



# IMPORTANCE OF PROCESS IMPROVEMENT IN MEDICAL DIAGNOSTICS – A LITERATURE REVIEW

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## ABSTRACT

Since last decade, Healthcare has been acknowledged as the most crucial service sector and even is reaching out remote areas to serve the needy and sick patients. Diagnostics Laboratories are the basic functional departments in hospitals meant to investigate on samples of patients and report about diseases that may be present. Available literature review reveals research being done in pathological aspects, disease management, procedures for biopsy, report formats etc. It is observed that not much of research has been done in the operational aspects of Diagnostics service. It is the need of the hour to lay emphasis on improving these processes. Hospitals and Diagnostics centres with well-defined processes would entail in increased level of customer satisfaction. Awareness of people about patient's rights, safety is demanding delivery of service with "quality". Hence the aspect of "Process improvement" needs deeper insight. Hospitals and Diagnostics Laboratories need to integrate people, process and productivity. The current study consolidates the findings in the literature from two perspectives: (i) evolution of healthcare and medical diagnostics (ii) process improvement in medical diagnostics. This study gives the direction for further research in improvisation of process aspects in healthcare in general and medical diagnostics in particular.

**KEY WORDS:** Process, Process Improvement, Operations, Customer Satisfaction, Operational Effectiveness, Diagnostics, Healthcare

## 1. INTRODUCTION

The Healthcare is one of the most crucial service sectors intended to serve patients with commitment and dedication. Though the terminology "Healthcare" is a recent one, the principles behind it have been in vogue since ages. The history of practice of Medicines dates back to ancient Babylonia, China, Egypt and India. These regions of the globe introduced the concept of medical diagnosis, Prognosis and advance medical ethics [1]. Public awareness became more evident in later part of 19th century. Early decades of 20th century witnessed establishment of more advanced research centers attached to hospitals. Practice of medicine got recognized as a prestigious profession in the later part of the 20<sup>th</sup> century. 21<sup>st</sup> century is becoming an era of more advanced researches in the concerned field.

Healthcare is a culmination of delivery of service of various departments and specializations. Diagnostics Laboratories are one of the departments, where the basic diagnosis of illness or diseases is reported. Based on diagnosis, further management of disease will be taken care of. It is observed that in Pathology, more research has gone about specific diseases, pattern of reporting, biopsies and other related pathological procedures. Functioning of Diagnostic center depends on pathologist, laboratory technicians, medical transcriptionists (typists, reporting staff), housekeeping staff and customer care executives. They all work as a team to deliver quality service to patients. It is noteworthy to mention that not much of research

has been carried out in the "operations" of diagnostic centers. As healthcare is a series of coordinated activities, operations of diagnostic centers assume a vital role.

Operation is an act of functioning and process is a series of steps involved to accomplish a particular task. Process improvement is an aspect aiming at improving processes and performance. If this is achieved, it entails in increased level of customer satisfaction. Customer satisfaction is a measure of the degree to which a diagnostic center or hospital meets the expectations of customers. Operational effectiveness is the utilization of available resources, implementing better practices and achieving the mission and goals. Thus, it can be said that all the above is oriented towards continuous improvement of functional performance.

Customers are aware about their rights and safety. Quality of Service (QoS) is the highlighted aspect in the service industry and more focus is being laid on the same by the top-management of hospitals and diagnostic centers. In the wake of all these circumstances, it is envisaged that process improvement needs more focus in research studies.

Even though the issues of waste management, adoption and implementation of Lean principles, essentials of housekeeping services and importance of human resources are addressed in the existing literature, research studies on importance of improving the processes are conspicuously absent. As a whole,



hospitals and diagnostic centers will have service-oriented issues, operations related challenges. Improving operations will substantially reduce the issues associated with customer service. Hence it is the need of the hour to lay emphasis on improving the processes of operations.

## 2. LITERATURE REVIEW

Healthcare being utmost important for individuals, families, societies and the humankind as a whole, it is necessary and important to review and retrospect the importance of process improvement in diagnostics laboratories of healthcare sector.

