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A Practitioner Centred Assessment on Health Information Systems Interoperability Readiness in Zimbabwe: Mixed Study Approach

Prosper Tafadzwa Denhere[1,*], Munyaradzi Zhou[2], Ephias Ruhode[3]

[1]Manicaland State University of Applied Sciences, Mutare, Zimbabwe
[2]Midlands State University, Gweru, Zimbabwe
[3]Wits Business School, Johannesburg, South Africa

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Abstract Contemporary health information systems have moved to become electronically supported. This has presented the need for these eHealth systems to exist as an ecosystem that allows for healthcare service collaboration amongst service practitioners. In this research paper, the aim is to form an understanding of the healthcare practitioner readiness for Health Information Systems (HIS) interoperability in Zimbabwe. Some qualitative interview and quantitative 5 point Likert scale questionnaires were used to gather the data concurrently before the data were analysed both qualitatively and quantitatively. The HIS interoperability readiness survey was captured from responses made by 71 practitioners. The assessment was aimed at assessing factors which were healthcare practitioner readiness, technological infrastructure ownership readiness, policy readiness, core readiness and financial readiness. The findings presented indicate that healthcare practitioners and patients are ready to exist and function as part of an interoperable HIS although some enabling factors were identified in terms of policies needed to support its existence and functionality. Recommendations towards interoperability of HISs achievement were suggested.

Keywords e-Health Systems, Interoperability Readiness, Health Information System

1. Introduction

The creation of a unified healthcare ecosystems requires for the integration of various existing e-Health systems to create a seamless interoperable Health Information System (HIS) [1]. However, for any Information Communication Technology (ICT) related solution adoption assessment, there is a need to identify the readiness of that particular society in accepting the technical solution through an e-readiness assessment [2]. The study aims to look at national readiness through measuring healthcare practitioners' personal readiness in utilising E-Health systems in an interoperable environment [3]. E-readiness is considered as the desire to obtain value possibilities from ICT that should be portrayed by the preparedness of a society or institution in anticipating positive results through usage of a technical product [4] [5].

Therefore, this study focused on the idea of measuring the readiness of the healthcare practitioners in practising healthcare in an interoperable Health Information System (HIS) in Zimbabwe. The investigation thus interrogated the proposition of an interoperable technology solution for healthcare and provides an insight into the probability of achieving the desired state [6].

To that end, healthcare practitioner survey metrics were used to assess the readiness of the country for an Interoperable HIS [7]. These survey included interviews

and structured questionnaires. Moreover, the research withdraws interoperability of systems to be the future concept that will foster efficient and effective information management in various HISs of developing nations and other economic sectors included.

Ideally, the emerging evolution of information systems to seamlessly integrate different system environments for service collaboration addresses many challenges faced by autonomous stand-alone systems. The benefits of having e-Health systems integration have been observed to allow scalability and enrichment of healthcare service provision.

2. E-Health Readiness Models

Different e-health readiness assessment models were looked at as pillars to the evaluation of e-health readiness of a nation. From the work done by [2], an e-health readiness framework was developed to focus on discovering the readiness of a nation in terms of sector readiness obtain from individual players involved in the domain. Such readiness assessment areas include readiness of management, infrastructure and institution to derive readiness by healthcare service providers [3].

According to Beebeejaun and Chittoo [8], e-readiness measurement should include determining, policy readiness, core readiness, technological readiness, societal readiness, engagement readiness and acceptance and use readiness. Rezai et al. [9] suggested a contingency approach in formulating an e-health readiness assessment model. Moreover, according to Kgasi and Kalema [10], assessment themes or constructs should be tailored to suit the specific country context under assessment. Therefore, the readiness assessment model for the study on healthcare practitioner readiness for an interoperable HIS in Zimbabwe was based on the conceptual framework in Figure 1.0 based on tenets withdrawn from e-readiness literature [11] [12] [13] [14] [8] [2].

2.1. E-Readiness Assessment Metric

In order to assess the e-readiness of healthcare service providers, interviews were conducted in trying to understand the national e-readiness in terms of technological infrastructure readiness, government policy readiness, core readiness and financial readiness. To aid in data collection through interviews, consent of interview participants was sort after prior to carrying out the interviews through the signing of a consent form and complementary to that, an ethical approval by the ministry of Health and Child Care to conduct the research was granted. Interviewees were made aware that their recorded responses would be transcribed as statements and be anonymously published in a research article. The research participants were kept anonymous and data collected was treated with confidence since it was used only for the purpose of this research and securely filed.

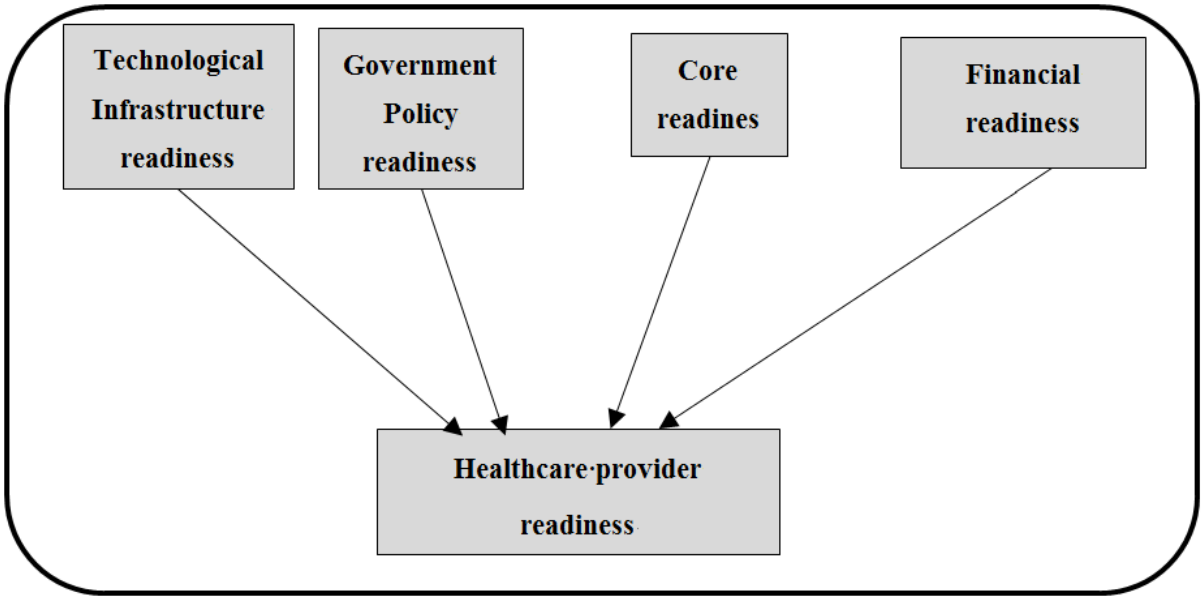

Figure 1. Healthcare practitioner HIS interoperability readiness conceptual framework

3. Materials and Methods

The research focused on looking at the readiness of healthcare practitioners in adopting an interoperable health information system in Zimbabwe. The study was based on the fundamental question, how ready are healthcare practitioners in participating in an interoperable health information system for seamless healthcare service provision.

