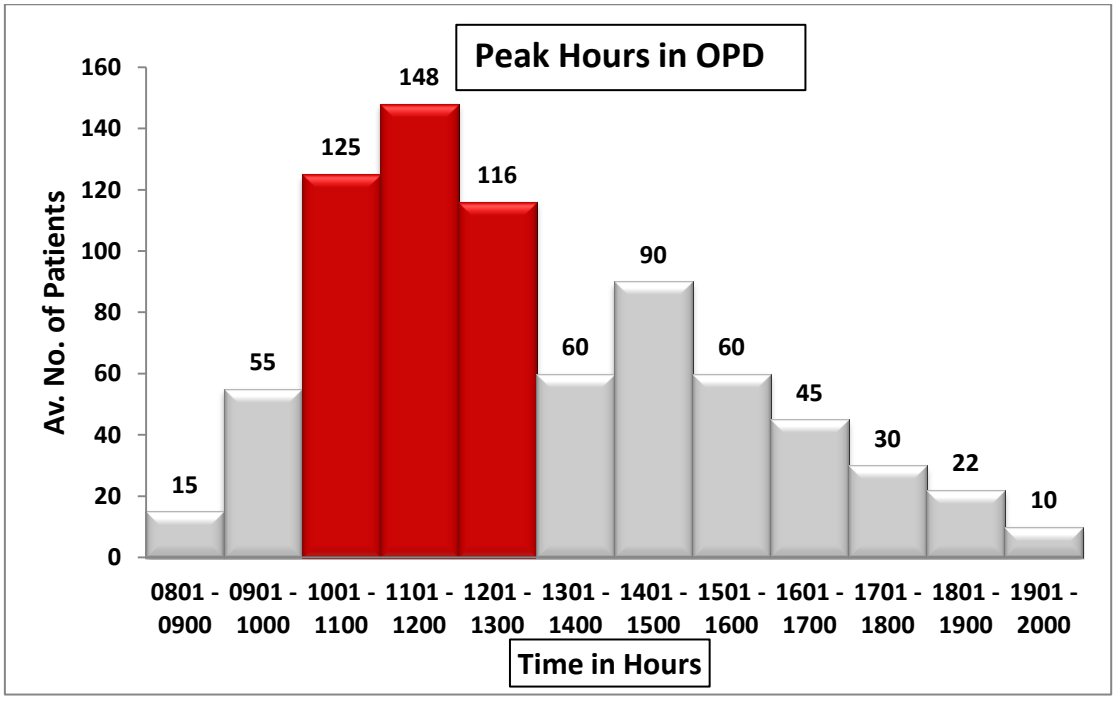


Figure 27 : Peak OPD Hours.

6.1: Appointment and Walk-in Patient Analysis

Data collected over a period of 5 months, comprised a total number of 5550 patients of which 2837 were with Appointments and 2713 attended the Walk-in clinic, indicating that the hospital received greater number of appointment patients. Although the difference is not very distinct in the study, the percentage of Appointment patients was 51% and Walk-in was 49%, making the difference statistically insignificant.

A Trend Analysis of Appointment and Walk-in patients from January 2013 to September 2014 (a span of 21 months) was done wherein total number of Outpatients, including those with Appointments and those who attended the Walk-in clinics were retrieved from the HIS. The data showed that over that period, the hospital observed a steady increase in the total number of Outpatients; however the ratio of patients with Appointments to those who attended the Walk-in clinics declined. It was noted that the number of Walk-in patient over- took the Appointments in the last three months (July 2014 – September 2014).

The graph in Figure 28 indicates the trend towards change in Appointment to Walk-in ratio from January 2013 to September 2014; clearly showing increasing number of Walk-in patients over those with appointments. A simultaneous increase in total number of outpatients is also observed reflecting the ***need for an improved Appointment System.***

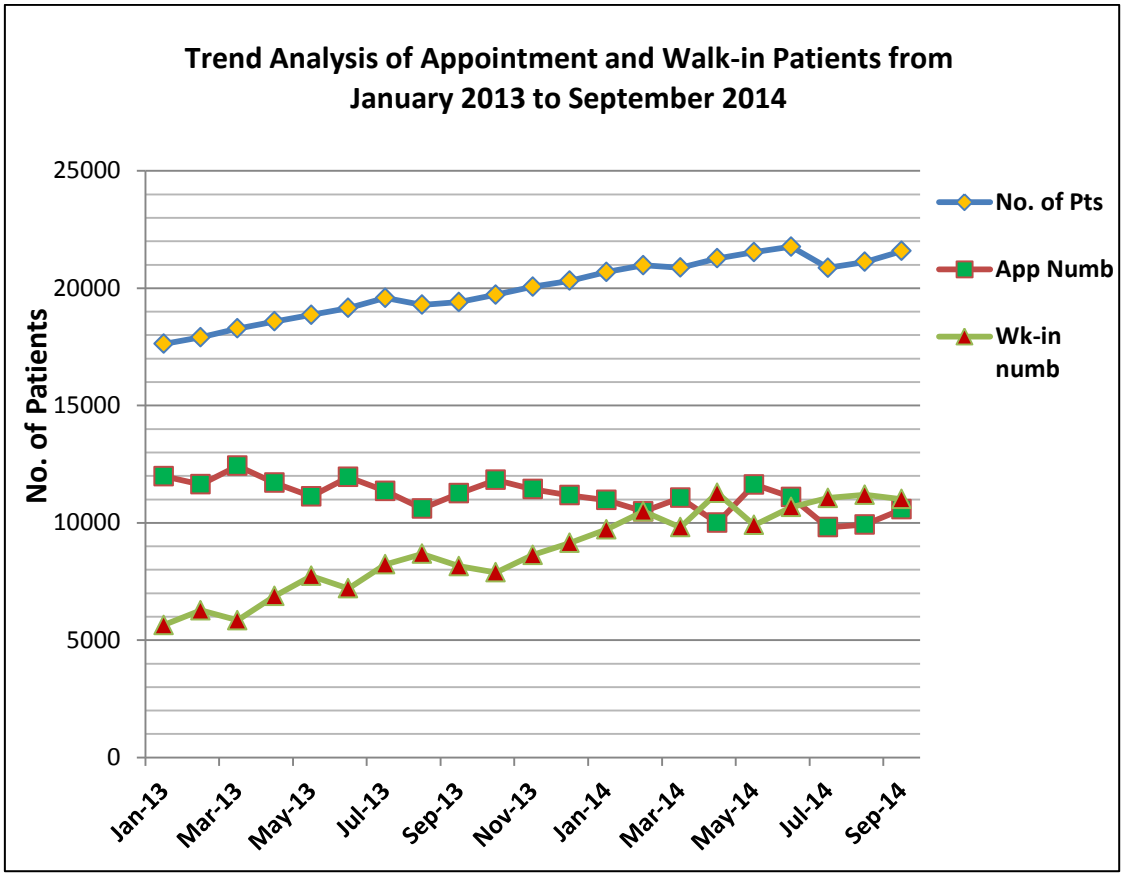


Figure 28 : Trend Analysis of Appointment and Walk-in Patients from January 2013 to September 2014.

A detailed analysis of the four OPD sectors revealed that the number of patients with appointments were greater than those who attended the Walk-in with respect to OPD2 and Cardiology OPD, confirming that these OPDs which mainly constituted the Surgical Specialities, received more patients with appointments. On the other hand, in OPD1 and Paediatric OPD the Walk-in patient numbers exceeded those with appointments, proving that the Medical Specialities received a greater number of Walk-in patients. However, Cardiology OPD had the least Walk-in percentage of 31%, as most of the patients who came here were either for cardiac procedures who preferred taking a prior appointment to schedule their procedures or were senior citizens who opted to book an appointment in order to cut down their waiting time for consultation.

A comparison between the Medical and Surgical Specialities showed that the Medical Specialities have a ratio division of 51% Walk-in and 49% Appointments and the Surgical Specialities have a ratio division of 55% Appointments and 45% Walk-in. This was mainly because with Medical Specialities, patients with minor ailments walk in for consultation without prior appointments accounting for inestimable number of Walk-in patients, whereas, in the Surgical Specialities, patients took prior appointment with surgeons to schedule elective surgery and complete preliminary investigations for fitness before surgery.

6.1.A : 80 – 20 Rule

In 1906, Vilfredo Pareto created a mathematical formula to describe the unequal distribution of wealth in Italy, observing that 20% of the people owned 80% of the wealth. In the late 1930s and 40s, the Quality Management pioneer Dr Joseph M. Juran recognised a universal principle of "vital few and trivial many" – 20 percent of something is always responsible for 80 percent of the results. He attributed the 80/20 Rule to Pareto, calling it Pareto's Principle. The 80/20 Rule states that, in anything, a few (20%) are vital and many (80%) are trivial. Thus it prompts a manager to focus on the 20% that matter.

In Pareto's case it meant 20 percent of the people owned 80 percent of the wealth. Juran's work identified 20 percent of the defects caused 80 percent of the problems. The 80/20 Rule can be applied in almost anything, from the science of management to the physical world. 20 percent of the stock takes up 80 percent of the warehouse space and that 80 percent of the stock comes from 20 percent of the suppliers. Also 80 percent of the sales come from 20 percent of the sales staff. 20 percent of the staff causes 80 percent of the problems, yet another 20 percent of the staff will provide 80 percent of your production. It works both ways.

The total number of Outpatients over a period of 3 months (1st March 2014 – 31st May 2014) was analysed specialty-wise to determine the top three demanding specialities (as in Table 16.) and the 80 – 20 Rule was applied. Thus, the top three

specialities were responsible for 80% of the problems occurring in the OPD. Hence, any changes in these specialities (vital few) for the betterment of the process would solve the problems in other specialities (trivial many).

