# Theoretical Application Assessing Adaptation of District Health Information System (DHIS 2) for HIV/AIDS Surveillance in Uganda

**Bwesigye, DA.,**[1]
**Loneck, BM.,**[2]
**Sherman, BR.,**[3] and
**Carpenter, DO.**[4]

1   Post-doc Fellow, The SPEED Project, Makerere University, School of Public Health, Uganda
2   Associate Professor, School of Social Welfare, State University of New York, The University at Albany, Albany, NY
3   University at Albany School of Public Health, Associate Professor, Health Policy, Management, and Behavior and Director, Doctor of Public Health (DrPH) Program, Renselaer, NY, USA.
4   Professor Environmental Health Sciences, Department of Environmental Health Sciences, University at Albany, School of Public Health, NY, USA

**Corresponding author:**
Denis Akankunda Bwesigye

✉   akankunda.denis@gmail.com

## Abstract

**Background:** With support from the United States government, Uganda introduced the District Health Information Software 2 (DHIS2) in 2012 to improve surveillance for better prevention and treatment of HIV/AIDS. However, districts have yet to fully adopt this system given a 70.2% reporting completeness attained nationally between April-June 2013. To get a deeper understanding of how Uganda has been progressing in the implementation of its DHIS2, this study applied the Boundary Objects and Social Order theories.

**Methods:** The study has one dependent variable: Districts' reporting completeness and four independent variables. 1) Number of client visits; 2) Number of district health units; 3) Number of NGOs delivering HIV and AIDS services; and 4) Regional location. These data were collected from inpatient, outpatient, and maternal newborn health programs.

**Findings:** Districts reporting the lowest number of client visits (under 2500) attained the highest mean reporting completeness (81.6%), whereas a range of 2501-5000, or over 5001client visits recorded 72.4% and 51.7% respectively. The higher the number of client visits the lower the reporting completeness (p<0.0005). Districts that were receiving support from only one NGO recorded a mere 56.7% whereas those from two recorded 67.2%. Districts supported by over three NGOs had the highest (80.6%) mean reporting completeness score. The number of NGOs was statistically associated with reporting completeness (p<0.0005). The number of health units operated by a district was also significantly associated with reporting completeness (p<0.0005). The regional location of a district was not associated with reporting completeness (p=0.674).

**Conclusion:** Results of this study suggest that districts with higher patient volume for HIV and AIDS services should be identified and targeted with additional NGO support. Newly funded NGOs should be established in districts operating over 40 health units. Incomplete reporting undermines identification of HIV- affected individuals and limits the ability to make evidence-based decisions regarding program planning and service delivery for HIV prevention and antiretroviral therapy for this needy population.

**Keywords:** Health information, Uganda, HIV, AIDS

# Background

Over the last 20 years, Uganda has piloted and implemented various management information systems (MIS) for better surveillance of HIV prevention, AIDS care and treatment [1]. Uganda is currently implementing a five-year (2011-2015) anti-HIV and AIDS plan entitled the "National HIV Prevention Strategy" (NPS). The data pertaining to this strategy's interventions are reported through an MIS called the District Health Information Software (DHIS2). DHIS2 was rolled out in all districts as a way for districts to report complete and timely data to the Ministry of Health. This information enables the government and partner organizations to remain abreast of the progress being made in reducing the spread of HIV and AIDS treatment nationally [1].

Data from antenatal clinic (ANC) sentinel surveillance sites and from the AIDS Information Centre (AIC) indicate that there was a decline in HIV prevalence, from a high of 22.0% in the early 1990's to a low of approximately 5.2% in 2004 [2]. However, according to the 2011 AIDS Indicator Survey (AIS), the HIV prevalence among Ugandans between the ages of 15-49 is on the rise. The national HIV prevalence in 2011 was reported to be 7.3% and even much higher among women at 8.3% up from 7.5% in 2005 [2].

The baseline measurement of 102,157 new cases of HIV in 2010 was used to set the country's 2011-2015 NPS spell out target of reducing new cases to 71,510 by 2015 (MOH, NPS 2011). To reach this target, there can be no more than 6,129 new cases of HIV per year. Achieving this target requires a functional national MIS that provides timely, accurate, and complete data, on not only up-to-date and accurate HIV new cases, but also for better management of AIDS care and treatment programs. Districts in Uganda have yet to fully adopt DHIS2 as revealed by low reporting completeness associated with medical records for outpatient, inpatient and antenatal services during the reporting period between April and June 2013.

