

## SPECIAL ISSUE ARTICLE

# COVID-19 critical success factors in Indian healthcare industry—A DEMATEL approach

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## Abstract

The proposed study aims to provide COVID-19 critical success factors (CSF) associated with pandemic circumstances in the Indian healthcare industry (HCI). The CSF was identified via expert team inputs and a detailed literature review. The Decision-Making Trial and Evaluation Laboratory (DEMATEL) method is used to determine the causal relationship between identified CSF. The methodology was supported by the case study of the Indian HCI. A total of 15 CSF in the Indian HCI during COVID-19 are identified and prioritized using the DEMATEL method. The findings indicate that the high-quality personal protective equipment (PPEs; LC8) and testing laboratories/facilities, centres, and kits (LC15) are the significant cause, and appropriate healthcare laws (LC13) are the least effect group. The study shows that policy and decision-makers need to emphasize on LC8 and LC15 CSF in the Indian HCI and act accordingly to win the battle against post-COVID-19 circumstance. The policy/decision-makers and healthcare administrations can identify the CSF and focus on that particular CSF. The identified CSF will help policy and decision-makers swiftly build up the HCI to cope with the future pandemic.

## KEYWORDS

COVID-19, critical success factors, DEMATEL, healthcare industry (HCI)

## 1 | BACKGROUND OF STUDY

The first unknown aetiological pneumonia cases are identified in Wuhan City, and the Chinese Centre for Disease Control and Prevention named it Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2; Rowan & Laffey, 2020). The World Health Organization (WHO) renamed the SARS-CoV-2 as COVID-19. Because of high health concern and health system vulnerability, the pandemic outbreak was declared public health emergency of an international nature on 30 January 2020 (WHO, 2020a). The COVID-19 pandemic in India is far better than other affected countries as there are only 6.59% active cases, and the recovery rate is 92.11% as of 7 April 2021, 08:00 IST (GMT + 5:30; MoHFW, 2020a).

The COVID-19 pandemic has placed a significant burden on the world's healthcare industry (HCI). This industry is an essential and

front leading sector during COVID-19 in Indian and the world over. During the fight against COVID-19, the HCI and the healthcare staff (HCS) were the front lines defence providing patient care by ensuring COVID-19 infection prevention and control (Chatterjee et al., 2020). However, the outbreak was a clinical threat to HCS working in the HCI as they and their dear ones are becoming susceptible to the COVID-19 (Misra, 2020). During the pandemic's initial phase, the Indian HCI faced a critical care crisis and lacked enough medical support. The COVID-19 difficulties faced by HCI include quality and quantity of PPEs, ventilators and PPEs supply, medical infrastructure, testing facility, drug/vaccinations, and so on (Godlee, 2020; Namendys-Silva, 2020; Rowan & Laffey, 2020; Tanne et al., 2020). Earlier studies also discussed HCI issues related to scarce medical resources, fair allocation, allocation of monetary funds, and effective crisis management (Lee et al., 2020; Xie et al., 2020). Indeed,

healthcare availability mismatch may result in COVID-19 exposure and infection to the HCS (Misra, 2020). The insights about capacity and supply scarcity in the Indian HCI is highlighted in earlier literature (Chatterjee et al., 2020; Rajagopalan & Choutagunta, 2020). Indeed, in the combat against the COVID-19 pandemic, it is crucial to have an effective strategy for crisis management and healthcare resource management (Krishnakumar & Rana, 2020). The past studies have highlighted the approaches, emergent preventive strategy, planning/guidelines, and recommendations to be taken by HCI in confining COVID-19 spread (Agarwal et al., 2020; Ehrlich et al., 2020; Huh et al., 2020; Yang et al., 2020).

Further, different psychological, ergonomic, organizational, technological, and working conditional factors requiring focus attention on improving the condition of HCS as pointed by Rathore and Gupta (2021). Irrespective of scarce medical and other resources, the spread of the COVID-19 pandemic in India was appropriately contained, and several cases eventually started to decrease (MoHFW, 2020a). To cease the damage associated with COVID-19, the Indian HCI took adequate measures on an urgent basis. Thus, it is paramount to study and understand the COVID-19 critical success factors (CSF) in Indian HCI and understand the cause-effect relationship among identified CSFs.

There was a shortage of published literature and reports related to COVID-19 CSF endure by the HCI in detail during the research work. Identifying the CSF experienced by the HCI will help to put accelerated efforts in the post-COVID-19 scenario. More importantly, the study will help reduce the COVID-19 further transmission, increase positive cases, and improve the service offered by HCI. It is high time and relevant to identify India's efforts against the COVID-19 pandemic by identifying CSF in Indian HCI. The proposed study fills this literature gap by contributing to identifying the COVID-19 CSF, mainly the Indian HCI. The proposed research provides a theoretical contribution in this direction and showcases their priority vis-à-vis DEMATEL approach. The study finding will help prepare the HCI against the post-COVID-19 pandemic environment and provide policy or planning response in this direction.

Based on the literature review and research gaps, the proposed research work addresses the following research questions.

**RQ1**—What are the CSF of COVID-19 in the Indian HCI and their causal relationship?

**RO2**—What are the future directions for the policy and decision-makers for containing the COVID-19 situation via identified CSF?

The structure of the proposed study covers the literature review in Section 2. The research methodology is covered in Section 3. The case study, data collection, and demographic details are covered in Section 4. The result and discussion are covered in Section 5. The conclusion, future scope, and limitations are covered in Sections 6 and 7.

## 2 | LITERATURE REVIEW

The HCI during the COVID-19 pandemic has faced several challenges involving multiple perceptions. The complexity and various perceptions ensure that the strategies and planning are appropriately intertwined,

multi-structural, which later help implement. The COVID-19 successful mitigation broadly depends on healthcare, economic, social aspects, efficiency, effectiveness, and healthcare delivery reliability (Haleem et al., 2020). Prominent healthcare CSF includes (i) identification, treatment, and quarantine of patients, (ii) responsive medical system, (iii) availability of HCS and medical facilities, (iv) safety and protection of HCS, and (v) healthcare resources supply chain, and so on. There is a plethora of literature highlighting COVID-19 impact on HCI. For instance, Ivanov (2020) studied the effect of COVID-19 on the global supply chain of China, Europe, and the USA and investigated the impact of different supply chain performance parameters. Govindan et al. (2020) studied a decision support system for managing the demand in the healthcare supply chain to mitigate the healthcare supply chain disruptions during a pandemic. Rowan and Laffey (2020) studied the scarcity of personal protective equipment (PPE) in Ireland during the COVID-19 pandemic. Chen et al. (2020) proposed a citizen and social media theoretical model to promote citizen engagement through social media during the COVID-19 crisis. Pamučar et al. (2020) explored the selection of sustainable strategies to reorganize the HCI during the COVID-19 pandemic. Manupati et al. (2020) and Bharsakade et al. (2020) propose an assessment framework for selecting the best healthcare waste disposal technique generated during COVID-19 and a lean approach to managing healthcare waste. However, scanty literature is available on CSF in HCI, particularly in the developing economy. The subsequent section provides insight into different CSF identified in the proposed study.

