

Maturity Evaluation of Teleconsultation Platforms and Solutions in India: Nothing Extraordinary, but Nothing Less!



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As tele-consultation has gained prominence the need for a comprehensive evaluation framework for tele-consultation platforms became apparent. To address this we developed a multi-themed maturity model incorporating diverse stakeholder perspectives. The model grounded in cognitive workflow analysis assesses platforms across various dimensions including feature complexity and compliance with national telehealth guidelines and global health data standards. By applying this model on sample of Indian teleconsultation platforms we found that while platforms generally demonstrate intermediate maturity in terms of features many lag behind in adherence to regulatory requirements and data standards. Findings highlight the need for continued efforts towards tele-consultation delivery.

1. Introduction

With the declaration of coronavirus disease 2019 (COVID-19) as global health emergency in March 2020, the telemedicine emerged as key tool for rapid triage and remote provision of clinical care. National healthcare regulators across the globe released guidelines on practice of telemedicine, particularly video-based consultation (Ohannessian et al., 2020). In India, the medical council of India, in consultation with the Government advisory body (NITI Ayog) notified *Telemedicine Practice Guidelines (TPG)* on 25th March, 2020. Guidelines outlined responsibilities of technology platforms providers (software vendors of telemedicine platforms) along with registered medical practitioners and healthcare organizations. With the announcement of the guidelines, the user community—doctors, patients, and health informatics personnel—felt the need for a framework to evaluate available teleconsultation platforms.

The majority of previous evaluation frameworks and studies on telemedicine solutions (including teleconsultation platforms), have two major limitations. To begin, in most frameworks, telemedicine solutions are commonly evaluated in isolation for adoption decision, economic feasibility, and technological suitability for clinical workflow. Second, we discover a lack of a multi-user centric evaluation framework for teleconsultation platforms, which may be attributable, in part, to prior studies' narrow conception of users of telemedicine solutions (for example: Mack & Nielsen, 1994; Virzi, 1997; Cockton, Lavery & Woolrych, 2003; Bastien, 2004). Further, most of these existing evaluation frameworks (for instance Model of Assistance of Tele-medicine (MAST) framework¹) comprise guidelines to review the outcome of implementation of teleconsultation while stating the maturity of solution as a prerequisite. But, frameworks often do not list features that mature solutions are expected to have; a list that could benefit healthcare IT Practitioners and developers. To close this gap between academia and practice, a research consortium with representatives from stakeholder organizations² who were “*either affected by or can affect*” the delivery of tele healthcare, particularly teleconsultation, was formed. Broadly speaking, the goal of this consortium was to answer two research questions:

- How should a tele-consultation solution be evaluated for its maturity?
- How mature were the tele-consultation providers of India during 2020-2021, post COVID-19 was declared as global pandemic?

Authors of this article lead the research work of the consortium as part of alliance. The alliance members³ (interchangeably called consortium in this article) looked into the frameworks, models, and other evaluation studies of telehealth and particularly teleconsultation solutions. Most frameworks were unidimensional i.e. focusing on single stakeholders independently and evaluations mostly relied on user perception ratings. The extensive review of literature enabled us to map teleconsultation ecosystem and identify the stakeholders (“who”) and their expectations (“what”) from teleconsultation solutions. We arranged stakeholders to represent teleconsultation ecosystem (Fig 1) and this drove our further research as we adapted a multi-user-centered approach to incorporate the perspectives of diverse stakeholders and developed a maturity model.

¹ (Kidholm K, Clemensen J, Caffery LJ, Smith AC. The Model for Assessment of Telemedicine (MAST): A scoping review of empirical studies. *J Telemed Telecare*. 2017 Oct;23(9):803-813..),

² Authors of the paper were part of a consortium and contributed to the research work.

