

# **Development and verification of a thorough assessment instrument to evaluate the effectiveness of medical equipment management systems (Mems) in public hospitals in India**

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## **Abstract:**

In order to measure how well Medical Equipment Management Systems work in public hospitals in India, this project aims to build and validate an extensive assessment instrument. For healthcare delivery to be both safe and of high quality, medical equipment management must be done effectively. Using a mixed-method approach, the research designs and validates the instrument by combining qualitative interviews with quantitative surveys. The tool includes important criteria including financial management, personnel training, regulatory compliance, maintenance procedures, and equipment utilisation. In order to evaluate validity and reliability using statistical metrics, pilot testing was carried out at a few chosen hospitals. The results provide a standardised framework for regular assessments and well-informed decision-making, while also shedding light on the advantages and disadvantages of MEMS in public healthcare facilities. The goal of this study is to improve hospital management and the standard of healthcare in general.

**Keywords:** Mems, Development, Verification, Public hospitals, India

## **INTRODUCTION**

By guaranteeing that medical equipment are accessible, secure, and efficient, Medical Equipment Management Systems (MEMS) are essential to the smooth operation of healthcare institutions. Budgetary limitations, a lack of training, and disjointed management systems make handling medical equipment in India's public healthcare system very difficult. These

problems are made worse by the lack of a standardised evaluation tool to evaluate MEMS efficacy.

By creating and approving a thorough instrument that evaluates MEMS in India's public hospitals, our research seeks to close this gap. Equipment purchase, preventive and corrective maintenance, personnel competence, regulatory compliance, and financial management are among the important elements that the instrument is intended to assess. Hospital managers and legislators may use this evaluation to identify problem areas and carry out focused initiatives to maximise the provision of healthcare services.

The study takes a methodical approach, beginning with a comprehensive assessment of the literature to find best practices and gaps in the field. Tool creation, pilot testing, reliability analysis, and validation via expert reviews and field testing are the following stages. It is anticipated that the findings would provide practical advice for enhancing MEMS and enhancing the general efficacy and efficiency of public healthcare facilities.

#### **Biomedical device management and maintenance program:**

To say that medical equipment is in disrepair, particularly in terms of upkeep and repair, would be an understatement. Typically, hospitals only have about 60% of their equipment in perfect working order. Research conducted by the Department of Electronics (DOE) inside the Indian government has shown that public hospitals in nine states, including Delhi, have lately spent fifty million rupees on a variety of state-of-the-art medical equipment. It is because there aren't enough resources or replacement parts available. Researchers from nine different states (Tamil Nadu, Uttar Pradesh, Maharashtra, Assam, Bihar, Delhi, Madhya Pradesh, Orissa, Bihar, Punjab, and Uttar Pradesh) visited 132 public hospitals using survey data as their foundation. Evaluation results indicate that the medical electrical equipment, which was acquired for 180.58 million rupees and has a total value of 48.61 crore, is no longer operational. Extrapolating the findings to other states would suggest that they do not have the means to acquire equipment worth at least 50 crore rupees, as the research was confined to hospitals in Punjab. The research only covered hospitals located in Punjab, as stated by Dasanayaka et al. (2012).

## **Medical equipment Maintenance in nursing hospital in India**

To maintain equipment in good working order or to fix it so it may be used again is what the word "maintenance" refers to. Performing maintenance on a manufacturing plant may increase its availability, which in turn can boost efficiency and safety while keeping costs down. Many different kinds of tools are included under the general phrase "medical technology" at healthcare facilities. These tools aid in diagnosis, treatment, monitoring, rehabilitation, and more. The administration of medical technology is crucial to the provision of healthcare. Medical device management has to be thorough if patients are to get top-notch therapy (David et al., 2004). Developing a maintenance strategy that considers the technology's operation and potential faults is essential for the management of medical equipment. 4 Any company whose major source of income is its physical assets should prioritise creating and maintaining a strong maintenance department. But even the most cutting-edge technology has the potential to become outdated within six to seven years after purchase and installation. In tertiary hospitals, medical equipment makes up to 40-50% of the whole budget. Companies with substantial fixed assets may find that maintenance expenses consume 50% of their operating budget. People may cut down on these expenses significantly if they have access to sophisticated maintenance solutions. Consequently, maintenance costs might wind up being a company's primary source of controlled spending. Healthcare businesses must prioritise cost reduction and enhance their financial management. Medical device failure rates are typical worldwide, even in moderately developed nations like the US. Medical device failure rates may reach 60% in certain regions of the globe, according to the National Centre for Health Systems Resources. This is true despite the fact that modernising health technology enhances the general effectiveness and safety of medicinal treatments. An indisputable effect is the fact that it raises healthcare costs. When providing services, it is crucial to keep patients' requirements in mind for health technology to work well. Any company involved in health care will tell you that purchasing medical equipment is their biggest investment. Regular maintenance is crucial for ensuring the safety of users and patients, increasing service availability, and keeping key equipment reliable (National Treasure, 2017).

