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Short Communication

Reshaping Healthcare Systems for Communicable Disease Control: Insights from the COVID-19 Pandemic

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A B S T R A C T

The COVID-19 pandemic has underscored the urgent need for resilient and adaptive healthcare systems to effectively manage communicable diseases and prevent future outbreaks. Healthcare providers face increasing pressure to enhance disease surveillance, emergency preparedness, and service efficiency, ensuring that public health interventions remain proactive and responsive especially during the communicable disease outbreaks. Despite advances in medical research and healthcare infrastructure, many systems still struggle with resource allocation, outbreak containment, and community engagement, particularly in developing nations like India, where accessibility and affordability remain critical concerns. This study identifies 33 critical success factors (CSFs) that directly impact healthcare system resilience in communicable disease management, emphasising the importance of economic stability, organizational efficiency, social awareness, smart technologies, performance management, and sustainability. Findings highlight those economic investments in disease preparedness, along with strong governance and policy interventions, significantly enhance a system's ability to respond swiftly to emerging threats. Additionally, the integration of AI-powered diagnostics, telemedicine, and real-time epidemiological tracking improves healthcare accessibility while reducing the burden on traditional medical infrastructure. By strategically reinforcing data-driven interventions and sustainable healthcare practices, this study presents a structured framework for pandemic resilience, ensuring that healthcare systems remain agile, adaptive, and capable of mitigating future communicable disease threats.

Keywords: Communicable Diseases, Healthcare Resilience, Pandemic Preparedness, Public Health Systems, Smart Healthcare Technologies, Epidemiological Surveillance

Introduction

The outbreak of novel coronavirus disease 19 (COVID-19) pandemic has surfaced many problems and priorities that have affected the healthcare sector in many ways (Kumar *et al.*, 2020; Nimavat *et al.*, 2022).[1] It has unravelled and thrown a spotlight on deep-rooted challenges in the healthcare system and has emphasized the urgent need to upgrade and improvise the socio-technical discrepancies. The healthcare sector is one of the most significant and cost- intensive sector of an economy. The prime objective of this sector is to provide much -needed healthcare services to each individual irrespective of the cultural and regional dissimilarities and how these services are delivered and utilised effect the health outcomes (Padma *et al.*, 2009).[2] The healthcare industry in the developing countries has come of age and is capable of offering quality service at a competitive price (India Brand Equity Foundation, 2023)[3] In the era of limited financial and workforce resources, healthcare systems and policies are constantly under pressure with the issue of delivering high quality services to an increasing number of customers (patients and attendants) (Chokshi *et al.*, 2016).[4]

Substantial studies have been devoted to the healthcare system. The goal of this paper was to explore the factors responsible for the performance and utilisation of the healthcare system in India. As the Indian population is undergoing great transitions in social, demographic, and epidemiological attributes, disparities in healthcare utilization and associated risks have increased (Peters, 2003). Also, COVID-19 pandemic has unearthed the challenges for the Indian healthcare system to respond in new ways. There have been few studies done highlighting different attributes of healthcare systems in India during and pre-pandemic (COVID-19) delineating the importance of various factors in enhancing the healthcare services and performance of healthcare system in India. However, the existing literature lacks a framework that present the relationships between these critical success factors.

While previous studies have explored various attributes affecting healthcare efficiency, existing literature lacks a structured framework that elucidates the hierarchical relationships among CSFs. Therefore, this paper aims to:

1. Identify the CSFs influencing healthcare performance in managing communicable diseases.
2. Prioritise these CSFs to determine their relative impact on healthcare efficiency.
3. Develop a hierarchical model using Total Interpretive Structural Modelling (TISM) and MICMAC analysis, establishing interdependencies among the CSFs for strategic implementation.

By proposing a structured framework, this study seeks to enhance healthcare system resilience, reduce uncertainties in pandemic response, and facilitate data-driven decision-making for healthcare stakeholders. A nuanced understanding of these critical factors will aid in strengthening India's healthcare infrastructure, ensuring effective disease management and promoting equitable access to healthcare services in future outbreaks.

