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EVIDENCE-BASED MEDICINE & MEDICAL INFORMATICS | RESEARCH ARTICLE

The functionality status and challenges of electronic health management information system: The case of public health centres in Amhara Region, Ethiopia

Mulusew Andualem Asemahagn^{1*}

Abstract: *Background:* Although electronic health management information systems (eHMIS) have been applied in the Ethiopian healthcare system since 2006, the functionality status and challenges are not assessed yet. *Methods:* A facility based cross sectional study was conducted in April 2017 to assess the eHMIS adoption rate, functionality status, and challenges in public health centres from Amhara Region, Ethiopia. Data were collected through phone interviewing of HMIS focal persons and data extraction from eHMIS databases. Data were analysed using SPSS version 23 software. Different descriptive statistics were computed to describe study objectives. Multivariable logistic regression analysis was used to identify factors affecting eHMIS functionality and variables showing p-value of less than 0.05 were considered as statistically significant. *Results:* The eHMIS adoption rate in the study area was 87.3% (733 from 839 health centres). Two third (66.6%) of the respondents were health information technicians (HIT). The majority, 653 (89.0) of the respondents took training on eHMIS. About 213 (29.0%) of the eHMIS focal persons were non health information technician staffs. More than half, 430 (58.7%) of health centres have functional eHMIS. Being HIT eHMIS focal person, absence of training,

ABOUT THE AUTHOR

I am Mr Mulusew Andualem Asemahagn, a higher education instructor in one of the Ethiopian higher education institution called Bahir Dar University. I graduated with master of public health (MPH) from Addis Ababa University school of Public Health on 5 July 2012. From September 2012 to October 2014, I served as instructor and researcher at the Institute of Public Health, University of Gondar, and since then, I am working as instructor, lecturer and consultant at the School of Public Health, Bahir Dar University. My research areas are TB, HIV, malaria, human parasitology, ICTs in health (eHealth), health information system, data management and evidence based practice, traditional practices in health, healthcare service quality, non-communicable diseases, and neglected diseases. I have conducted more than 50 research works including the current on these areas.

PUBLIC INTEREST STATEMENT

“The electronic health management information system” is crucial to collect, process, use, and communicate healthcare data in each health facility. Incompleteness, inconsistency, non-timeliness, non-representativeness are typical features of data from paper based data handling system, which are bottle necks to better decision-making. This article tried to describe the functionality status of electronic data handling system and challenges in the public health centers in Amhara Region, Ethiopia. Having strong data recording and handling system is important to improve data quality and decision-making at all levels. The study revealed 87.4% system adoption rate and 58.7% functionality rate. Being certified eHMIS staffs, absence of training, system failure, skill gaps, computer problems, and electric power interruption were factors affecting the eHMIS functionality. Improving training, maintenance service, electric power, and recruiting adequate trained staffs is needed to improve eHMIS adoption and functionality.



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system failure, skill gaps, computer problems, and electric power interruption were variables showing statistical significant on the eHMIS functionality. *Conclusions:* This study revealed relatively high eHMIS adoption rate, but lower functionality status for various reasons. Improving training access, maintenance service, electric power, and recruiting adequately trained staffs is needed to improve eHMIS adoption and functionality.

Subjects: Medicine; Medical Statistics & Computing; Primary Health Care & Family Practice

Keywords: eHMIS; functionality status; factors; health centres; Amhara Region; Ethiopia