### 2.1 | The CSF in the HCI

Along with medical readiness, the legal provisions play a crucial role in controlling the further spread of COVID-19. To contain the COVID-19 pandemic requires urgent and strict legal action from government authorities (Gowd et al., 2020). To address the COVID-19 emergency, the Government of India (GoI) invoked the Disaster Management Act (DMA), 2005, Epidemic Disease Act (EDA), 1897 and made subsequent amendment in Epidemic Diseases Act 1897 (EDA, 1897; DMA, 2005; Nomani & Tahreem, 2020). The standard operating procedures (SOPs) are also crucial documents to refer to avoid further transmissions of an outbreak (Dhahri et al., 2020). These SOPs include guidelines related to personal protective equipment (PPEs), personal hygiene, delivery of healthcare, healthcare facility, preventive measures for the community and public, etc. Indeed, during pandemic circumstances, the guidelines, rules, policies, strategies, and action plans to contain pandemic spreads need continuous updates and strict follow-up (Khalid & Ali, 2020). In a time-bound manner, GoI, Ministry of Health and Family Welfare (MoHFW), came up with different SOPs, guidelines, rules, policies, strategies, and action plans related to controlling COVID-19 and made sure that these SOPs are appropriately followed (MoHFW, 2020a).

The main concern during the COVID-19 pandemic was that the pandemic might exhaust available healthcare resources, infrastructure, and HCS. Even in developed nations, there was a concern that these facilities may get overwhelmed due to the sudden surge of COVID-19

patients. Further, the scarcity of healthcare resources, infrastructure, and HCS in developing countries may lead to deterioration in the quality of health support and increased workload on HCS (Alhalaseh et al., 2020). There was a global shortage of medical resources during the pandemic, and global supply chains of necessary medical equipment, PPEs, ventilators, masks, and so on was at strain (Rowan & Laffey, 2020). Mainly there was an acute shortage of high-quality PPE worldwide due to irrational use, panic-buying, rise in demand, and so on (WHO, 2020b). To cope with the demand and supply gap of medical resources, the strategic approach and adequate in-house planning, local manufacturing, and increasing procurement and stockpiling are necessary. The GoI took appropriate steps on a war footing basis and imported high-quality PPE conforming to national, international standards and restricted the export of ventilators, breathing devices, diagnostic kits, PPE, masks, etc. The shortage of ventilators during the COVID-19 pandemic was also taken care of by exploring alternative options, developing indigenous ventilators, and so on (Kumar & Kumar, 2020; Rayasam & Mande, 2020; Tempe et al., 2020). The launch of the Aarogya Setu and other specialized apps were also developed to have real-time monitoring of healthcare resources (Tempe et al., 2020).

Further, to avoid the rapid depletion of medical resources and their potential reuse, it is crucial to have in-house cleaning and disinfection facilities. The appropriate in-house pre-cleaning and disinfection facility such as microwave steam, hydrogen peroxide, ultraviolet light, warm air/steam, dry heat processing, autoclaving, and so on, was developed ensure safe material functionality even after effective COVID-19 treatments. Such in-house facility availability will reduce the burden on the supply of medical equipment, PPEs, ventilators, masks, and so on (Czubryt et al., 2020).

The continuous influx of COVID-19 patients and the demand-supply gap of healthcare resources require rapid expansion of existing healthcare infrastructure and sensible use of healthcare resources. The earlier available literature and guidelines emphasize the careful use of healthcare resources and adequate stockpiling to take care of the demand and supply gap (CDC, 2020a; CDC, 2020b; WHO, 2020c; MoHFW, 2020a). Along with available guidelines, the HCS must ensure that the available resources are wisely allocated to patients requiring critical care. The HCl and public health administration can implement coping strategies for improving the supply, rational use, appropriate sharing, and allocation of healthcare resources (Devereaux et al., 2020; Sharma et al., 2020).

The widespread use of PPEs, syringes, and other healthcare resources during the pandemic also created huge downstream healthcare waste disposal problems (Singh et al., 2021). Thus, it is necessary to have proper management of healthcare waste and increase healthcare waste handling to avoid further spread of the virus (WHO, 2020d; Das et al., 2021). Thus, to take care of healthcare waste disposal, strict waste disposal policy guidelines need to be followed. Further, healthcare waste management requires appropriate identification, collection, segregation, and storage in color-coded bins, transportation, treatment, and disposal, followed by disinfection, personnel protection, and training (Hantoko et al., 2021; Manupati

et al., 2020). The healthcare waste generated in Indian HCl has been managed appropriately as per the GoI and WHO guidelines (CPCB, 2020; WHO, 2020d).

Due to the sudden surge in COVID-19 patients, there was an acute shortage of sufficient and trained HCS. Thus, to cope with the situation, the deployment of additional dedicated HCS in HCl is necessary. Besides, training related to COVID-19 precautionary measures to HCS is also vital. Earlier authors argue that the HCS needs an education and training program related to sample collection, using PPE and their safe disposal, ventilatory management, and so on (Sri et al., 2020; Tempe et al., 2020). These adequate education and training programs impart skills and awareness regarding precautionary measures and appropriate management of healthcare resources among HCS (Ojha et al., 2020). The GoI took initiatives related to an online training program for HCS under the aegis of MoHFW (MoHFW, 2020a). The health authorities also explored an option of young and retired HCS joining the fight against COVID-19 (Alhalaseh et al., 2020). However, to take care of COVID-19 patients, the HCS spends hours with bulky PPEs leading to stress and fatigue during healthcare delivery. Therefore, it is crucial to have a reasonable working hour for HCS to discharge their duties effectively. A dedicated team of HCS can look after COVID-19 patients with a periodic rotation and adequate rest in between (Chandra & Vanjare, 2020). Further, to ensure the safety of HCS, high-quality PPEs can be provided, such as goggles, shoes, head cover, face shield, face mask, gloves, apron, and so on (Goel et al., 2021).

The HCS was widely praised as a COVID-19 warrior by government leaders and media across the globe. However, there were few instances of stigmatization of HCS (Ramaci et al., 2020). These instances lead to an unwanted burden on HCS, leading to ineffectiveness in their healthcare delivery (Taylor et al., 2020). The HCS requires support and collaboration from government authorities, society, and zero tolerance to any violence against HCS (Padubidri et al., 2020). And the communities at large need to behave responsibly towards HCS to discharge their duties efficiently. The supportive, collaborative working atmosphere with trust and professional unity can help HCS discharge their COVID-19 duties more effectively (George et al., 2020). Indeed, to boost the morale of HCS and take their active support during the COVID-19 fight, policymakers and managers need to give attention to appropriate insurance/monetary incentives to HCS. To ensure decent working conditions for HCS, governments and policymakers need to develop policies related to compensation and benefits (Williams et al., 2020). The GoI provided a unique insurance scheme to HCS covering all HCl and wellness centres across pan India. Further, the central and state government provided incentive funds, insurance coverage, encouragement allowance, monthly cash benefits, and so on, to HCS (ILO, 2020).