### 2.1 Evolution healthcare and medical diagnostics

#### 2.1.1 Saga of healthcare

Today's Healthcare industry is the result of gradual development seen through the journey of several milestones in the history of human civilization. Ancient Greeks, Babylonians, Egyptians, Indians and Chinese played significant role in the history of medicine. During prehistoric age, herbs were used as healing agents and tribal people recognized the importance of clay and soil in curing diseases. The first known trepanning operation was done in 5000 BCE in France. The first known surgery, an amputation, was also carried out in France in 4900 BCE. During early civilisation, Herodotus described that ancient Egyptians were practicing medicine in the name of supernatural elements. They cured diseases through observations and the details are written in the book 'Edwin Smith Papyrus' believed to be written in 1600 BCE. The 'Kahun Gynaecological Papyrus' written in 1800 BCE describes about women's health. The book 'Diagnostic Handbook' was written by Esagil-kin-ali of Babylon in the first half of 2nd millennium BCE. The book explains about the methods of therapy and etiology. Practice of Islamic medicine was seen during medieval period in Arab, Turkey and Persia.

Ancient Indians practised Ayurveda, Unani and Siddha medicine. 'Atharvaveda' which comprises 'Ayurveda' explains about prescription of herbs for various ailments. Two schools of thought belonging to Charakasamhita and Sushruthasamhita describe about examination, diagnosis, treatment and prognosis. Sushruthasamhita is notable for its description about surgical procedures and scientific classification. Another alternative form of medicine, Unani, got deep roots and royal patronage during medieval times.

In China, Taoist physicians practised medicine. The ancient medical text in China is 'Huangodi neijing', written between 5th and 3rd century BCE. During 2nd century BCE, 'Treatise on cold damage' was written. Traditional Chinese medicine is based on the use of herbal medicine, acupuncture, massage and other forms of therapy. The Hong Kong College of Medicine for Chinese was founded in 1887 AD by London Missionary Society. Dr. Mary Honnoah Fulton in 1902 founded the first medical college for women, Hackett Medical College in Guangghan.

Greeks dedicated temples to the healer God Asclepius. Alcmaeon of Croton has written a book between 500 to 450 BCE and argued that channels link sensory organs to the brain.

Hippocrates (460-370 BCE) is regarded as the father of Western Medicine. He invented the Hippocrates oath for Physicians, which is still relevant and in use today. Two great Alexandrians, Herophilus of Chalcedon and Elastratus, laid the foundations for science of Anatomy and Physiology.

Romans invented surgical instruments such as forceps, scalpels, cautery, cross-bladed scissors, and surgical needles. In Europe, after 400 AD, medicine got transformed into deep discipline. In Italy, during 9th century, medical schools were opened. During Renaissance, neurology was developed. University of Padua was established and concentrated more on autopsies.

During 19th century, hospitals began examining patients based on symptoms. Operation theatres became aseptic. Advanced procedures of chemistry and laboratory techniques revolutionised the medical field and epidemiology was replaced with bacteriology and virology. Vaccines were discovered. During civil war (1861-65), soldiers died of diseases and wound than as victims of war and medical supply was in shortage. John Hopkins hospital, founded in 1889, introduced the service of residency and rounds. Japan adopted European approach of open community of collaboration based on expertise on the latest scientific methods.

During 20th century, ABO blood group was discovered in 1901, facilitating blood transfusion. From 1917 to 1928, American Red Cross moved to Europe. The World Health Organisation (WHO) founded in 1948 as a United Nations (UN) agency to improve global health. Life expectancy has increased since then. Small pox has been completely eradicated in 1970s and Rinderpest has been completely wiped off in 2011. Eradication of Polio is underway. Tissue culture has become more important for the development of vaccines. Cancer treatment is being done with radiotherapy, chemotherapy and oncological surgeries. Oral rehydration therapy has been extensively used to treat cholera and other diarrhoea inducing infections. Family planning has promoted a demographic transition in most of the world. The struggle against Human Immunodeficiency Virus (HIV) is continuing with antiretroviral treatment. Ultrasound, Computerised Tomography (CT) and Magnetic Resonance Imaging (MRI) have evolved as the latest Radiological investigations. Genetics have advanced with the discovery of Deoxy-ribose Nucleic Acid (DNA) molecule, genetic mapping and gene therapy. Stem cell therapy has been invented as the promising method of treatment. Concept of evidence-based medicine has emerged. Prosthetics has improved and cardiac pacemakers are saving the lives of many. Though first open heart surgery was done in 1925, it became more common after 1948. Transplantation of Kidney, Heart, Liver and Pancreas is being done for almost a decade now. By the end of 20th century, Micro-Technology is being used to create tiny robotic devices to assist microsurgeries involving micro video and fibre-optic cameras to view internal tissues during surgery with minimal invasive practices. Laparoscopy and natural orifice surgery are based on the latest available technologies. Harvesting of organs is becoming very popular in developing countries.