1. Background/Introduction

The Ethiopian Health Management Information System (HMIS) was adapted in 2006 to generate quality healthcare data and improve decision-making at all levels (Ethiopian Federal Ministry of Health, 2015; Ethiopian Federal Ministry of Health TU, 2008; Ministry of Health-Federal Democratic Republic of Ethiopian, 2012; Teklegiorgis, Tadesse, Terefe, & Mirutse, 2016). Poor data quality (incompleteness, inconsistency, inaccuracy, and non-timeliness) has challenged the Ethiopian health information system (Belay, 2013; Ethiopian Federal Ministry of Health, 2013a, 2013b, 2015, 2016; Ethiopian Federal Ministry of Health TU, 2008; Ministry of Health-Federal Democratic Republic of Ethiopian, 2012; Teklegiorgis et al., 2016; USAID/MEASURE SnanoE, 2009). The possible explanation could be having paper based HMIS, high cost for duplicating HMIS formats, transportation, tediousness to compile formats, personal errors while recording and compiling reports (Akmel, 2013; Teklegiorgis et al., 2016). The Ethiopian government has lost for about \$US 5,073, 996.00 each year for printing HMIS formats besides to poor data quality (Akmel, 2013).

As a result, the Ethiopian Federal Ministry of Health (FMoH) together with Tulane University, Centre for diseases control (CDC), and the UNAID is working on changing the paper based HMIS to the electronic form of HMIS, eHMIS, since 2009 (Ethiopian Federal Ministry of Health, 2015; Belay, 2013; USAID/MEASURE SnanoE, 2009; Ethiopian Federal Ministry of Health, 2013b, 2016; Akmel, 2013; Ethiopian Federal Ministry of Health, MEASURE Evaluation (JSI), 2012). The eHMIS is aimed at overcoming data quality issues and improving decision-making at managerial and clinical practices of Ethiopian healthcare system. In addition, it will improve routine healthcare data recording, handling, report generating, communication and use at all levels (Ethiopian Federal Ministry of Health, 2015, 2016; Ethiopian Federal Ministry of Health, MEASURE Evaluation (JSI), 2012; Health EFMo, 2016). As of mid-2016, more than 3,000 Ethiopian health facilities has adopted the eHMIS (Health EFMo, 2016).

Amhara regional state, one of the nine regions in Ethiopia, is the second largest and more populated region which is administratively divided in to 10 zones and 3 city administrations. According to the Ethiopian administrative system, zone is the second administration level next to region. Based on the 2016 Amhara Regional Health Bureau (ARHB) report, there were about 4,244 public health facilities (69 hospitals, 839 health centres, and 3,336 health posts) which are expected to use the newly adopted eHMIS to manage their routine healthcare data (Amhara Regional Health Bureau, 2017). Although there were few assessment reports on the Ethiopian HMIS (Abajebel, Jira, & Beyene, 2011; Abera, 2011; Akmel, 2013; Ministry of Health-Federal Democratic Republic of Ethiopian, 2012), no research evidence was found on eHMIS, mainly in Amhara Region. Thus, the current study was aimed at assessing the implementation status, functionality, and challenges of eHMIS in public health centres found in Amhara Regional State, Ethiopia.

2. Methods

2.1. Study design and study setting

An institution based cross-sectional study was carried out in 2017 to assess the implementation status, functionality and challenges of eHMIS in public health centres found in Amhara Regional

State, Ethiopia. Amhara Regional state is the second largest and populated region from the nine Ethiopian regions. Amhara region is divided into 10 zones, and 3 administrative cities. The capital city of Amhara Regional state is Bahir Dar, where the regional health bureau is located. Based on the 2016 Amhara region health bureau report, the region has a total population of 21.5 million; 19.7 million urban and 1.8 million rural. There were 4,244 public health facilities (69 hospitals, 839 health centres and 3,336 health posts) in Amhara Region. According to the Ethiopian healthcare delivery system, health posts are the smallest health facilities at the community level staffed with two to four health extension workers to provide primary healthcare services, mainly preventive, to populations of 5,000–8,000 (Amhara Regional Health Bureau, 2017). The Ethiopian healthcare system has three tiers: specialized hospitals (tertiary level healthcare), general hospitals (secondary level healthcare), and the primary health care units/PHCU/(primary level healthcare). The PHCU, consisting of one health centre and five health posts, is designed to provide healthcare services (mainly preventive, and curative services) for about populations of 25,000–40,000 (Amhara Regional Health Bureau, 2017; Ethiopian Federal Ministry of Health, 2015; Ministry of Health-Federal Democratic Republic of Ethiopia, 2012).