Specialties	Total no. of Patients
Paediatrics	**9509**
Internal Medicine	**7977**
Gynaecology	**5961**
Orthopaedics	4632
ENT	3325
Urology	2429
Dermatology	2322
Neuro-diagnostics	2255
Endocrinology	2188
Cardiology	1983
Ophthalmology	1760
General Surgery	1665
Psychiatry	832
Geriatric Medicine	549
S.Gastroenterology	541
Rheumatology	492
Neuro-surgery	477
Vascular Surgery	365

Table 16 : Total Number of Outpatients seen Speciality-wise Over a Period of 3 Months (1st March 2014 – 31st May 2014).

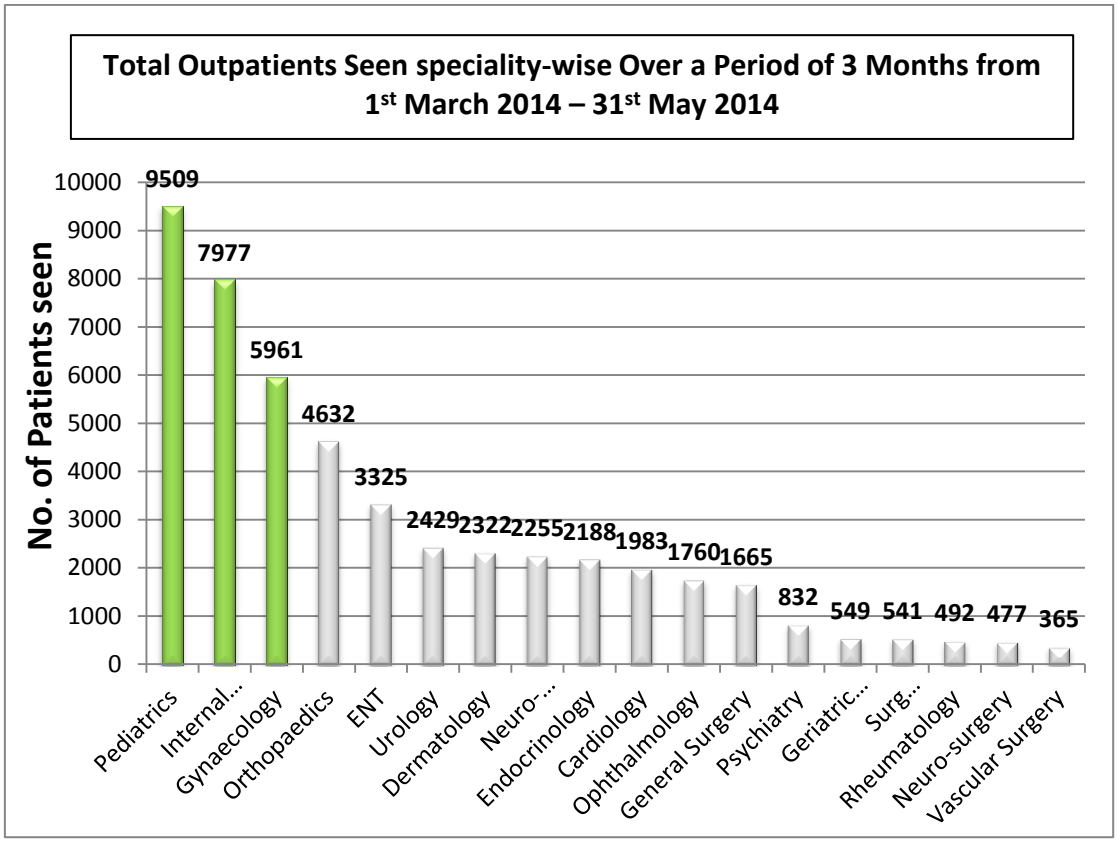


Figure 29 : Comparison of the Total Number of Outpatients Seen Speciality-wise Over a Period of 3 Months from 1st March 2014 – 31st May 2014.

Figure 29. Clearly illustrate that Paediatrics, Internal medicine and Gynaecology are the top three demanding specialities in descending order. Thus, process modification within these three specialities may resolve a majority of the OPD problems. Whilst, there are other specialities which need process modification, these 3, represent the majority of the bottlenecks due to demand for their service. Hence, the changes recommended should be first implemented in these three specialities in order to make the improvements more evident.

6.2 : Waiting Time Analysis

The most prevalent problem in the Outpatients Department was the protracted waiting time experienced by the patients. Table 7 and Table 8 on Page 92 and 93 respectively show that four specialties; Gynaecology, Paediatrics, Internal Medicine

and Cardiology had an average waiting time of more than 60 minutes for Walk-in patients and an average waiting time of more than 30 minutes for patients with appointment.

Reasons for the prolonged waiting were –

A. Medical Specialties
    a) The allotted consultation slots fell short of the time needed to elicit patient history and for examination.
    b) Inestimable number of Walk-in patients.
    c) Occasional late arrival of the Consultant to the OPD.
    d) Conducting Ward rounds during OPD hours.
B. Surgical Specialties
    a) Overlapping of OT and OPD time of the consultant.
    b) Occasionally, the consultant would be in the treatment room with post-operative follow up cases for minor dressing/procedures.

6.3 : Existing versus New Registration Patients and First Visit to Follow-up Patient Analysis

Two other important parameters; Patient's Registration status and the consultation Visit Number of the patient were tracked during the study. This reflected, patient satisfaction in terms of resources and services provided, effectiveness of the treatment prescribed which would impact on the reputation of the consultants as well as the hospital in general.

From the total number of patients studied, the number who were Newly Registration were 1186, existing patients were 4364, number of First Visit were 4587 and the number of consultant requested Follow-up were 963. It was observed that the hospital had a high percentage of 79% existing patients and a considerable rate of 17% Follow-ups. This potentially indicates that the patients were content

and relied on the hospital services to a great extent and returned to the hospital to seek treatment, thus demonstrating their loyalty.

Furthermore, a comparison between the four OPD sectors showed, Cardiology OPD to have the highest percentage of Follow-ups which was 29% and Paediatric OPD with the least at 14%. The high Follow-up rate for Cardiology was because all patients who underwent Angioplasty, Coronary Artery Bypass Grafting, Cardiac catheterisation and other cardiac procedures were advised to have a minimum of three follow-up visits as part of their procedure package and were hence not billed for those follow-up visits. A comparison between Medical and Surgical specialities showed 19% follow-up for Surgical against 16% for Medical speciality. This was mainly because the post-operative patients returned for suture removal and surgical wound dressing.

6.4 : DNA (Did Not Attend) Patient Analysis

A very significant finding of the study was the high percentage of patients with appointments who 'did not attend' (DNA). These booked appointments made consultation slots unavailable for genuine patients who had to come as a Walk-in. Following data analysis, it was found that the hospital had a high average DNA percentage of 26.5%. Considering the four OPD sectors individually, Cardiology presented with the least DNA percentage of 23%, whereas, OPD1 and OPD2 had an equal DNA percentage of 28%. Further, on analysing individual specialities, Dermatology showed highest DNA rate of 43% contrary to Psychiatry with the least DNA rate of 16%.

The following reasons were given by patients who did not attend their appointments and were contacted by telephone:

1. Patient was cured (45%)
2. Unsatisfied with hospital services (6%)

3. Went to a different hospital for consultation (7%)
4. Fail to remember the appointment (21%)
5. High cost (4%)
6. Others (17%)

While a majority, constituting about 45% of DNA was because the patient had been cured and did not require any further consultation indicated a positive feedback, a small 4% of them complained that the fee charged by the hospital was very high. During the study of the DNA sample, it was found that out of the 200 patient's interviewed on telephone, 96% of them were existing patients who had previously attended the hospital. The remaining 4% were all new patients who withdrew mainly because of the high consultation fee opting for a different hospital.

Thus, this topic needs a further explorative study to find out the means by which the percentage of DNA for individual consultants can be reduced in order to bring down the average DNA percentage of the hospital to below 15%.

6.5: Analysis of OT-OPD Time Overlap

The lack of communication between the surgeons who schedule the surgeries and the PRM/OPD reception staff blocking consultation slots for appointments for patients, often led to the overlapping of the OT and OPD timing of the surgical speciality consultants. This inevitably prolonged the waiting time for an Outpatient causing confusion, especially annoying the patients who had made appointments and became discontented.

A study into the OT-OPD overlap, conducted for a period of 24 days indicated that, the Urology specialty had the maximum of 43 overlaps, whereas the ENT and General Surgery specialties both had the least of 8 overlaps. This is mainly because, all Urology consultants are allotted a longer duration of fixed OPD hours on all days (except Sunday), which makes planning of surgeries on any of the days intercept with the OPD hours at some point. On the other hand, each consultant of ENT and

General Surgery speciality are not scheduled for OPD consultation on all days of the week thus, enabling the surgeons to plan surgeries on their non-OPD days, to avoid overlapping with their OPD hours.

7. OBSERVATIONS and RECOMMENDATIONS

This chapter consists of discussions about the problems encountered in the Out Patient Department, instigating constraints in the process flow. Recommendations are made for some changes that could ease patient flow making it more convenient for the patients and augmenting their satisfaction.

A. At the Registration Desk

Starting from the time the Registration file is taken to fill in details, till the UHID card is printed, the average time to register a patient varies from 3-5 minutes.

Problems

1. Long queue at the registration desk during peak hours is a usual occurrence due to one operating system (desktop) and a single staff member handling the counter.
2. At times, a few patients have difficulty in filling the registration form and complying with the Registration process.
3. System failure within; either the computer or the UHID card printer.

Recommendations

- Introduce a second system (desktop) to work on and have adequate staff at peak hours, to quickly disperse the large numbers of patients and avoid long queue at the counter.
- Have dedicated personnel on floor for patients who need assistance in filling the form, or have difficulty in communicating due to variance in the language spoken and for guidance in directing to respective departments. These personnel can be floor navigators, easing the process flow for those patients who have difficulty in complying with the outpatient process.