Literature Review

Communicable diseases continue to pose significant challenges to healthcare systems, particularly in developing nations like India, where they contribute substantially to morbidity and mortality rates. The COVID-19 pandemic exposed critical vulnerabilities in healthcare infrastructure, policy implementation, and resource allocation, emphasising the need for structured frameworks to enhance healthcare resilience (Kumar et al., 2020; Nimavat et al., 2022).[5] A systematic review of healthcare resilience during COVID-19 highlights the importance of adaptive governance, resource optimisation, and emergency preparedness in mitigating the impact of infectious diseases (Chokshi et al., 2016; Roberton et al., 2020).[6] Studies indicate that health financing and ICT adoption significantly improve disease surveillance and response, with governments prioritising mass vaccination programmes and digital health integration to strengthen healthcare systems (Peters, 2003; Raghupati, 2020).[7] The pandemic also underscored the role of behavioural risk factors, such as smoking and obesity, in exacerbating disease severity, necessitating targeted public health interventions (Ashraf et al., 2019).[8] Additionally, the adoption of telemedicine, electronic health records, and AI-driven diagnostics has revolutionised healthcare delivery, enabling real-time monitoring and improved patient outcomes (Snoswell et al., 2020; Goyal et al., 2021.[9] Sustainability remains a crucial aspect of healthcare resilience, with ethical standards, waste management, and green healthcare practices contributing to long-term system efficiency (Gostin, 2017; Schröder-Bäck et al., 2014).[10] By integrating critical success factors (CSFs) into a structured framework, healthcare systems can enhance preparedness, improve service delivery, and strengthen resilience against future outbreaks. Understanding the hierarchical relationships among CSFs will enable policymakers and healthcare providers to implement targeted interventions, ensuring effective responses to communicable diseases (Fridell et al., 2019).[11]

A comprehensive literature review, supplemented by expert opinions, led to the identification of 33 critical success factors (CSFs) that influence healthcare system performance in managing communicable diseases. These CSFs were categorised into six domains-social, organisational, economic, smart technologies, performance management, and sustainability-to ensure a structured evaluation of their impact on healthcare efficiency and

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resilience. The social dimension plays a crucial role in healthcare utilisation, shaping patient awareness, access to healthcare services, and community initiatives that enhance disease prevention (Andersen, 2008; Li et al., 2016).[12] The organisational dimension highlights the importance of leadership, management styles, and resource availability, with studies emphasising how well-structured healthcare institutions can improve service delivery, particularly during pandemic scenarios (WHO & UNICEF, 2022; Brodtkorb et al., 2019).[13] Economic factors, including government health policies, financing, and population health indices, have a direct effect on healthcare accessibility, with effective governance and investment in health systems being key to pandemic preparedness (Chokshi et al., 2016; Raghupati, 2020).[14] The integration of smart technologies, such as telemedicine, AI-driven diagnostics, and electronic health records, has emerged as a transformative factor in managing disease outbreaks efficiently (Snoswell et al., 2020; Goyal et al., 2021).[15] Performance management, measured through key performance indicators (KPIs), consumer segmentation, and risk mitigation strategies, ensures healthcare systems function optimally during crises (Braithwaite et al., 2017; Ramani et al., 2011).[16] Lastly, sustainability remains a critical consideration, with ethical standards, waste management, and green practices contributing to long-term resilience and improved system efficiency (Gostin, 2017; Schröder-Bäck et al., 2014).[17] By integrating these domains into a hierarchical framework, this study aims to enhance healthcare system resilience, improve emergency preparedness, and develop data-driven strategies for managing communicable diseases effectively.

Methodology

The present study adopts a qualitative modelling approach to investigate the critical success factors (CSFs) that influence the performance of the healthcare system in managing communicable diseases in India. In light of the exploratory and developmental nature of the research, a three-tiered methodology was employed beginning with an extensive literature review, followed by a Delphi study, and culminating in the application of Total Interpretive Structural Modelling (TISM). The TISM method was instrumental in establishing the hierarchical structure among the identified CSFs and understanding their mutual influence and relative driving power within the healthcare system (Patri & Suresh, 2017; Sherwani & Ali, 2018; Sushil, 2012).[18] The Delphi technique, carried out in two structured rounds with a panel of 32 experts, was used to validate and refine the initially identified factors. In the first round, experts reviewed the comprehensiveness of the factors derived from the literature and suggested modifications or additions based on their domain experience. In the second round, these experts assigned weights and grouped the refined CSFs into logical categories, thereby helping to minimise bias and build consensus. To maintain the independence and objectivity of responses, the experts were consulted individually to avoid mutual influence and ensure confidentiality. The final set of CSFs, validated and categorised through this process, served as the basis for TISM modelling, through which the hierarchical interrelationships among the factors were developed offering a systems perspective on strengthening healthcare performance in the context of communicable disease management.