# Theoretical Application

## The Boundary Objects Theory

To get a deeper understanding of how Uganda has been progressing in the implementation of its DHIS2, this study will draw lessons from the theory of Boundary Objects and its construct of social worlds [3-6]. Boundary Object theory, originally developed by Susan Leigh Star, (1989) has been applied to study the processes for transfer of information technology from developed countries to the developing world. According to Susan Leigh Star, (1989), the technologies created and introduced to the developing world can be referred to as the "boundary objects". The boundary object being referred to in this study is the Uganda's DHIS2 which was introduced by the United States PEFAR program improve surveillance of HIV/AIDS and other health care programs. The theory of boundary objects, as delineated by Star and Griesemer (1989) has been increasingly employed in the study of project management, organizational learning and information and knowledge management (Robyn et al., 2000). The theory has a construct called, 'social worlds' which refers to the processes of implementing boundary objects that involve multiple stakeholders from different 'social worlds'

working in partnership [3,7,8]. Different 'social worlds' involved in the implementation of Uganda's DHIS2 include; government Ministry of Health, PEPFAR-funded NGOs, districts managers and hospital personnel. This theory will add an analytical framework for the statistical design of this study.

## The Negotiated Order Theory

Finally, the theory of Negotiated Order will also be applied in this study. It was developed by Anselm Strauss (1978), who argued that virtually all social order is negotiated order. Negotiated order being referred to in this study is the reporting completeness attained in DHIS2 by districts during the period between April-June 2013. Under the negotiated order theory the participants involved in the implementation of a boundary object are expected to comply with a set of performance standards to ensure successful adaptation of the new technology [9]. However, other researchers have dubbed the process of "technological transfer" from the developed to the developing countries, as often carried out without taking into account local adaptation, and the local learning, which, in turn undermines successful implementation and buy-in by the local stakeholder . Implementation of such technologies involves contextual and cultural elements such as language and meanings, which are not transferrable, but rather need to be learned and developed from the local settings [3,10-15]. Therefore reporting completeness achieved by the districts will be the indicator for negotiated order between the United States' PEPFAR program and the Uganda's Ministry of Health. This study argues that investigating the factors that impact reporting incompleteness of Uganda's surveillance system can be assisted by the Boundary Object and Negotiated Order theories.

# Methods

The study has one dependent variable: Districts' reporting completeness and four independent variables. 1) Number of client visits recorded per district during the reporting period (April-June 2013); 2) Number of district health units; 3) Number of PEPFARspell out NGOs delivering HIV and AIDS services; and 4) Regional location of districts. These variables constituted the overall study of reporting completeness attained for inpatient, outpatient and a program for prevention of mother to children transmission of HIV (PMTCT) medical records submitted by districts into the national 2013.

# Procedure

The study assessed four independent variables: number of client visits, the number of nongovernmental organizations (NGOs) involved with HIV and AIDS programming per district, number of health units operated in each district, and regional location of the districts. These predictor variables were further subdivided into ordinal groups to assess for statistical differences in reporting completeness. The operational definition of the study variables as well as the relevancy for their inclusion is explained below **(Figure 1)**.
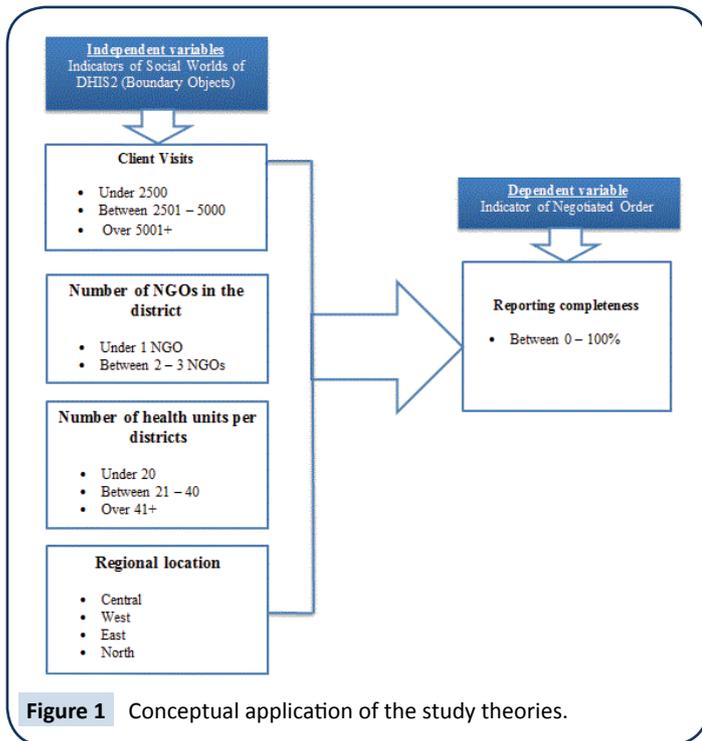
**Figure 1** Conceptual application of the study theories.

