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DEVELOPMENT OF A RELIABLE AND VALIDATED QUESTIONNAIRE TO COMPREHEND THE ROLE OF AI POWERED ANALYTICAL AND DIGITAL TOOLS IN INDIAN HEALTHCARE

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ABSTRACT *Introduction -* The use of Artificial Intelligence is bringing a paradigm shift to healthcare, powered by increasing availability of healthcare data and rapid progress of analytical techniques. The objective of this study is to develop a reliable and validated questionnaire to comprehend the role of AI powered analytical and digital tools to maximize competitive advantage in Indian healthcare. *Research Design & Methods* – Attributes of AI powered analytical and digital tools were collected from 40 healthcare providers like doctors, nurses and technical staff working in hospitals, nursing homes and clinics and through literature reviews to arrive at a 36 item questionnaire. Some of these items were evaluated through providing multiple options to select one or more than one choices and some were evaluated on a five point Likert scale. Reliability of the questionnaire was calculated through cronbach's alpha using spss software version 20.0. *Result -* The results of the analysis show that one item was discarded resulting in a valid and reliable questionnaire. The Internal consistency of all the sections of the questionnaire together was 0.714 measured by cronbach's alpha with the help of spss software. The Questionnaire underwent rigorous development, to ensure it had reliable and valid properties. *Conclusion -* The Questionnaire underwent careful analysis and improvement, subsequent to which it contained reliable and valid properties. This questionnaire is intended to help in considering and measuring the role of AI Powered analytical and digital tools in Indian healthcare.

KEYWORDS : Digital, Artificial Intelligence, Reliability, Validity

INTRODUCTION

Artificial intelligence (AI) refers to the replication of human intelligence in machines that are programmed to think like humans and imitate their actions. The term may also be applied to any machine that exhibits traits associated with a human mind such as learning and problem-solving. The term is frequently used to the project of developing systems endowed with the intellectual processes characteristic of humans, such as the ability to reason, discover meaning, generalize, or learn from experience. Since the development of the digital computer in the 1940s, it has been demonstrated that computers can be programmed to carry out very complex tasks. (Copeland, 2020) Machines can learn from experience, adjust to new inputs, and perform the human-like task because of Artificial intelligence (AI). (SAS Analytics, 2020)

Some programs have attained the performance levels of human experts and professionals in performing certain specific tasks, so that artificial intelligence in this limited sense is found in applications as diverse as medical diagnosis, computer search engines, and voice or handwriting recognition. AI covers several aspects of intelligence which include Learning, Reasoning, Problem-solving, Perception (Copeland, 2020). Artificial intelligence can be seen as a collection of technologies that facilitates machines to sense, perceive, interpret, and generate results so that they can perform administrative and clinical healthcare tasks (Javiya, 2018). AI is also helping clinicians take a more comprehensive approach for disease management, better coordinate care plans, and help patients to better manage and comply with their long-term treatment programs (PwC Global report, 2020).

This article reports the development of a self administered questionnaire whose items are customized to examine the current status and usage of digital and AI applications in healthcare and challenges for real-life deployment of these tools and techniques in hospital healthcare system through survey of users (medical practitioners, nurses and other technical staff) and providers of these solutions.

Aim:
To develop a reliable and validated questionnaire to comprehend the role of AI powered analytical and digital tools to maximize competitive advantage in Indian healthcare.

Objectives:
- To construct a conceptual framework for a self administered questionnaire in order determine the usage of digital and AI applications in healthcare
- To elaborate and develop important questions to address the nature of motivators and challenges for real-life deployment of these tools and techniques in hospital healthcare system
- To formulate a preliminary questionnaire from the item pool of questions.
- To establish and construct a final valid and reliable questionnaire addressing key issues related to usage of AI powered analytical and digital tools in Indian healthcare setting.
- To ensure proper reliability and validity of the questionnaire in order to further refine the questionnaire.