To flatten the growth curve of COVID-19 essentially depends upon early, accurate detection of the COVID-19 patients, isolating them, and providing effective drug/vaccines. The availability of scientific COVID-19 laboratory testing/facility and kits helps in widespread community testing, patient care, subsequent contact-tracing, and minimizes the mortality rates (Kumar et al., 2021). The efforts were

**TABLE 1** The COVID-19 CSF in the Indian HCI

Sr. no.	CSF	Description	Reference
LC1	Adherence to the standard operating procedure (SOPs)	To control the spread of COVID-19 within and outside of healthcare facility, and to provide safe COVID-19 patient care, adherence to SOPs is essential. The SOPs and guidelines related to personal protective equipment (PPEs) and personal hygiene need to be appropriately followed by the healthcare staff (HCS). Adhering to SOPs and guidelines during the use and removal of appropriate PPEs, personal hygiene, and precautions by HCS is paramount to prevent COVID-19 infection	Xie et al., 2020; MoHFW, 2020a; Dhahri et al., 2020; Khalid & Ali, 2020
LC2	Appropriate in-house pre-cleaning and disinfection facility	Suitable in-house facilities to clean, reprocess, disinfect, or decontaminate the medical equipment, and one-time use of PPE, masks, gloves, and so on, is essential in HCI, specifically during the pandemic scenario. Such a facility helps to ensure safe material functionality even after effective COVID-19 treatments and reduces the burden on the supply chain of medical equipment, PPEs, ventilators, masks, and so on	Rowan & Laffey, 2020; Czubyrt et al., 2020
LC3	Ventilators associate medical infrastructure	The COVID-19 patients, as well as other patients, need ventilator support to recover. The ventilator-equipped infrastructure in India was adequate to tackle infected persons, and appropriate measures were taken if there is a shortfall of ventilators and associated medical infrastructure during the peak of the COVID-19 pandemic	Xie et al., 2020; Agarwal et al., 2020; Goel et al., 2021; Tempe et al., 2020; Rayasam & Mande, 2020; Kumar & Kumar, 2020
LC4	Appropriate working hours	During the COVID-19 pandemic, a high patient load frequently leads to long duty hours of HCS. Appropriate working hours are essential to avoid the fatigue and risk of COVID-19 infection to HCS. The HCS must discharge their duties in regular or small shifts based on a proper rotation to avoid fatigue, physical, and psychological burden	Godlee, 2020; Tempe et al., 2020; Chandra & Vanjare, 2020; Rathore & Gupta, 2021
LC5	Responsible behaviours	During on-duty and community surveillance work, the HCS needs responsible behaviour and support from the community and the public. The responsible behaviour and support lead to greater dissemination of the services offered by HCS. Further, it also helps to have positive morale of HCS, leading to discharging their duties more effectively	Godlee, 2020; Chen et al., 2020; George et al., 2020; Padubidri et al., 2020
LC6	Training to healthcare staff (HCS)	The HCS providing care to suspected or confirmed COVID-19 patients need to be aware of COVID-19 risk factors, protective behaviours, use, and disposal of PPEs. Based on their current and potential duties, the knowledge and training in vernacular language about the selection, use, and disposal of PPE are paramount to avoid cross-contamination	Rowan & Laffey, 2020; Yang et al., 2020; Lee et al., 2020; Xie et al., 2020; Huh et al., 2020; Agarwal et al., 2020; Tempe et al., 2020; Chandra & Vanjare, 2020; Ojha et al., 2020; Sri et al., 2020
LC7	Appropriate information on quantity, rate of use healthcare resources, and allocation	In the event of a national pandemic and outbreak situation, the information about the requirement and frequency of the use of valuable healthcare resources such as PPEs, antiviral drugs, ventilators, and or healthcare facilities is crucial. It is imperative to utilize, wisely allocate, and conserve resources during the COVID-19 pandemic. The information about the required quantity, rate of use of these resources, and contingency planning during stock shortage will help to have adequate stockpiling in pandemic situations	Rowan & Laffey, 2020; Yang et al., 2020; Ehrlich et al., 2020; Ojha et al., 2020; Alhalaseh et al., 2020; Sharma et al., 2020; WHO, 2020c; CDC, 2020a; CDC, 2020b; Devereaux et al., 2020
LC8	High-quality personal protective equipment (PPEs)	The lack of PPEs was of concern during the COVID-19 pandemic. However, the availability of high-quality PPEs in the Indian HCI has managed appropriately. The COVID-19 pandemic circumstances call to have PPEs in adequate quantity. In extraordinary times, due to amid and a severe shortage of PPEs, the HCS may be forced to used tailor-made low-cost PPEs as a measure against pandemic exposure. Thus, the availability of high-quality PPEs will contain COVID-19 infection more effectively and prevent its further spread to HCS	Rowan & Laffey, 2020; Yang et al., 2020; Xie et al., 2020; Rajagopalan & Choutagunta, 2020; Huh et al., 2020; Agarwal et al., 2020; Dhahri et al., 2020; Sharma et al., 2020
LC9	Regularity policies and technologies for end of life (EoL)/disposal of healthcare waste	During the COVID-19, the generation of healthcare wastes increased rapidly. Such a sudden increase in healthcare waste led to mismanagement in healthcare waste treatments as these waste management facilities were designed for normal conditions. There is a need for appropriate regulatory policies/rules, approaches, and techniques related to the safe disposal of COVID-19 healthcare waste from regulatory agencies. A Bio-Medical Waste Management Rules, 2016, and WHO guidelines were strictly followed in the country for COVID-19 healthcare waste management	CPCB, 2020; Manupati et al., 2020; Sharma et al., 2020; WHO, 2020d; Hantoko et al., 2021; Singh et al., 2021; Das et al., 2021

TABLE 1 (Continued)