2.2. Sample size and sampling methods

All 733 health centres which adopted the eHMIS during the study period were included in the study. A total of 733 eHMIS focal persons, one from each HC, also participated in the study.

2.3. Data collection tools and techniques

Two types of data were collected: review of regional health bureau eHMIS data base (for eHMIS adoption status and functionality), and phone interview of eHMIS focal persons of HCs (data on functionality status and challenges). Data on the current functionality status and challenges affecting system functionality were collected through phone interviews using a structured questionnaire and call recording among the HMIS focal persons. Data extraction guideline was used to collect data related to eHMIS adoption rate and functionality status. Phone call recording was employed in order not to miss responses of the respondents.

2.4. Data quality assurance

Questionnaire pretesting, informing the study objectives and data collection procedures, getting orientation from regional eHMIS focal persons how to use the eHMIS data base, using phone call recording, and frequent data edition were major activities to keep data quality.

2.5. Data analysis

Data were analysed using statistical packages for social sciences (SPSS) version 23. Various descriptive statistics including percentages, proportions, and frequencies were computed to describe study objectives. The eHMIS is said to be functional if data recording and reporting activities are using the system. It was measured in terms of proportion of health facilities which have functional or non-functional eHMIS. Bivariate and multivariable logistic regression analyses were applied to identify factors of the HMIS functionality status. Variables with p -value of <0.2 on the bivariate logistic regression analysis were considered for multivariable logistic regression analysis. Variables having p -value of less than 0.05 were considered as statistically significant and the associations between dependent and independent variables were described using odds ratios at 95% confidence level (CI).

2.6. Ethical clearance

The Bahir Dar University Ethical Review Committee reviewed the research protocol and gave the ethical clearance. A support letter was taken from Amhara Regional Health Bureau. Informed consent was obtained from heads of each health centre, and eHMIS focal persons after clear explanation on study objectives, data collection procedures, and data confidentiality. Participation was fully voluntary based. Data confidentiality was kept through anonymity. Phone calls were recorded after informing participants and obtaining their consent.

3. Results

3.1. Socio-demographic descriptions of respondents

A total of 733 eHMIS focal persons from 733 studied health centres were interviewed. More than two-third, 506 (69.0%), of the respondents belonged to the age group of ≤ 30 years, and 498 (68.0%) were males. The majority (520; 71.0%) of the study participants were diploma in education status. Only 488 (66.6%) of eHMIS focal persons were health information technicians (HIT). More than half of the respondents were from health facilities located in Western Amhara Regional State. Most (89.0%) of the respondents took training on eHMIS (Table 1).

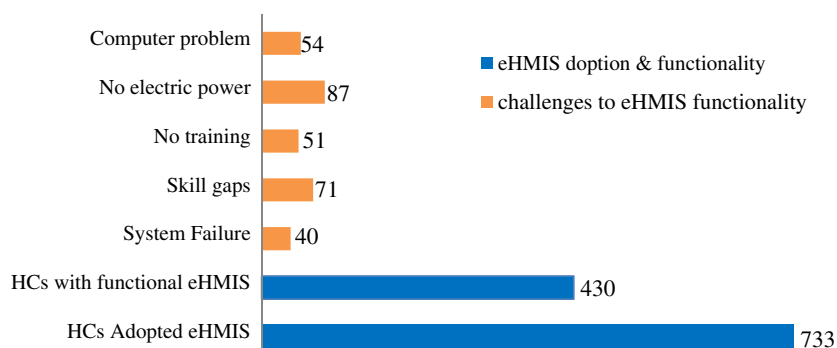
Table 1. Socio-demographic descriptions of study participants, Amhara Region, 2017