RESEARCH METHOD
A pilot study was done through circulation of an online questionnaire as Google form. The resulting questionnaire –Role of AI powered analytical and digital tools to maximize competitive advantage in Indian healthcare consisted of 36 questions and responses to some item were based on multiple choice while for others a Likert scale ranging from rating 1-5 (Strongly Disagree, Disagree, Can't Say, Agree, and Strongly Agree) was used. A few questions were kept open ended. Responses of forty subjects who all were healthcare service providers including doctors of different specializations, nursing and other technical staffs was analyzed so that a higher item score indicated a more favorable view.

2.1 Questionnaire Development Process - A questionnaire development process usually consists of these steps:

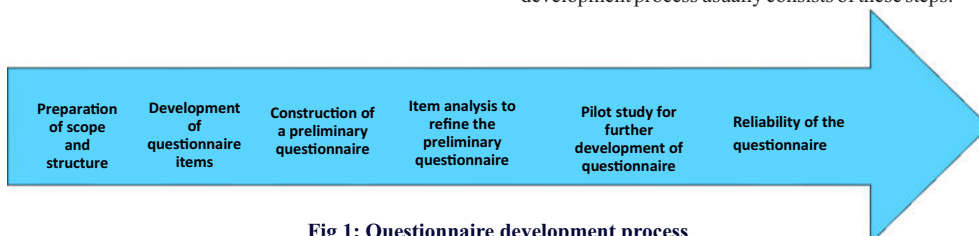| Preparation of scope and structure	Development of questionnaire items	Construction of a preliminary questionnaire	Item analysis to refine the preliminary questionnaire	Pilot study for further development of questionnaire	Reliability of the questionnaire

Fig 1: Questionnaire development process

These steps were followed to develop the questionnaire:
Step 1- Preparation of scope and structure
Data was collected through in depth interviews of some medical practitioners and technicians who practice digital health. Also intensive literature review was done to get in depth information of different aspects a questionnaire should cover. A few seminars, webinars and lectures about AI in Healthcare were also attended.

Step 2 – Development of questionnaire items
Based on all the available information content and items considering doctors perspective about digital and AI based technology in context to India were identified. The questions were framed in two categories-closed ended and open ended. Some items asked on Likert scale which is a five point response scale ranging from strongly agree to strongly disagree and initially an item pool of 52 questions was generated. The initial item pool was further reduced to 45 items and only definite, clear and unambiguous items were considered. Emphasis was laid on using explicit and simple wording of responses and items. The most important part of questionnaire development lies in ensuring that they should be developed in such a manner that reliability and validity is established (Saw and Ng, 2001).

Types of validity and reliability in quantitative research:
Content validity refers to systematic examination of the test content to determine if it covers a representative sample of behaviour domain to be measured (Haladyna, 1999) (Hendrie et al, 2008), It indicates how well a test or an instrument measures is supposed to measure. The items should cover essential aspects of usage, promoters and challenges of AI based tools in Indian healthcare (Haladyna, 1999).