- Introduce online registration forms for new patients so that they can fill the form and bring it along to cut down on their waiting time for registration. This on other hand will avoid long queues at the registration desk.
- Introduce iPads/Tablets with staff who can walk amongst the queues and register patients while they wait, quickly dispersing the crowd.

B. At Front Office

Inpatient Admission, Investigation Billing and Laboratory Report Collection are completed in the Front Office.

- The Inpatient admission process, from the time the admission request form is submitted and the details are fed into the system, till a room is blocked, the process takes about 5-7 minutes on an average for each patient, provided the requested category of the room is available at that time.
- Investigations are billed by entering the UHID number of a patient and selecting the respective investigations to be billed. This on an average takes 3-5 minutes for each patient, varying according to the number of investigations that need to be billed.
- When a patient comes to collect the laboratory reports, the UHID number is entered into the system and the patient's reports are printed and handed over. This takes about 1-3 minutes on an average for each patient.

Problems

Limiting the investigation billing and laboratory report collection to the front office, results in amassing of people.

Recommendations

- Have well trained staff to enable decentralised billing for investigations at respective OPDs on days of lower footfall; this will diffuse the crowd at the

front office and reduce unnecessary movement of the patient making it more convenient.

- Laboratory investigation report printouts should be made obtainable at respective OPDs as well, to further reduce patient movement.
- In the long term, digital copies of all investigations, histories and diagnoses should be the aim of the hospital.

C. At the OPD Reception

The average time taken to enter the UHID of a patient into the system, bill the consultation and tie the ID band on the patient is around 2-4 minutes.

Problems

1. Lengthy queue for UHID number acknowledgement and billing the consultation due to under-usage of the available systems and inadequate amount of staff resulting in large numbers of people waiting during peak hours.
2. Long waiting time is experienced by patients at the Walk-in and at times even by those with appointments especially with Medical specialities, as the slots presently allocated in the system are not specific to the speciality and consultants, thus the consultation time exceeds the time set aside for it.
3. Extension of the doctor's OPD consultation hours due to continuous unpredicted Walk-in patients.
4. Intermittently, situation arises when the consultant calls a Walk-in instead of a patient with an appointment even though the latter has arrived on time, making the patient wait beyond the allotted time, thereby leading to patient annoyance.
5. A few consultants arrive late to the hospital setting back the first appointment consultation time, thereby further delaying the subsequent consultations.
6. A considerable number of Did Not Attend (DNA) customers result in wasted slots as the appointments are not cancelled with prior intimation, thus making slots unavailable for genuine patients who come as walk-ins.

7. Overlapping of OT and OPD timing of surgical speciality consultants.
8. Doctors often complain about consultation room cleanliness and readiness.
9. During peak hours, a single nurse assessing the vitals of each patient is unable to examine each patient thoroughly. Many times, this results in the patients being called in for consultation before their vitals are checked.
10. Errors made by the OPD reception staff -
    a) Third consultation within 7 days of first consultation is occasionally mistaken as a follow up visit and not billed.
    b) Frequent refunds are made because of wrong UHID number acknowledgement and billing.
    c) At times, acknowledging (entering) the patient UHID number into the system is missed in-spite of billing the consultation, unnecessarily prolonging the waiting time with delayed consultation.
11. Wrong booking of – appointment time/ missed blocking appointment slot by the PRM (Patient Relations Department) when patient calls to book an appointment.
12. Non-availability of certain speciality consultants during hospital OPD time span.
13. System failure: it could be the computer, the printer, card swipe machine or the UHID display screen in the waiting area. The IT department usually takes about 15-20 minutes to attend to the problem.

Recommendations

- Redeploy OPD reception staff when OPD gets busy, to address the increasing number of patients and avoid large queues of patients.
- Fix consultation slot time specific to each consultant for every speciality, in accordance with the average consultation time for a booked appointment, thereby reducing the waiting time for patients.
- Have a fixed number of Walk-ins that can be allocated per consultant for each speciality to avoid inestimable Walk-in patients. This allows the doctor to finish his consultations within his OPD hours and the room will be ready to be

occupied by the next consultant. For this purpose, have well trained, efficient staff to answer telephone calls regarding appointments and consultation. Thus, Walk-in patients beyond the allocated number for a particular consultant would be offered appointments on other days.

- Reschedule each doctor's consultation hours based on their OPD arrival time and the average number of patients consulted by them per session.
- Have a fixed schedule allocation by which the patients with appointments and Walk-in patients are called for consultation. This means that the Walk-in can be informed of an approximate waiting time period (arbitrarily 2 patients with appointments followed by one Walk-in patient for those consultants who have greater numbers of patients with appointments).
- For fully booked appointment specialities, assign Walk-in days for each consultant for every specialty so that Walk-in patients can be seen on first come first serve basis without disturbing the appointment schedule.
- To avoid overlapping of OT and OPD timing, have fixed OT and OPD days for every consultant to completely avoid overlapping or develop an efficient HIS program that does not allow a surgeon to book an OT case during his consultation hours.
- When OPD is busy, have two nurses to assess patient's vitals to ensure all patients have a thorough vital check before being called for consultation.
- Recognise the reason for occurrence of DNA and follow up those patients to reduce the overall DNA percentage to below 15%.
- Have well trained, competent staff at the OPD desk and the PRM Department to minimize errors and work towards achieving zero error.
- Optimise OPD time and space utilisation in a way such that, there is one consultant from each speciality available in the OPD throughout the OPD timings of the hospital.
- In case of system failure (usually the printer or the UHID display screen), have a member of IT staff to attend and fix it as soon as possible or have back-up systems ready to replace it immediately, if repair will be delayed. This obviously

has to be balanced with cost and at what point during the working day the failure occurs. If it happens towards the end of the working day, it may be prudent to fix it during the out of work maintenance hours, depending on the likely impact to OPD operations.

- Every department must organise a bi-monthly meeting with their respective departmental staff, to discuss the problems confronted on the floors and how best to resolve them.
- Implement OPD reception and consultation room checklist to make sure all necessary resources are available at all times and check to ensure cleanliness and readiness of the consultation rooms before the arrival of the doctor.

The OPD checklists recommended are as follows –

7.1 : OPD Reception checklist

This checklist is introduced in the OPD reception area which is situated in the OPD waiting lounge. All the Outpatients are seated here while waiting for their consultation turn. The checklist will help in providing more organised and satisfactory services to the patients.

1. Reception desk a) Cleaned b) Telephone working c) All systems checked and functional d) Functional printers with sheets e) Visiting cards of the consultants f) Feedback forms g) Card swipe machine h) Tissue paper	
2. Clean seating arrangement for patients	
3. Good Lighting	

4. Fan/Air conditioner working	
5. Fire extinguisher and sensors	
6. Doctor availability display board working	
7. Drinking water with disposable glasses	
8. Brochure stand filled	
9. Newspaper (English and local language)	
10. Magazine (News, Business, Health)	
11. Television working	
12. Name card of all doctors at doors of respective rooms placed	
13. Clean and empty dustbin	
14. Stationary a) Plain sheets and extra pens b) Prescription, admission, consent forms c) Radiological investigation forms d) Patient history file e) Stapler with pins f) Consultant letter heads g) Envelopes h) Hospital seal i) Punching machine	
15. Sockets and plug-in points tested	
16. Floors and washroom to be clean and dry	

Table 16 : OPD Reception Checklist.

7.2 : OPD Consultation Room Checklist

This checklist is introduced in the consultation rooms to meet the needs of the patient as well as the consultant and ensures room readiness before the consultant arrives.

1. Good Lighting	
2. Fan/Air-conditioner working	
3. Table and chair cleaned	
4. 3 Chairs (doctor, patient, attender)	
5. Pen and Writing pad	
6. Telephone functioning	
7. System checked and functional	
8. Examination couch cleaned	
9. Curtains cleaned	
10. Bedspread and pillow cover clean	
11. Examination Light working	
12. Calendar	
13. Sealed water bottle and disposable glasses	
14. Clean Apron	
15. Stethoscope, BP apparatus and torch	
16. Clean Dustbin for proper segregated waste disposal	
17. Prescription forms, Admission forms and surgery forms	
18. Letter heads of the consultant	
19. X-ray and other investigation forms	
20. X-ray view box working	
21. Sterile Gloves and face mask	
22. Height tape attached	
23. Weighing machine functional	

24. Clean wash basin and mirror checked	
25. Soap/Liquid soap and sanitizer	
26. Clean Towel and tissue roll	
27. Clock working	
28. Kidney tray, cotton, gauze and bandage	
29. Bin to dispose sharps	
30. Punching machine and stapler with pins	
31. Stool to step onto the bed	
32. Plugs and sockets tested	

Table 17 : OPD Consultation Room Checklist.

7.3 : Additional Resources Needed in Ophthalmology Consultation Room

This checklist is introduced in the ophthalmology consultation room along with the previously mentioned OPD consultation room checklist. It enlists the additional resources that are needed in this room.

1. Snell's chart and different reading charts	
2. Torch	
3. Lens	
4. Slit lamp	
5. Direct and indirect ophthalmoscope	
6. Alcohol swab and cotton buds	
7. Near vision charts	
8. Colour blindness test charts	

9. Pupil dilating drops	
10. Fluorescein sodium ophthalmic strip	
11. Lacrimal syringing set (sterile needle, syringe, distilled water)	

Table 18 : Additional Resources required in Ophthalmology Consultation Room

7.4 : Additional Resources Needed in ENT Consultation Room

This checklist is introduced in the ENT consultation room along with the OPD consultation room checklist mentioned earlier. It enlists the additional resources that are needed in this room.