# Study variables

## Client visits

Client visits refers to total number of individuals seeking HIV prevention and treatment services within a particular district during the months of April-June, 2013. Services range from voluntary counseling and testing (VCT), educational campaigns, antenatal services (ANC), early infant diagnosis, safe male circumcision (SMC), prevention of mother-to-child transmission of HIV (PMTCT), and anti-retroviral therapy (ART).

## Number of NGOs in a district

The United States Government's Presidential Emergency Plan for AIDS Relief (PEPFAR) is the major funder for the Uganda's HIV and AIDS programs. Between 2009 and 2010, the US government contributed 83% and 93% of the entire donor funding. Data on NGO support is only available on the US supported NGOs [16]. These NGOs work in numerous districts and are required to report their HIV and AIDS program data through the DHIS2. Districts are disproportionally supported by PEPFAR NGOs termed as the Implementing Partners (IPs), with some districts having over ten NGOs and others with one or none.

## Number of health units

Districts operate varying numbers of health units, with some operating as few as ten, whereas others manage over one hundred. This disparity in distribution of health units represents the reporting pressure faced especially by districts running more health units than others. Given the earlier noted manpower shortages, the districts find themselves overwhelmed in terms of ensuring timely and complete reporting of monthly medical records into the government's surveillance system. This situation is exacerbated by disproportionate NGO support.

## Region

In Uganda, management and delivery of HIV and AIDS services are through regional administrative structures, which include the Central, Eastern, Northern and Western regions [17]. The Central region, home to the capital city of Kampala, is more industrialized than the other regions and the districts within this region have better access to electricity and other Internet capabilities needed to run the DHIS2 database. Districts in the Northern region are more underdeveloped, primarily due to a 20 yearlong war in the region.

# Results

The number of client visits was grouped into an ordinal scale that includes; under 2500, between 2501-5000, and over 5001+ clients. The number of health units operated by the districts was also grouped into ordinal categories that include; under 20 health units, between 21-40 health units, and over 41 health units. The NGO numbers were also grouped into three categories that include; only one, only two, and three and above; and regional distribution of the districts remained categorical **(Table 1)**.

## Client visit

A consistent increase in the number of client visits is associated with a consistent reduction is mean reporting scores of the study districts **(Figure 2)**.

Districts that recorded the fewest client visits (under 2500) had highest mean reporting score (81.6%). The categories of 'between 2501-5000, and 'over 5001' recorded 72.4% and 51.7% reporting scores. Whether or not the differences in these reporting completeness scores are statistically significant will be discussed below. However, a 30% difference in mean reporting scores between districts that recorded client visits under 2500 and over 5001 is very substantial and may not have been as a result of a mere chance. A standard deviation of 20.47% associated with the districts reporting scores implies high variability in reporting completeness.

## Number of NGOs

An increase in the number of NGOs supporting districts in with HIV and AIDS programming is associated with an increase in mean reporting scores of the study districts **(Figure 3)**. Districts that were receiving support from only one NGO recorded a mere 56.7% mean reporting completeness score whereas those that
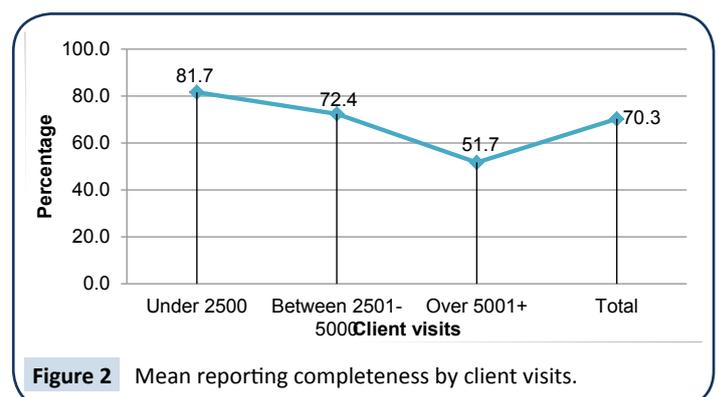