Face validity is the extent to which a measure appears to be related to a precise construct, in the judgment of non-experts such as test takers and representatives of the healthcare system. That is, a test has face validity if its content simply looks significant to the person taking the test. It evaluates the appearance of the questionnaire in terms of
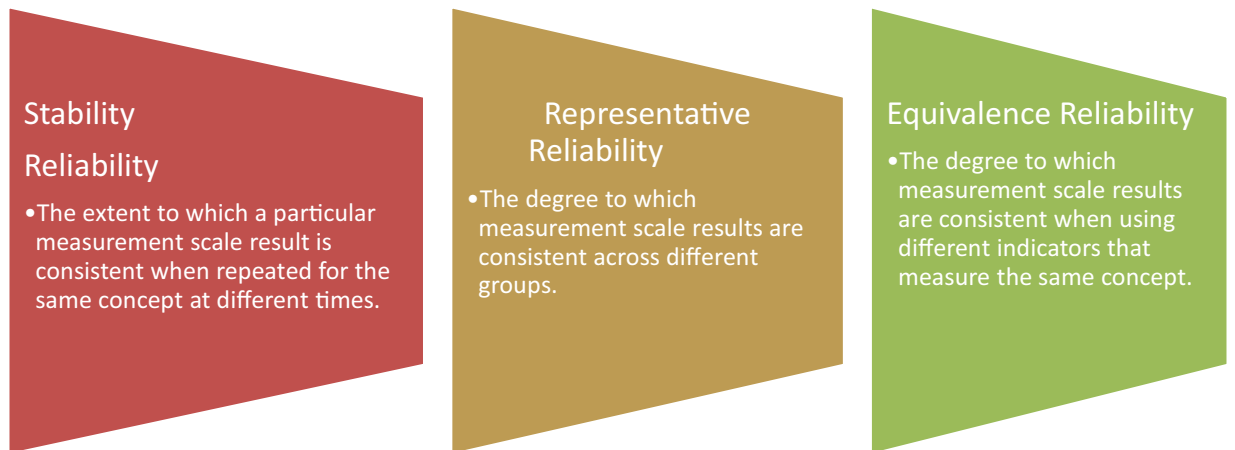
feasibility, readability, consistency of style and formatting, and the clarity of the language used. Face validity is an individual conclusion on the operationalization of a construct (Bolarinwa O A, 2015).

In other words a test can be said to have face validity if it looks like it is going to measure what it is supposed to measure (Trochim, 2001) People who are expert with the target group are usually the good judges of face validity (Haladyna T, 1999).

A summary of the different types of validity and reliability, along with the descriptions, is shown below:

Validity (true measure)	
Type	**Description**
Construct validity	The extent of consistency in a multiple-item Measurement
Content validity (sometimes used interchangeably with face validity)	The extent to which all aspects of the intended constructs are represented in the measure, as well as the extent to which others believe the method of measurement make sense or fits the defined concept.
Convergent validity	The extent to which two measurement scales measuring the same concepts are similar to each other.
Discriminant validity	The extent to which two measurement scales measuring different concepts can be differentiated.
Criterion-related validity	The extent to which the selected measurement scale agrees with an external set standard.
Predictive validity	The use of a future occurrence criterion to predict a current measure.

Reliability (dependable measure)

Stability Reliability
• The extent to which a particular measurement scale result is consistent when repeated for the same concept at different times.

Representative Reliability
• The degree to which measurement scale results are consistent across different groups.

Equivalence Reliability
• The degree to which measurement scale results are consistent when using different indicators that measure the same concept.

Source: Queen Usadol 2017; *The impact of social exchange of volunteer's workplace outcomes in non-profit Organisations;* www.researchgate.net/publication/315818530

Fig 2: Different Types of Validity & Reliability

Step 3- Checking the Validity of Questionnaire
In order to ensure face validity and content validity of the questionnaire, two reviews were carried out for item pool was evaluated by a panel of five experts (medical practitioners and people working with AI tools) having relevant experience in target field. They were requested to evaluate the questionnaire with item pool of 45 questions for accuracy, appropriateness and relevance measuring the need, opportunities and challenges of use of digital and AI based tools in healthcare as per their perspective in reference to India. The experts selected 36 items from the item pool and these items became the final questionnaire draft and all questions were constructed on multiple choice or Likert scale. Only 2 questions were open ended in which name of AI based tools used and opinion of respondents regarding AI based technology were asked.

Step 4 – Construction of preliminary questionnaire
A self administered questionnaire was constructed consisted of 36 questions. The first page of the questionnaire included a brief description of the topic and details of respondents including their

designation, field of specialization and experience. The 36 items were randomly ordered within their respective sections in the questionnaire in order to avoid any biasness in positioning of items in the questionnaire.

Step 5 - Pilot study in target group
A pilot study was conducted to test whether the questionnaire was appropriate in the target group i.e 40 healthcare providers like doctors, nurses and technical staff working in hospitals, nursing homes to respond to different items of the questionnaire. The results were analyzed quantitatively for internal consistency using spss software version 20.0 and qualitatively by looking at the respondent's comments on interpretability of items, lack of important items and time used for filling in the questionnaire.