Data was collected through qualitative interviews and quantitative healthcare practitioner survey for triangulation of the analysis [15] [16]. The qualitative interviews were chosen since they are essentially ideal in determining who, what, and where various unclear circumstances surrounding an unclear situation [17].

The research was contextualised for the Zimbabwean nation with various health care institutions which include both public and private. 32 interviews were conducted with healthcare practitioners and responses captured for qualitative analysis [16] [18]. The interview respondents were made up of a sample purposively selected constituting of medical doctors, pharmacists, ICT practitioners, Policy providers, medical insurers, Healthcare administrators and laboratory technicians. These were selected since they appear to possess more understanding of the nature of e-healthcare ecosystem and representing service providers from various healthcare domains such as hospitals, pharmacies, laboratories, medial board and ICT service providers. Participants selection was based on familiarity with the healthcare sector measured by at least two years of experience in the profession. Interview questions and questionnaires were created informed by literature survey findings as a guide to the thematic areas around the study area and respondents treated anonymous ([19] [20]. The interview questions were:

Qualitative

1. What is your perspective to the creation of an interoperable ZHIS?
2. Are you familiar with usage of any eHealth system? If yes, which eHealth system do you use and for what purpose?
3. Do you think you are ready to participate in an interoperable HIS which allows integrated eHealth systems information sharing and healthcare service chain collaborative interactions?

Quantitative

1. Which synergies or collaborations exist in your line of work that require eHealth systems integration?
2. Which eHealth care resources are provided by your organisation to support interoperability and collaboration of healthcare services?
3. In your opinion, how do government policies support healthcare collaboration and service information interoperability?

A purposive nonprobability sample was selected for 100 questionnaire distribution to a sample that represented the entire population since the research was exploratory. Purposive sampling allowed for the selection of participants who had better knowledge of the domain under study and who possessed the traits and specific characteristics that met the demands of the data quality. A response rate of 71% was achieved in obtaining quantitative gathered using Likert scale and therefore, responses obtained from a total of 71 healthcare practitioners before being quantitatively analysed using SPSS Varimax rotational factor loadings. Finally, the results of both qualitative and quantitative analysis were then converged to allow for completeness of findings [21] [22].

4. Results

Results of data analysis were presented in two sections which are qualitative results and quantitative results from qualitative interviews and quantitative questionnaires respectively.

4.1. Qualitative Interview Results

4.1.1. Healthcare practitioner readiness

Out of the 32 respondents who were interviewed, the majority were made up of 9 doctors among whom 6 were general practitioners and 3 were physicians who constituted 28.1% of the respondents. These were followed by 6 pharmacists (18.8%), 5 healthcare nurses (15.6%), 2 Health administrators (0.06%), 2 IT officers (0.06%), 1 ambulatory technician (0.03%), 2 lab scientists (0.06%), 1 radiographer (0.03%), 3 insurers (0.09%) and 1 MOHCC policy maker (0.03%).

From the responses which emanated from medical doctors, the indication was that the practitioners were very comfortable and very willing to do medical practise in a collaborative environment fostered by ICT [23]. All respondents were very literate in using computers and perceived the development of an interoperable environment as a positive development in the medical fraternity. One medical doctor (Respondent R9) actually said,

> *"Oh if that initiative comes to life that will be a great development and a good platform that unifies service provision in healthcare. At our institution we are very much isolated and would love to be integrated into a greater community that allows remote collaboration even with other pharmacies or medical aid societies."* (R9)

Moreover, all the pharmacists happened to be ready to participate in an interoperable HIS and all pharmacy respondents appeared happy and ready since they already have some of their systems integrated with medical aid

providers with elements that allow them to verify whether a patient was up to date with medical aid subscription before dispensing prescribed drugs from medical doctors. Respondent R13 who was a pharmacist said,

> *"It seems good to us pharmacists since we already have some form of inventory management systems and mechanisms to inquire from medical aid societies to find if a patient is fully paid up with the medical aid service provider. Somehow we have taken baby steps to interoperability but we feel there could be better models which can incorporate other players like medical doctors who still dispatch paper based prescriptions to patients. In this Covid-19 era its good not to touch papers especially from patients."* (R14)

On the other hand, medical doctors also feel if they could receive products of diagnosis from either laboratories or radiographers via the internet and also send prescriptions to pharmacists via the same. Various respondents which include R1, R2, R3, R6, R9 converged in their sentiments to having a unified healthcare ecosystem whereby they could collaborate amongst themselves to share patient data history and clinical notes or even diagnostics. Respondent R6 specifically had this to say say,

> *"Recently we had a team of surgeons who separated conjoined twins. This can still happen through the help of ICT where one specialist can give remote instructions on a procedure. Technology can help augment team work or even an anatomy practical lecture delivery to medical students via video."* (R6)

From the interview interactions, many organisations are providing computers and internet connectivity. This in turn demonstrates that healthcare organisations are ready to connect to other organisations in the fraternity. However, the existence of eHealth systems seems to be the lacking enabler to the overdrive of interoperable healthcare national system. R14, R15, R26, R30 and R32 reiterated the need for government to take a national policy stance that ensures the unification of the national healthcare ecosystem through policies or a bill of parliament. This will in turn drive efforts for the building of a unified National HIS. R31 and R32 said,

> *"The government through the line ministries of Health and Child Care and that of Information Communication Technology and Courier Services could draft policies that facilitates breeding of eHealth systems that can interoperate especially in terms of standards and protocols through a legislative framework."* (R32)