### 2.1.2 Progression in Diagnostics

History says that documentation of diseases began with ancient Egyptian medicine practice. They had details of different types of bone injuries, trachoma, ulcerating lumps and other diseases. Mummies of Egypt have revealed the details of bone tumor, tuberculosis of Spine, arthrosclerosis, gallstones and abscesses [2]. It is observed that Alexandrian Greeks, influenced by Hippocrates, made significant contributions to anatomy and pathology. Hippocrates has defined about pathological features of wound inflammation, tumors, hemorrhoids, malaria and tuberculosis. They also did animal dissection. Human dissection was done by Herophilus (335-280 BCE) and Erasistratos (304-250 BCE). Celsus and Tertullian recorded that Alexandrians performed vivisection on living criminals, as a part of punishment. Herophelio pursued anatomy as a science and tried to correlate structures with diseases, while Erasistratos, his contemporary was a physiologist.

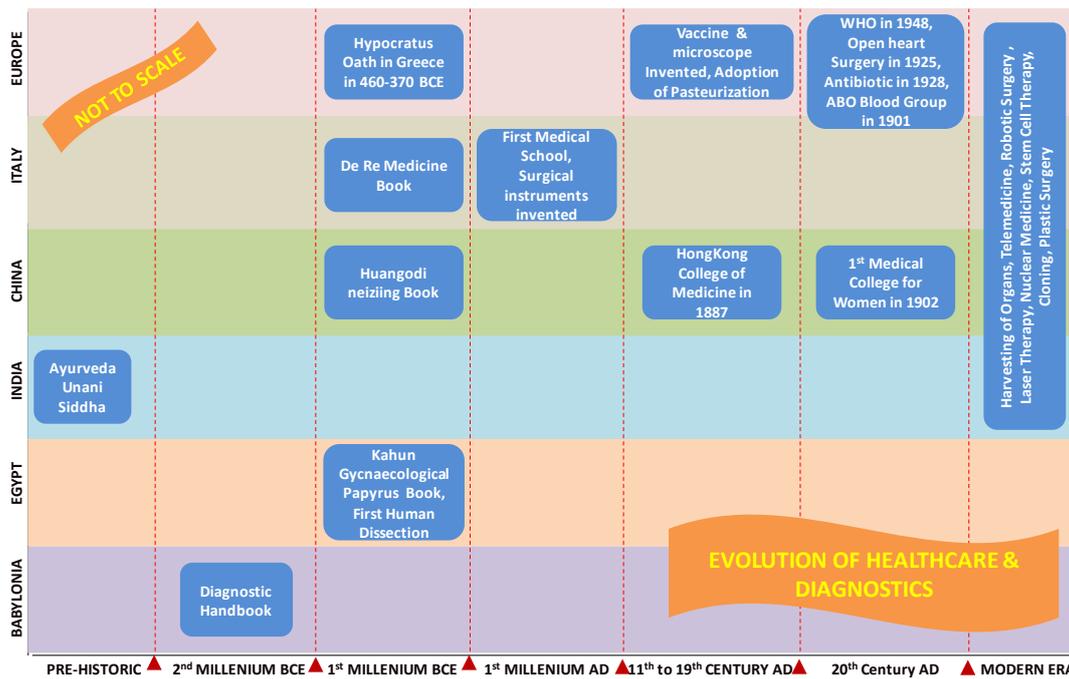
During Roman Empire, Cornelius Celsus (about 30 BCE-38 AD) practiced medicine. Being a physician, he educated people through his book "De Re Medicine", written in eight volumes. Classic definition of "inflammation" is given by him. During 2nd century, Galen (129 AD-201AD), considered as the greatest figure in the medical field, followed Hippocrates and Greek concepts and travelled extensively to contribute his knowledge to the field of healthcare. His famous books are "Seats of diseases" and "Abnormal Tumors".