Variable	Response	Frequency	Percent
Age in years	≤ 30	506	69.0
	> 30	227	31.0
Sex	Male	498	68.0
	Female	235	32.0
Education	Diploma	520	71.0
	Bachelor	213	29.0
Profession	HIT	488	66.6
	Nurse	195	26.6
	Health officer	30	4.1
	Other	20	2.7
Income	≤ 3500	477	65.0
	< 3500	286	35.0
Address	Western Amhara	403	55.0
	Eastern Amhara	330	45.0
Trained on eHMIS	Yes	653	89.0
	No	80	11.0
Position of HMIS focal persons	Staffed	520	71.0
	Delegated	213	29.0

3.2. The eHMIS adoption rate and its functionality status

Of the total 839 HCs found in Amhara Region, 733 have adopted the eHMIS as a routine data recording, handling and reporting system. During the study period, only 430 (58.7%) of the 733 HCs had functional eHMIS (recording and reporting are based on the eHMIS) (Figure 1). The most frequent challenges to the functionality of eHMIS in HCs were absence/interruption of power ($n = 87$, 28.7%), skill gaps ($n = 71$, 23.4%), computer problems ($n = 54$, 17.8%), no eHMIS training (51, 16.8%), and system failure (40, 13.2%) (Figure 1). While assessing the Amhara Regional Health Bureau eHMIS data base, I found that these variables were identified as challenges to the non-functionality of HCs' eHMIS.

Figure 1. eHMIS adoption, functionality & challenges in HCs of Amhara Region, 2017.



3.3. Factors affecting functionality of HCs' eHMIS

The multivariable logistic regression analysis revealed that being HIT professional, staffed for eHMIS, system failure, no electric power, skill gaps, no training, and computer problems were statistically associated with functionality of eHMIS (p -value < 0.05) (Table 2).

Table 2. Factors affecting HCs' eHMIS functionality, Amhara Region, Ethiopia, 2017

Variable	Response	eHMIS Status		OR (95% CI)	p-value
		Functional (%)	Non-functional (%)		
Age in years	≤30	304 (41.4)	202 (27.6)	1.21 (0.88–1.66)	0.245
	>30	126 (17.2)	101 (13.8)	1	
Sex	Male	286 (39.0)	212 (29.0)	0.85 (0.62–1.17)	0.323
	Female	144 (19.6)	91 (12.4)	1	
Education	Diploma	298 (40.7)	222 (30.3)	0.82 (0.59–1.14)	0.244
	Bachelor	132 (18.0)	81 (11.0)	1	
Profession	HIT/IT	320 (43.6)	168 (23.0)	2.34 (1.71–3.20)	0.001
	Health workers	110 (15.0)	135 (18.4)	1	
Income	≤150\$US	288 (39.3)	189 (25.8)	1.22 (0.89–1.66)	0.198
	>150\$US	142 (19.4)	114 (15.5)	1	
Address	Eastern Ethiopia	231 (31.5)	173 (23.6)	0.87 (0.65–1.20)	0.36
	Western Ethiopia	199 (27.2)	130 (17.7)	1	
Position	Staffed	360 (49.1)	160 (21.8)	4.60 (3.26–6.47)	0.001
	Delegated	70 (9.6)	143 (19.5)	1	
System failure	Yes	14 (1.9)	26 (3.5)	0.36 (0.18–0.70)	0.002
	No	416 (56.8)	277 (37.8)	1	
Skill gaps	Yes	23 (3.1)	48 (6.6)	0.27 (0.16–0.47)	0.001
	No	407 (55.5)	255 (34.8)	1	
Trained on eHMIS	Yes	408 (56.6)	245 (32.4)	4.39 (2.1.62–7.35)	0.003
	No	22 (3.0)	58 (8.0)	1	
No electric power	Yes	37 (5.1)	50 (6.8)	0.48 (0.30–0.75)	0.001
	No	393 (53.6)	253 (34.5)	1	
PC problems	Yes	22 (3.0)	32 (4.3)	0.46 (0.26–0.80)	0.005
	No	408 (55.7)	271 (37.0)	1	