³ The stakeholders represented ** removed for ensuring anonymity of authors

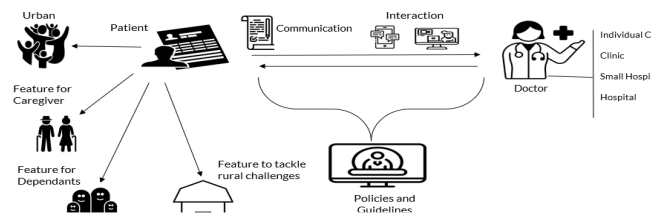


Figure 1 Ecosystem of Tele Consultation

2. Background

We examined studies that empirically evaluate telemedicine platforms, particularly platforms that enable remote consultation through the use of information and communication technologies (summarized in table 1). We would like to emphasize right away that the primary goal of this study differs from that of evaluation studies, such as Model of Assistance of Tele-medicine (MAST) framework (Kidholm et al., 2017), Telehealth Usability Questionnaire (TUQ) (Parmanto et al., 2016), Telemedicine Satisfaction Questionnaire (TSQ) (Yip et al., 2003), and other similar frameworks. These studies, in particular, do not list features that mature solutions should have, which is the research gap addressed in this article. The earliest comprehensive framework for teleconsultation was proposed in by De Chant. et al., where authors highlighted the need for cost effectiveness and adherence to clinical pathways for the platform in order to enhance adaptability of tele solutions. This framework demarcated the clinical needs from technology performance such as reliability and accuracy. In later studies we find very less focus on technology capabilities of platforms. We came across some frameworks which combines various parameters but then, there is no guarantee of consensus in their application. There is lack of focus on the non-clinical needs of patients that determine the context of use of teleconsultation solutions. Furthermore, most evaluation studies focus on isolated stakeholders—low cost and advanced information technology integration for hospital administrators; technical suitability and usability of documented patient details for doctors; compliance with Health IT standards and regulatory policies (De Chant. et al., 1996; Van Dyk & Schutte, 2013; Lapierre et al., 2018). Most models of telehealth evaluation give undue importance to cost optimization over doctor-patient relationship i.e. human aspects of healthcare provision (Trupia et. al., 2021; Williams et al., 2003). We started with a procedural depiction of the teleconsultation that highlights multiple stakeholders (Fig 1). This guided our further research as we adapted human-centered design (HCD) principles to leverage multi-stakeholder viewpoints (Cornet et al., 2020 In accordance with HCD approach, researchers, healthcare providers, technology developers and vendors, and users (with direct experience of teleconsultation); henceforth called as domain experts were involved in this research (Göttgen and Oertelt-Prigione, 2021). Developers and vendors are critical stakeholders in the teleconsultation ecosystem but we did not come across studies that had approached them for evaluation of the teleconsultation system. A need to engage with vendors to develop guidance and maturity evaluation models for the development, and procurement of teleconsultation systems is evident. Healthcare service delivery is typically complex and involves user-user interaction that is different from the system engineering approach taken by most HIT vendors in human factor engineering. Further, patients are considered outside of the workflow of doctors using teleconsultation systems and hence most studies do not account for the context of the patient and its contribution towards evaluation of maturity of teleconsultation solution. Overall, we find that health informatics literature lacks a toolkit to evaluate maturity which could incorporate all relevant stakeholders, owing to a narrow and isolated focus on either clinical or administrative aspects of telehealth delivery (Trupia et. al., 2021; Williams et al., 2003). Thus, a *holistic*⁴ approach towards needs of stakeholders and capabilities of teleconsultation solution is required to fill this gap.

Table 1 Studies that Empirically Evaluate Telemedicine Platforms, Particularly Platforms that Enable Remote Consultation

Stakeholders Considered	Studies	Summary of Findings
Clinicians and hospital administrators on Information and Communication Technology (ICT)	Di Cerbo et al., 2015; Saechow et al., 2014; Choemprayong et al., 2021; Yawn, 2000; Yan et al., 2016	Mostly these studies involved post adoption evaluation of teleconsultation solutions by doing surveys of clinical users or organizational preparedness assessment based on network infrastructure, and hardware. Focus on software features to provide medical services that are necessary for the teleconsultation process (Saechow et al., 2014). Differentiate solutions on their abilities to support clinical needs arising during different consultations, such as, first time visit, follow-up, specialty specific consultation, etc. (Choemprayong et al., 2021; Yawn, 2000; Yan et al., 2016). Studies generally adapt cost effectiveness and user satisfaction as key evaluation metrics (Di Cerbo et al., 2015).
Hospital administration and management	(Birkmire-Peters et al., 1997; Frade & Rodrigues, 2019; Lesh	There are clear inclinations towards economic value of teleconsultation system (Frade & Rodrigues, 2019). Since the earlier decades of teleconsultation use, researchers have shown interest in low cost secure data handling (data validity, safe data storage and forward)

⁴ *Holistic* means that we emphasize the importance of taking the needs of stakeholders as a whole (in the process of teleconsultation) and at the same time consider interdependence of needs to avoid separate analysis.

	et al., 2007; Nifakos et al., 2021; Sabrina & Defi, 2021	(Birkmire-Peters et al., 1997). Recently researchers also investigated teleconsultation solutions post adoption for adherence to policies on data storage and data exchange standards such as ISO/IEEE, safety, security, privacy protection and interoperability (Lesh et al., 2007; Nifakos et al., 2021; Sabrina & Defi, 2021).
Patients	Dixon and Stahl, 2008; Oettingen et al., 2019; Bergrath et al., 2013; Rogers et al., 2017; Trupia, et al., 2021; Faija et al., 2020	Suffer from narrow conceptualization of patients as stakeholders as they focus on satisfaction ratings, cost reduction, and clinical data exchange only. The quality of teleconsultation sessions and its outcome for patients is equated with reduction in time to consult a doctor (Dixon and Stahl, 2008; Oettingen et al., 2019). No focus on use of teleconsultation platforms by low income patients living in remote regions (Bergrath et al., 2013; Rogers et al., 2017). Sometimes the presence of onlookers (online) could make patients uncomfortable (Trupia, et al., 2021). This also necessitates the inclusion of privacy and security of data capturing and data sharing in the technology evaluation metric from a patient's perspective (Faija et al., 2020). The studies did not address other relevant aspects such as transparency of health data sharing, coordinating with caregivers and quality of life indicators while evaluating teleconsultation solutions (Verhoeven et al, 2007).