1. Explanation Charts of Ear, Nose and Throat	
2. Head Mirror	
3. Tuning fork	
4. Otoscope	
5. Torch	
6. Nasal twang	
7. Ear drops (to soften wax)	
8. Sterile forceps set	
9. Sterile syringe with needle	
10. Tongue Depressor	

Table 19 : Additional Resources required in ENT Consultation Room

7.5 : TO – BE Process Map

After the study results were obtained, problems in the Outpatient process flow were discussed with the management and a TO – BE process was proposed. Before suggesting any changes to the process, bottlenecks in the present process flow were identified which were, mainly crowding of the patients at the Registration desk and OPD reception and unnecessary movement of the patients for billing investigation and report collection. Following these, certain changes were suggested in the current process flow in order to reduce waiting time, cut down unnecessary patient movement and make the process more efficient. In the present process flow all investigation billing and laboratory report collection was delimited to the front desk making it inconvenient for the patients counting for their needless movement and over-crowding at the front desk. Initially, the primary changes recommended were to decentralise billing and make outpatient laboratory reports available at all counters to ease the patient flow and disperse the crowd at the front desk.

A greater detail of the To-Be Process is elucidated in the Implementation Plan in section 7.6.

7.5.A : Validation of the TO – BE Process

The TO – BE process was validated by Dr. Vinit Samant (Operations Manager) on the 20th September, 2014.

NOTE : Refer **Appendix C** for the **TO – BE Process Map** of the OPD.

7.6 : IMPLEMENTATION PLAN

As a result of discussion and proposing recommendations with a TO – BE process map, the project was validated by the Operations Manager before developing a strategy to implement the pilot study.

7.6.1 : Strategy for Implementation (as in Figure 30.)

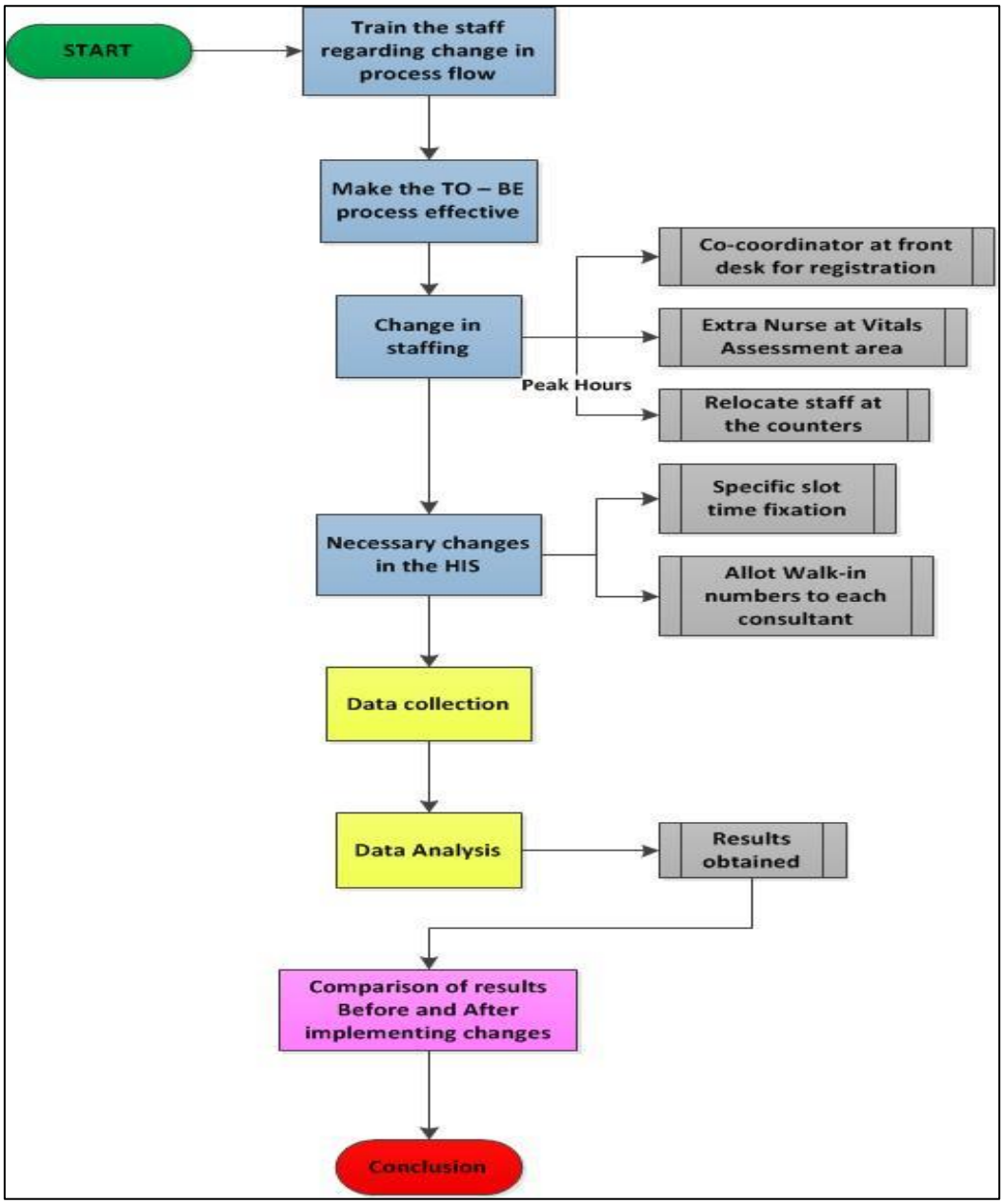


Figure 30 : Implementation Strategy

Implementation involves three phases –

1. **Phase 1** : includes the following
    a) Train the entire staff involved in the outpatient services regarding the changes adopted in the process flow.
    b) Make the validated TO – BE process effective.
    c) Bring about the necessary changes in staffing.
        i. Appoint a coordinator to attend Registration queries at front desk.
        ii. Allocate an extra nurse in vitals assessment area.
        iii. Have an effective staff schedule such that it allows relocating of the staff during peaks hours to quickly disperse the large groups of patients at the counter.
    d) Modifications in the HIS
        i. Introduce online Registration.
        ii. Fix consultation slot time in the system, specific to individual consultants.
        iii. Have software that recognises the maximum number of Walk-in patients that can be allowed to every consultant so that the staff does not encourage Walk-in patients beyond this.

2. **Phase 2** : Following the changes made effective in Phase 1, this phase involves
    a) Data collection of all parameters that were included during the original study.
    b) Data analysis to obtain the results.

3. **Phase 3** : Involves comparison of the results before and after implementing the pilot study to evaluate the effectiveness of the Research.

Here are some of the recommendations that were implemented at the end of the study –

a) A second terminal at the Registration counter was introduced with additional staff to speed up patient processing.
b) Man power (OPD coordinators/navigators) one in each OPD sector were appointed, to assist patients having difficulty in complying with the hospital process.
c) A result of Lean application and implementation of the TO – BE process map was that the reception staff were trained to bill investigations at all counters and a decentralised billing helped to scatter crowd gathering at the front office and eliminate unnecessary movement all the way to a single billing counter.
d) All systems at the OPD counter were made functional and the staff were scheduled in a way that during the period of high footfall, the OPD coordinators could help process patients much more quickly.
e) Checklists were introduced and Japanese 5S was implemented to make sure that each consultation room is checked before the consultant arrived. The OPD reception was also inspected regularly to make sure all required resources were available.
f) Training sessions were conducted for the staff to motivate them to work more efficiently towards achieving zero error.
g) Bi-monthly individual departmental meetings were scheduled, where the manager discussed problems faced on floors by the staff and brainstorming sessions were conducted to find best solutions for resolving these issues.

8. CONCLUSIONS

The conclusions derived from the study are discussed in this chapter. It aims to identify and understand the problems and drawbacks of the present system. This study proposed ways to bring about changes that would be acceptable to the stakeholders in order to improve the processes, whilst carefully considering the work culture of the organisation.

1. During the study, the **main operational issues** concerning the Outpatient department that were identified were –
    a) **Waiting Time**: This was of prime concern as the majority of the patients who remained dissatisfied were mainly because of indefinite period of waiting for consultation. This caused great annoyance especially for the Appointment patients whose consultation was not at the scheduled time. This was one of the reasons for refunds requested by patients who chose to leave without consulting the doctor, affecting the hospital revenue.
    b) **Inestimable number of Walk-in patients**: As the total number of Outpatients increased over the period, it was observed that the ratio of Appointment to Walk-in patients declined. A trend analysis from January 2013 to September 2014 revealed that the appointment percentage had dropped from 68% to 49% and simultaneously walk-in percentage had risen from 32% to 51% (as in Figure 31.). Presently, 3 out of 10 Walk-in patients were those who previously were Appointment patients. They had now turned into Walk-in patients because of their previous experiences of not being seen at the time scheduled. This proved that the hospital needed to strengthen its Appointment Scheduling system in order to improve patient satisfaction.