4. Discussion

Based on this study, 106 (12.6%) of the total 839 HCs did not adopt the eHMIS. This clearly showed that significant numbers of HCs are providing healthcare services with compromised data quality and poor decision support which is high compared to the Ethiopian health sector transformation plan where all health facilities need to have improved health information system and informed decisions (Akmel, 2013; Ethiopian Federal Ministry of Health, 2015, 2016). This will lower the performance of HCs if Amhara Regional Health Bureau (ARHB) and Federal Ministry of Health (FMOH) do not take action on the adoption, and functionality of eHMIS. In addition, the ARHB and FMOH will continue losing high cost for printing paper based HMIS formats and reports besides poor data quality (Akmel, 2013; Wu, Shortell, Rundall, & Bloom, 2017). The above non-adoption rate is high compared to health facilities at national level (more than 3,000 HCs adopt the system), and in the southern part of Ethiopia where almost all adopted the eHMIS system. The possible reason to this variation could be the presence of non-governmental organizations (USAID, CDC, MEASURE evaluation/JSI) to support the eHMIS implementation (technical, monetary, maintenance, training, budget) in the southern Ethiopia (Ethiopian Federal Ministry of Health, 2013b; Ethiopian Federal Ministry of Health, MEASURE Evaluation (JSI), 2012; Health EFMO, 2016; Wu et al., 2017).

Another important finding from this study was lower proportion of eHMIS functionality in HCs. Limited number of HCs (430, 58.7%) of 733 HCs had functional eHMIS during the study period. This obviously showed that large proportion of HCs did not have functional eHMIS which might have impact on decision supports of each HC, ARHB, and FMOH since HCs are major sources to the routine health care data in Ethiopian health system (Ethiopian Federal Ministry of Health, 2015, 2016; Health EFMO, 2016; Ministry of Health-Federal Democratic Republic of Ethiopia, 2012). It is failure compared to the case with HCs which did not adopt the system because more budget was invested for recruiting eHMIS focal persons, system establishment, material/equipment purchasing, and infrastructure in the latter (Akmel, 2013; Belay, 2013; Ethiopian Federal Ministry of Health, 2015; Wu et al., 2017). This clearly showed that the health information system of the studied region is problematic, because, 12.6% HCs did not adopt the eHMIS, and 41.3% of HCs which adopted the system had non-functional eHMIS. All these could lead to have poor healthcare services and decision-makings, failed to achieve eHMIS's objective (Akmel, 2013; Ethiopian Federal Ministry of Health, 2013b, 2015; Ethiopian Federal Ministry of Health TU, 2008; Ministry of Health-Federal Democratic Republic of Ethiopia, 2012).

Hence, the region, FMOH, health centres, and nongovernmental organizations (NGOs) need to work to improve the adoption and functionality of eHMIS in Amhara Region since it will have impact on the national health care system performance, the region is the second largest in geographic coverage in the country.