> *"The government has made two initiatives that support national ICT developments in various sectors of the economy. The government has developed a High Performance computing centre hosed at the University of Zimbabwe. Moreover, president of Zimbabwe has recently commissioned the National Data Centre which is stationed at the Kaguvi building in Harare which shows positive national policy operational developments."* (R31)

4.1.2. Technological infrastructure ownership readiness

Most respondents were not confident in terms of infrastructure and other ICT resources being ready for the creation of an interoperable national HIS. Respondents were conservative to boldly approve on the quality of broadband and affordability of data and other digital devices in Zimbabwe by all participants of the healthcare ecosystem which coincides with the literature study findings [12]. Respondent R16 said,

> *"In as much as some infrastructure exists through some telecommunication service providers, challenges still exist in affording broadband connectivity. Some areas are still remote and they lack basic ICT infrastructure unlike urban areas. Zimbabwe still needs some commitment in developing grassroots technology infrastructure in remote areas."* (R16)

However, in terms of technology infrastructure support, Zimbabwe possess the right technical personnel who have the right requisite skills to implement and support such technological infrastructure. Of interest was the response from respondent R16 who said,

> *"Zimbabwe has produced a lot of graduates who can work in the technology sector and some have worked with the Chinese to set up the national data centre and some have worked with Huawei to craft some telecommunications base stations. We are able as a country."* (R16)

4.1.3. Policy readiness

Policy readiness was considered as a variable to be tested as it deals with the existing policies which were analysed to discover whether the government was addressing issues that promote interoperability of healthcare systems and collaboration amongst healthcare practitioners. Most respondents mentioned the nonexistence of specific policies in line with legal and regulatory frameworks to create an operational climate in which interoperability should exist.

Institutional policies were also not clear about sharing of healthcare patient databases and therefore presented a challenge for inter-organisational collaboration and sharing of patient data. Moreover, standards and protocols for data and information architectures are not in existence thereby posing a challenge for the unification of such systems which possess different architectures. The concern raised by respondent R31 was,

> *"Government is yet to come to terms with the eHealth systems existing as strategic subjects for national healthcare governance. No attention has since been specifically given to their functionality and let alone their coexistence in driving the provision of proper*

healthcare. Government should be involved through legislature or other incentivizing policies to reinforce or otherwise clearly spell out the modus operandi of such e-healthcare systems within Zimbabwe especially targeting operational integration and core existence." (R31)

To that effect it is therefore imperative for the government of Zimbabwe to strengthen these healthcare systems through policy reforms to support the otherwise positive evolution [24].

4.1.4. Core readiness

The findings from the interviews were that most healthcare practitioners were not using any eHealth systems although they are aware of some other systems that are currently already in operation elsewhere in other organisations. A fair representation of all the categories from the respondents indicated that they were not happy with the existence of isolated eHealth systems and especially the non-existence of some computer based health management systems in some healthcare centres. This was the likes of respondents R1, R2, R3, R4, R6, and R9 who were totally practicing without any computer based system to manage their patient data and were currently relying on paper file records. R2 said,

"We are not liking the way we are currently administering our patient records and it looks ancient for a doctor of my age. It is high time we move to a computer based system probably you can even assist us with one. We will be happy to be fused into the greater national health system and hope it finds us ready." (R2)

Therefore, most healthcare practitioners showed some welcoming perceptions to the development of an interoperable National HIS. However respondent R6 mentioned that,

"The relationship between a healthcare provider and a patient will always be the core of healthcare service and the adoption of sophisticated healthcare systems should maintain such relationships or rather improve them especially on issues to do with securing patient healthcare data. Security should not be compromised by all means, otherwise it should be reinforced through ICT." (R6)

4.1.5. Financial readiness for interoperability

Mostly medical insurance service providers were financially ready to finance the developments of interoperable healthcare systems unlike most medical practitioners who do not have the autonomy regarding financial matters. R29 and R30 attributed the drive or appetite to finance healthcare financing systems, especially those to do with healthcare financial claims since they perceived it as a good financial risk management tool. R29 said,

"Due to the complexity of financial claims by mostly pharmacies and medical practitioners on services rendered to patients, it is imperative to have such safeguards and controls through ICT systems that help in the data audit process and track all claims and at the same time be in a position to verify such claims. Otherwise we are at the risk of fraudulent claims." (R29)

Respondents R10, R11 and R13 concurred to be financially ready since their systems are already operational and if there is need to improve on them they would happily do so as long as they see the financial benefit of the investment. R11 suggested that,

"*It is not an issue of willing to part with money, but the drive to protect money through spending money. We have done it before and so why can we not do it again since it is investment for the greater benefits to come and all we need are results"* (R11)

Respondent R32 attributed issues to do with healthcare financing to the Ministry of Finance and Economic Development. The respondent was reluctant to suggest whether the MOHCC was financially ready. The respondent concluded that the government can fund such initiatives through some strategies being developed through the ministry of Finance and Economic Development since the new dispensation government was on a hype of activities to improve healthcare services and other economic indicators. Respondent R32 said,

"The government is trying even though the economy was at its lowest before the new dispensation came in. Roads are being constructed, dams are being constructed, the new parliament is on its way, national data centre was commissioned, ideally agriculture has been financed through command agriculture, and therefore why not health. Any good initiative or cause can attract government funding in this new dispensation." (R32)

4.2. Quantitative Analysis Results

Internet access statistics were gathered and presented as a metric to assess readiness in terms of ICT infrastructure readiness of practitioners.