Pathology in the period between Galen and the later middle ages was mainly influenced by Byzantine and Arab physicians. Aetius of Amida (502AD -575AD) has given descriptions of Carcinoma of Uterus, hemorrhoids, condylomata, fissures and ulcers of rectum. Well-known physician of Arab period, Avicenna (980 AD-1037AD) wrote "Canon Medicinæ" and it remained as the best single work in medicine till 15th century. A century later, his successor, Avenzoar (1070AD-1162AD) described cancer of Oesophagus and Stomach and other lesions. After the decline of Arabs, monasteries, across Europe, kept the work of Greek medicine intact. Bologna practiced human dissections as early as 1270 AD as regular part of teaching of medicine. Hence dissection became more common. By the end of 15th century, pathology grew as a specialized branch of medicine. Its evolution is well documented in the work of Florentine Antonio Benivieni (1443AD-1502AD) and gives the descriptions of case histories and autopsies. Details of post-mortems were published in "De Abditis Nonnullis Ac Mirandis Morborum et Sanationum causis" (About the hidden causes of diseases). During 16th century, anatomists gave brilliant ideas about pathological structures and details of abnormal features started accumulating in the works of pathology. Jean Ferner (1497AD-1558AD) became full-fledged pathologist. His work "Medicina" was a standard

throughout Europe. He classified diseases into general and special ones based on signs and symptoms. His successors were Swiss anatomist, Felix Plater (1536AD - 1614AD), Dutch anatomist, Volcher Coiter (1534AD-1576AD) and German Johann Schenk Von Graftenberg (1530AD - 1598AD).

The new dawn began when William Harvey (1578AD - 1657AD) published "De motu cordis et sanguinis" in 1628, which described about circulation of blood and disease causation. He also made important observations on the pathology of heart. During 18th century, more publications authenticated the procedures of autopsies. In Britain, Thomas Hodgkin (1798AD - 1866AD), general physician, described pathological changes in tissues. Richard Bright (1789AD - 1858AD) studied about the relation between kidney diseases and oedema and Thomas Addison (1793AD -1860AD) gave an elaborate account of pernicious anemia.

From the mid-19th century onwards, a new technology shaped future of pathology with the usage of Microscope. During this time, physiology and chemistry were done considerably and these studies led to more specific approach to study the pattern of disease. Johannes Muller (1801AD – 1851AD) of Berlin, was the first to use microscope in tissue analysis. His disciple, Schwann, pointed out that cellular growth is the basic principle of animal's life and this paved a way for a new era in the pathological science during second half of the 19th century. Discovery of microscope totally changed the concepts of diseases from whole organs to the focus on cells and enabled the practice of histopathology and it entailed in the new techniques of modern practice. Paraffin embedding was introduced in 1869 by Edwin Klebs (1834AD - 1913AD) and this type of embedding required hardening and dehydration. So, chromic acid, chrom-osmium-acetic acid and Zenker's fluid entered the routine practice. In 1893, Issac Blum (1833AD - 1903AD) introduced Formaldehyde and till today it is used as a fixative in histopathology. Nikolai Anitschkov (1885-1964) described histopathology of the heart and proposed the role of cholesterol in atherosclerosis. New understanding of kidney diseases stemmed from the work of Franz Volkard and Theodor Fahr and Paul Klemperec (1884AD – 1964AD). Karl Landsteiner (1868AD - 1943AD) provided the basis for modern blood typing (1901AD) and this led to the new field of blood transfusion and tissue transplantation. Ongoing research in the field of fixation, embedding, cutting immuno-histochemical staining, molecular methods, microscopy has contributed to yield better diagnostic tools and hence more precise diagnosis. These new techniques are describing, refining, classifying and re-describing the new concepts in the field of diagnostics. The milestones in healthcare and diagnostics are shown in Figure 1.