Based on the participants response and regional eHMIS data based evidence; skill gaps, absence of trained manpower (HIT), system failure, absence/poor maintenance services, budget shortage, and frequent interruption of electric power were mentioned challenges that have association with the functionality of eHMIS (Amhara Regional Health Bureau, 2017). These were mentioned as determinant factors to adopt and use the eHMIS in Ethiopia and abroad (Akmel, 2013; Belay, 2013; Ethiopian Federal Ministry of Health TU, 2008; Ethiopian Federal Ministry of Health, 2015; Ethiopian Federal Ministry of Health, 2013a, 2016; Ethiopian Federal Ministry of Health, MEASURE Evaluation (JSI), 2012; Health EFMO, 2016; Wu et al., 2017). In addition, being HIT professional (OR = 2.34, 95% CI (1.71–3.20)), and trained on eHMIS (OR = 4.39, 95% CI (2.62–7.35)) showed statistical association with eHMIS functionality (Table 2). According to this study, 89.0% took eHMIS training and 71.0% HMIS focal persons were HIT staffs (Table 1). It is to mean that about 29.0% eHMIS focal persons of HCs were non-HIT professionals (healthcare workers who did not take proper HIT training). This clearly showed that there would be skill gaps due to not being training well, and being non HIT professionals which could compromise the performance of eHMIS (Akmel, 2013; Belay, 2013; Ethiopian Federal Ministry of Health, 2015, 2016; Ministry of Health-Federal Democratic Republic of Ethiopia, 2012; Wu et al., 2017). Improving the eHMIS performance could be difficult unless either adequate

HIT professionals are recruited or continual training is given to the non-HIT personnel who are using the system, and serving as eHMIS focal persons in each HC. Giving attention to the primary level data handlers (HIT and health extension workers) is the primary agenda to the information revolution roadmap of the Ethiopian FMoH (Ethiopian Federal Ministry of Health, 2013a, 2016; Akmel, 2013; Ethiopian Federal Ministry of Health, MEASURE Evaluation (JSI), 2012; Health EFMo, 2016).

Being HIT staff showed positive association with eHMIS functionality status; (OR = 4.60, 95%CI (3.26–6.47)) compared to non-HIT staffs who worked on eHMIS (Table 2). It is because of high responsibility, better knowhow, and skills on eHMIS among the HIT staffs than the counter parts. Thus, giving on job training to non-HIT staffs and recruiting HIT professionals are important interventions to improve eHMIS functionality status in Amhara Region (Akmel, 2013; Ethiopian Federal Ministry of Health, 2013a, 2013b; Ethiopian Federal Ministry of Health, MEASURE Evaluation (JSI), 2012; Health EFMo, 2016).

According to this study, system failure can greatly affect the performance of eHMIS; respondents who had encountered system failure were 64% times less likely to have functional eHMIS compared to those who had no problem of system failure (OR = 0.36, 95% CI (0.18–0.70)). It is a critical issue to the functionality of eHMIS since it is a computerized system and system failure means no functional eHMIS in a given HC. Other factors may contribute to the non-functionality of eHMIS, but system failure is a back bone (Belay, 2013; Ethiopian Federal Ministry of Health, 2016; Health EFMo, 2016). The possible justification to system failure could be presence of non-trained eHMIS users (11.0%), computer related problems (7.4%), skill gaps (9.7%), electric power interruption (11.9%), and non-HIT focal persons (29.7%). All these variables can directly or indirectly contribute to the eHMIS failure (Akamel, 2013; Belay, 2013; Ethiopian Federal Ministry of Health, 2015, 2016). Hence, unless great attention is given to prevent system failure such as having maintenance system and giving adequate training, HCs will safer much in having quality healthcare data which will affect decision-making and timely communication.

Respondents who had skill gaps on managing eHMIS were 73% times less likely to have functional eHMIS in HCs (OR = 0.27, 95% CI (0.16–0.47)). It is clear that skill gaps can affect using, and maintaining the eHMIS. On the other hand, skill gaps could be the cause for non-functional eHMIS due to miss use, and unable to understand the how to use guideline (Ethiopian Federal Ministry of Health, 2015, 2016; Ethiopian Federal Ministry of Health, MEASURE Evaluation (JSI), 2012). Skill gaps could be resulted from limited training access, and assigning non trained personnel as eHMIS users/focal persons due to shortage of trained HIT staffs. Thus, it is better to give training on eHMIS and its performance to those who are using the system, and serving as delegated eHMIS focal persons. Recruiting the HIT staffs is appropriate solution to solve the problem and enhance eHMIS performance in a better manner (Akamel, 2013; Belay, 2013; Ethiopian Federal Ministry of Health, 2015, 2016; Health EFMo, 2016).