4.2.1. Frequency of sources of internet connectivity

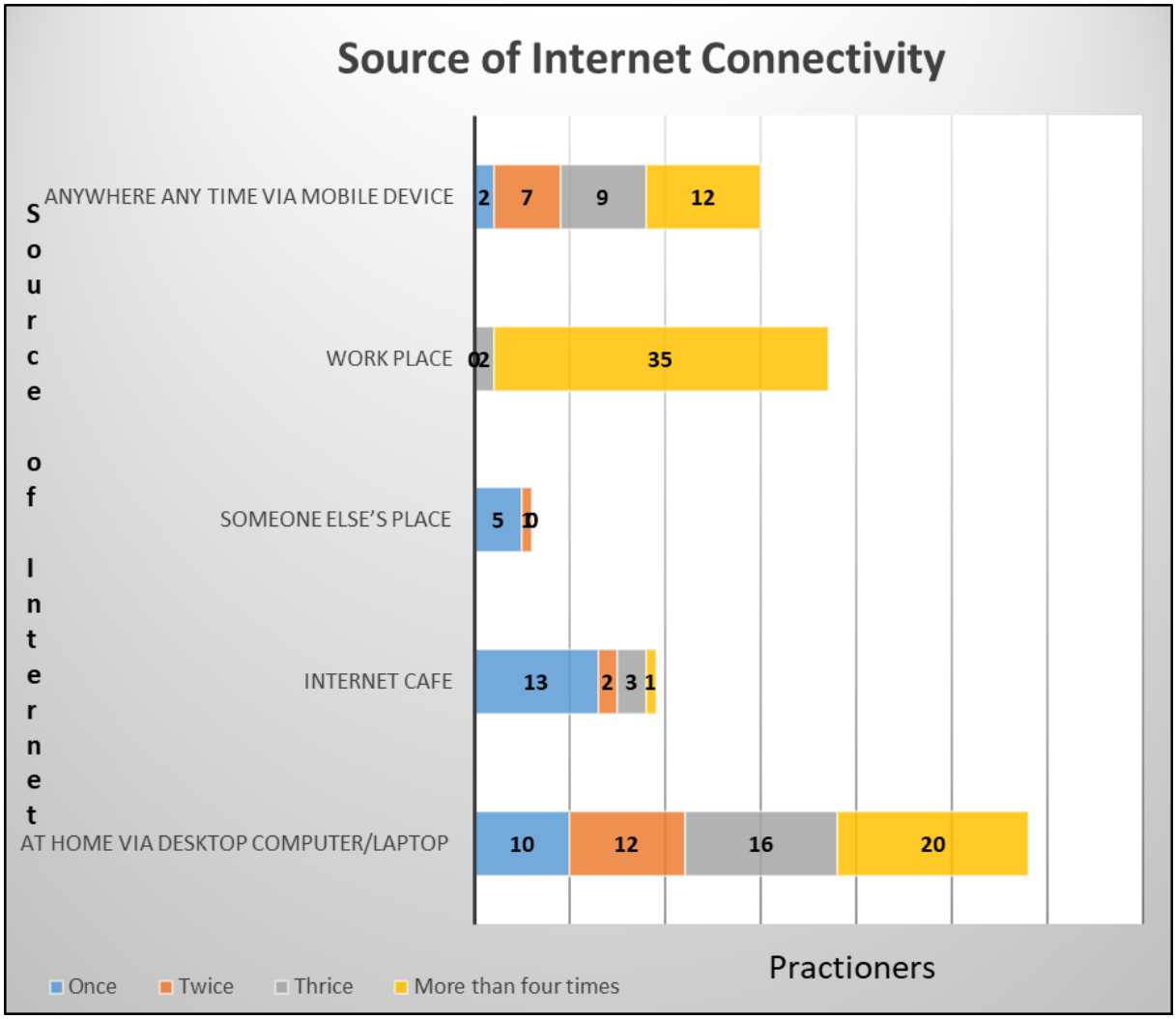

Figure 2. Sources of internet connectivity

4.2.2. Frequency of general healthcare service activities by Healthcare Practitioners

Table 1. General healthcare service activity by healthcare practitioners

	Not Frequent		2		3		4		Very Frequent	
General Healthcare Activities	**N1**	**% of Total**	**N2**	**% of Total**	**N3**	**% of Total**	**N4**	**% of Total**	**N5**	**% of Total**
Radiology or Laboratory results	1	1.41%	0	0.00%	8	11.27%	19	26.76%	43	60.56%
Storing information	0	0.00%	0	0.00%	0	0.00%	0	0.00%	71	100.00%
Expert advice and decision support	3	4.23%	1	1.41%	3	4.23%	58	81.69%	9	12.68%
Collaborate on patient record	0	0.00%	1	1.41%	7	9.86%	42	59.15%	21	29.58%
Contact Tracing	0	0.00%	1	1.41%	11	15.49%	23	32.395	36	50.70%
Education and training	0	0.00%	5	7.04%	9	12.68%	24	33.80%	33	46.48%
Collect and monitor case information	1	1.41%	3	4.23%	5	7.04%	38	53.52%	24	33.80%
Finding work groups	0	0.00%	0	0.00%	21	29.58%	41	57.75%	9	12.68%
Monitor conditions	0	0.00%	0	0.00%	7	9.86%	7	9.86%	64	90.14%
Epidemiology (Spatial dynamics from GIS)	0	0.00%	1	1.41%	4	5.63%	52	73.24%	14	19.72%

Table 1. Continued

Track health funding and performance	0	0.00%	3	4.23%	33	46.48%	21	29.58%	14	19.72%
Book appointments	0	0.00%	0	0.00%	1	1.41%	2	2.82%	68	95.77%
Prescription and drug administration	0	0.00%	0	0.00%	1	1.41%	31	43.66%	39	54.93%
Crowd sourcing and data aggregation	1	1.41%	5	7.04%	28	39.44%	26	36.62%	11	15.49%
Create awareness	0	0.00%	1	1.41%	38	53.52%	25	35.21%	7	9.86%
Handle referrals	0	0.00%	0	0.00%	1	1.41%	2	2.82%	68	95.77%
Mortality statistics	13	18.31%	17	23.94%	29	40.85%	9	12.68%	2	2.82%
Identifying and sharing medical resources	9	12.68%	2	2.82%	9	12.68%	37	52.11%	14	19.72%
Augment patient self-care	0	0.00%	0	0.00%	1	1.41%	46	64.79%	24	33.80%
Knowledge management	1	1.41%	3	4.23%	27	38.03%	24	33.80%	16	22.54%
Healthcare intelligence and indicators	2	2.82%	6	8.45%	12	16.90%	41	57.75%	10	14.08%
Aiding data analytics	28	39.44%	4	5.63%	9	12.68%	16	22.54%	14	19.72%
Confidentiality	13	18.31%	22	30.99%	12	16.90%	19	26.76%	5	7.04%
Integrity and reliability	13	18.31%	18	25.35%	11	15.49%	23	32.39%	6	8.45%
Availability and Access	18	25.35%	9	12.68%	9	12.68%	19	26.76%	16	22.54%
Real-time service	0	0.00%	3	4.23%	1	1.41%	7	9.86%	51	71.83%