**Figure 1 Milestones in healthcare and diagnostics**

**2.2 Process improvement in medical diagnostics**

As operations hover around routine activities of day-today work, improving the operations assume a vital role. Operational activities need to be captured in Standard Operating Procedures (SOP) for each department for the benefit of staff. Success of implementing process improvement in one department can readily be adopted by another department. Hence there is a connectivity between quality of service with respect to customer satisfaction and importance of process improvement in departments.

Sublime aspects of care and attitude strongly determine the service quality and hence customer satisfaction [3, 4]. These research papers discuss about customer loyalty, reputation of hospitals, infrastructure, efficiency, accuracy and Turn-Around-Time (TAT). The hospitals should have a good customer relation management that will aid in accountability, accessibility and flow of apt information. Similarly, administrative procedures and importance of human and non-human factors that play an important role are explained in one of the research papers [5]. Aspects of emotional bonding and trust are the main focus of another research paper [6]. If all the mentioned aspects are taken care, an increased level of customer satisfaction will be achieved [7]. Communication, innovation and processes that are prevalent in the hospital will also have an impact on the satisfaction of customers [8]. Soft skills and competency of staff pave the way for improvement in the quality of service to the customers [9] and so also the aspect of managerial orientation [10]. Physicians rely on the accuracy of reports [11]. Patient safety is an integral part of service and hence errors related to the same need to be reduced [12]. Improved communication between staff and customers will further reduce errors [13]. Incomplete request forms may increase the possibility of committing errors and collecting

history of patients and reporting in the specific format will decrease errors [14, 15]. The factors of achieving customer satisfaction through operational excellence, adoption of models of service quality and assessing them are extensively discussed in the available literature [16-25].

Turn-Around-Time (TAT) is the buzz word of quality of service in service industry and more so in healthcare sector. It plays an important role in treating patients of emergency departments [26]. If the patient is served well within minimum turn-around-time, it entails in increased level of patient satisfaction [27].

Functioning of hospitals depend on staff. Recruiting and retaining the competent staff impact customer satisfaction [28]. Service is delivered to patients by various departments of the hospital and this parameter relies on existence of an excellent communication within the system. It is important to assess communication and display signs and symbols in the hospital premises [29, 30]. Patient's attenders need to be communicated about patient's condition often. Patient safety plays a vital role in communication and the onus of advocating effective communication rests on the management [31]. The role of communication assumes a major role in nurse-patient relationship [32]. Hence the top-management needs to implement a system involving patient safety and high level of quality of service [33]. Effective principles involving the implementation of the same are discussed in [34]. The role played by communication and collaboration in transforming the healthcare into a patient-centered organization is elaborately explained in [35]. Top executives need to keep the vital information in their dash boards [36]. Phenomenal role of lean concepts and display of the same in improving the communication are extensively discussed [37].



In today's world of technology, Information Technology (IT) is playing the pivotal role and healthcare is also utilizing IT services to leverage the processes involved. The application of IT in healthcare for leveraging processes for high quality is crucial [38]. The concepts of Digital technology have created a new wave in the field of healthcare and particularly in Pathology [39].

Training is an integral part of staff empowerment [40]. Healthcare has been implementing the concepts of Lean Management, which have already proved successful in manufacturing industries. The concepts which could be adopted in healthcare are now a days extensively discussed [41]. The impact of training could affect customer experience and hence the aspect of training is always measurable in terms of feedback of customers [42]. As training is itself a vast domain, healthcare has to focus on need-based training [43].

Quality is the measure of excellence and imminent challenges are invariably associated with it. This is particularly observed in developing countries [44]. As hospitals are segmented into various specialized streams, each department has to focus improving the quality of service and this is achieved only if there is a role-based quality management programs [45]. Quality influences on performance indicators and have to promote zero defect mentality [46, 47]. Adoption of Kanban and Just-in-Time (JIT) increases the working efficiency of staff [48,49] It demands inter-departmental co-operation different categories of quality namely high, intermediate and low could be recognized depending on the implementation of models of service quality [50]. The problems associated with the implementation of Lean in healthcare are discussed in [51]. 5S concepts, which are the foundation principles of Lean practice are being adopted [52] and it is observed that the combination of lean thinking and Six-Sigma (multidisciplinary approach) enhances the efficiency of the working of hospitals.