To ensure a comprehensive and multidisciplinary understanding of the factors influencing healthcare system performance in managing communicable diseases, insights were gathered from a panel of 32 domain experts. The demographic characteristics of the experts reflected a balanced representation across gender, age, and professional experience. Of the participants, 12 were female and 20 male. A majority (59%) were within the 35–45 year age group, followed by 31% in the 25–35 year range, and 10% above 45 years of age. In terms of professional experience, more than half (53%) of the respondents had 5–10 years of experience, while others had varying degrees of seniority, including 11–20 years (25%) and over 20 years (9%).

The expert panel encompassed a diverse range of healthcare stakeholders, enhancing the credibility and richness of insights gathered. From the domain of administration, 3 experts were involved, while the majority represented the medical profession, including both private[7] and public sector (7) clinicians specializing in psychiatry, paediatrics, surgery, emergency medicine, and ophthalmology. The panel also included 8 paramedics and 7 informed consumers of healthcare services. This diversity in professional backgrounds enabled a well-rounded validation of the identified critical success factors, ensuring both clinical and operational relevance to the study of healthcare performance in the context of communicable disease management.

Findings

In this study, Total Interpretive Structural Modelling (TISM) was applied to analyse the structural relationships among critical success factors (CSFs) influencing healthcare system performance in managing communicable diseases. TISM is a methodology that establishes hierarchical relationships between complex factors, aiding in the identification of key determinants that drive healthcare efficiency and outbreak response. Using expert validation through a Delphi study, the research identified 33 CSFs, categorised into six domains-each playing a vital role in the prevention, surveillance, and management of communicable diseases.

By employing TISM, the study mapped interdependencies among CSFs, determining which factors drive systemic

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resilience and which depend on broader structural enablers to function optimally. This hierarchical framework revealed that economic, organisational, and social dimensions hold strong driving power, shaping healthcare funding, institutional preparedness, and community engagement. These factors directly influence policy formulation, healthcare accessibility, and resource distribution-elements that are critical for controlling the spread of infectious diseases such as COVID-19, tuberculosis, malaria, and influensa. Smart technologies, including m-health services, electronic health records, AI-driven diagnostics, and automated disease surveillance systems, emerged as linkage variables-both dependent on core governance structures and essential for enhancing real-time tracking, early warning systems, and patient management during outbreaks.

Meanwhile, performance management and sustainability were classified as dependent variables, meaning their effectiveness is largely contingent upon strong economic investments, healthcare infrastructure, and policy enforcement. Performance management encompasses key performance indicators (KPIs) for disease control, risk mitigation strategies, and adaptive resource allocation, ensuring timely and effective public health interventions during epidemics. Sustainability factors, including waste management, ethical compliance, and green healthcare practices, help maintain healthcare efficiency during prolonged crises, preventing environmental hasards that exacerbate disease transmission.

Following the TISM analysis, MICMAC (Cross-impact Multiplication Applied to Classification) was employed to assess the dependence and driving power of the identified CSFs in the context of communicable disease prevention and response. MICMAC enables the identification of key determinants by mapping their direct and indirect interdependencies, offering a clearer understanding of hierarchical influences within healthcare systems (Saxena et al., 1990).[19] Based on MICMAC analysis, the CSFs were classified into four quadrants-autonomous variables, dependent variables, linkage variables, and driving factors, helping delineate their impact on pandemic preparedness, emergency response strategies, and healthcare system resilience.

Findings revealed that the economic dimension (ED) holds the highest driving power, reinforcing its critical role in funding vaccination programs, strengthening hospital infrastructure, expanding digital health services, and supporting public health campaigns-all essential components in mitigating widespread infectious disease transmission. Additionally, social (SD) and organisational dimensions (OD) emerged as strong drivers, influencing public awareness campaigns, healthcare accessibility, community-based disease monitoring, and institutional coordination during outbreak responses. Meanwhile, smart technologies (ST) were identified as linkage variables, indicating their dual role in enhancing early disease detection and telemedicine accessibility, particularly during highly transmissible outbreaks like COVID-19 and seasonal influensa.

The sustainability (SE) and performance management (PM) dimensions, classified as dependent variables, rely on systemic enablers such as economic investments and healthcare policies for long-term success. Sustainability factors, such as smart hospital designs, energy-efficient healthcare practices, and medical waste disposal systems, help prevent secondary disease outbreaks stemming from environmental contamination. Performance management plays a pivotal role in streamlining patient flow, monitoring epidemiological trends, and assessing healthcare system adaptability-critical in containing outbreaks and preventing healthcare collapse during pandemics.