4.2.3. Frequency of online digital device activities

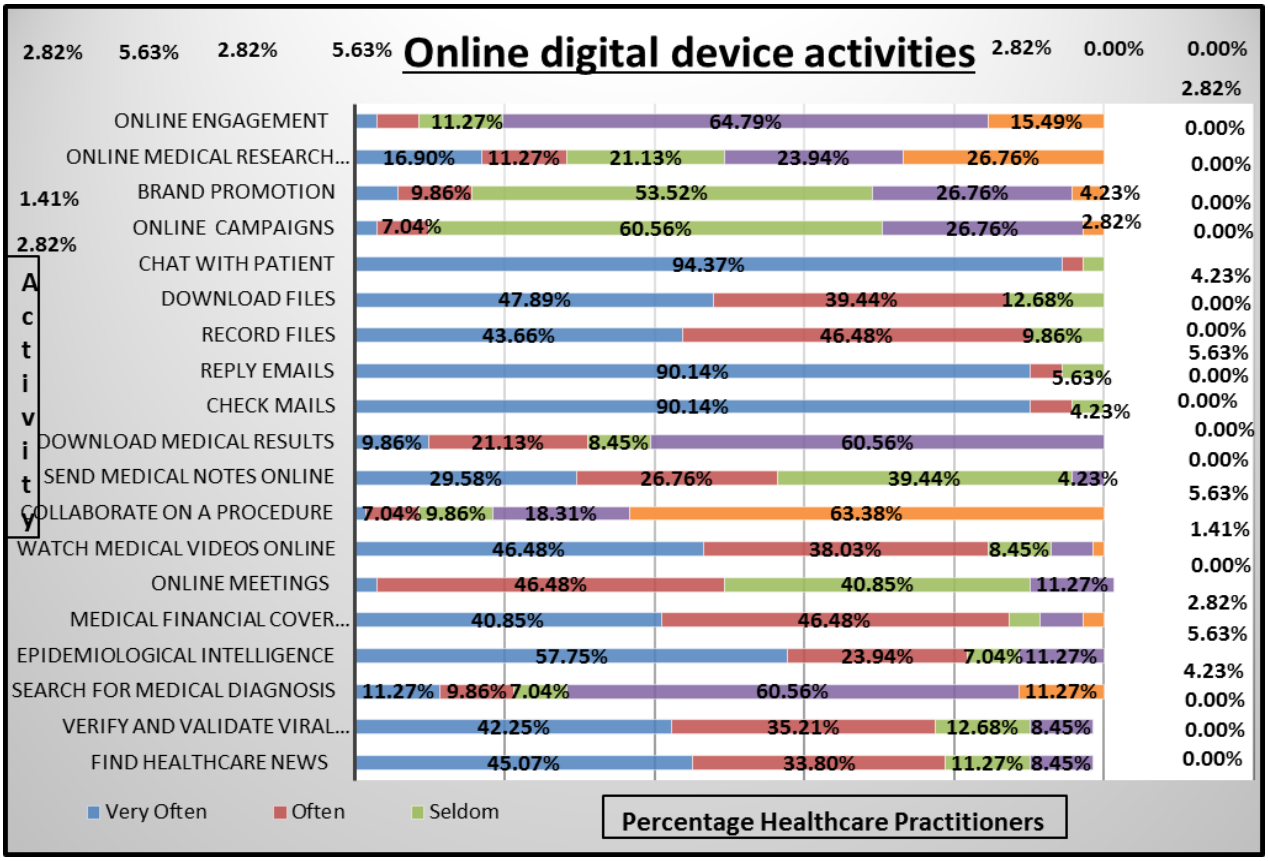

Figure 3. Frequency of online digital device activities

Through the usage of a five point Likert scale the question on interoperability readiness of healthcare practitioners is shown through online digital activities frequency. Data analysis output are displayed in the form of the graph in **Figure 3.** The digital activities which were executed very often were associated with, chatting with patients with a 94.37%, replying emails and sending emails both existing with a 90.14% each, epidemiological intelligence claiming a 57.75%, downloading files having 47.89%, find healthcare news contributing 45.07%, record files having 43.66%, verify and validate viral messages contributing 42.25%, send medical notes making up 29.58%, medical research taking a chunk of 16.90%, Search for medical diagnosis making 11.27%, download medical results contributing 9.86%, brand promotion existing on 5.63%, engagement making 2.82%, campaigns contributing 2.82%, meetings claiming a stake of 2.82% and collaborate on a procedure having a contribution of 1.41%.

However, there are activities by practitioners which tend to show higher frequency in terms of comparative often execution, thus showing a higher proportion of frequency as shown in the graph. Furthermore, a complementary Factor analysis was conducted to investigate and come up with latent variables from the digital device activities dataset in the discussion that follow.

4.2.4. Digital device activities reliability tests

The Table 2 shows labels that were used in place of actual variable names to run the analysis. The analysis tables will display the labels in place of the actual variables.

For the “Digital Device Activities”, the Cronbach's alpha was: $\alpha = 0.853$, which indicates a very high level of internal consistency for the scale in this specific study. The reliability statistics are shown in **Table 3**.

Moreover, the Inter-Item Correlation Matrix is shown in **Table 4**.