Sr. no.	CSF	Description	Reference
LC10	Sufficient healthcare staff (HCS) and infrastructure	The existing public healthcare facilities faced tremendous burden and patient load during the COVID-19 outbreak. However, sufficient availability of HCS and healthcare staff managed this burden. The available HCS in the HCI met the high COVID-19 viral load. The country supported frontline healthcare professionals with adequate healthcare infrastructure against the COVID-19, particularly during the COVID-19 mass community spread	Godlee, 2020; Tanne et al., 2020; Xie et al., 2020; Rajagopalan & Choutagunta, 2020; Namendys-Silva, 2020; Chatterjee et al., 2020; Agarwal et al., 2020; Alhalaseh et al., 2020
LC11	Effective drugs/vaccination and its distribution for COVID-19	To flatten the growth curve of COVID-19, the healthcare agencies, researchers, and government bodies in Indian and the world over are strongly focusing on developing a proven, useful drug/vaccination for suspected or confirmed COVID-19 patients. The tested, effective drugs/vaccination for COVID-19 is available, and its supply and distribution are adequate at the grass-root level. The availability, distribution of drug/vaccination, testing facility, quarantine, social distancing, frequent handwashing, and so on will help contain the COVID-19	Rowan & Laffey, 2020; Krishnakumar & Rana, 2020; Xie et al., 2020; Rajagopalan & Choutagunta, 2020; Rayasam & Mande, 2020; Chakraborty & Agoramoorthy, 2020; MoHFW, 2020b; Thiagarajan, 2021; Foy et al., 2021
LC12	Long-term and appropriate insurance/monetary schemes	The union and state government provided long-term and proper insurance/financial plans to HCS who are directly or indirectly in contact with COVID-19 patients. The central and state government has approved various insurance, incentive funds, encouragement allowance scheme for HCS fighting against the COVID-19. These COVID-19 schemes are provided for a suitable period and cover loss of life, treatment or quarantine expenses, and so on. Such schemes covering all exposure risk of COVID-19 is essential to boost the morale of HCS	Godlee, 2020; ILO, 2020; Williams et al., 2020
LC13	Appropriate healthcare laws	The government took efforts and measures to tackle the COVID-19 pandemic. The laws, that is, the epidemic diseases act, 1897, Disaster Management Act, 2005, were immediately brought into action that governs healthcare and other emergencies in India. Further, the centre has given advice and powers to the individual states to invoke relevant laws and regulations to contain the pandemic	The Epidemic Diseases Act (EDA), 1897; Disaster Management Act (DMA), 2005; Gowd et al., 2020; Nomani & Tahreem, 2020
LC14	Awareness, cooperation, and coordination	The policymakers and healthcare administrators understood the importance of HCS and provided full cooperation and coordination during the COVID-19 crisis. The awareness, cooperation, and collaboration help HCS to discharge their COVID-19 duties more effectively. Such support help to maintain the well-being of HCS and make them resilient during the COVID-19 challenging circumstances	Godlee, 2020; Huh et al., 2020; George et al., 2020; Ramaci et al., 2020; Rathore & Gupta, 2021
LC15	Testing laboratories/facilities, centres, and kits	Sufficient testing laboratories/facilities and centres are essential during COVID-19 for widespread community testing. The central government approved sufficient COVID-19 testing laboratories/facilities and centres to cope with the COVID-19 load. Further, the central, states and union territories have also approved private players to establish testing laboratories/facilities and centres for COVID-19	Godlee, 2020; Rajagopalan & Choutagunta, 2020; Huh et al., 2020; Rayasam & Mande, 2020; Alhalaseh et al., 2020; Kumar et al., 2021

made from the government side to ensure that the testing is conducted uniformly across all states, districts, and tehsils places (ICMR, 2021). Further, India's private and public research organisations took unprecedented effort to develop effective COVID-19 drug/vaccines (Foy et al., 2021; Rayasam & Mande, 2020). The Gol came up with two Covishield and Covaxin as an effective drug/vaccine for COVID-19. These vaccines were immediately supplied and distributed in adequate quantity at the grass-root level. As of date, 9,01,98,673 individuals are vaccinated, and the effective rollout of vaccines across the country targeting healthcare, frontline workers, and the venerable population is now underway (Chakraborty & Agoramoorthy, 2020; Thiagarajan, 2021; MoHFW, 2020a, MoHFW, 2020b).

Table 1 shows the identified COVID-19 CSF in the Indian HCI based on the literature review and expert doctors' inputs.

### 3 | RESEARCH METHODOLOGY

A multi-criteria decision-making (MCDM) tool is highly preferred (Abrantes et al., 2020; Devarakonda et al., 2021). Among all the MCDM methods, the DEMATEL method attracts a great deal of attention due to a simplified analysis of complex problems. The DEMATEL method is employed when the analysis of qualitative criteria requires degree of relationships and a robust weighting tool that can consider an interdependent relationship between the criteria.

The technique considers interrelationships between the evaluation criteria and analyses their importance along with cause-effect relationships (Perçin, 2019). Further, the criteria divided into cause-effect relationship helps in better understanding of the relationship among identified criteria. The DEMATEL methodology offers numerous benefits to decision and policymakers in complex decision-making scenarios. The method provides a solution to a complex problem and helps policymakers examine interrelationships and the influence between criteria or factors. The DEMATEL process also helps in gathering groups of ideas and analysing the structural issues. The method further helps in providing a simple hierarchical approach irrespective of the complexity of criteria or factors.

Compared to DEMATEL, other methods are inadequate when dealing with the assumption that decision-makers' judgments and criteria can depend on one another. For instance, the stepwise weight assessment ratio analysis (SWARA) considers the significance of criteria. In contrast, the best-worst method (BWM) recognizes the most significant and least significant criteria in analysing the attributes' weights. Further, the complete consistency method (FUCOM) stipulates optimal weight coefficients' optimal values (Perçin, 2019). Whereas, in the AHP method, the complex problem is decomposed into different hierarchical levels, and it is assumed that all the hierarchical levels are equally independents (Hancerliogullari Koksalmis et al., 2019). It is important to note that most of these methods lack using crisp information, uncertainty during decision-making, impreciseness, simplifying the complex nature of the information, and assumption, which is realistic in nature and decision-making real-world scenarios.

The DEMATEL method was first studied at the Science and Human Affairs Program at Battelle Memorial Institute of Geneva. The earlier literature in HCI highlighted the use of MCDM and emphasized the use of the DEMATEL method. For example, Afful-Dadzie et al. (2016) investigated the criteria framework for assessing the online health information quality and assessment, ranking health information providers using the MCDM method. Glaize et al. (2019) and Hancerliogullari Koksalmis et al. (2019) studied the application of MCDA methods in different healthcare areas and during medical decision making to provide practical insights, respectively. The use of the MCDM method and its importance while prioritizing investments decision during testing new vaccines for epidemic infectious diseases was explored by Gouglas and Marsh (2019). Devarakonda et al. (2021)'s recent work demonstrates the use of the MCDA method in the HCI and illustrates the method's utility and other methods. Perçin (2019) investigated the hospital website quality operational in Turkey using the Fuzzy-DEMATEL method. During the current pandemic circumstance, Bharsakade et al. (2020) further emphasize applying the MCDM method for applying the lean approach in healthcare management. Si et al. (2017) and Shieh et al. (2010) used DEMATEL to rank KPIs for hospital management and service quality, respectively. The DEMATEL approach was used to evaluate supply chain performance for the hospitals (Supeekit et al., 2016), for sustainable supply chain adoption in healthcare (Leksono et al., 2019). Thus, to resolve multidimensional issues and ease the clear understanding of relationships among different criteria, the proposed study uses the DEMATEL method to identify CSF

in the Indian HCI during the COVID-19 pandemic. Figure 1 shows the adopted research methodology.

The DEMATEL step-by-step methodology adopted from study of Shieh et al. (2010); Supeekit et al. (2016); Si et al. (2017) is presented below.

*First step: The initial relationship matrix 'Z' calculation*—The DEMATEL first step is to calculate matrix 'Z' based on inputs received from HCS and experts of the Indian HCI. The experts provided their ratings based on the linguistic scale of 0–4. The scale used is ranging from 0–4, where 'zero influence' is 0; moderately low influence is '1'; moderately high influence is '2'; high influence is '3'; and very high influence is '4'.

$$Z = \begin{bmatrix} 1 & z_{12} & z_{13} & \dots & z_{1(n-1)} & z_{1n} \\ z_{21} & 1 & z_{23} & \dots & z_{2(n-1)} & z_{2n} \\ \dots & \dots & \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots & \dots & \dots \\ z_{(n-1)1} & z_{(n-1)2} & z_{(n-1)3} & \dots & 1 & z_{(n-1)n} \\ z_{n1} & z_{n2} & z_{n3} & \dots & z_{n(n-1)} & 1 \end{bmatrix} \quad (1)$$

*Second step: The normalized direct-relationship matrix 'N' calculation*—The initial matrix shown in Equation (1) and obtained via 1st step is normalized. The normalization of the matrix is done via Equations (2) and (3).

$$Y = \frac{1}{\max_{1 \leq i \leq n} \sum_{j=1}^n z_{ij}} \sum_{j=1}^n z_{ij} \quad (2)$$

$$N = Y \times Z \quad (3)$$

*Third step: The total influence matrix 'I' calculation*—During this method, the matrix 'I' is calculated. The matrix 'I' is obtained from the second step using Equation (1), where 'M' implies as identity matrix.

$$I = N + N^2 + \dots + N^h = N(M - N)^{-1}, \text{ when } \lim_{h \rightarrow \infty} N^h = [0]_{n \times n} \quad (4)$$

where  $I = N + N^2 + \dots + N^h = N(M + N + N^2 + \dots + N^{h-1})(M - N)(M - N)^{-1} = N(M - N^h)(M - N)^{-1}$ .