3. Method

This paper is based on the outcomes of a larger project that was carried out between April 2020 and October 2021 and executed in accordance with HCD principles. There are two key guiding principles of HCD (Dieter et al., 2019; Mahatody, Sagar, Kolski, 2010): 1) Valuing stakeholders' tasks and environment, 2) Re-visiting stakeholders if and when required. In brief, the process began with survey-based recruitment of teleconsultation solution providers, via various social media platforms such as Facebook, LinkedIn by using relevant "hashtags"⁵. This survey was extensive (had open ended questions also) and in order to help the representatives of teleconsultation solution provider fill out form we, 1) Recruited postgraduate students of healthcare management as interns and 2) An extensive glossary and information on how to fill the form was provided on the consortium website. We enquired about the solution provider's interest in demonstrating their platform/solution to the expert panel, and then conducted online cognitive evaluation of 58 platforms⁶.

We followed multiple user centered cognitive walkthrough method (Mahatody et al., 2010; Georgsson et al., 2019; Light et al., 2018). The users are not only limited to healthcare providers and patients but involved health informatics executive, health standards and Indian policy expert, consultant on IT security and data exchange standards, and HIT researcher. In accordance with the walkthrough method procedure, we prepared (1) a general description of use cases (scenarios) (Farzandipour et al., 2021), and (2) a specific description of one or more representative tasks to be performed in order to carry out the teleconsultation session efficiently (Rieman et al., 1995). The scenarios included, 1) teleconsultation of patients with limited functional literacy, 2) appointment booking for patients by caregivers (loved ones), 3) patients with health conditions requiring privacy during teleconsultation, 4) doctors deeming cross-consultation or follow-up consultation necessary for patient teleconsulting, etc. Teleconsultation solutions were walked through by the platform provider to the subject matter experts nominated by the organizations part of the consortium⁷. The expert group included doctor, health informatics executive, health standards and Indian policy expert, consultant on IT security and data exchange standards, telehealth researcher, and founder of established HIT company. All experts used to assemble online to evaluate the telehealth solutions, and each platform provider had around forty minutes for cognitive walkthrough-based demonstration of their teleconsultation platform. During the online demonstrations, teleconsultation platform provider (vendor along with their team of developers and other experts) were required to show the workflow of conducting teleconsultation as doctor and patient both. The action sequences corresponding to these scenarios, as demonstrated by the teleconsultation platforms providers were assessed by the experts. Based on the demonstration and assessment, the experts provided short notes on each platform (see Appendix A). Two authors (the first and second) carried out qualitative analysis utilizing a *Directed Content Analysis* method (Hsieh and Shannon, 2005). We applied the well adapted consensus development process (James and Warren-Forward, 2015), which is frequently used to develop guidelines by systematically synthesizing the available information and expert opinions (Corbie-Smith et al., 2018). We repeatedly revised the framework in discussion with other experts until they were satisfied that the themes were meaningfully represented arranged in a hierarchical way (Fig 2) and could be further used in a methodical manner (see Appendix B). Further, to objectively explain the maturity of the Indian teleconsultation platforms amid COVID-19 (early phases), we sent out a validation form to all teleconsultation platform providers as part of the workflow demonstration. We got 37 complete responses.

4. Findings

Maturity Model and Indian Teleconsultation Ecosystem

The evaluation summaries created during expert evaluations were then analyzed from a multi-stakeholder perspective to arrange findings across six themes (See Table 2 for representative quotes from summary grouping across themes). Each level corresponds to increase in product usability by taking into consideration the feature complexity, and policy landscape of India

⁵ Almost all teleconsultation solution providers are active on LinkedIn and have their official webpage. The survey was promoted online by the partner organizations in the consortium as they were followed by providers in HIT industry.

⁶ Total solutions evaluated were 67, but 9 among those were not providing teleconsultation platforms or were only in the concept stage so their evaluation details are not considered in this article.

⁷ All of the professionals who were nominated had experience with teleconsultation as users in their organizations or as patients.

(Figure 2). We discuss each level next.

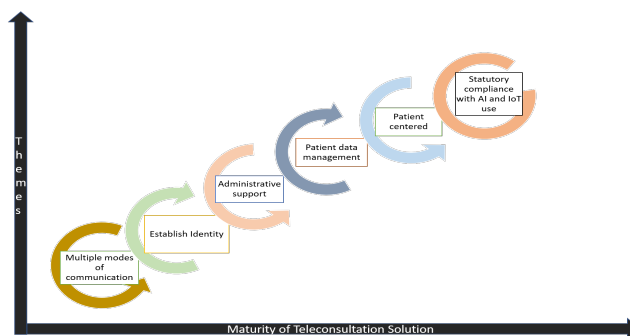


Figure 2 Themes of Maturity Model of Teleconsultation from Expert Evaluation Summaries

Multiple Modes of Interaction and Communication

Most quintessential ability of any teleconsultation platform is to connect remotely located doctors and patients. Based on the summary, we noted that features of teleconsultation platforms highly valued by the experts are those that ensure easy interactions between doctors and patients (Table 2). Next, critical feature is ensuring communication or exchange of documents (like prescriptions). An average platform should support multiple modes for doctor patient interaction, such as audio, video, images and text. Providing flexibility in modes of interaction is crucial as this enables switching to mode that suits the contextual needs of doctor patient interaction (for example switching to audio when there is bandwidth issue). Experts also noted that support for asynchronous communication (such as email, fax, etc.) is vital since it does not require additional infrastructure. In situations where sharing information with a patient or doctor is critical, platforms that provide flexibility to use WhatsApp and SMS are favored by patients. Similarly, for communication of prescription most flexible and easy modality is image of handwritten prescription. But, in turn this ease of usability creates the need to ensure secure data transfer from personal domain to professional domain (de Oliveira Andrade et al., 2021). Next improvement is ability to evaluate connection quality between doctors and patients and recommend a default communication mode. This could reduce the interaction related challenges, for example error in prescription. Advance teleconsultation solutions are expected to have robust data management and data exchange features. Such solutions must aid doctors in following clinical rules and guidelines during interaction, by verifying names of the drug and interaction between drugs, ensuring correct dosage, frequency, route of administration, generic name, etc. Experts noted that for useful teleconsultation sessions, platforms must allow multiple parties or patient’s ‘circle of care’ to join consultation sessions. Different modes of communication can be further aided by the use of remote devices for augmenting the data collection that may be required for better diagnosis or further management of patients.