Table 2. Variables Key

Digital Device Activities	
Variable	**Code**
SearchHealthcareNews	DDA_1
VerifyViralMessages	DDA_2
MedicalDiagnosis	DDA_3
EpidemiologicalData	DDA_4
MedicalCoverEnquiry	DDA_5
CommunicateWithPatients	DDA_6
WatchMedicalVedios	DDA_7
SurgicalProcedureCollaboration	DDA_8
SendMedicalNotes	DDA_9
DownloadRadiologicalImages	DDA_10
CheckMails	DDA_11
ReplyMails	DDA_12
RecordVedios	DDA_13
DownloadDocuments	DDA_14
ChatwirhColleagues	DDA_15
OnlignCampainsAwareness	DDA_16
BrandPromotion	DDA_17
Researching	DDA_18
OnlineCollaboration	DDA_19

Table 3. Reliability statistics

Reliability Statistics		
Cronbach's Alpha	**Cronbach's Alpha Based on Standardized Items**	**N of Items**
.853	.840	19

Table 4. Inter-Item Correlation Matrix

Inter-Item Correlation Matrix																			
	DDA_1	DDA_2	DDA_3	DDA_4	DDA_5	DDA_6	DDA_7	DDA_8	DDA_9	DDA_10	DDA_11	DDA_12	DDA_13	DDA_14	DDA_15	DDA_16	DDA_17	DDA_18	DDA_19
DDA_1	1	0.613	0.41	0.347	0.332	0.331	0.127	0.347	0.126	0.405	0.174	0.164	-0.01	0.135	-0.006	0.281	0.166	0.284	0.398
DDA_2	0.613	1	0.45	0.476	0.273	0.171	0.096	0.418	0.262	0.418	0.213	0.169	0.175	0.269	0.076	0.394	0.209	0.385	0.36
DDA_3	0.41	0.45	1	0.267	0.32	0.187	0.097	0.641	0.449	0.598	0.16	0.185	-0.143	0.297	-0.11	0.046	-0.043	0.389	0.663
DDA_4	0.347	0.476	0.267	1	0.415	0.105	0.08	0.334	0.159	0.368	0.307	0.263	0.055	0.209	-0.002	0.217	0.141	0.22	0.238
DDA_5	0.332	0.273	0.32	0.415	1	0.249	0.212	0.253	0.103	0.364	0.005	-0.021	-0.079	0.015	-0.032	0.201	0.072	0.184	0.299
DDA_6	0.331	0.171	0.187	0.105	0.249	1	0.253	0.261	0.019	0.161	-0.071	-0.042	0.005	0.058	0.272	0.151	0.12	0.275	0.246
DDA_7	0.127	0.096	0.097	0.08	0.212	0.253	1	0.361	0.024	0.161	0.131	0.129	0.072	0.229	0.296	0.22	0.164	0.357	0.316
DDA_8	0.347	0.418	0.641	0.334	0.253	0.261	0.361	1	0.423	0.678	0.196	0.198	-0.133	0.333	0.069	0.25	0.043	0.575	0.741
DDA_9	0.126	0.262	0.449	0.159	0.103	0.019	0.024	0.423	1	0.624	0.21	0.219	-0.013	0.171	0.08	0.094	0.053	0.333	0.511
DDA_10	0.405	0.418	0.598	0.368	0.364	0.161	0.161	0.678	0.624	1	0.254	0.279	-0.17	0.327	-0.001	0.25	0.138	0.535	0.726
DDA_11	0.174	0.213	0.16	0.307	0.005	-0.071	0.131	0.196	0.21	0.254	1	0.973	0.117	0.34	-0.073	-0.129	0.079	0.058	0.095
DDA_12	0.164	0.169	0.185	0.263	-0.021	-0.042	0.129	0.198	0.219	0.279	0.973	1	0.122	0.368	-0.074	-0.126	0.105	0.065	0.093
DDA_13	-0.01	0.175	-0.143	0.055	-0.079	0.005	0.072	-0.133	-0.013	-0.17	0.117	0.122	1	0.422	0.182	0.054	0.039	-0.183	-0.174
DDA_14	0.135	0.269	0.297	0.209	0.015	0.058	0.229	0.333	0.171	0.327	0.34	0.368	0.422	1	0.175	0.056	-0.013	0.209	0.291
DDA_15	-0.006	0.076	-0.11	-0.002	-0.032	0.272	0.296	0.069	0.08	-0.001	-0.073	-0.074	0.182	0.175	1	0.256	0.215	0.273	0.088
DDA_16	0.281	0.394	0.046	0.217	0.201	0.151	0.22	0.25	0.094	0.25	-0.129	-0.126	0.054	0.056	0.256	1	0.778	0.47	0.184
DDA_17	0.166	0.209	-0.043	0.141	0.072	0.12	0.164	0.043	0.053	0.138	0.079	0.105	0.039	-0.013	0.215	0.778	1	0.488	0.044
DDA_18	0.284	0.385	0.389	0.22	0.184	0.275	0.357	0.575	0.333	0.535	0.058	0.065	-0.183	0.209	0.273	0.47	0.488	1	0.71
DDA_19	0.398	0.36	0.663	0.238	0.299	0.246	0.316	0.741	0.511	0.726	0.095	0.093	-0.174	0.291	0.088	0.184	0.044	0.71	1

Table 5. Item-Total Statistics

Item-Total Statistics					
	Scale Mean if Item Deleted	**Scale Variance if Item Deleted**	**Corrected Item-Total Correlation**	**Squared Multiple Correlation**	**Cronbach's Alpha if Item Deleted**
DDA_1	43.0571	71.417	.527	.538	.842
DDA_2	43.0571	70.402	.614	.659	.838
DDA_3	41.3857	69.023	.579	.661	.839
DDA_4	43.0714	69.719	.451	.403	.847
DDA_5	43.1286	74.490	.384	.394	.848
DDA_6	42.6143	75.661	.301	.297	.852
DDA_7	43.1714	75.361	.335	.355	.850
DDA_8	40.5429	68.310	.707	.718	.833
DDA_9	42.7286	73.418	.434	.515	.846
DDA_10	41.7429	66.310	.717	.753	.831
DDA_11	43.7714	78.527	.293	.959	.851
DDA_12	43.7571	78.302	.290	.960	.851
DDA_13	43.2571	80.860	-.014	.454	.860
DDA_14	43.2714	75.882	.388	.506	.848
DDA_15	43.8286	79.854	.171	.303	.854
DDA_16	41.7143	75.337	.412	.791	.847
DDA_17	41.8143	76.472	.286	.808	.852
DDA_18	41.4571	65.701	.635	.788	.836
DDA_19	41.0857	69.645	.710	.827	.834