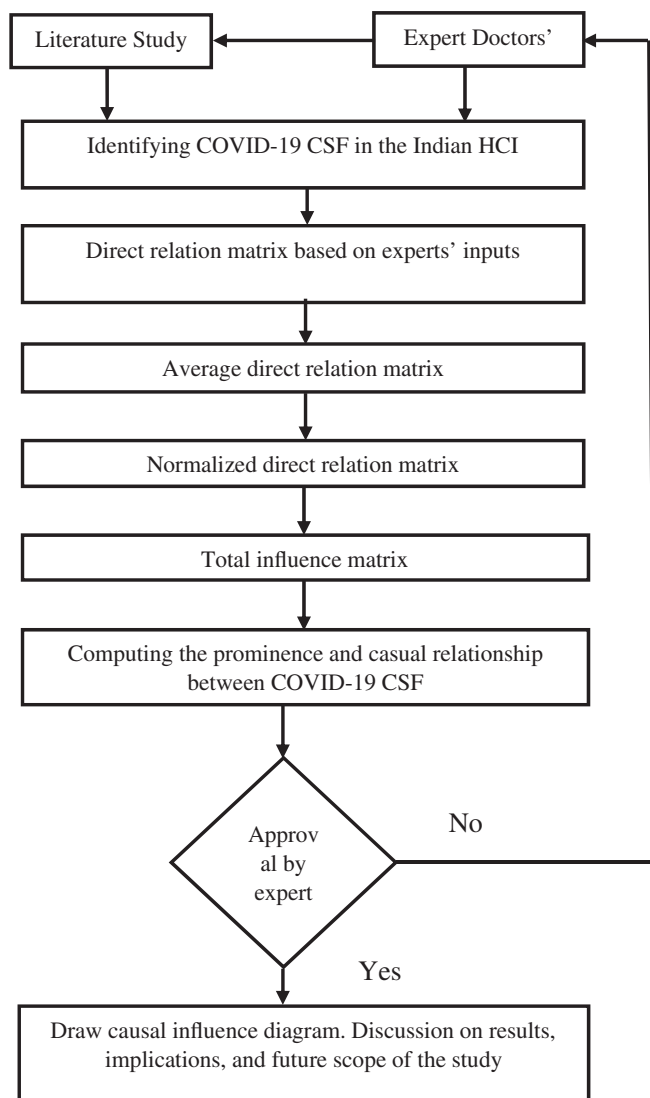
Then  $I = N(M - N)^{-1}$ , when  $h \rightarrow \infty$ .

*Fourth step: The sum of rows and column calculations*—During this step, the sum of rows and columns is calculated. The 'a' and 'b' shows the sum of rows and column and can be obtained using Equations (5) and (6).

$$a = [a_i]_{n \times 1} = \left[ \sum_{j=1}^n i_{ij} \right]_{n \times 1}, s = [b_j]_{n \times 1} = \left[ \sum_{i=1}^n i_{ij} \right]_{1 \times n} \quad (5)$$

$$I = [i_{ij}], i, j = 1, 2, \dots, n \quad (6)$$

*Fifth Step: The causal influence diagram plotting*—During this stage, the causal influence diagram is plotted. If  $a_i$  is the sum of the  $i$ th row in



**FIGURE 1** Research methodology

the 'I' matrix, then the  $a_i$  highlights the sum of the influence of factor  $i$  on the other factors. If  $b_j$  is the column sum of the  $j$ th column of the 'I' matrix, then  $b_j$  highlights the sum of the influence of factor  $j$  on other factors. Thus, with the 'a' and 'b', assistance causal influence diagram is drawn.

#### 4 | CASE STUDY, DATA COLLECTION, AND DEMOGRAPHIC DETAILS

The COVID-19 outbreak has strained the HCI worldwide and was in a constant state of flux. The best defence against the COVID-19 epidemic was to have a robust healthcare system. Therefore, it is crucial to strengthen the existing HCI and understand the different CSF to strengthen the HCI in a post-COVID-19 pandemic. To investigate the CSF in the Indian HCI during the COVID-19 battle and validate the proposed CSF's feasibility, as shown in Table 1, the DEMATEL method was used.

The methodology adopted in the proposed research work is also supported by literature review and case study. The presented case study has a small sample of participants from a single hospital involved. The case study was undertaken in XXX hospital from dedicated hospitals identified by Maharashtra's Government for COVID-19 treatment. The names of the hospital provide here are pseudonyms to preserve the privacy of the hospital involved. During the study, expert teams consisting of doctors and district health officers from the public and private hospital designated for COVID-19 patients located in Maharashtra, India, were contacted. The CSF were identified via a detailed literature search and with the consultation of an expert team. The expert team consists of 11 experts comprised of doctors, a district health officer providing COVID-19 patient care, three academicians, and four experts from the healthcare consulting sector who have the expertise, experience, and knowledge of COVID-19 medical services. The expert professionals' demographic details are provided in Table 2. The senior doctors and district health officer later approved the finalized CSF. The primary data was collected based on the telephonic interaction with 11 experts in the hospital. These 11 individuals were singled out because they were directly involved in providing care to COVID-19 patients. The sample size is not significant; because most of the doctors are highly occupied and engaged. The expert team has analysed the 15 CSF (Table 1) faced by them and provided the required linguistic ratings. Table 3 shows the sample response. Similarly, a sample from other doctors was collected for 15 CSF. Further DEMATEL method discussed in Section 3 was used to analyse collected data (Tables 4–6).

#### 5 | RESULT AND DISCUSSION

The study fills the literature gap related to COVID-19 CSF in the Indian HCI using the DEMATEL method. The final results and cause-effect calculations are shown in Table 7.

The (B-A) values are calculated to know the cause-effect relationship among CSF, and from this result, the causal influence diagram (Figure 2) is plotted.