**Figure 2** Mean reporting completeness by client visits.

**Table 1** Reporting completeness associated with study variables.

| Variables | Number of client visits | Mean | N | Std. Deviation |
|---|---|---|---|---|
| Number of client visits | Under 2500 | 81.653 | 45 | 16.3864 |
| | Between 2501-5000 | 72.4 | 22 | 10.5035 |
| | Over 5001+ | 51.72 | 30 | 18.4377 |
| | Total | 70.297 | 97 | 20.4745 |
| Number of NGOs | Only one NGO | 56.785 | 27 | 19.1132 |
| | Only two NGOs | 67.244 | 27 | 15.1328 |
| | Three and above NGOs | 80.698 | 43 | 18.8725 |
| | Total | 70.297 | 97 | 20.4745 |
| Health units | Under 20 health units | 84.58 | 25 | 15.6172 |
| | Between 21-40 health units | 74.623 | 39 | 14.636 |
| | Over 41 health units | 54.364 | 33 | 19.3992 |
| | Total | 70.297 | 97 | 20.4745 |
| Region | Central | 72.443 | 21 | 19.6803 |
| | East | 70.693 | 28 | 20.3767 |
| | North | 68.665 | 23 | 26.0592 |
| | West | 69.552 | 25 | 16.035 |
| | Total | 70.297 | 97 | 20.4745 |

received support from two NGOs recorded 67.2% mean reporting completeness score. The districts supported by over three NGOs had the highest (80.6%) mean reporting score.
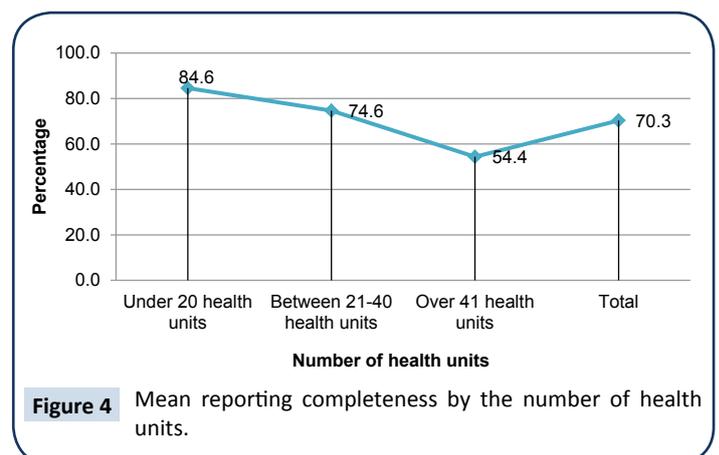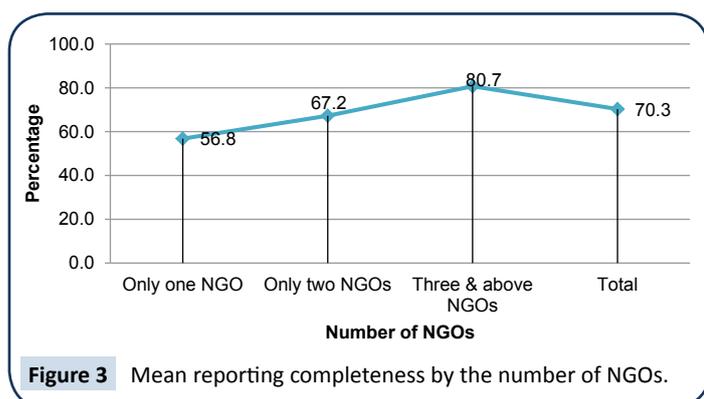
## Number of health units

An increase in the number of health units operated by districts is associated with a decrease in mean reporting scores. Districts with fewest (<20' health units) have the highest mean reporting completeness score (84.5%). As the scale of health units is increased to, 'between 21-40', and further to 'over 41', the mean reporting score reduces by 10% and 30% consistently. Districts operating over 41 health units attained the lowest mean reporting completeness score (54.3%) **(Figure 4)**. This finding suggests that districts with more health units are more likely to have lower reporting completeness than those with few health units due to the presence of less staff to enter the data. The chart above demonstrates a declining trend in reporting completeness as the number of health units operated by districts is increased. Therefore, districts operating fewer health units attained higher reporting completeness and vice versa.

## Regions

Districts' distribution by regions is relatively equal although the Eastern region has slightly higher proportion of districts (28.9%), followed by the Western (25.8%); the Northern (23.7%) and the Central has the least (21.6%) proportion of districts in the study **(Figure 5)**.

The national mean reporting score was 70.2% and the central region had a slightly higher mean reporting completeness score (72.4%). The Eastern region recorded a mean reporting completeness score of 70.6% which was almost equal to the national mean reporting completeness score. The Northern and Western mean reporting scores of 68.6% and 69.5% respectively, were lower than the national average, although the differences in reporting were not substantially. The differences in the mean reporting completeness scores among the four regions do not look significant, as was originally hypothesized.