Step 6 - Reliability of questionnaire
The trend towards uniformity found in repeated measurements of the same event is referred to as reliability (Deniz and Alsaffar, 2013). After completing the validity procedures and conducting item analysis the

questionnaire was examined to assess its reliability. Reliability refers to the ability of a questionnaire to measure the consistency of an attribute and how well the items correlate and fit together, conceptually (Parsian and Dunning, 2009) (Haladyna, 1999), **Internal consistency** describes the homogeneity of all the items of the questionnaire. This was measured by cronbach's α using spss software version 20. Cronbach α values range from 0 to 1 and a score of 0.7 or higher is acceptable (Bryman and Cramer D, 1999)(Hendrie, Cox and Coveney, 2008). This was calculated for the whole questionnaire i.e. entire scale and individually for the different sections of the questionnaire i.e. subscales.

RESULTS
Face Validity
Face validity refers to the importance or precision of a measuring instrument as they appear to test participants (Hamed, 2015) (Hendrie, Cox and Coveney, 2008). All the experts indicated that they have thoroughly understood the questions and found them easy to answer, and mostly indicated the layout and the appearance of the questionnaire would be fine with the intended target population thus assuring good face validity of the questionnaire.

Content Validity
Content validity pertains to the degree to which the instrument fully assesses or measures the construct of interest. The development of a content valid instrument is typically achieved by a rational analysis of the instrument by raters (experts) familiar with the construct of interest or experts on the research subject (Queen U, 2017). A dichotomous

rating method was used where the rater indicated whether an item is 'favourable' (which is assign a score of +1) or 'unfavourable' (which is assign score of +0. According to the CVI index, a rating of four or three indicates that the content is valid and is compatible with the conceptual framework (Lynn 1996). For example, if three of five experts rate an item as +1, the CVI would be 3/5=0.6, but the level required is 0.8, and indicates that the item should be dropped (Devon et al. 2007). Therefore, five items in the questionnaire were invalid because they yielded CVIs of 3/5=0.6 to 2/5=0.4 and were removed from the questionnaire. All the remaining items were valid with CVIs ranging from 0.8 (4/5) to 1.00 (5/5) and were retained.

Internal Reliability
Reliability coefficient was calculated for the questionnaire after item analysis was computed. It was done by analyzing reliability of 36 items through cronbach's alpha with spss and was 0.654 which shows that there was slightly low correlation between different items of the questionnaire. Because of it one item was discarded to bring reliability value to acceptable level i. e. equal to 0.7 or more and it reached to 0.676 (Table 3.2, 3.3).

Table:3.1 Case Processing Summary(1)

		N	%
Cases	Valid	28	77.8
	Excluded[a]	8	22.2
	Total	36	100.0
a. List wise deletion based on all variables in the procedure.			

Table: 3.2 Item-Total Statistics (showing 35 Items)