When the value of (B-A) is positive, the factors are categorized in the cause group. The Table 7 shows that, LC1 (0.43), LC2 (0.39), LC5 (0.67), LC6 (0.3), LC8 (1.21), LC11 (0.12), LC12 (0.23), LC15 (1.2) are categorized in the cause group. Further, when the (B-A) value is negative, then factors are categorized in the effect group. It can be observed from Table 7 that, LC3 (-1.1), LC4 (-0.49), LC7 (-0.01), LC9 (-0.4), LC10 (-0.47), LC13 (-1.84), LC14 (-0.24) are categorised in effect group. Figure 1 and Table 7 show that the High-quality personal protective equipment (PPEs) (LC8) and Testing laboratories/facilities, centres, and kits (LC15) are the most significant cause among all. On the other hand, the appropriate healthcare laws (LC13) are having the least effective among all. In summary, the influence of all the CSF are raked in the order of the magnitude of influence as:

LC8 > LC15 > LC5 > LC1 > LC2 > LC6 > LC12 > LC11 > LC7 > LC14 > C9 > LC10 > LC4 > LC3 > LC13.

After the results, the literature was further explored to ensure the findings of the proposed study. The earlier literature highlighted that;

**TABLE 2** The expert professionals' demographic details

Demographic parameters	Demographic elements		
Sex (male M; female F)	M and F	M and F	M
Average age	37+	35+	32+
Scholastic background	MBBS and MD	PhD	MTech and MBA
Average years of experience	Greater than 10 years	Greater than 8 years	Greater than 5 years
Area of expertise	HCI	Academia	Consulting
Experts' numbers	11	3	4

**TABLE 3** Sample response

	LC1	LC2	LC3	LC4	LC5	LC6	LC7	LC8	LC9	LC10	LC11	LC12	LC13	LC14	LC15
LC1	0	3	4	1	4	4	0	3	1	3	0	2	0	0	4
LC2	3	0	0	2	3	3	2	3	2	3	0	0	0	2	0
LC3	4	4	0	4	4	4	2	3	1	3	0	0	0	2	1
LC4	3	3	3	0	4	2	1	3	0	3	0	0	0	3	3
LC5	3	4	2	3	0	3	3	3	2	3	0	0	3	3	1
LC6	3	3	4	3	3	0	3	1	2	3	0	0	0	4	0
LC7	0	2	1	0	3	4	0	3	4	3	0	3	0	3	1
LC8	4	1	1	3	3	0	0	0	0	1	0	0	0	0	0
LC9	1	3	1	1	3	3	3	0	0	1	0	0	2	1	4
LC10	2	4	4	3	4	2	3	4	1	0	0	0	0	1	3
LC11	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0
LC12	0	2	2	1	0	1	0	0	0	0	3	0	2	0	4
LC13	4	1	1	3	4	4	2	4	4	4	0	2	0	3	0
LC14	2	3	4	3	4	4	3	2	2	4	0	0	0	0	0
LC15	2	0	0	0	0	0	0	0	0	0	0	2	0	0	0

**TABLE 4** Normalized direct-relationship matrix (step 2)

	LC1	LC2	LC3	LC4	LC5	LC6	LC7	LC8	LC9	LC10	LC11	LC12	LC13	LC14	LC15
LC1	0.00	0.08	0.08	0.08	0.09	0.09	0.03	0.07	0.07	0.09	0.05	0.07	0.03	0.03	0.09
LC2	0.08	0.00	0.05	0.07	0.07	0.09	0.07	0.08	0.07	0.07	0.06	0.04	0.04	0.06	0.07
LC3	0.09	0.09	0.00	0.09	0.09	0.10	0.07	0.07	0.06	0.09	0.06	0.04	0.03	0.06	0.07
LC4	0.09	0.09	0.07	0.00	0.10	0.08	0.05	0.06	0.05	0.08	0.06	0.04	0.04	0.09	0.07
LC5	0.08	0.09	0.05	0.07	0.00	0.07	0.08	0.08	0.05	0.07	0.05	0.04	0.07	0.08	0.05
LC6	0.09	0.09	0.09	0.08	0.07	0.00	0.08	0.06	0.07	0.08	0.06	0.05	0.04	0.08	0.05
LC7	0.06	0.06	0.04	0.04	0.07	0.09	0.00	0.06	0.08	0.08	0.05	0.07	0.03	0.07	0.06
LC8	0.07	0.03	0.05	0.06	0.07	0.05	0.05	0.00	0.04	0.06	0.06	0.05	0.03	0.05	0.03
LC9	0.05	0.07	0.05	0.04	0.05	0.09	0.08	0.05	0.00	0.06	0.07	0.04	0.05	0.06	0.10
LC10	0.09	0.09	0.09	0.09	0.08	0.07	0.09	0.09	0.06	0.00	0.05	0.04	0.03	0.06	0.08
LC11	0.07	0.07	0.06	0.04	0.08	0.05	0.05	0.05	0.04	0.04	0.00	0.07	0.05	0.05	0.05
LC12	0.03	0.03	0.05	0.05	0.05	0.04	0.03	0.05	0.04	0.04	0.08	0.00	0.07	0.05	0.09
LC13	0.06	0.03	0.04	0.05	0.08	0.08	0.05	0.07	0.07	0.08	0.05	0.07	0.00	0.07	0.04
LC14	0.06	0.07	0.08	0.07	0.09	0.09	0.08	0.06	0.05	0.07	0.04	0.04	0.03	0.00	0.04
LC15	0.09	0.07	0.05	0.06	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.06	0.03	0.04	0.00



TABLE 5 Total influence matrix (step 3)

	LC1	LC2	LC3	LC4	LC5	LC6	LC7	LC8	LC9	LC10	LC11	LC12	LC13	LC14	LC15	(A)	B + A	B-A	
LC1	0.48	0.54	0.50	0.51	0.57	0.57	0.45	0.50	0.46	0.54	0.44	0.42	0.32	0.45	0.51	7.26	14.95	0.43	Cause
LC2	0.54	0.46	0.46	0.50	0.54	0.56	0.47	0.50	0.45	0.51	0.44	0.39	0.33	0.46	0.49	7.11	14.61	0.39	Cause
LC3	0.60	0.59	0.46	0.57	0.61	0.63	0.52	0.53	0.49	0.58	0.48	0.43	0.35	0.51	0.54	7.89	14.68	-1.10	Effect
LC4	0.58	0.57	0.51	0.46	0.60	0.59	0.48	0.51	0.46	0.55	0.46	0.41	0.34	0.51	0.51	7.55	14.60	-0.49	Effect
LC5	0.55	0.54	0.47	0.50	0.49	0.55	0.49	0.50	0.44	0.52	0.43	0.40	0.35	0.48	0.48	7.18	15.03	0.67	Cause
LC6	0.58	0.57	0.52	0.53	0.58	0.52	0.51	0.51	0.48	0.56	0.46	0.42	0.35	0.51	0.51	7.62	15.53	0.30	Cause
LC7	0.50	0.49	0.43	0.45	0.52	0.53	0.39	0.46	0.44	0.50	0.41	0.40	0.30	0.45	0.46	6.71	13.41	-0.01	Effect
LC8	0.44	0.40	0.38	0.40	0.45	0.44	0.38	0.34	0.35	0.42	0.36	0.33	0.26	0.38	0.38	5.72	12.65	1.21	Cause
LC9	0.50	0.50	0.44	0.45	0.50	0.54	0.46	0.45	0.37	0.48	0.42	0.38	0.32	0.44	0.50	6.74	13.08	-0.40	Effect
LC10	0.60	0.59	0.54	0.56	0.60	0.60	0.53	0.55	0.48	0.50	0.47	0.43	0.35	0.50	0.54	7.84	15.21	-0.47	Effect
LC11	0.47	0.46	0.41	0.41	0.48	0.46	0.40	0.41	0.37	0.43	0.33	0.37	0.30	0.40	0.41	6.12	12.36	0.12	Cause
LC12	0.39	0.39	0.37	0.38	0.42	0.42	0.35	0.38	0.34	0.39	0.37	0.27	0.29	0.36	0.41	5.53	11.29	0.23	Cause
LC13	0.49	0.45	0.42	0.44	0.51	0.51	0.42	0.45	0.42	0.48	0.40	0.39	0.26	0.44	0.43	6.52	11.20	-1.84	Effect
LC14	0.51	0.51	0.47	0.48	0.54	0.56	0.47	0.47	0.42	0.50	0.41	0.38	0.30	0.39	0.45	6.89	13.53	-0.24	Effect
LC15	0.46	0.44	0.39	0.41	0.43	0.43	0.37	0.38	0.36	0.41	0.36	0.34	0.26	0.37	0.35	5.76	12.73	1.20	Cause
(B)	7.69	7.50	6.79	7.05	7.85	7.91	6.70	6.93	6.34	7.37	6.24	5.76	4.68	6.65	6.96				