Similarly, frequent electric power interruption was a challenge to low eHMIS performance; respondents who worked with electric power interruption were 52% times less likely to have functional eHMIS compared to their counter parts (OR = 0.48, 95% CI (0.30–0.75)). Talking about eHMIS functionality is impossible with the absence of electric power since the system is automated. Disrupted power makes the system off, and users may use paper based data handling system which affects data quality, management and use.

5. Conclusions

This study revealed relatively high eHMIS adoption rate, but lower functionality status for various reasons. Skill gaps due to (shortage of HIT professionals and training gaps), electric power interruption, system failure, and computer related problems were statistically significant factors to low eHMIS functionality status in HCs of Amhara Regional State. Recruiting trained HIT personnel, training of eHMIS users, availing uninterrupted power source including a stand by generator, and having maintenance service are key interventions to enhance eHMIS functionality in the study area.

6. Limitation of the study

Shortage of literature on eHMIS, no site observation, and using only quantitative data may affect paper quality.

Ethical approval and consent to participate

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

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Competing interests

The authors declare no competing interest.

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Authors' contributions

The author did all research activities with the consultation of senior researchers.

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References

Abajebel, S., Jira, C., & Beyene, W. (2011). Utilization of health information system at district level in Jimma zone Oromia regional state, South West Ethiopia. *Ethiopian Journal of Health Sciences*, 21(3).

Abera, M. (2011). *Health policy and the extent of health information use in Woreda health care system of Arsi zone, Oromia Region, Ethiopia* (Unpublished thesis work). Addis Ababa University, Ethiopia.

Akmal, M. (2013). *Factors affecting the implementation of electronic health management information system (eHMIS) in public hospitals in Addis Ababa, Ethiopia* (Thesis work). Amhara Regional Health Bureau. (2017). *Annual performance report of 2016*.

Belay, D. T. (2013). Factors affecting the adoption of health management information systems (HMIS) among health workers: The case of SmartCare Software in Addis Ababa Regional Public Hospitals.

Ethiopian Federal Ministry of Health. (2013a). *HMIS information use training manual*.

Ethiopian Federal Ministry of Health. (2013b). *HMIS information use guide technical standards area 4: Version 2*.

Ethiopian Federal Ministry of Health. (2015). *Health sector transformation plan (HSTP) from 2015/16-2020*.

Ethiopian Federal Ministry of Health. (2016). *Information revolution roadmap*.

Ethiopian Federal Ministry of Health, MEASURE Evaluation (JSI). (2012). *HMIS scale-up project in Ethiopia*.

Ethiopian Federal Ministry of Health TU. (2008). *HMIS Reform Training for master mentors in Ethiopia. Lecture Notes of HMIS reform training*. Tulane University Technical Assistance Project Ethiopia/TUTAPE.

Health EFMo. (2016). *Ethiopia's experience on strengthening community health information systems, data quality and data use Southern Sun Mayfair Hotel, Nairobi, Kenya*.

Ministry of Health-Federal Democratic Republic of Ethiopia. (2012). *National Health Information System Road Map: 2012/13 - 2019/20 2012*.

Teklegiorgis, K., Tadesse, K., Terefe, W., & Mirutse, G. (2016). Level of data quality from health management information systems in a resources limited setting and its associated factors, eastern Ethiopia. *South African Journal of Information Management*, 18(1), 1–8.

USAID/MEASURE SnanoE. (2009). *Assessment of health management information system (HMIS) performance in SNNPR, Ethiopia*.

Wu, F. M., Shortell, S. M., Rundall, T. G., & Bloom, J. R. (2017). The role of health information technology in advancing care management and coordination in accountable care organizations. *Health Care Management Review*, 42(4), 282–291. <https://doi.org/10.1097/HMR.000000000000123>



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