Table 6. Total Variance Explained

Total Variance Explained									
Component	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**		**Extraction Sums of Squared Loadings**	**Rotation Sums of Squared Loadings**		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.557	32.686	32.686	5.557	32.686	32.686	3.737	21.982	21.982
2	2.277	13.394	46.08	2.277	13.394	46.08	2.431	14.298	36.281
3	1.771	10.418	56.498	1.771	10.418	56.498	2.356	13.857	50.138
4	1.385	8.146	64.644	1.385	8.146	64.644	2.114	12.435	62.573
5	1.202	7.068	71.713	1.202	7.068	71.713	1.554	9.14	71.713
6	0.868	5.104	76.816	0.868					
7	0.816	4.799	81.616						
8	0.617	3.627	85.243						
9	0.539	3.17	88.413						
10	0.496	2.916	91.329						
11	0.395	2.325	93.654						
12	0.358	2.105	95.759						
13	0.291	1.713	97.473						
14	0.19	1.12	98.593						
15	0.137	0.805	99.398						
16	0.082	0.482	99.88						
17	0.02	0.12	100						

We can see that removal of questions DDA_13 and ARN_15, would result in a higher Cronbach's alpha. Therefore, removal of questions 13 and 15 would lead to an improvement in Cronbach's alpha. We therefore consider removing these 2 variables in subsequent analysis and leaving us with 17 components to analyse.

We observe and consider 5 components whose Eigenvalue is at least 1 based on Kaiser's criteria. Therefore, the 19 variables/questions under the "**Digital Device Activities**" topic seem to measure 5 underlying factors. This is because only our first 5 components have an Eigenvalue of at least 1. The other components having low quality scores are not assumed to represent real traits underlying our 19 variables/questions. Such components are considered "scree" as shown by the line chart below.

Scree plot

The scree plot visualizes the Eigenvalues (quality scores). From the Figure, we can visualise that the first 5 components have Eigenvalues over 1. Henceforth, we consider to retain these "strong factors". As we observe, component 4 and onwards to preceding components, the Eigenvalues drop off significantly.

4.2.5. Rotated Component Matrix through Varimax Rotation

Our rotated component matrix shown in Table 7 shows that our first component represents variables such as, DDA_19- Online Collaboration, DDA_10- Download Radiological Images, DDA_9- Send Medical Notes, DDA_8- Surgical Procedure Collaboration, DDA_3- Medical Diagnosis and DDA_18- Researching.

We observe that these variables all relate to online use and sharing of educational information. Therefore, as such we interpret component 1 as "Use and sharing of educational information through collaboration". This is the **underlying trait** measured by DDA_19, DDA_10, DDA_9, DDA_8, DDA_3 and DDA_18.

Our rotated component matrix in **Table 7** shows that our second component is measured by variables DDA_1- Search Healthcare News, DDA_4- Epidemiological Data, DDA_2- Verify Viral Messages and DDA_5- Medical Cover Enquiry. Henceforth, we realise that these variables all point to public health news and information. Therefore, we interpret component 1 as "Use of public health news and information". This is thus, the **underlying trait** measured by DDA_1, DDA_4, DDA_2 and DDA_5.