**TABLE 6** Inter-dependency matrix

	LC1	LC2	LC3	LC4	LC5	LC6	LC7	LC8	LC9	LC10	LC11	LC12	LC13	LC14	LC15
LC1	0.48	0.54	0.50	0.51	0.57	0.57	0.45	0.50	0.46	0.54					0.51
LC2	0.54	0.46	0.46	0.50	0.54	0.56	0.47	0.50		0.51				0.46	0.49
LC3	0.60	0.59	0.46	0.57	0.61	0.63	0.52	0.53	0.49	0.58	0.48			0.51	0.54
LC4	0.58	0.57	0.51	0.46	0.60	0.59	0.48	0.51	0.46	0.55	0.46			0.51	0.51
LC5	0.55	0.54	0.47	0.50	0.49	0.55	0.49	0.50		0.52				0.48	0.48
LC6	0.58	0.57	0.52	0.53	0.58	0.52	0.51	0.51	0.48	0.56	0.46			0.51	0.51
LC7	0.50	0.49			0.52	0.53		0.46		0.50					0.46
LC8															
LC9	0.50	0.50			0.50	0.54	0.46			0.48					0.50
LC10	0.60	0.59	0.54	0.56	0.60	0.60	0.53	0.55	0.48	0.50	0.47			0.50	0.54
LC11	0.47	0.46			0.48	0.46									
LC12															
LC13	0.49				0.51	0.51				0.48					
LC14	0.51	0.51	0.47	0.48	0.54	0.56	0.47	0.47		0.50					
LC15	0.46														

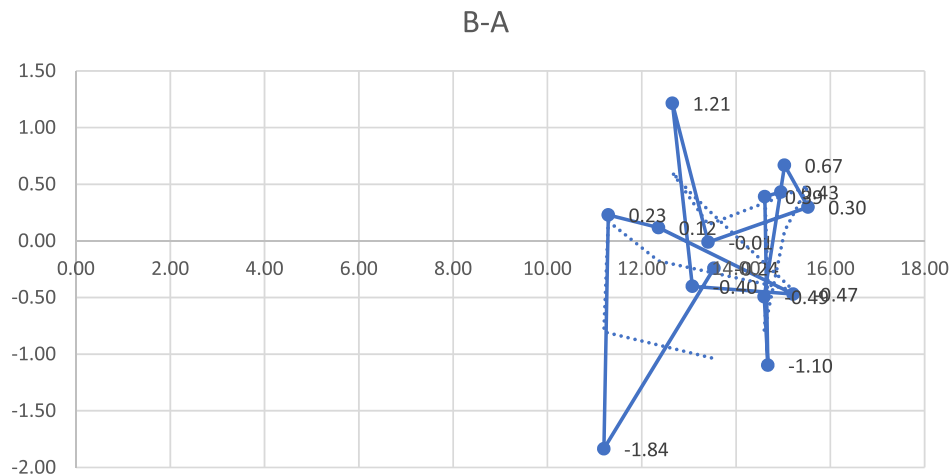
**TABLE 7** Cause-effect ranking

Challenge no.	Challenge	B-A	Cause-effect	Ranking
LC8	High-quality personal protective equipment (PPEs)	1.21	Cause	1
LC15	Testing laboratories/facilities, centres, and kits	1.2	Cause	2
LC5	Responsible behaviours	0.67	Cause	3
LC1	Adherence to the standard operating procedure (SOPs)	0.43	Cause	4
LC2	Appropriate in-house pre-cleaning and disinfection facility	0.39	Cause	5
LC6	Training to healthcare staff (HCS)	0.3	Cause	6
LC12	Long-term and appropriate insurance/monetary schemes	0.23	Cause	7
LC11	Proven, effective drugs/vaccination for COVID-19	0.12	Cause	8
LC7	Appropriate information on quantity, rate of use of health-care resources, and allocation	-0.01	Effect	9
LC14	Awareness, cooperation, and coordination	-0.24	Effect	10
LC9	Regularity policies/rules for end of life (EoL)/disposal of exposed healthcare waste and PPEs	-0.4	Effect	11
LC10	Sufficient healthcare staff (HCS) and infrastructure	-0.47	Effect	12
LC4	Appropriate working hours	-0.49	Effect	13
LC3	Ventilators associate medical infrastructure	-1.1	Effect	14
LC13	Appropriate health-care laws	-1.84	Effect	15

there is an international concern regarding the supply chain of PPEs and testing laboratories/facility/kits (Godlee, 2020; Rowan & Laffey, 2020). Developed countries are increasingly focusing on an adequate supply of PPE and other medical support. The HCI can effectively discharge its duties with adequate PPEs and testing laboratory /facility/kits (Agarwal et al., 2020). The earlier studies highlighted that during the COVID-19 pandemic, the focus was on manufacturing, logistics, supply chain, appropriate use, reuse of PPEs, and testing laboratory/facility/kits (Huh et al., 2020; Xie et al., 2020; Yang et al., 2020). The National Preparedness Survey on Covid-19 based on

Indian administrative service responses highlighted that in the combat of Covid-19, PPE's and testing laboratory/facility/kits play an important role. Thus, it is vital that procurement, logistics, and supply chain of PPEs and testing kits is essential to address the pandemic circumstance. The healthcare supply chain and resilience need particular focus during epidemic outbreaks (Govindan et al., 2020). In India, the government agencies, that is, Defence Research and Development Organisation (DRDO), Department of Biotechnology (DBT), Council of Scientific and Industrial Research (CSIR), Indian Council for Medical Research (ICMR), HLL Lifecare, and so on played a vital role during

**FIGURE 2** Causal influence diagram plotting



COVID-19 combat. Many government and private research labs in India are actively involved in providing affordable testing facilities directly or supporting state governments with instruments and expertise (Rayasam & Mande, 2020). As of date, more than 1228 government and 1212 private testing labs are operational for COVID-19 testing in India (MoHFW, 2020a).