Waste Management is an important criterion for functioning of hospitals and the concept is gaining ground in the recent past. Unless done properly, waste disposal can lead to cross-infections and can become hazardous. As public awareness has increased about environmental pollution, greater responsibility is bestowed again on the top management to dispose medical waste in a socially responsible manner. At the same time, latest technology innovations should be adopted to manage medical waste and there should not be mixing of medical waste and general, domestic waste [53]. Standard Color codes should be followed while segregating different categories of medical waste [54].

A reference book by A.G. Chandorkar [55] describes about hospital administration and planning. As hospital functioning depends on both human and non-human factors, Human resource (HR) related issues play a vital role in the human factor area. Emotional well-being of staff will go a long way in interacting with patients [56]. An analysis of law of Wong and Law of Emotional Intelligence (WLEIS) revealed that staff with

high emotional intelligence experience positive moods often and also recognize and manage their problems, overcoming the obstacles. Hence, they exhibit job satisfaction [57]. People with high level of emotional intelligence also handle multi-tasking easily [58] and are inclined towards customer orientation.

Housekeeping is an essential part in the day-to-day service of hospital and the issues associated with it are discussed in paper [59]. The paper discusses about descriptions of various parameters of housekeeping, standards and protocols and concludes that good housekeeping is an essential part of healthcare industry. Thus, it can be said that having efficient housekeeping service also increases customer satisfaction.

The theme of organizational effectiveness is depicted through the corporate social responsibilities towards a sustainable future in [60]. If organizational efficiency is achieved, operational excellence would follow it [61]. Improving the processes of operations will also result in operational effectiveness [62]. Organizational effectiveness relies on relationship management and hence customer-relation management is vital for healthcare [63].

Measuring customer satisfaction always enhances reputation and competitive advantage for hospitals and the impact of variables namely customer service, product quality, customer satisfaction and customer loyalty is multi-fold and deserves a fresh insight into the aspects involved.

Diagnostic Laboratories are crucial department of hospitals as the plan of treatment relies on the reported diagnosis. Eventually, TAT of reports, accuracy, staff courtesy, hygienic environment, maintenance of adequate inventory level of lab accessories and materials, notification of critical values play a vital role in enhancing the satisfaction about laboratory service [64]. Against this backdrop, adequate staffing and inter-departmental communication assume a major role towards improving the processes involved [65]. In addition, technical skills of phlebotomists and their communication with customer come into the forefront. Price structure of investigations is also an important factor in assessing the customer satisfaction [66] as it aids in the decision-making of customer in opting the lab for undergoing the prescribed investigations [67]. Customers evaluate the mentioned aspects in framing the opinion about the service of the particular laboratory [68].

Considering the above aspects, a diagnostic lab can implement concepts of lean management. It is observed that Just-in-Time (JIT) principles help to achieve operational excellence [69]. It is felt that tools of quality management increase the efficiency of pathology laboratories [70]. Application of 5S concepts in the work system improve the clarity of work processes and reduces time of staff doing relevant and repetitive work and the same time could be used to interact with the customers [71].

Dr. M.V. Rao *et al.* captured the responses of customers in a questionnaire and concluded that waiting period and communication need to be improved. Dr. Asitava Debroy and