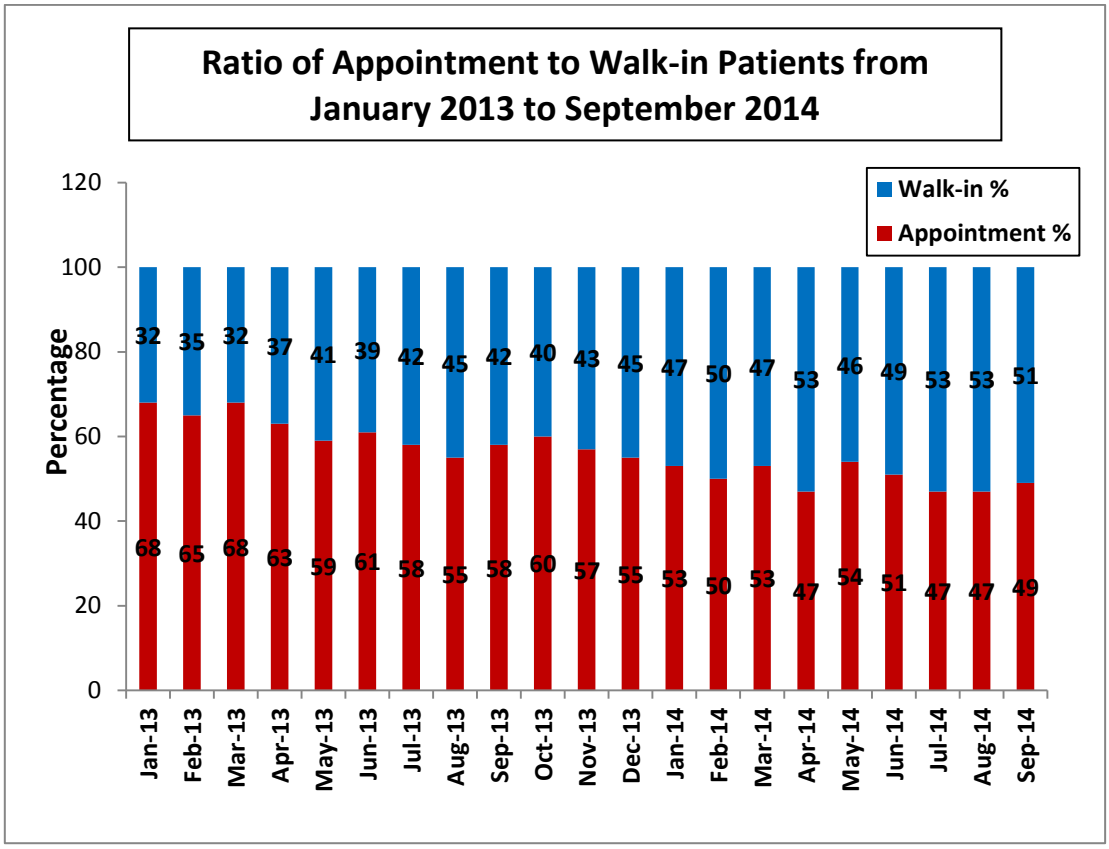


Figure 31 : Comparison of the Appointment to Walk-in Patients Ratio from January 2013 to September 2014.

c) **Extension of doctor's consulting hours beyond the allotted time***:* Two reasons that caused this were: *firstly*, as the consultation slots in the system were not specific to the speciality and the consultant, it was often noted that the allotted slot time was inadequate. Appointments require time to elicit history and examine the patient. The lack of this establishment of patient history had a "knock on" effect which delayed every subsequent appointment scheduled. *Secondly*, the continuous flow of unexpected and unplanned Walk-in patients who came for consultation. This reflected the need for fixing consultation slot time specific to the consultant.

d) **Significant number of DNA patients**: Consultation slots booked by patients who later neither attended the OPD nor cancelled their appointment was another reason that increased the number of Walk-in patients as the

appointment slots were made full and unavailable to genuine patients who had to come as walk-in.

e) **Double booking of Surgical consultants**: This was an outcome of the communication gap between the surgeons scheduling surgeries and the staff blocking slots for OPD Clinic patients. It was mostly observed in specialities where all consultants were allotted OPD hours every day. This meant that, elective surgeries scheduled on any day would overlap with the OPD clinic at some point in time. Also, there was no allowance in the HIS to indicate to the staff booking appointments, that the surgeon had scheduled a surgery. Thus, updating the HIS was necessary to include this option.

f) **Insufficient and operationally deficient OPD reception staff**: There was not enough training sessions for OPD Reception Staff. This prevented them from learning ways to eliminate and reduce errors. It also prevented them discussing the difficulties faced by them while interacting with the patients. Thus methods to improve the hospital services and patient experience were not voiced and thus overlooked. This may have contributed to the noted lack of staff motivation many of whom were unwilling to adapt to changes proposed for the betterment of the organisation.

2. In spite of the above problems, the consultant's dedication towards treating the patient, the quality of service provided and the latest medical and surgical equipment and technology offered by the hospital was successful in retaining 79% of its patients. These patients not only marked their loyalty to the brand name but were also willing to suggest the hospital name to others which aided in recruiting a higher number of new patients.

3. Although the hospital observed a considerable DNA rate of 26.5% for follow up visits, 45% of the DNA rate was because the patients were usually cured after their first visit to the consultant. Thus, their pre-booked appointment for a follow up visit was not used. This caused inefficiency in scheduling appointments, wasted

consultants' time and caused dissatisfaction for patients trying to book appointments. However, despite the problems caused by "cured" DNAs, this was a positive feedback for the hospital due to the consultants' proficiency in treating the patients. Therefore, these expert consultants, to a great extent were responsible for upholding and improving the reputation of the hospital and its brand.

4. The most significant impact was the implementation of Lean and Japanese inspired OPD reception and consultation room checklist. This was prepared following a thorough inspection of the OPD, process analysis, and interviews with the consultants. The OPD house-keeping team who ensured room cleanliness and readiness before arrival of each consultant expereinced immediate results (within 2 days), almost reducing consultants complaints on room readiness to zero. This improved consultant mood, increased patient satisfaction, and ensured lost revenue was minimised.

5. Nevertheless, a well-planned OPD process flow is the key for effective operations. Having a uniform and streamlined process flow in every OPD sector, eliminating unnecessary patient movement for billing and report collection and by reducing the waiting time for a patient at every step of the process would help ensure a more efficient process flow. Ultimately, the patient experience is key to this hospital and its "sister" hospitals in the group maintaining and growing its brand reputation. There is a high level of competition for the "patient Dollar" (Rupee) and Indians are very quick to change allegiance when faced with poor service, bad staff attitude, and inefficient practices. Thus, ensuring everything in their experience has a positive effect is best served by refining the process and making it patient centric.

6. Finally, in answer to the research question, it has been proven that with appropriate adaptation and consideration, western manufacturing techniques can be successfully implemented in an Indian hospital to a wide extent. Indian Healthcare follows the US model and thus is profit driven rather than patient need driven. Thus, any methods, strategies or initiatives which drive down costs and

thus improve profits are always welcomed. The research adds the dimension of not just reducing operating costs, but improving the patient experience. It has shown by creating operational process focused on the patient, that efficiency gains and thus operating cost reduction can be both achieved. The main consideration the researcher notes is not the methodology or implementation of the procedures and processes, but the support of senior management and the buy-in of the operational, nursing and clinical staff. It is therefore this researcher's contention that the research aim has been met and demonstrated, albeit with the exception that full implementation was not possible.

8.1 : Limitations of the Study

Possible limitations posed by the study were –

1. Authenticity of the information entered into the HIS. Unlike the UK NHS, for example, Indian healthcare does not have unique, personalised and lifetime medical records allocated at birth which remain with the patient irrespective of where the patient is treated. In the UK NHS, the medical records belong to the patient not the hospital. Thus, each healthcare organisation has a duty to update and pass on the medical record on the request of either the patient or a healthcare organisation. In India, medical records are guarded by the healthcare organisation/hospital as a means to encourage the patient to return. Due to this, HIS has many duplicate, incomplete, incorrect and inaccurate medical records. This means that the information cannot give a full medical picture to the consultant potentially risking the patient and perhaps complicating treatment.
2. In the course of the study, there were several consultants who left the hospital, in the middle of data collection and thus were excluded. Contrastingly, there were several new consultants who joined towards the

end of the study and they could not be included. Hence the consultation slot and number of Walk-in patients was not allocated in these cases.

Ideally the work should have been process modelled instead of process mapped, but due to time scale constraint and corporate concern regarding hospital information security breaches this was not possible. Process modelling is more detailed and accurate capture of the process. Object oriented data is collected at each event. The sort of data collected varies, but mostly includes timings, utilisation levels, capacities and throughput levels amongst other things. A process map is a one-dimensional expression of a chain of events essentially, irrespective of notation method, a flow diagram.

3. Without capturing object data decision making is somewhat handicapped since, identifying the improvements will require examination of the very data not collected.
4. The biggest limitation and most disappointing occurred towards the end of the project. The Chief Executive Officer, who was also the main supporter of Cranfield and the commissioner of the research left for a new position in Malaysia with a rival organisation. This catalysed a change in the management staff, a change in priorities and a different focused strategy. However, it did bring a new HIS software system, but its introduction put the implementation plan on hold. This resulted in the proposed To-Be process and all the recommendations suggested not being implemented as intended.

8.2: Further Work

This study was conducted for a duration of 36 weeks. It paves the way for further work that can be carried out in the Outpatients Department:

1. Implementation of the TO – BE process. Improve effectiveness by changing staff schedule to reflect OPD peak hours and their requirements. Implement the recommendations as suggested and execute the implementation study as planned in the Implementation strategy.
2. Have regular monthly checks on the process for up to two years to check improvement levels in the OPD system. Select and compare the following metrics: total patient waiting time, number of patients consulted hourly, the ratio of Appointment to Walk-in patient and percentage of DNA patients, patient satisfaction levels. This will allow monitoring and checking on the success levels of the implemented process.
3. A further study on DNA levels is required to explore methods that would help bring down the overall DNA percentage from 26.5% to below 15%. This could be achieved by following up on the unattended appointments and inculcating ways by which DNA occurrence can be minimized.
4. Ultimately, the entire hospital requires every department, every speciality and every process in medical, clinical, clinical support and facilities to be process modelled in its entirety. Often bottlenecks and process obstructions often lie in what seems to be completely unconnected and remote locations. Unless a complete process modelling is conducted of the entire hospital it may well be impossible to achieve as close to 100% efficiency.