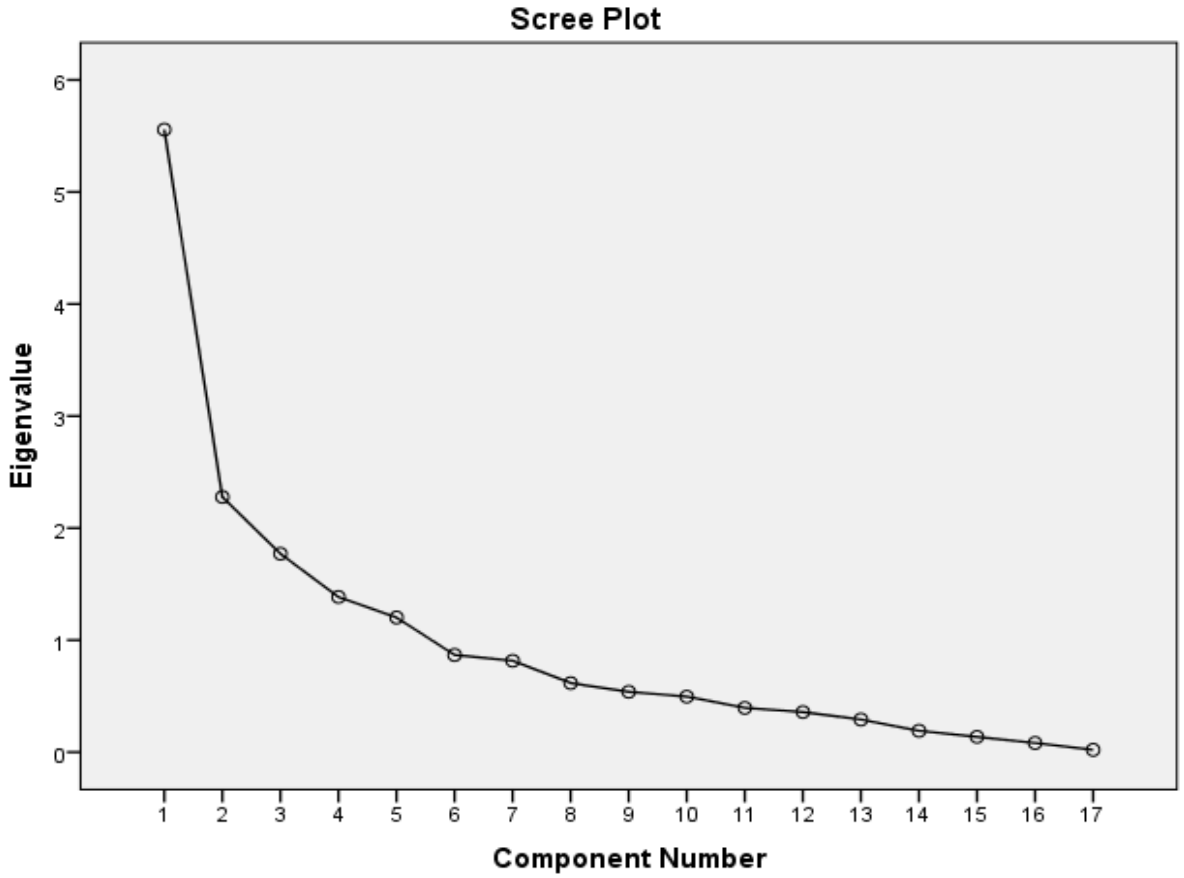

Figure 4. Scree plot

Table 7. Rotated Component Matrix of online digital activities

Rotated Component Matrix[a]					
	Component				
	1	2	3	4	5
DDA_19	.859	.181	.003	.052	.283
DDA_10	.798	.306	.179	.122	.018
DDA_9	.757	-.001	.144	.067	-.254
DDA_8	.755	.231	.137	.059	.319
DDA_3	.730	.371	.071	-.148	.057
DDA_18	.613	.075	.007	.533	.326
DDA_1	.206	.733	.073	.122	.134
DDA_4	.121	.692	.276	.115	-.046
DDA_2	.311	.682	.145	.265	-.052
DDA_5	.137	.657	-.125	-.030	.242
DDA_12	.083	.086	.957	-.006	-.028
DDA_11	.063	.128	.954	-.015	-.046
DDA_14	.307	.036	.503	-.026	.240
DDA_17	-.029	.069	.079	.938	.045
DDA_16	.107	.237	-.141	.879	.096
DDA_7	.130	-.048	.194	.176	.801
DDA_6	.063	.327	-.137	.019	.634

To add on, our rotated component matrix in the **Table 7** also shows that our third component is measured by the variables including DDA_12-Reply Mails, DDA_11-Check Mails and DDA_14-Download Documents. An observation picks that these variables all relate to mail and email. Therefore, we interpret component 1 as "Use of mail and email". This is the **underlying trait** measured by DDA_12, DDA_11 and DDA_14.

Furthermore, our rotated component matrix (above) shows that our fourth component is measured by metrics including, DDA_17- Brand Promotion and DDA_16-Online Campaigns Awareness. As such, it can be picked from observation that these variables all relate to awareness campaigns and promotions. Thereof, we interpret component 1 as "Brand promotion". This is the **underlying trait** measured by DDA_17 and DDA_16.

To sum up, our rotated component matrix in Table 7 shows that our fifth component is measured by the following variables, DA_7- Watch Medical Videos and DDA_6-CommunicateWithPatients. To that end, we deduce that these variables all relate to communication and visuals. Henceforth, we interpret component 1 as "Communication methods". This is the **underlying trait** measured by DDA_7 and DDA_6.

After interpreting all components in a similar fashion, we arrived at the following descriptions, Component 1 - *"Use and sharing of educational information through collaboration*"; Component 2 - "*Use of public health news and information*"; Component 3 - "*Use of mail and email*"; Component 4 - "*Brand promotion*" and Component 5 - "*Communication methods*"

5. Discussion

The investigation established that all the medical practitioners use at least one digital device to conduct their daily activities and indicated to be ready to use such digital devices to carry out their healthcare activities and collaborate in an interoperable healthcare environment. From the interviews conducted, all the practitioners appeared to be computer literate and hence could easily comprehend the evolution of a new computer based systems and mobile device models that will allow for interoperability of their healthcare activities [25] [26] [27].

Moreover, some practitioners like pharmacists and medical insurers indicated that they are more than ready for healthcare collaboration since it was discovered that most pharmacies are already using systems that enquire for medical cover through a network that connects pharmacies to medical funders. Moreover the internet connectivity penetration rate is fairly good for interoperability of the Zimbabwean HIS [28].

Medical doctors also feel their services could be enhanced if they are able to share patients' data or receive

medical examination results from various laboratories and other examination centres [29]. This shows that such practitioners are ready to participate in an interoperable healthcare environment for healthcare service collaboration [30].

Most work places are providing broadband internet connectivity which allows for various practitioners to connect their devices to the internet to access certain medical information resources [31]. Moreover, to supplement work place internet, some practitioners use personally subscribed internet connections when not at their work places and this then shows that they are very ready to use their devices to perform healthcare activities from anywhere if provided with broadband connectivity. Therefore, mobile internet connectivity provision will allow working from remote places outside the conventional workplace environment effective since they indicated the prohibitive high costs of internet connectivity.

The investigation revealed that, healthcare practitioners are ready to use digital devices for sharing healthcare educational information, find public healthcare news and information and communicate on various healthcare related activities. The study results confirmed that most practitioners are familiar with using their devices for emails, searching the internet for news and epidemiology, chatting with patients and medical resources enquiry. However, a few practitioners indicated that they do not fully know the powerful features that their digital devices possess and thereby fail to completely exploit the functions embedded in their devices [32]. Therefore, it is imperative for practitioners to be trained on the technical features on their devices and more so on new e-Healthcare systems.

The studies however indicated that healthcare practitioners seldom carry out healthcare collaboration via a digital ecosystem although there is evidence that they desire to practise in a seamless connected environment for healthcare collaboration. From the studies, it was discovered that some healthcare entities were using some eHealth care systems although the challenge was that of existing as silo stand-alone systems which in turn showed that practitioners are ready to work in an interoperable environment if such an ecosystem is created. There is in turn the need for government initiative to drive the integration concept from a policy perspective to push for a unified Health Information System which is interoperable through standardised Information architectures and protocols for healthcare data storage [33].

The studies observed the use and sharing of educational healthcare information through collaboration as a variable that relates to online healthcare collaboration, downloading radiological images, sending medical notes, surgical procedure collaborations, medical diagnostics and general medical research.

The research also discovered that the practitioners used their devices for accessing public health news and information related to epidemiology, verifying viral messages and medical cover enquiry. This therefore shows that healthcare practitioners are ready and have an appetite to use their digital devices for healthcare service related activities and hence giving an indication that they are ready to practise in an interoperable Health Information System [34].

6. Conclusions

The research ascertained the interoperability readiness of healthcare practitioners to derive the readiness of healthcare sector in operating in an Interoperable Health Information System in Zimbabwe. Interoperability is a seamless model that should be created through a fusion of various entities to share and operate in an integrated manner. However, there are underlying enablers to the achievement of such a position which requires, financial resources, adequate equipment infrastructure, reliable broadband connectivity, Standardised protocols for data engines and technical skills and literacy for it to be successful.

The findings show that, HIS interoperability readiness can also be influenced by institutional support and government policy in terms of the operational climate creation through standards and regulation. Therefore, the studies serve to recommend that, Institutions and the government should create a framework that drive for the creation of an interoperable HIS architecture and such a blueprint to be financially supported through adequate infrastructure resources and moreover, provide technical training and support to the personnel involved in the ecosystem creation and use.

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