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
What kind of tools do you use in practice?	68.04	54.999	-.020	.680
What kind of Patient portal Software/Digital Platforms do you use?	67.89	55.358	-.074	.686
Do you use any Artificial Intelligence based tool in hospital?	68.21	52.249	.263	.665
Do you have a telemedicine facility in your hospital?	67.50	55.074	-.052	.687
Do you think that your presence on the digital platform increases your visibility on the internet that leads to increase in patient inflow?	67.25	51.380	.293	.662
In what ways Electronic Medical Record system is better than conventional health record system	67.00	54.444	.035	.678
Which kind of M-health Apps do you use?	67.93	51.254	.136	.679
Which digital tools do you advise most to patients?	67.79	58.545	-.296	.714
For which purpose do you advise to use m-health apps/ wearable?	68.11	54.173	.073	.676
The usage of m- health apps or software have improved the quality of healthcare	67.14	48.868	.605	.641
For which purpose (s) you or your hospital is using AI based tools?	68.36	53.571	.168	.671
Do you think there should be a digital or AI based preliminary screening system on registration counter of a hospital to ease the traffic?	67.00	52.296	.260	.665
Do you think a technical/ AI based solution should be adopted by more hospitals for coding and billing?	67.43	53.587	.066	.680
Do you think AI based solutions are more useful in claims processing and should be adopted?	67.43	49.810	.392	.653
What can be the advantage (s) of having a telemedicine facility?	67.46	52.925	.276	.666
What can be the limitations of having Telemedicine facility in a hospital?	67.11	56.025	-.167	.687
Do you think, Telemedicine facility should be available in all hospitals?	67.04	54.628	.011	.680
Have you read recent regulations on Telemedicine given by GOI?	68.32	52.374	.248	.666
Do you think more hospitals will start Telemedicine facility after release of these regulations?	67.29	57.397	-.336	.695
Accuracy in diagnosis	65.86	50.794	.517	.652
Better Decision making	65.68	46.819	.763	.626
Effective treatment	65.57	48.402	.552	.641
More time for face to face discussion with patient	65.43	50.476	.333	.658
AI-driven tools help reveal early disease risks	65.75	47.898	.557	.638
Help in surgical interventions	65.79	44.915	.591	.625
Investment cost is high	65.29	47.249	.473	.641
Complexity of use	65.36	49.423	.451	.649
Didn't realize need for use	65.71	52.212	.186	.670
Technical support not available	65.32	51.189	.286	.662
Customized AI based tools are not readily available	65.18	53.411	.090	.677
Data security and privacy issue	65.32	56.597	-.172	.701
Regulatory Concerns	65.36	49.794	.388	.653
Chances of faulty diagnosis	65.25	57.750	-.286	.703
Can AI completely replace humans in future?	68.79	55.063	.000	.676
Which other department (s) in a hospital do you think would benefit from AI?	68.79	55.063	.000	.676

Table: 3.3 Reliability Statistics

Cronbach's Alpha	N of Items
.676	35

Now the questionnaire contained 35 items (Tables 3.2, 3.3). Further one item was discarded from the questionnaire on the basis of spss results cronbach's alpha if item deleted. This raised the reliability coefficient to 0.711 which is considered to be a good and ideal alpha value for the questionnaire and hence a questionnaire with 34 items was developed (Tables 3.4, 3.5, 3.6)

Table:3.4 Case Processing Summary(2)

		N	%
Cases	Valid	29	80.6
	Excluded[a]	7	19.4
	Total	36	100.0

Table: 3.5 Item-Total Statistics (showing 34 Items)

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
What kind of tools do you use in practice?	67.17	57.076	-.030	.716
What kind of Patient portal Software/Digital Platforms do you use?	67.03	57.463	-.083	.721
Do you use any Artificial Intelligence based tool in hospital?	67.34	54.448	.240	.704
Do you have a telemedicine facility in your hospital?	66.66	57.234	-.064	.723
Do you think that your presence on the digital platform increases your visibility on the internet that leads to increase in patient inflow?	66.38	53.172	.312	.699
In what ways Electronic Medical Record system is better than conventional health record system	66.14	56.052	.084	.712
Which kind of M-health Apps do you use?	67.10	54.525	.063	.724
For which purpose do you advise to use m-health apps/ wearable?	67.28	56.421	.041	.714
The usage of m- health apps or software have improved the quality of healthcare	66.28	50.635	.628	.681
For which purpose (s) you or your hospital is using AI based tools?	67.48	55.401	.187	.707
Do you think there should be a digital or AI based preliminary screening system on registration counter of a hospital to ease the traffic?	66.14	54.052	.289	.702
Do you think a technical/ AI based solution should be adopted by more hospitals for coding and billing?	66.55	55.256	.093	.714
Do you think AI based solutions are more useful in claims processing and should be adopted?	66.55	51.899	.380	.694
What can be the advantage (s) of having a telemedicine facility?	66.59	54.751	.291	.703
What can be the limitations of having Telemedicine facility in a hospital?	66.24	57.690	-.118	.720
Do you think, Telemedicine facility should be available in all hospitals?	66.17	56.148	.068	.713
Have you read recent regulations on Telemedicine given by GOI?	67.45	54.470	.235	.705
Do you think more hospitals will start Telemedicine facility after release of these regulations?	66.45	59.470	-.339	.729
Accuracy in diagnosis	64.97	52.320	.541	.689
Better Decision making	64.86	49.266	.685	.673
Effective treatment	64.72	50.493	.543	.683
More time for face to face discussion with patient	64.55	51.970	.374	.694
AI-driven tools help reveal early disease risks	64.90	49.810	.566	.680
Help in surgical interventions	64.90	47.025	.574	.671
Investment cost is high	64.41	49.180	.477	.683
Complexity of use	64.52	51.401	.452	.689
Didn't realize need for use	64.86	54.123	.196	.707
Technical support not available	64.45	52.899	.311	.699
Customized AI based tools are not readily available	64.34	55.591	.075	.715
Data security and privacy issue	64.48	58.259	-.145	.733
Regulatory Concerns	64.48	51.544	.407	.692
Chances of faulty diagnosis	64.41	59.608	-.271	.735
Can AI completely replace humans in future?	67.93	57.067	.000	.712
Which other department (s) in a hospital do you think would benefit from AI?	67.93	57.067	.000	.712