Dr. Jyotsna did a root-cause analysis of delay in despatch of reports and opined that lack of control over phlebotomy service and lack of Pneumatic Tubing Transport System (Ptt) are causing delay in reports [72]. Vaneer Kaur et al have discussed about advantages of Pneumatic Tubing System (PTS) in hospitals and mentioned that it helps in quick transport of samples from various departments to laboratory [73]. Incidentally, it is seen that delay in reports is causing delay in procedures related to discharge of admitted patients. Importance of communication is widely discussed in this regard [74]. The factor of effectiveness in pathology is also reiterated [75]. The role of leadership is extensively dealt with [76], thus indicating their proactive initiative in making quality programs a continuous one in hospitals and diagnostic labs. To make this happen, there should be a defined roles and responsibilities for all. As technology is getting advanced, the concept of digitisation and outsourcing is gaining ground in laboratory service also. Available literature review report [77] that medical laboratory service is an integral part of clinical service and there is an urgent need to train the young and fresh laboratory technicians as senior staff are getting retired and the younger generation is getting attracted to other professions. The essence of quality in service should be again given more focus [78]. Available literature also throws light on suitability of lean principles and tools to diagnostic laboratories, communication and customer satisfaction, need for training, pathology reporting format for specific diseases Toolkits for quality based service [79], manuals for laboratory test related steps [80], infrastructure of pathology services in developing countries

need to reshape the service of laboratory service in an era of personalised medicine [81]. Innovative methods to improve hospital efficiency [82], survey of customer satisfaction [83] and about the need to take collective action for feedback obtained through the survey of customer satisfaction [84] need to be given a fresh look.

Three quality standards in the field of diagnostic laboratories namely Indian Standard Organisation (ISO), National Accreditation Boards for Laboratories (NABL) and World Health Organisation (WHO) [85-87] recommend practice of specific standards for the prescribed quality. ISO and NABL accreditations are awarded to the particular laboratories which follow these guidelines. As these accreditations bring more popularity and reputation to diagnostic laboratories, there is an increased initiative from the top-managements to implement the quality aspects in their day-today operations. Importance of disposing medical waste is also discussed Process improvement is one such aspect of quality that can bring in phenomenal outcome in customer service. It may be summarised that achieving customer satisfaction is the prime focus in the service of both healthcare and diagnostic laboratories.

In view of all the discussed areas of healthcare, it is observed that not much of research has gone into the topic of process improvement in operations of diagnostic laboratories. It is envisaged that integrating people, process and productivity is the need of the hour. Hence this paper recommends more research in Process improvement of diagnostic laboratories which delivers the potential benefits given in Table 1.

**Table 1. Potential Benefits of process improvement in diagnostics laboratories**

Sl. No.	Potential Benefits of Process Improvement
1	Reduces Turn-around-time
2	Planning and asset utilisation
3	Demand Forecasting
4	Capacity Management
5	Schedule of Resources
6	Reduces expenses
7	Increases Customer satisfaction
8	Increases speed-throughput
9	Enhances strategic decision-making related to process-flow, patient-flow and facility design
10	Transfers knowledge from operational experts to patient-facing staff members [88,89]

### 3. CONCLUSION

In ever-changing scenario of healthcare service sector, it is important to retain popularity and reputation to compete with the potential competitors. Hence it is of tremendous importance to understand the value of “delivery of service with quality”. In this context, the tools adopted by a hospital should integrate its mission and vision with its operational activities, as more streamlined operational flow of activities drastically reduces variability and provide “Standard” for the way to do work and bring in continuous improvement within the organization. Process improvement should be envisaged as the journey of patients through the care delivery system. This helps in identifying constraints and bottlenecks, rework and unnecessary steps that are involved. It is highlighted as the single most useful diagnostic tool for determining the origin of

problems. Bottlenecks of Process could be further classified into Process bottlenecks and functional bottlenecks, which will help in setting the pace of each of the processes and overall co-ordination. In this context, it is relevant to state that an organization has to adapt to opportunities and threats of the immediate environment with specific focus of becoming process-centric through the concept of innovation and agility. At the same time, there should be a clear reflection of co-ordination between strategy and execution, thus promoting process innovation. Incidentally, process improvement could bring in enormous changes in the following aspects:

- Determining target in the area of consideration
- Understanding current situation
- Contemplating required situation, Implementing changes



Since healthcare is a complex socio-technical system, the following attributes of process improvements are highlighted:

- Reliability
- Robustness
- Maintainability
- Rapidity

Hence it could be concluded that the multi-fold benefits of process improvement can upgrade the diagnostic laboratory from the existing level to the next higher level.

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