India's government has also provided guidelines on rational use of PPEs and explored the option of importing PPEs and testing kits from other countries to satisfy the demand and supply of PPEs. Further, under Make in India, initiatives boosted the internal manufacturing capacity of PPE in large quantity. Many government and private organizations were roped in to manufacture PPE and fill the demand and supply gap (Sharma et al., 2020).

## 6 | CONCLUSION AND FUTURE SCOPE

There was an increasing health concern during the COVID-19 outbreak, which spread to most countries worldwide, including India. The outbreak has placed unprecedented challenges on the world HCI. However, the Indian HCI and workforce effectively controlled the pandemic circumstance. The proposed study focused on CSF in the HCI in the Indian context. The CSF identified could improve the further functioning of the HCI in India and abroad, particularly in post-pandemic time. During the proposed study, 15 CSF were identified from the literature review, expert team consultation, and DEMATEL methodology. The findings show that LC8 and LC15 hold the highest position in the diagram, expressing that both of them are the most significant and influential CSF in the HCI. On the contrary, LC13 holds the lowest position in the diagram, expressing the least influential factor.

The policy/decision-makers and healthcare administrations need to identify the CSF and focus on that particular CSF rather than focusing on other, less prominent CSF. The appropriate strategic guidelines in the HCI need to be best placed to face the COVID-19 post-pandemic scenario (Pamučar et al., 2020). The COVID-19 pandemic is on the verge of containment due to the implementation of COVID-19

guidelines, rules, policies, strategic action plans, and effective vaccine availability. However, the containment plan and healthcare guidelines need continuous updates in case of a future outbreak. Looking towards India's population, the decision-makers can focus on funding the HCI by multiple factors, introducing economic relief measures such as fiscal, monetary incentives, constructing CSR funds, stimulus package, and so on (Goel et al., 2021). Managing the COVID-19 pandemic requires inclusive and cohesive science and technology-driven interventions focused on cutting-edge and robust research and development. The Indian research organization needs to strengthen its existing scientific capability and capacity to win the war against COVID-19 (Rayasam & Mande, 2020). The policy and decision-makers can explore the option of disruptive technologies to provide healthcare during pandemic scenarios such as artificial intelligence (AI) based diagnostics, digital surveillance, internet of medical things, virtual visits, IoT, autonomous robots, and so on. The use of such disruptive technologies can ensure that healthcare teams are working safely, maintaining patients' psychological and physical conditions (Abdel-Basset et al., 2020). The policy and decision-makers must also ensure that not only the patients' but HCS's psychological and physical conditions are restored and are less stressful. Therefore, continuous communication, dedicated psychological support, and sensible and straightforward public education campaigns are paramount (Chandra & Vanjare, 2020; Ramaci et al., 2020). The healthcare administration and government should make sure that the culture of resilience is embraced in HCI as a part of health delivery, helping fight present and future pandemics (George et al., 2020).

To avoid post-COVID-19 pandemic complexities further, the individual suspected with COVID-19 needs to be identified and tested by an exceptional team of doctors with appropriate protective equipment rather than being tested in a hospital. Only those individuals diagnosed positively with COVID-19 need to be hospitalized, reducing the load on HCI. The policymakers can identify COVID-19 clusters in different states/districts based on reported numbers of cases and growth rates. The clusters can be grouped into different zones such as red, orange, and green, and accordingly, containment strategy, allocation, and mobilization of the healthcare resources can be planned.

The government and healthcare authorities need to emphasize a sufficient number of testing in the mentioned clusters and ramp up its per day COVID-19 testing. To flatten the curve of COVID-19 depends on early detection of the positive patients and their isolation. The MoHFW can develop a low-cost testing kit for COVID-19 to facilitate cost-effective and affordable tests per million. It is crucial to have compulsory testing of all suspected cases and their isolation in clustered areas, ensuring that the testing-related supplies reached every laboratory promptly. The government and health administrators also ensure that every individual living in containment zones should be tested to avoid further transmission of COVID-19. Indeed, the country's vast population demands further efforts to increase testing outreach in villages and remote places. A robust approach of tracing, tracking, testing, and treatment can be applied to control the spread of the COVID-19. Additionally, a practical, coordinated communication system between government, healthcare settings, and the community can lead to better dissemination of information, subsequently containing pandemics of any nature.

The government and private players should undertake mass production of effective and affordable COVID-19 vaccines. Once the COVID-19 vaccine is available, the government should develop a vaccination program or policy guideline specifying the availability of the COVID-19 vaccine to healthcare workers, frontline workers, and the venerable population. Later, policymakers can plan and ensure an effective rollout of COVID-19 vaccines. The vaccine is available at an affordable cost to all people (after the priority population is vaccinated), especially those from lower socio-economic groups. The policymakers can develop a suitable vaccination strategy for the COVID-19 vaccine and communicate the same at the district, state, and national levels, ensuring that the COVID-19 vaccination process and vaccines reach a gross root level.

Additionally, during pandemic outbreaks, to ensure optimal utilization of healthcare resources. The policymakers need to classify the healthcare facility into different types, such as temporary patient facilities outside the hospitals, standard hospitals, Jambo COVID-19 hospitals, and so on. In these hospitals, to conserve the healthcare resources, appropriate pre-treatment and disinfection facilities for extended use and or limited reuse can be provided (CDC, 2020a; CDC, 2020b). The government and health administration need to ensure the timely supply of healthcare resources in COVID-19 highly affected areas and in sufficient quantity. The state, local, and healthcare administration can further double-check that the healthcare resources are being distributed based on an actual need (Sharma et al., 2020). The policymakers must further rope as many private labs and hospitals to provide care and testing facilities by providing them proper support. The government can also involve big and small industry players to cope with HCl's healthcare resource security during the pandemic circumstance. The government can formulate the rapid response team to coordinate the post-COVID-19 pandemic healthcare emergency and tackle the supply and demand of healthcare resources in states, districts, villages, or clusters.

Compared to developed nations, India lacked healthcare resources; however, India's fight against COVID-19 is international.

Indeed, India had the upper hand against COVID-19 because of the strategic approach, taking into account different possible scenarios, providing all necessary facilities and protection to HCS. The identified CSF can further help the Indian HCl contain the COVID-19 second wave and future pandemics. The policymakers have imposed smart lockdowns based on clusters and permitted industrial, commercial, and essential economic activities to sustain economic growth. The CSF identified in the proposed study will help mitigate future pandemics and healthcare challenges and an economic downfall arising from such pandemic.

In summary, the COVID-19 pandemic has placed a mammoth burden on the HCl. However, the help of CSF, as identified in Table 1, can help the HCl to mitigate pandemic challenges. The identified CSF certainly has the utmost importance, and sharing the Indian HCl experiences can help to mitigate the post-COVID-19 pandemic is paramount. The identified CSF will help policy and decision-makers swiftly build up the HCl to cope with the COVID-19 second waves and future pandemic.

## 7 | LIMITATIONS OF THE STUDY


One of the few limitations of this study is that the expert team's sample size is not significant. The expert team's inputs could be of biased nature, leading to influence in finding and the DEMATEL method's reliability. Future studies can be performed using more advanced and sophisticated MCDM methods such as fuzzy DEMATEL, ISM-DEMATEL, and so on, to get more exciting results.

### DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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