Establish Identification of Users

Given that records are made retrievable using unique identifiers, identity management is essential feature in teleconsultation platforms. At the most at initial level, identity is established either by sharing name, image, gender, mobile number, etc. Some platforms reported that they do not have explicit feature for identification but during teleconsultation workflow doctors and patients communicate their identities verbally before consultation proceeds. In an improved solution details shared between doctor patients are supported by documentation of established identification number or identifier (for example national resident identity Aadhaar and registration number for healthcare workers), or mobile/email-based identification etc. The creation of a universal registration for all healthcare providers in India is ongoing and teleconsultation platform providers are anticipated to benefit greatly from the creation of this registry. In an advanced solution features for user registration, one-time identification and authentication with the help of a valid identity database or video call/biometric authentication of users is present. This capability is frequently expanded to support user login and user profiles.

Table 2 Representative Quotes from Expert Evaluation Grouped Across themes

Theme in maturity model	Representative quote from evaluation summaries
Multiple modes of interaction and communication	<ul style="list-style-type: none"> • “Doctors can video call with patients in synchronous and asynchronous manner and take notes i.e. noting clinical conditions, writing prescriptions and/or entering data concurrently in the interfaced EMR.” • “When the doctor is on call they cannot do documentation. ... Doctors are expected to write on paper and upload by clicking images, preferably with the header having their details and it is shared with patients.” • “Doctors can interact with patients in both synchronous and asynchronous manner. The solution provides multimode interaction i.e. Video and audio.” • “Platform also has IoT integration for capturing data that patients can use to share for more authentic monitoring.”

Establish Identification of Users	<ul style="list-style-type: none"> • “Patients have the facility to upload documents and enter vitals which doctors can access. Log-in is OTP protected, which requires verification to log in.” • “Patients were registered using phone numbers. The number was used to verify users and register patient. For registering a doctor use employer hospital ID.” • “The patient is also expected to know the unique number for follow ups (This is also limiting functionality for many users, varying in capabilities, especially literacy).” • “...application providers have mechanisms associated with platforms to validate registration details of doctors either with the help of the support team and manual (Personal) confirmation of ID/credentials from state/ national registry of doctors.”
Administrative Support	<ul style="list-style-type: none"> • “Role of doctors can be defined (like primary care providers, specialty consultations or frontline workers).” • “The patient can only call at the pre-allocated time and if doctors are not free the patient is expected to wait for doctors. While the doctor could call before and after scheduled time as well. Automatic call is triggered to both doctor and patient.” • “...has provision to exchange data. It is claimed that the solution has ICD-10 for diagnosis with master tables for drugs, procedures, tests, etc. The system can exchange pre-consultation (FHIR). Platform has integration with lab systems based on ASTM protocol.” • “The platform provides facility to initiate refund to patients in case of appointment cancellation.”
Patient Data Management	<ul style="list-style-type: none"> • “After appointment booking patients are asked to provide history, clinical symptoms and signs.” • “Platform also has features for easy documentation of complaints, symptoms, and prescriptions in the same search toolbar, which makes it user friendly. Previous patient data is easy to access.” • “Template for note-taking to the doctor is only for general physicians. Doctors have to confirm that medicine prescribed follows the government guidelines.” • “This solution supports basic clinical workflow in terms of writing subjective details and objective clinical diagnosis along with assessment and planning.”
Patient-Centered Teleconsultation System	<ul style="list-style-type: none"> • “Premium members can add family members and book appointments for them on their behalf.” • “Prescriptions are generated in English, but SMS of prescription could also be sent in the regional language. • “All reports of patients are available to all doctors (till unsubscribed to individual doctors, by patient). Patient has control over data sharing access.” • “Patients as a dependent are not well thought of, especially patients low in technology literacy or lacking resources (capabilities) for e-KYC would face difficulty in using the platform for consultation.”
Statutory Compliance for Intelligent Healthcare	<ul style="list-style-type: none"> • “Consent is implicit as is part of terms and conditions. Audit trail is there but data is stored without encryption.” • “In terms of compliance, a patient has to agree to terms and conditions before registering into the system, but no consent is available for every encounter.” • “Data is stored in a HIPAA certified cloud and the doctors can view the data historically and real time. Platform is claimed to be providing a secure interface.”