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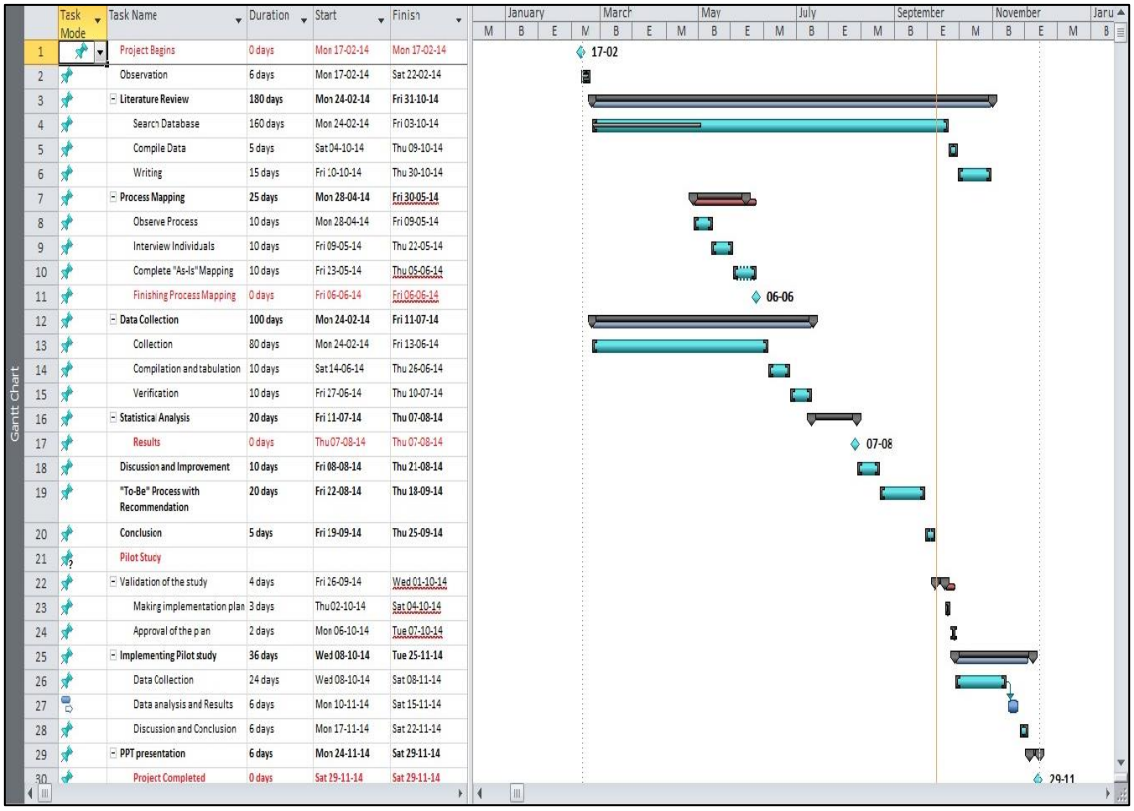
APPENDIX

APPENDIX A

Project Plan Gantt Chart



	Task Mode	Task Name	Duration	Start	Finish
1		Project Begins	0 days	Mon 17-02-14	Mon 17-02-14
2		Observation	6 days	Mon 17-02-14	Sat 22-02-14
3		Literature Review	180 days	Mon 24-02-14	Fri 31-10-14
4		Search Database	160 days	Mon 24-02-14	Fri 03-10-14
5		Compile Data	5 days	Sat 04-10-14	Thu 09-10-14
6		Writing	15 days	Fri 10-10-14	Thu 30-10-14
7		Process Mapping	25 days	Mon 28-04-14	Fri 30-05-14
8		Observe Process	10 days	Mon 28-04-14	Fri 09-05-14
9		Interview Individuals	10 days	Fri 09-05-14	Thu 22-05-14
10		Complete "As-Is" Mapping	10 days	Fri 23-05-14	Thu 05-06-14
11		Finishing Process Mapping	0 days	Fri 06-06-14	Fri 06-06-14
12		Data Collection	100 days	Mon 24-02-14	Fri 11-07-14
13		Collection	80 days	Mon 24-02-14	Fri 13-06-14
14		Compilation and tabulation	10 days	Sat 14-06-14	Thu 26-06-14
15		Verification	10 days	Fri 27-06-14	Thu 10-07-14
16		Statistical Analysis	20 days	Fri 11-07-14	Thu 07-08-14
17		Results	0 days	Thu 07-08-14	Thu 07-08-14
18		Discussion and Improvement	10 days	Fri 08-08-14	Thu 21-08-14
19		"To-Be" Process with Recommendation	20 days	Fri 22-08-14	Thu 18-09-14
20		Conclusion	5 days	Fri 19-09-14	Thu 25-09-14
21		Pilot Stucy			
22		Validation of the study	4 days	Fri 26-09-14	Wed 01-10-14
23		Making implementation plan	3 days	Thu 02-10-14	Sat 04-10-14
24		Approval of the plan	2 days	Mon 06-10-14	Tue 07-10-14
25		Implementing Pilot study	36 days	Wed 08-10-14	Tue 25-11-14
26		Data Collection	24 days	Wed 08-10-14	Sat 08-11-14
27		Data analysis and Results	6 days	Mon 10-11-14	Sat 15-11-14
28		Discussion and Conclusion	6 days	Mon 17-11-14	Sat 22-11-14
29		PPT presentation	6 days	Mon 24-11-14	Sat 29-11-14
30		Project Completed	0 days	Sat 29-11-14	Sat 29-11-14

Figure 32 : Project Gantt Chart

APPENDIX B

AS – IS Process Map of the OPD

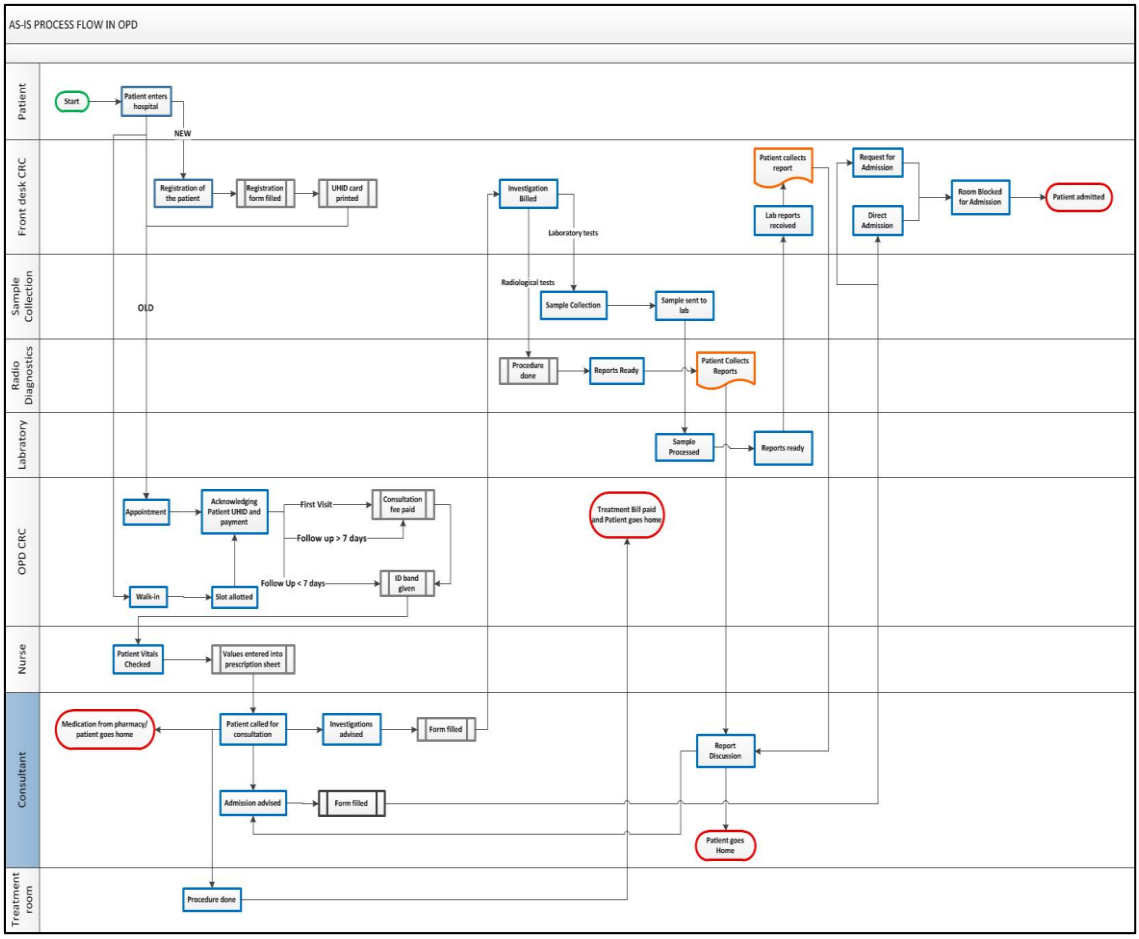


Figure 33 : AS – IS Process of the OPD

The AS – IS process was validated by Dr. Vinit Samant (Operations Manager) on the 12th May, 2014.