The best way to maintain medical equipment is not a simple question to answer. The majority of the challenge arises from the need to improve equipment performance while decreasing capital expenditures and extending residual life in order to reduce equipment maintenance costs. In response to ever-tightening regulatory requirements, healthcare companies have also

neglected to preserve substantial strategic planning flexibility. Even if regulatory standards have been tightened, this is still relevant. The maintenance procedure, sometimes referred to as the "daily bread" of clinical engineering, is the most crucial aspect of a medical device's existence. Equipment operability, accessibility, and safety must be the first concerns during maintenance. The first obstacle that clinical departments must overcome is figuring out the best way to preventively maintain each piece of equipment. Patient safety, the resource's inherent maintenance needs, and the organization's goals must be considered while determining the order of maintenance chores. The multidimensional models show that distributing the resources (human, material, financial, and documentation) is a prerequisite to implementing the selected plan. If the selected approach is successfully implemented, then (Di Virgilio, et al., 2010).

Furthermore, clinically rigorous resource maintenance, which was long despised, is now seen as crucial to value development. Following a period of undervaluation, its role was at last acknowledged. Maintenance departments in healthcare organisations, like those in other industrial sectors, rely heavily on performance measurement. Execution of improvement projects, comparing maintenance plans and operations, and countless other tasks may all benefit from well-designed KPIs. We thus anticipate that this study will lay the framework for future research that will assess the continuity of care process and investigate the factors that cause operational problems with medical devices. Determine the efficacy of healthcare is another objective of ours. Accordingly, finding out what the health sector can gain from clinical maintenance performance monitoring is the fundamental goal (Enshassi, et al., 2015).

### **Healthcare in India**

There is a clear separation between the public and private sectors of healthcare in India. Customers are not charged for the basic, intermediate, or tertiary health services that are provided by the public sector. From elementary school all the way up to college, everyone has access to free preventative and curative healthcare via the national public sector. The government oversees and pays for these services, which account for around 18% of overall health expenditure and 0.9% of GDP. On the other hand, when it comes to providing outpatient services for individualised treatment, the private sector is leading the way. More than 82 percent of healthcare spending and 4 percent of GDP come from the private sector. The primary goal of privately financed private health services, according to statistics on national

health care consumption, is to provide basic healthcare. So, low-income and working-class people may end up paying a disproportionate share for these services. There are typically three main styles of management in the field of public health. Every government should prioritise protecting the public's health. Second, the federal government is ultimately responsible for ensuring access to healthcare in regions without their own legislative. As a middleman between the states and funding organisations, it also promotes a number of US state-level initiatives, writes and oversees federal laws and regulations, and more. The NIST, or National Institute of Standards and Technology, is responsible for carrying out these duties. Furthermore, the programmers on the concurrent list are jointly held accountable by both the federal and state governments for the programming tasks they fulfilled, as stated in the Health Environment - Medical Device Management Plan (2010). All branches of government and relevant interest groups participate in a consultation process to establish public health objectives and plans. With its facilitation function, the Central Council on Health and Family Welfare (CCHFV) is tasked with maintaining oversight. There was a dramatic increase in medical facilities and physicians in India between the 1950s and the 1980s. Furthermore, the large population rise in the late 1980s is largely responsible for the decline in the number of licensed doctors per 10,000 population, which decreased from four per 10,000 in 1981 to three per 10,000 in 1989. Reason being, India has a very little population. The United States had a bed availability of 10 per 10,000 in 1991. New projections show that starting in 2005, the number of medical professionals graduating annually will be close to 15,000. In all, 242 certified facilities make up the countrywide network, employing an estimated 250,000 dentists. Primary health clinics (PHCs) play an essential role in rural areas' healthcare systems. Official statistics show that in 1991, India had 27,400 pharmacies, 11,200 hospitals, and 22,400 basic healthcare institutions.

According to the United Nations, these centres are a component of a larger healthcare system that transports the sickest patients to larger hospitals in cities so that some people may get treatment on a regular basis. Typically, paramedics with specialised training take care of patients in primary health care facilities and subcenters. One hundred eighty-one thousand eleven beds were available in American hospitals and other healthcare institutions in 1991. The geographic distribution of hospitals is significantly affected by the socioeconomic condition of the local population. The study's conclusions were based on official government statistics, which were seen as more credible than a private survey from the early 1990s, and

they showed that 7,300 hospitals were operating in India in 1992. Almost 4,000 of these assets were jointly owned by federal, state, and municipal governments, all of which were responsible for their maintenance. A total of 2,000 hospitals, including several smaller ones, were funded by philanthropic groups and the government. Rural regions also housed a number of these healthcare institutions (Health Environment - Medical Device Management Plan, 2010).