Administrative Support

Besides interaction between doctor patients and identification of both end users, appointment booking and payment are two most critical functions for providing teleconsultation. At the most basic level solutions are required to support appointment management and role-based login (especially roles such as paramedical staff, secretary and receptionists). While at the intermediate level, platform features should assist doctors and hospital managers with activities such as cancellation and refund management, data analytics, and dashboards for various roles. In the light of TPG guidelines, experts noted that consent documentation from patients are responsibility of teleconsultation providing healthcare organizations or hospitals. Hence, features on taking consent from patients are required in the technology based remote consultation platforms. Consent can be for one-time platform use to more advance consent documentation before each virtual encounter between the doctor and the patient. In order to facilitate secondary usage of teleconsultation data by hospital administrator, mature teleconsultation solutions must comply with the requirements for interoperability and standards like Health Level Seven International Fast Healthcare Interoperability Resources (HL7 & FHIR), International Classification of Diseases (ICD10) or 11, Systematized Nomenclature of Medicine - Clinical Terms (SNOMED CT), Logical Observation Identifiers Names and Codes (LOINC), etc. Evaluation by experts revealed that hospital administrators, Chief Information Officers (CIOs), etc. prefer that teleconsultation platform providers guide and train both patients and doctors, at least initially, for “good teleconsultation practice habits”. This is an important feature offering of advanced teleconsultation platforms.

Patient Data Management

This theme captures the usability of teleconsultation platform for clinical purposes, i.e., assessment of patient’s ailments and concerns along with diagnostic reports, and prescription. The features provided are at the very least expected to serve the needs of doctors to gather information from patients. Patient data recording and management has vital role of patient’s side of teleconsultation platform interface, particularly ease of usability to share details while booking appointment and during

interactions with doctor. From doctor's side of interface prescriptions could be written using pen and paper (hand written) with their signature and required qualifications. They could use platform image upload feature to maintain digitized record of teleconsultation notes. This feature is patient centric (discussed in detail) as the platform enables doctors to document information in a manner that patients with limited understanding of health and digital literacy could take advantage of teleconsultation platforms. Experts acknowledged the utility of private note-taking feature when doctors have to advise patient's diagnosis that is stigmatized (infertility treatment) or do basic mental health counseling (especially for patients with long COVID). But, they agreed that this is basic feature as it creates problems for future retrieval of records, potentially impacting continued care delivery. More acceptable solutions for clinical and administrative purposes are those that include features on retrieval of past records, plotting and charting of vitals, warnings and recommendations based on pre-entered rules, etc. Advance features include customization of the prescription and teleconsultation workflow (Especially dashboard or main UI screen) as per their specialty or consulting style.

Patient Centered Features

Patient's was defined by most teleconsultation platforms as someone who shares clinical details of ailments and illness, and was then expected to act as per the prescription provided by the doctors. But, all experts agreed that patients are having their own lived experiences, situations and contexts which influences their use and reliance on teleconsultation platforms. Patient's marginalized background along with digital literacy, health literacy, etc. can be an impediment in successful adoption of teleconsultation as a mainstream modality by the patient as well as the doctor. Doctors providing remote consultations must rely on patients or people in their immediate vicinity to provide details of symptoms and vital measurements useful for diagnosis. This frequently widens the communication chasm between doctors and patients, resulting in either incomplete or incorrect information. The experts often quoted parameters similar to the study by McGraw et al. (2008) that provides a list of patient-related factors to be considered for ensuring the effectiveness of remote care at home, such as dementia, depression, and relationship with caregivers. Thus, patient centered teleconsultations not only cater to the clinical aspects of a patient's needs but also value nuances of their day to day life, for example, privacy requirements among family members, consulting functionally illiterate patients and providing care to dependent or marginalized patients. This also implies that platform providers have to understand the socio cultural and socio-economic background of patients for making more patient centric solutions. Experts noted that patients who consult for stigmatized conditions (for example bad obstetric history, psychiatric counseling, infertility treatment etc.), their interaction with doctors should be protected in a secure manner. Patients also should be communicated and explained the data usage and data storage policies. Thus, advance consent management support is desired from teleconsultation platforms, such as audio and translation (multi lingual) of data use policies by doctors or care providing healthcare organizations.

Along with this, patients' experience on access to care, continued availability of care, and suitability of interpersonal interaction with doctors for patient's need are important for quality-assessment of teleconsultation (Thijssing et al., 2016). Further, teleconsultation platforms are to ensure integration with easily accessible and popular digital communication applications in low income and low literacy regions, such as WhatsApp (Atiwoto, et al.,2022). Patients may be useful allies in ensuring health data quality and handling privacy issues in addition to healthcare professionals. It is anticipated that telehealth organizations and providers educate patients.

Statutory Compliance for Intelligent Healthcare

Compliance with regulations and rules is crucial, and in the fast-expanding world of digital health, they are anticipated to alter dramatically in the near future. The statutory compliance in design and evaluation of teleconsultation platforms are contingent on the policy regulations in the country (or state). For instance, in India TPG (2020) define and prescribe acceptable interaction and communication modes, consent management, and liabilities of the platform providers and revision to these guidelines based on public consultation is under consideration. Overall, in terms of compliance this maturity model is very easy to understand. Any solution that is compliant with the latest teleconsultation guidelines is mapped to an acceptable level of maturity otherwise they are considered to be in early stages of development. In addition to this, protecting electronic medical records is directly tied to the specific criteria for data security and patient health data protection that apply to teleconsultation data. Unfortunately, though, actual legal protections frequently fall short of what was intended. Experts agreed that the TPG (2020) was not comprehensive, so additional features were included in the maturity model from Data Protection Bill, 2021 and blueprint of Health Data Management Policy, released by National Digital Health Mission ("NDHM") (now known as the Ayushman Bharat Digital Mission). These policies are ongoing attempt to legitimize the existing teleconsultation services provided in India so that medical bodies could regulate them appropriately. Experts agreed that as and when newer guidelines/ bills or acts are available for discussion the criteria need to be modified appropriately. Solution providers must aspire to develop platforms compliant with most of the recent laws and bills under discussion.