APPENDIX C

TO – Be Process Map of the OPD

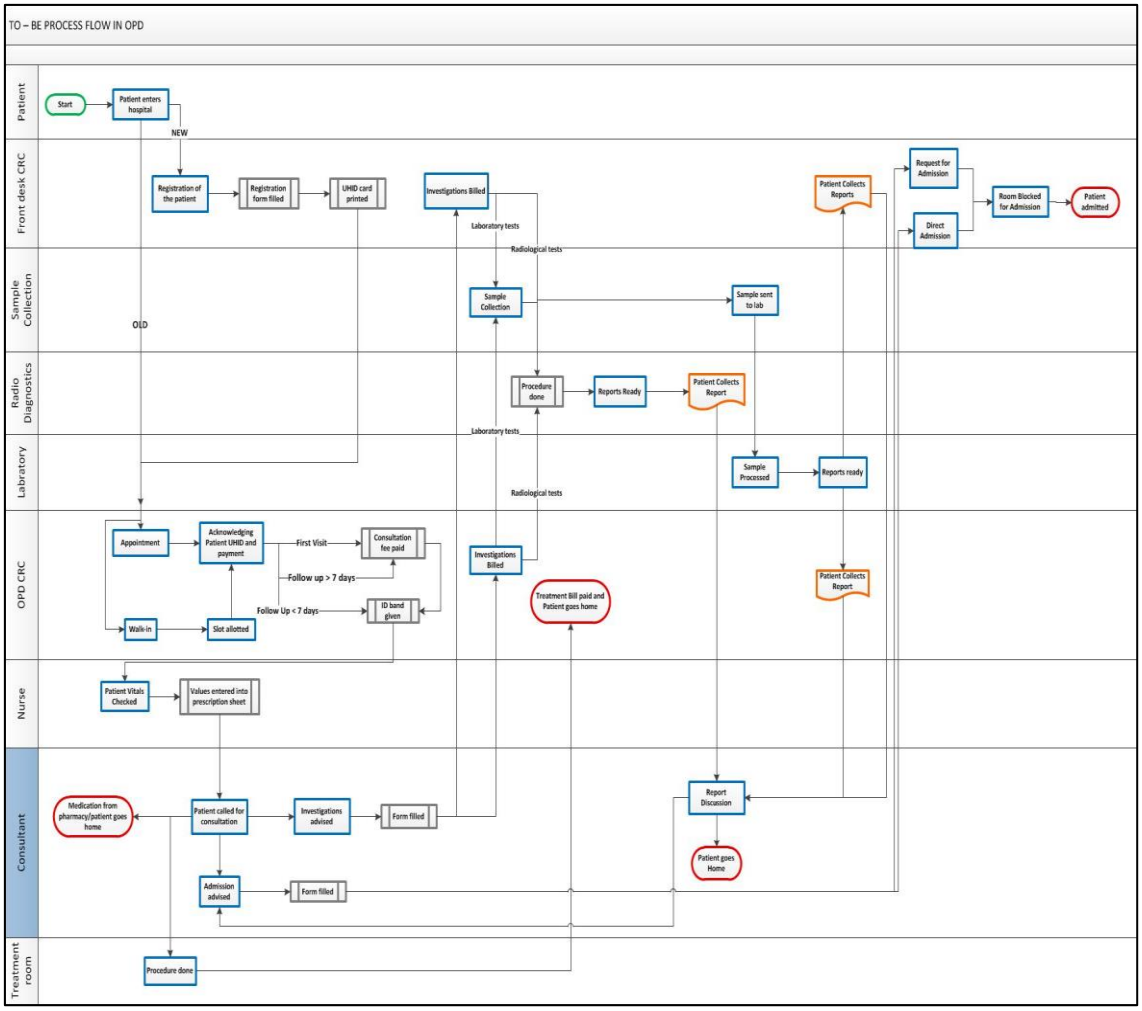


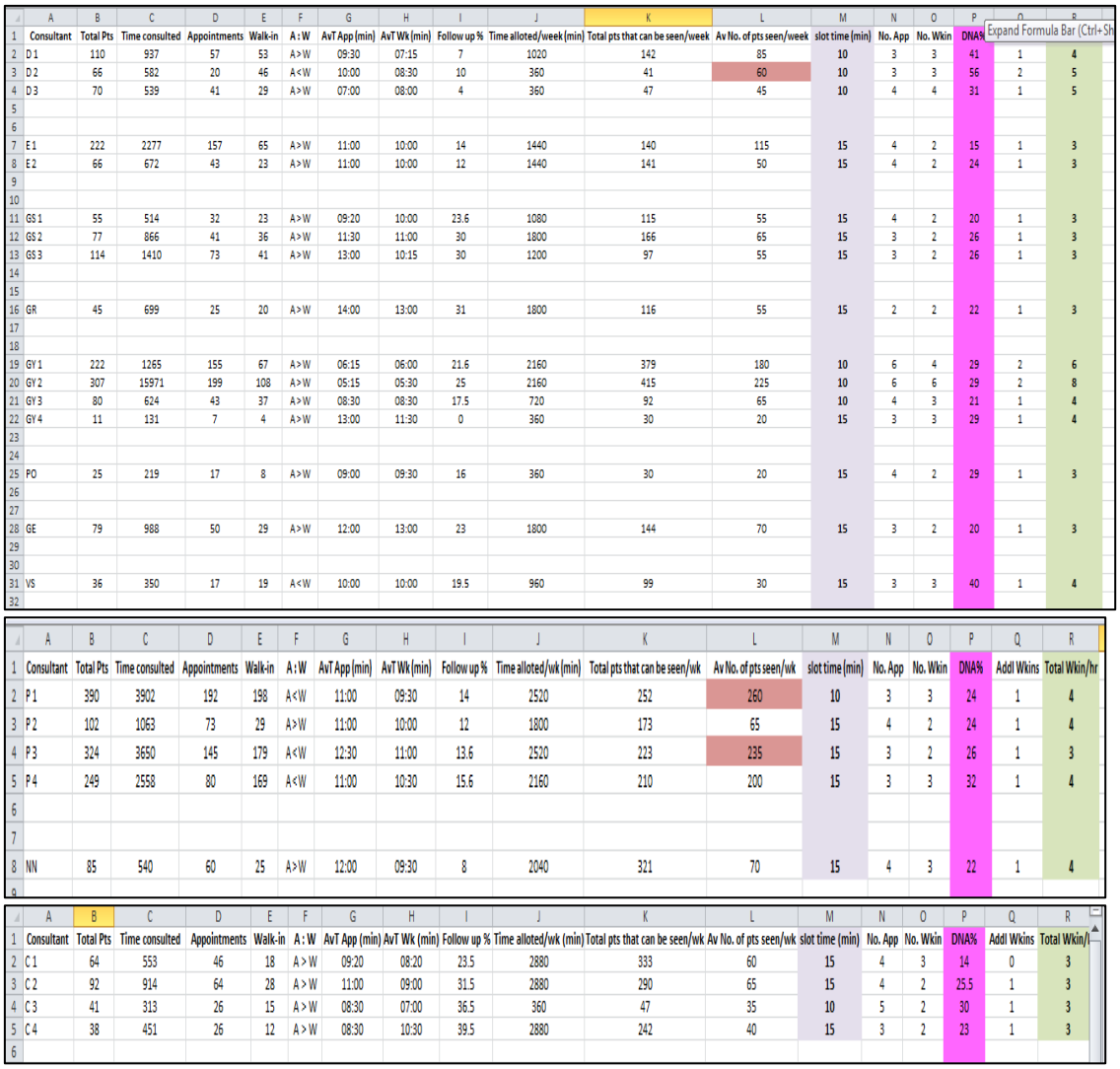
Figure 34 : TO – BE Process Map of the OPD

The TO – BE process was validated by Dr. Vinit Samant (Operations Manager) on the 20th September, 2014.

APPENDIX D

Data compilation table.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	onsultanotal Patientie taken for consultato. of Appointmeno. of Walk-i A : W vT App (miiivT Wk-in (mir ollov up ?me alloted/week (mial pts that can be seen/w No. of pts seen/welot time (mirp that can belo. Wkir															DNA%	Addl Wkin	otal Wkin/hr
2	ENT 1	118	1685	41	77	A>W	15:00	14:30	76	840	59	85	20	2	2	38	1	3
3	ENT 2	127	1793	65	62	A>W	14:30	14:30	66	960	68	85	15	2	2	36	1	3
4	ENT 3	101	1307	55	46	A>W	13:30	13:00	73	1140	88	80	15	3	2	30	1	3
5																		
6																		
7	IM 1	106	1152	53	53	A=W	11:30	11:20	70	1800	166	85	15	4	2	23	1	3
8	IM 2	133	1870	67	66	A=W	14:30	13:00	90	1200	85	85	15	2	2	27	1	3
9	IM 3	154	2486	89	65	A>W	17:00	15:20	87	1200	74	85	20	2	2	22	1	3
10	IM 4	199	2372	96	103	A<W	13:00	11:00	85	1800	151	145	15	3	2	26.5	1	3
11	IM 5	131	1338	50	81	A<W	11:00	10:00	73	1440	141	95	15	3	3	23	1	4
12	IM 6	84	1247	35	49	A<W	15:30	14:00	70	1680	113	75	15	2	2	28	1	3
13	IM 7	65	591	36	29	A>W	11:00	08:00	71	900	93	30	15	3	3	22	1	4
14																		
15																		
16	NM 1	67	1037	31	36	A<W	16:00	15:30	72	1680	109	70	20	2	2	38	1	3
17	NM 2	150	1838	70	80	A<W	16:00	11:30	74	1620	132	100	20	2	3	32	1	4
18	NM 3	51	583	15	36	A<W	12:30	10:00	49	1080	94	35	15	2	3	22	1	4
19																		
20																		
21	NS	52	651	40	12	A<W	15:00	12:00	62	1080	86	40	15	2	3	32	1	4
22																		
23																		
24	OP 1	90	1008	34	56	A<W	13:00	10:00	72	840	75	75	15	2	3	23	1	4
25	OP 2	37	415	30	7	A>W	12:20	10:30	38	660	59	45	15	2	3	29	1	4
26																		
27																		
28	OR 1	63	794	32	31	A=W	12:30	12:30	68	600	48	45	15	2	3	32	1	4
29	OR 2	103	1151	56	47	A>W	11:30	12:00	81	1440	129	110	15	3	2	27	1	3
30	OR 3	51	554	28	23	A>W	12:30	09:50	61	840	77	50	15	3	3	16	1	4
31	OR 4	66	554	34	32	A>W	13:00	11:00	79	960	114	75	15	3	2	27	1	3
32	OR 5	31	449	20	11	A>W	15:30	13:00	71	780	54	15	20	2	2	31	1	3
33	OR 6	64	692	43	21	A<W	12:00	09:30	77	1080	100	50	15	3	3	16	1	4
34	OR 7	47	661	28	19	A>W	14:00	14:00	66	1440	102	50	15	2	2	25	1	3
35	OR 8	11	156	6	5	A>W	11:30	15:00	55	360	27	10	15	3	2	80	2	4
36	OR 9	17	96	14	3	A>W	13:00	11:30	65	480	42	15	15	2	3	0	0	3
37	OR 10	10	115	3	7	A>W	11:00	12:30	60	1440	125	25	15	3	3	0	0	3
38																		
40	PSY 1	46	770	27	19	A>W	18:00	14:30	61	1080	65	35	20	2	2	13	1	3
41	PSY 2	46	1033	29	17	A>W	24:00:00	20:30	61	1080	48	35	20	2	1	18	1	2
42																		
43	RH 1	31	449	18	13	A>W	14:00	15:00	81	1080	75	25	15	2	2	24	1	3
44	RH 2	31	571	18	13	A>W	17:30	20:00	68	1080	59	25	15	2	2	32	1	3
45																		
46																		
47	UR 1	118	1190	47	71	A<W	10:30	10:30	74	1200	119	85	15	3	3	35	1	4
48	UR 2	50	667	38	12	A>W	12:30	15:30	84	1080	81	45	15	2	2	30	1	3
49	UR 3	72	929	36	36	A=W	14:30	12:00	71	1440	112	45	15	2	3	32	1	4
50																		