Table: 3.6 Reliability Statistics

Cronbach's Alpha	N of Items
.711	34

DISCUSSION

In this study, special attention was paid to the development of questionnaire analysing role of AI powered analytical and digital tools to maximize competitive advantage in Indian healthcare. Main priority during the whole study was to ensure validity and reliability of the questionnaire. Every draft of the questionnaire was reviewed by board of experts so as to guarantee face and content validity and to select best items in terms of precision, non ambiguity and representativeness of items. Certain items were discarded and some new items were added depending upon the suggestions of the experts. In this study adequate efforts were taken to ensure face validity of questionnaire which was done by including and analyzing the discussion of all questions and answers with experts and the respondents so that they can comment on design and impact of questionnaire . (Ajmera et al, 2015) (Anderson et al, 2002)

Face validity helped to provide significant concepts about operational feasibility of the questionnaire by international patients considering India for medical procedures. Content validity provided the information that content was relevant to the concept of AI implementation in context to India. The questionnaire was divided into few sections which provide the opportunity to assess both the general and more specific information regarding AI implementation in healthcare in Indian context.

Internal consistency for the questionnaire was calculated by using Cronbach's alpha (Delaney, 2005). Cronbachs's alpha calculated for the questionnaire and it was 0.711 which indicates that there exists a high correlation between different items of the questionnaire and the questionnaire is considered to be consistently reliable. There are different opinions about ideal Cronbach's alpha value. One opinion is that alpha should be at least 0.90 for instruments which are used in clinical settings (Nunnally and Bernstein, 1994). Other opinion is that an alpha of 0.70 is acceptable for the new instrument (Parsian and Dunning, 2009) (DeVellis Robert F, 1991). In this study, alpha computed for the entire questionnaire was 0.711 which is pretty good for a new instrument.

LIMITATIONS
1.   The numbers of responses collected during the pilot study were

less. Therefore item based detailed analysis like item discrimination could not be done.
2. Split Half reliability test could not be performed to check the consistency between two halves of the questionnaire.
3. The items included in each section of questionnaire were insufficient to perform section wise reliability test.

CONCLUSION

This questionnaire was designed to assess the current use and practice of AI related tools and techniques in healthcare in context to India. It has been designed to find out the reasons, implications and factors to promote the use of AI based analytical and digital tools in Indian healthcare, how the healthcare sector is being benefitted by adopting these tools and what can be the challenges which may lead to reluctance or non adoption of such tools by healthcare sector. The questionnaire had good content and faces validities and fair reliability and should provide a useful tool for analysing the role of AI powered analytical and digital tools to maximize competitive advantage in Indian healthcare.

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