Indian Teleconsultation Ecosystem

Opportunistic Motivation vis a vis Personal Motivation

Many teleconsultation solution providers were motivated by personal experiences, for instance arranging healthcare remotely for their loved ones or themselves. Providers shared that the difficulty in accessing healthcare and implications on patients and caregivers in the form of stress, anxiety, etc. drove them to build easy to use tele consultation solutions. Most of these providers

mentioned ease of use for patients as the main challenge that they were trying to solve.⁸ Some of the providers were also trying to solve the problem of doctors, such as patient retention, with the help of teleconsultation platforms to provide continued care. We observed that post Covid-19 pandemic and release of telemedicine guidelines (by the Government of India) provided opportunity to HIT providers as they leveraged their experiences and existing customer base of hospital information systems, particularly electronic medical records and provided teleconsultation modules as extension. The providers who were motivated by changing healthcare ecosystem post COVID-19 (see sample motivations below) largely the focus was on reducing hospital visits, preventing spread of infection, and preventing delay by introducing early triage of critical patients.

“We have been in the primary care business for a while, and when the government opened up Telemedicine, and guidelines, we jumped on the opportunity”

“We are a company that already has a clinic management software and a lab management software, with over 70 clients already. As soon as the government put out guidelines for telemedicine, we immediately built a telemedicine module and fit it into our existing ecosystem.”

“We were already offering patient management on our platform pre-Covid. The pandemic propelled telemedicine as the go-to healthcare delivery model and it became a logical extension for us.”

Maturity of Indian Teleconsultation Platforms

Experts also rated the maturity of 58 teleconsultation platforms post demonstration on feature complexity and statutory compliance as beginner, intermediate or advance. We find that in terms of feature complexity, teleconsultation platforms in India are fairly. As less than 20% percent of the platforms evaluated by experts had beginner level features, while most platforms (around 70%) had at least intermediate level features. Also, platforms rated as having beginner level features were actually serving in rural regions or targeting tier 2 tier 3 cities, this to a large extent influences their ability to integrate advanced features. Experts also rated most teleconsultation platforms (98%) to be either beginner or average in ensuring statutory compliance. Thus, expert evaluation shows that the Indian teleconsultation ecosystem is far from maturity in statutory compliance, with most solutions supporting basic or average adherence to *TPG, 2020*. 68.5% of the platforms did share the RMP's details to the patient but only 22.8% platforms verified the RMP's details. Due to lack of easy access to the centralized database of national registry of doctors (or RMPs) platforms did not authenticate registration details of doctors. It is also important to note that grievance redressal and customer support was not provided by most platforms. Only 25.7% of the platforms provided customer support to the patients. Most teleconsultation solutions suffer from problem of data integrity, i.e., accountability for data modification; as not many (17.14% of participating platforms) have ability to maintain audit trails of interaction and communication logs.

Table 3 Survey Responses from Teleconsultation Platform Providers on Features in their Platform after a Workshop on a Maturity Model

Theme	Features	Number of participating teleconsultation platforms (with features) Total count=36
Modes of communication and interaction	Synchronous communication with interaction (audio video facility with Note taking)	20
	Switch modes of interaction between consultation	11
	Multiparty consultation	9
	Prescription using platform	22
	Prescription scanned / photo upload	17
	Medical devices integration	13
Establish identity of user	Doctor identification	25
	Patient identification	29
	Doctor authentication	11
	Patient authentication	18
	Login to patients	19
Administrative support	Appointment booking	33
	Role based login	21
	Categorizing consultation type	11
	Training of users	13
	Waiting room	4
	Cancellation and refund [appointment]s	23
Patient Data Management	Patient upload data	29
	patient search doctor	5
	Basic Workflow	33

⁸ We learnt in this study that only a few solutions were actually delivering patient centric platforms, so there is a gap between motivation and actual delivery.

	Specialty workflow	17
	Specialty Specific Template (prescription)	16
	Frequent drugs list	12
Patient Centered	Patient Health Record (access)	11
	Drawing pad for doctor	4
	Private Note for doctor	11
	Care giver features (appointment booking)	22
	Advance record management among dependents	13
	Patient control record sharing	9
	Multilingual	15
Statutory Compliance for Intelligent Healthcare	Verification of Registered Medical Practitioners (RMPs)	8
	Sharing RMP details with patient	24
	Customer support	9
	Maintain audit trail	6
	Check for Prohibited drug in prescription	13
	Support for Consent taking	Implied = 21 Explicit, one time = 4 Explicit, every encounter = 10
	Health data Standards	Health Level Seven International Fast Healthcare Interoperability Resources (HL7 FHIR) = 13 Systematized Nomenclature of Medicine (SNo MED) = 9 International Classification of Diseases (ICD) = 22