Consultant	Total Pts	Time consulted	Appointments	Walk-in	A : W	AvT App (min)	AvT Wk (min)	Follow up %	Time alloted/week (min)	Total pts that can be seen/week	Av No. of pts seen/week	slot time (min)	No. App	No. Wkin	DNA%		
D 1	110	937	57	53	A>W	09:30	07:15	7	1020	142	85	10	3	3	41	1	4
D 2	66	582	20	46	A<W	10:00	08:30	10	360	41	60	10	3	3	56	2	5
D 3	70	539	41	29	A>W	07:00	08:00	4	360	47	45	10	4	4	31	1	5
E 1	222	2277	157	65	A>W	11:00	10:00	14	1440	140	115	15	4	2	15	1	3
E 2	66	672	43	23	A>W	11:00	10:00	12	1440	141	50	15	4	2	24	1	3
GS 1	55	514	32	23	A>W	09:20	10:00	23.6	1080	115	55	15	4	2	20	1	3
GS 2	77	866	41	36	A>W	11:30	11:00	30	1800	166	65	15	3	2	26	1	3
GS 3	114	1410	73	41	A>W	13:00	10:15	30	1200	97	55	15	3	2	26	1	3
GR	45	699	25	20	A>W	14:00	13:00	31	1800	116	55	15	2	2	22	1	3
GY 1	222	1265	155	67	A>W	06:15	06:00	21.6	2160	379	180	10	6	4	29	2	6
GY 2	307	15971	199	108	A>W	05:15	05:30	25	2160	415	225	10	6	6	29	2	8
GY 3	80	624	43	37	A>W	08:30	08:30	17.5	720	92	65	10	4	3	21	1	4
GY 4	11	131	7	4	A>W	13:00	11:30	0	360	30	20	15	3	3	29	1	4
PO	25	219	17	8	A>W	09:00	09:30	16	360	30	20	15	4	2	29	1	3
GE	79	988	50	29	A>W	12:00	13:00	23	1800	144	70	15	3	2	20	1	3
VS	36	350	17	19	A<W	10:00	10:00	19.5	960	99	30	15	3	3	40	1	4

Consultant	Total Pts	Time consulted	Appointments	Walk-in	A : W	AvT App (min)	AvT Wk (min)	Follow up %	Time alloted/wk (min)	Total pts that can be seen/wk	Av No. of pts seen/wk	slot time (min)	No. App	No. Wkin	DNA%	Addl Wkins	Total Wkin/hr
P 1	390	3902	192	198	A<W	11:00	09:30	14	2520	252	260	10	3	3	24	1	4
P 2	102	1063	73	29	A>W	11:00	10:00	12	1800	173	65	15	4	2	24	1	4
P 3	324	3650	145	179	A<W	12:30	11:00	13.6	2520	223	235	15	3	2	26	1	3
P 4	249	2558	80	169	A<W	11:00	10:30	15.6	2160	210	200	15	3	3	32	1	4
NN	85	540	60	25	A>W	12:00	09:30	8	2040	321	70	15	4	3	22	1	4

Consultant	Total Pts	Time consulted	Appointments	Walk-in	A : W	AvT App (min)	AvT Wk (min)	Follow up %	Time alloted/wk (min)	Total pts that can be seen/wk	Av No. of pts seen/wk	slot time (min)	No. App	No. Wkin	DNA%	Addl Wkins	Total Wkin/
C 1	64	553	46	18	A > W	09:20	08:20	23.5	2880	333	60	15	4	3	14	0	3
C 2	92	914	64	28	A > W	11:00	09:00	31.5	2880	290	65	15	4	2	25.5	1	3
C 3	41	313	26	15	A > W	08:30	07:00	36.5	360	47	35	10	5	2	30	1	3
C 4	38	451	26	12	A > W	08:30	10:30	39.5	2880	242	40	15	3	2	23	1	3

Figure 35 : Data Compilation Table

Abbrevations used

Speciality	Abbreviations
ENT	**ENT**
Internal Medicine	**IM**
Neuro Medicine	**NM**
Neuro Surgery	**NS**
Ophthalmology	**OP**
Orthopaedics	**OR**
Psychiatry	**PSY**
Urology	**UR**
Dermatology	**D**

Endocrinology	**E**
General Surgery	**GS**
Geriatrics	**GR**
Gynaecology	**GY**
Peds Orthopaedics	**PO**
Gastroenterology	**GE**
Vascular Surgery	**VS**
Paediatrics	**P**
Neonatology	**NN**
Cardiology	**C**

Signficance of each Column

A = Consultant

B = Total Pts : Total number of Patients studied

C = Time consulted : Time taken to consult the total number of patients studied.

D = Appointments : Number of patients in the study who had taken an appointment.

E = Walk-in : Number of patients in the study who walked in without an appointment.

F = A : W - Comparison between the number of appointments and number of walk-ins in the study.

G = AvT App (min) : Average time in minutes taken to consult appointment patients.

H = AvT Wk (min) : Average time in minutes taken to consult walk-in patients.

I = Follow up % : Percentage of patients in the study not billed.

J = Time allotted/week (min) : Consultation time allotted for the consultant in a week.

K =Total Pts that can be seen/week : Number of patients that can be consulted by respective doctors in one week.

L = Av No. of Pts seen/week : Average number of patients a doctor presently consults in a week.

M = Slot time (min) : Slot time suggested for each consultant from the study.

N = No. App : Number of slots that can be allotted for appointment patients in one hour.

O = No. Walk-in : Number of slots that can be allotted for walk-in patients in one hour.

P = DNA % : Percentage of patients who did not attend after booking an appointment.

Q = Addnl Wk-in : Additional number of walk-ins that can be allowed keeping in mind DNA%.

R = Total Wk-ins/hr : Total number of walk-ins that can be allowed per hour for respective Consultants.

All the data collected were compiled into a table. Due to large number and size of the individual consultant data sheets it was impossible to include them in the report. However they are available for inspection on the supplied data stick/cdrom.

APPENDIX E

OT – OPD Overlap Time

	Speciality	Consultant	Overlaps	Total
2	Genenral Surgery	GS 1	5	8
3		GS 2	1	
4		GS 3	2	
5	Orthopaedics	OR 7	8	20
6		OR 10	1	
7		OR 2	3	
8		OR 3	4	
9		OR 4	1	
10		OR 10	3	
11	Urology	UR 1	24	43
12		UR 2	12	
13		UR 3	7	
14	Gynaecology	GY 1	15	35
15		GY 2	18	
16		GY 3	2	
17	Ophthalmology	OP 1	9	11
18		OP 2	2	
19	ENT	ENT 3	4	8
20		ENT 2	4	
21	Sg Gastroentro	GE	9	9
22	Vascular Surgery	VS	11	11
23	Neurosurgery	NS	21	21

Figure 36 : OT – OPD Overlap Time of Surgical Specialities

	Consultant	Overlaps	
2	SG 1	5	
3	GS 2	1	
4	GS 3	2	
5	OR 7	8	
6	OR 10	1	
7	OR 2	3	
8	OR 3	4	
9	OR 4	1	
10	OR 10	3	
11	UR 1	24	maximum
12	UR 2	12	
13	UR 3	7	
14	GY 1	15	
15	GY 2	18	
16	GY 3	2	
17	OP 1	9	
18	OP 2	2	
19	ENT 3	4	
20	ENT 2	4	
21	GE	9	
22	VS	11	
23	NS	21	
24			

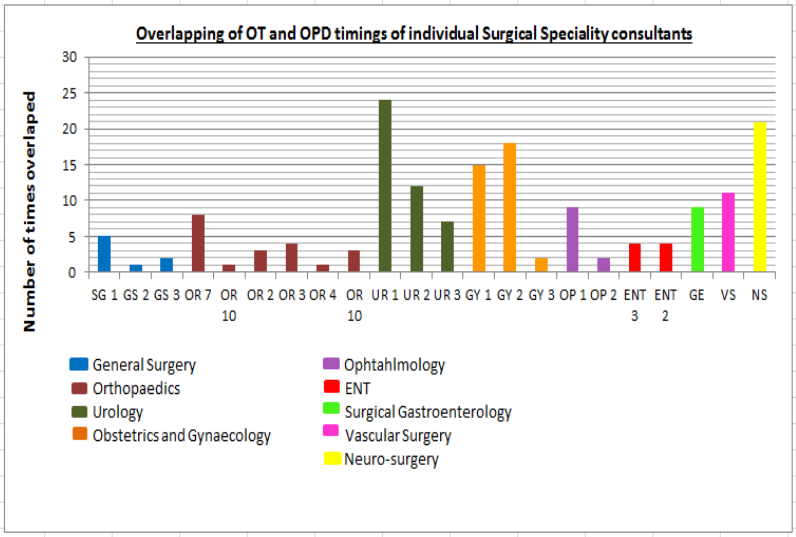


Figure 37 : OT – OPD Overlap Time of Individual Surgical Speciality Consultants