By integrating TISM and MICMAC insights into the structured framework, this study presents a data-driven model for healthcare optimisation, ensuring targeted interventions that strengthen communicable disease response strategies and enhance healthcare system preparedness for future outbreaks. The systematic classification of CSFs provides valuable insights for policymakers, healthcare administrators, and researchers, helping them formulate strategic, evidence-based solutions for disease control and healthcare resilience.

Discussion and Managerial Implications

The COVID-19 pandemic exposed significant vulnerabilities in global and national healthcare systems, reinforcing the need for structured, data-driven approaches to managing communicable diseases. This study presents a hierarchical framework designed to optimise healthcare resilience by analysing critical success factors (CSFs) that influence pandemic preparedness, emergency response, and infection control mechanisms.

The economic dimension emerged as the strongest driver of healthcare performance in managing pandemics, underscoring the necessity of financial investments, resource allocation, and policy enforcement to strengthen epidemic response capabilities. During COVID-19, nations with high healthcare investments and strong economic policies managed to rapidly scale up testing, vaccination, and emergency care facilities, demonstrating the pivotal role of economic stability in disease management. Similarly, the organisational dimension, comprising leadership structures, institutional adaptability, and healthcare governance, influenced how countries coordinated response strategies, facilitated hospital resource distribution, and ensured

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supply chain continuity for essential medicines and protective equipment.

Social factors were critical in public health intervention effectiveness—community engagement, disease awareness campaigns, and accessibility to healthcare information played a major role in controlling the spread of infectious diseases like COVID-19, tuberculosis, malaria, and influensa. Smart technologies, classified as linkage variables, were instrumental in pandemic surveillance, digital healthcare transformation, and AI-powered diagnostics. Telemedicine, mobile health apps, and electronic health records enabled healthcare systems to reduce in-person hospital visits while maintaining patient monitoring, contributing to infection control and continuity of care during lockdowns.

Sustainability and performance management emerged as dependent variables, relying on financial stability, technological integration, and governance models to ensure long-term resilience. Sustainable healthcare practices, including waste management, clean energy adoption, and green hospital designs, helped mitigate secondary risks associated with communicable diseases by reducing environmental contamination and biohasard exposure. Performance management, assessed through epidemiological tracking, mortality rate reduction, and vaccination efficiency, was vital in monitoring healthcare system effectiveness during the pandemic.

Implications for Future Communicable Disease Preparedness

To strengthen healthcare resilience against future pandemics and emerging infectious diseases, governments, healthcare institutions, and policymakers must:

- Prioritise economic investments in public health infrastructure, vaccination programs, and emergency response frameworks.
- Enhance organisational adaptability by integrating flexible healthcare policies, rapid disaster response mechanisms, and optimized hospital workflows to manage patient surges during disease outbreaks.
- Deploy smart technologies, including AI-assisted disease surveillance, IoT-enabled remote patient monitoring, and automated diagnostics, to detect, prevent, and contain infectious disease spread.
- Improve community engagement through public health campaigns, behavioural interventions, and digital education platforms to empower populations with disease prevention knowledge.
- Integrate sustainability measures, such as efficient medical waste disposal, ethical healthcare resource distribution, and renewable energy use, to reduce environmental risks associated with disease transmission.
- Continuously monitor healthcare system efficiency using key performance indicators (KPIs) focused on epidemiological data, healthcare accessibility, and emergency preparedness.[20]

Conclusion

In conclusion, this study provides a structured framework for enhancing healthcare system performance in managing communicable diseases, emphasising the interconnected influence of economic, organisational, social, technological, sustainability, and performance management factors. The hierarchical relationships established through TISM and MICMAC analysis offer data-driven insights into how healthcare resilience can be strategically improved for pandemic preparedness and effective disease response. By prioritising driving factors like economic investments, policy adaptability, and technological integration, healthcare systems can strengthen outbreak surveillance, optimise resource distribution, and ensure proactive emergency responses. The study highlights the critical role of smart technologies in bridging gaps between healthcare accessibility, real-time diagnostics, and infection control strategies. As communicable diseases continue to challenge global healthcare infrastructures, this research offers valuable implications for policymakers, healthcare practitioners, and decision-makers, ensuring that future interventions are structured, adaptive, and sustainable. The systematic classification of CSFs reinforces the need for evidence-based strategies, ensuring healthcare systems remain resilient, responsive, and prepared for emerging infectious threats.

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