The survey responses from teleconsultation platform providers after a workshop on a maturity model showed that many platforms have intermediate or advanced features across five themes, but platforms' statutory compliance is at a very basic level of maturity (see Table 3). Doctor authentication was not a common feature in teleconsultation platforms, while patient identification and authentication were done to restrict unregistered or non-Indian users. Appointment and cancellation were the focus of most platforms, but their usability needs improvement. Administrative support for appointments, cancellations, and refunds and role-based login were seen in most platforms, but only a few provided training and education to support staff in handling the platform and waiting room. Most platforms took implied consent, while a few took one-time explicit consent. Many platforms adapted to multilingual user interface, but the feature is not useful due to low literacy in India. Patient-centered care features such as access to patient health records, drawing pad for doctors, private note for doctors, advanced record management among dependents and caregivers, and patient control on record sharing are not common features. The finding reinforces the need to center the patient's context as a foundational step in designing informatics solutions to meet their needs.

5. Implications and Conclusion

This paper is motivated by the need to have tools to evaluate HIT infrastructure and readiness for pandemic response in LMICs. We looked at a very critical health IT component, i.e. Teleconsultation system. COVID 19 has increased the use and acceptability of teleconsultations across the globe including the lower middle-income countries, such as India. This widespread usage has also exposed the users to various technological and operational challenges, particularly on evaluation and selection of suitable teleconsultation platforms. We reviewed previous work relevant to teleconsultation platforms/solution evaluation and learnt that various stakeholders' engagement in evaluation of the teleconsultation platforms was mostly absent. Thus, making assessment studies unidimensional with majority focus on cost and clinical efficacy of the platform. We address this gap by taking multi user centric cognitive workflow approach. We demonstrate how teleconsultation platforms can be evaluated on features agreed upon by domain experts representing stakeholders in telehealth ecosystem. Our findings contribute to both theory and practice.

Theoretically, we proposed a multi themed maturity model for teleconsultation platform, that can be applied by utilizing cognitive workflow-based evaluation. We analyzed the maturity of more than 50 teleconsultation platforms that were servicing in India during pandemic and our findings show that: 1) In terms of feature complexity platforms are overall intermediate in maturity. 2) Many platforms are at lower levels of maturity in terms of compliance with the national telehealth guidelines and global health data standards. Our first finding is indicative of the ability of India to provide health IT solutions globally. Many solutions/ platforms assessed by us were already providing Teleconsultation services to not only other low- and middle-income countries but also to developed nations. Many of the systems were robust enough to be able to face any challenge similar to the COVID-19 pandemic and be deployable anywhere across the globe which could help low medium income countries lacking technological capabilities. Secondly, since regulation and guidelines are new in India, some of these telemedicine solutions and platforms were developed before the said guidelines came into force, which explains as to why many platforms are in lower levels of maturity in terms of compliance with Government guidelines. In order that IT innovation in India, particularly health IT solutions could be a gamechanger to address the COVID-19 or similar pandemic in future in LMICs, platforms have to adhere to laws and guidelines around e-health data and be flexible and agile to adopt global standards of data protection and exchange, such as General Data Protection Regulation (GDPR), Health Insurance Portability and Accountability Act (HIPAA).

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7. Appendix A

Evaluation Summary 1

This teleconsultation platform was rated advance on feature complexity and intermediate on statutory compliance.

The platform also supports performance of doctors in terms of time-efficiency by providing a user interface which requires minimum clicks and has easily navigable screens. Note taking is guided data entry, with suggestions based on previous usage. The application is easy to use for patients. Doctors can interact with patients in a synchronous manner; The solution provides multimode interaction i.e., audio, video, text and SMS. Doctors could interact with patients using audio/video call while simultaneously taking notes i.e. noting clinical condition, writing prescription and/or entering data concurrently. This platform supports basic clinical workflow and specialty specific note taking in terms of writing subjective details and objective clinical diagnosis along with assessment and planning. Recording of consultation is not facilitated.

Platform has a feature that enables doctors to take an image of their handwritten prescription, preferably with the header having their registration details and it is shared with patients. Doctors are supported with quick prescription writing by rule-based access to frequently used (favorite) drugs. Alerts for drugs and allergies are shown. Platform supports system generated prescriptions with doctor's registration details (without the doctor's signature).

Doctors are given training while onboarding. The doctors' credentials are verified manually and through the partner hospitals. The platform has an easy to use interface for doctors. The doctor's side of the interface has facilities to manage appointments, calendar scheduling and seamless appointments because of the waiting room facility (queue management). Platform has an admin role.

The platform has interfacing with the drug database (only CIMS) but does not have a feature to automatically restrict usage of schedule X / restricted drugs. The clinician has to manually check for restricted drugs in the prescription. There is notification of drug allergies and drug to drug interaction by pop up during consultation. Prescription is shared with the patient and uploaded in the patient's account for future use.

Patient side of the interface provides login for booking appointments, keywords-based doctor search facility, specialty specific guided searching of doctors based on symptoms (rules based). Platform also allows them to take appointments on behalf of family members / loved ones. Patients have the facility to upload documents and enter vitals which doctors can access. Patients can also set reminders and alerts for appointments and medication. Patients can arrange their records and catalogue it. Frontend is multilingual with translation at the user interface. Smart phones are essential to be able to use this solution. Application supports multi-party calling making it suitable for simultaneous cross-consultation with multiple doctors in the call (for multidisciplinary care and discussions). Application also facilitates sharing case records (referral) by providers through sharing of referral doctor's links to the patient. Patients have control over sharing and accessing their records. Platform provides

facility to initiate refund to patients in case of appointment cancellation. Patients are having features to rate and provide feedback about doctors.