The other 1,300 clinics were run by private individuals, and most of them were fairly small. In the early 1990s, much of the state-of-the-art medical equipment was used in major cities and metropolitan regions, and it was mostly imported from Western nations. Bringing this technology in from the outside was crucial. Before 1992, only over a quarter of the 1,300 private hospitals in the US had cutting-edge technology for the diagnosis and treatment of cancer and other potentially fatal illnesses. Hospitals and other healthcare facilities in India started to provide more personalised treatment as the country's middle class expanded and the private healthcare industry took off in the 1990s. More than 163,000 public health institutions, including hospitals, rose from 725 in the 1970s. Lack of responsibility for treatment quality, underfunded health care, incompetent leadership, and clumsy logistical administration all contribute to a tough management environment. The private sector is stepping up to the plate to address the ever-increasing need for medical care. Private health insurance is the preferred method of payment for medical care, according to a substantial amount of research (ESIC, 2017).

### **The Present State of Health Care Technology Management and the Obstacles It Faces**

Despite the best efforts of the World Health Organisation (WHO) and its health regulations and recommendations, maintaining hospital equipment is a challenging task for every nation's health ministry, especially those in rural and developing areas (World Health Organisation, 2011). As of 1989, the performance of medical equipment in Ghana, West Africa, was determined to be 64.3%, as reported in [4]. There was an improvement in the percentage of hospital equipment that failed, according to the statewide inventory study. A few of the challenges with hospital equipment management are listed below by Zienaa (2009):

- Equipment downtime is prolonged. (The amount of time that passes without the system delivering its main aim).

- The administrator of the hospital does not have enough understanding of the significance of regular maintenance and servicing of hospital equipment.
- Maintenance receives no or very little funding.
- There is no structure in place to ensure frequent audits.
- A deficiency in understanding and creative use of modern machinery.
- Delays in reporting faults, for instance BP Fixing device using plaster.
- Finding replacement components might be challenging.
- Operators were not given the necessary technical training.
- Unattended, outdated machinery in the wards and maintenance area.
- A healthcare IT decision-making information system that is not based on evidence.

### **The Five-S Managerial Tool as a Hospital Equipment Management Tool in Health Sector**

5S is really an acronym of five Japanese words: Seiri, Seiton, Seiso, Seiketsu, and Shitsuke, as stated by (5S Comprehensive Education and Resource Centre) and (What Is 5S? - Sort, Set in Order, Shine, Standardise, Sustain). In order to ensure high-quality work, these are the essentials of keeping the workplace clean. Gapp et al. state that the Japanese five S methods are a tool for comprehensive quality management. These techniques seek to increase output while maintaining a constant level of quality by improving workplace safety, efficiency, and cleanliness. Organisational managers often use it to maintain a tidy workplace by imposing rules and regulations. Those in charge of ensuring high-quality work will benefit from the 5S technique in the manner listed below, according to Graban:

- More safety and equipment availability.
- Raised spirits among workers.
- A rise in profits is the result of heightened morale, productivity, and quality of work.
- To act as a guide for maintaining equipment.
- To work as a more effective form of discipline to monitor the cutting of costs and waste.

- For the purpose of laying the groundwork for future enhancements, purpose
- Involvement, ownership, and responsibility are fostered in the workplace.

Healthcare technologists and biomedical engineers may now properly manage hospital equipment by using a concept based on the Japanese 5S quality tool, which has traditionally been utilised primarily by managers and industrial businesses.

### **Medical device handling problems**

In the health care industry, the many medical devices are widely recognised as an essential component of the infrastructure for service delivery. Additionally, it should be mentioned that medical gadgets, along with medications and several other technologies, have been instrumental in the remarkable progress made in health care over the last century. Many people fail to recognise the critical importance of equipment while planning, constructing, and operating a facility.

For less developed nations, whose economic conditions are already unstable, this is particularly true. An estimated 25% to 50% of all medical equipment in underdeveloped nations are deemed unusable due to a variety of factors, according to research carried out by the World Health Organisation (WHO) and other global organisations. The improvement of health care for the residents of these nations is severely impeded by this.

Although some unused gear was given out, the majority was borrowed from bilateral and multilateral organisations, which meant the beneficiaries had to make some serious concessions. On top of that, you may get a few pieces of content for nothing. When it comes to managing recurrent expenditures, there are additional factors to think about than a lack of funds, which is a common cause of device downtime. Experts from throughout the world have concluded that poor issue management is the primary cause.

### **CONCLUSION**

In order to improve India's healthcare system, it is necessary to create and validate an extensive evaluation tool to measure the efficacy of MEMS in public hospitals throughout the nation. The research shows that data-driven decision-making and the identification of operational deficiencies are both aided by rigorous review. This study gives legislators and hospital managers a way to keep tabs on medical equipment management procedures and make

improvements with the use of a trustworthy and verified instrument. Using the device continuously may enhance resource utilisation, decrease equipment downtime, increase patient safety, and overall care quality. The tool may be improved in future studies by adding more factors and using it in other healthcare settings. Public hospital medical equipment management stands to benefit greatly from this evaluation tool's adoption, which could lead to better healthcare for all Indians.

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