The platform has provision to exchange data (HL7 FHIR). It is claimed that the solution provides CDSS for diagnosis through symptoms and supports ICD-9/10 codes. Audit trail is maintained and data is anonymized for analytics. Transactional data is stored without encryption. Compliant with ISO 27001 and SHA 256-bit encryption.

The patient agrees to use the platform by a onetime consent to terms & conditions while onboarding. For every doctor patient interaction, there is either just an implied consent (patients making the call) or there is a verbal chat-based consent before the start of consultation. There is no explicit consent. There is no separate consent to use the patient data for purposes of use for AI.

Evaluation Summary 2

This teleconsultation platform was rated basic on feature complexity and statutory compliance.

The solution basically models tele-OPD and is designed to provide healthcare in rural remote areas with the help of PHC and front-line healthcare workers. The web-based application allows doctors to access past records and records about follow up consultation and thus ensuring records of continued care. Video call and document exchange facility is integrated with EMR and clinical notes exchange. They have designed a user interface for frontline workers as prescription is supported in Hindi, Telugu, English. The platform provides referral options and pre-customized advice templates for doctors like bed rest and diet advice to save time. Consent is taken at the time of registering a patient. The solution has provision to exchange data in HL7 2.0 which is a lower version than required by EHR-SI 2016. It is claimed that the solution has integration of SNOMED CT for clinical finding, ICD-10 for diagnosis and LOINC for observations codes in diagnostic reports. One of the facilities to patients using their tele-consultation product is subscription-based telemedicine solutions, where patients could give a missed call to a customer support number or schedule an appointment with a doctor. Patient can select their preferred language in which doctors could communicate

8. Appendix B

Theme in maturity model	Representative quote from evaluation summaries
Multiple modes of interaction and communication	<p>“Doctors can video call with patients in synchronous and asynchronous manner and take notes i.e. noting clinical conditions, writing prescriptions and/or entering data concurrently in the interfaced EMR.”</p> <p>“When the doctor is on call they cannot do documentation. ... Doctors are expected to write on paper and upload by clicking images, preferably with the header having their details and it is shared with patients.”</p> <p>“Doctors can interact with patients in both synchronous and asynchronous manner. The solution provides multimode interaction i.e. Video and audio.”</p> <p>“Platform also has IoT integration for capturing data that patients can use to share for more authentic monitoring.”</p>
Establish Identification of Users	<p>“Patients have the facility to upload documents and enter vitals which doctors can access. Log-in is OTP protected, which requires verification to log in.”</p> <p>“Patients were registered using phone numbers. The number was used to verify users and register patient. For registering a doctor use employer hospital ID.”</p> <p>“The patient is also expected to know the unique number for follow ups (This is also limiting functionality for many users, varying in capabilities, especially literacy).”</p> <p>“...application providers have mechanisms associated with platforms to validate registration details of doctors either with the help of the support team and manual (Personal) confirmation of ID/credentials from state/ national registry of doctors.”</p>
Administrative Support	<p>“Role of doctors can be defined (like primary care providers, specialty consultations or frontline workers).”</p> <p>“The patient can only call at the pre-allocated time and if doctors are not free the patient is expected to wait for doctors. While the doctor could call before and after scheduled time as well. Automatic call is triggered to both doctor and patient.”</p> <p>“...has provision to exchange data. It is claimed that the solution has ICD-10 for diagnosis with master tables for drugs, procedures, tests, etc. The system can exchange pre-consultation (FHIR). Platform has integration with lab systems based on ASTM protocol.”</p> <p>“The platform provides facility to initiate refund to patients in case of appointment cancellation.”</p>
Patient Data Management	<p>“After appointment booking patients are asked to provide history, clinical symptoms and signs. “Platform also has features for easy documentation of complaints, symptoms, and prescriptions in the same search toolbar, which makes it user friendly. Previous patient data is easy to access.”</p> <p>“Template for note-taking to the doctor is only for general physicians. Doctors have to confirm that medicine prescribed follows the government guidelines.”</p> <p>“This solution supports basic clinical workflow in terms of writing subjective details and objective clinical diagnosis along with assessment and planning.”</p>
Patient-Centered Teleconsultation System	<p>“Premium members can add family members and book appointments for them on their behalf.”</p> <p>“Prescriptions are generated in English, but SMS of prescription could also be sent in the regional language.”</p> <p>“All reports of patients are available to all doctors (till unsubscribed to individual doctors, by patient). Patient has control over data sharing access.”</p> <p>“Patients as a dependent are not well thought of, especially patients low in technology literacy or lacking resources (capabilities) for e-KYC would face difficulty in using the platform for consultation.”</p>
Statutory Compliance for Intelligent Healthcare	<p>“Consent is implicit as is part of terms and conditions. Audit trail is there but data is stored without encryption.”</p> <p>“In terms of compliance, a patient has to agree to terms and conditions before registering into the system, but no consent is available for every encounter.”</p> <p>“Data is stored in a HIPAA certified cloud and the doctors can view the data historically and real time. Platform is claimed to be providing a secure interface.”</p>