**Figure 3** Mean reporting completeness by the number of NGOs.



**Figure 4** Mean reporting completeness by the number of health units.

## Factorial analysis of variance

The factorial analysis of variance tested for the effects of client visits, number of NGOs, number of health units and regions, on reporting completeness **(Table 2)**.

The factorial analysis of variance tested for the effects of client visits, number of NGOs, number of health units and regions, on reporting completeness. The omnibus F-statistic=17.117 and p<0.0005 and effect size of .639. The results indicate that client visits has a significant effect on reporting completeness with F(15.144) and p<0.0005. The number of NGOs also had a significant effect on reporting completeness with F(13.872) and p<0.0005. The number of health units effect on reporting completeness was also significant with F(11.499) and p<0.0005. And finally, regions did not have a significant effect with F(0.514) and p=0.674.

# Discussion

## Client visits

The statistical analysis confirmed that an increase in the number of client visits was associated with a reduction in mean reporting completeness. Districts that recorded the lowest client visits of 'under 2500' have the highest mean reporting score (81.6%) whereas the categories of 'between 2501-5000', and 'over 5001' recorded 72.4% and 51.7% reporting completeness. These findings are consistent with the study in South Africa, which noted that performance of health systems were poor especially in health units faced with high overcrowding of patients with fewer health workers [18]. Hospitals that serve high numbers of HIV and AIDS clients face enormous pressure on the already low doctor-patient ratios. Uganda's doctor to patient ratio is 1 to 24,725 and the nurse/midwife to patient ratio is 1:11,000. The shortage of skilled health workers across the country makes complete reporting of HIV and AIDS data very difficult [19-21]. According to the 2011 Human Resources for Health Audit Report, the country has a health worker staffing shortage of 42%, with some remote districts faring much worse.

## Number of NGOs

Examining the effect of number of NGOs on reporting completeness is guided by the application of the Boundary Objects, and the Negotiated Order theories. The notion of



| | |
|---|---|
| **Figure 5** | Mean reporting completeness by the regions. |

'Social Worlds' set forth by the Theory of Boundary Objects, primarily refers to a mechanism of where groups of actors work collectively with shared goals and objects [21-24]. Districts are disproportionally supported by PEPFAR-funded NGOs, with some districts having over ten NGOs working within the health units whereas others have one or none.. The study hypothesized that reporting completeness would be lower for those districts that are receiving less NGO support in routine HIV and AIDS programming compared to districts with many NGOs. An analysis by cross-tabulating the variables of 'NGOs' and 'reporting completeness' indicated that an increase in the number of NGOs supporting districts with HIV and AIDS programming is associated with an increase in mean reporting completeness.

This finding is consistent with other studies which contend that the successes of implementing MIS in developing countries manifest slowly and requires negotiations, support, collaboration, mutual learning, and partnerships among relevant stakeholders [25-29].

## Number of health units

Districts operate varying numbers of health units, with some managing as few as ten and others over one hundred. This disparity in distribution of health units illustrates the reporting pressure faced especially by districts with more health units. This situation is exacerbated by disproportionate NGO support received in HIV and AIDS programing by the districts [30-33]. This study examined the effect of the number of health units per district and the associated reporting completeness. The number of health units operated by the districts was also grouped into ordinal categories that include; 'under 20', 'between 21-40', and 'over 41' health units. The statistical analysis observed that a consistent increase in the number of health units operated by districts was associated with a consistent decrease in mean reporting scores.

# Conclusion

Uganda relies primarily on data from HIV tests carried out during antenatal visits to estimate new HIV cases. However, reporting completeness related to prevention of mother-to-child transmission of HIV was merely 37% implying that the majority of reports were not completed in the DHIS2 as of April to June 2013. Moreover, only 23.5% of the HIV-exposed babies, whose mothers tested positive, received ART medicines in 2011 compared to 34.1% in 2010 [34]. The 37% reporting completeness associated with the PMTCT program represents a major weakness in Uganda's surveillance systems. Although data for this study were extracted from a short reporting period (April-June 2013) the statistical results reveal important policy implications that the Ministry of Health and PEPFAR can utilize to improve the performance of Uganda's HIV and AIDS surveillance system. Nationally, the fact that districts achieving reporting completeness of 70.3%, illustrates a major gap that should be addressed in order to improve overall surveillance of HIV and AIDS. The reporting completeness should be elevated to 100% in all the districts in Uganda. From the outset, the implementers of the DHIS2 in Uganda may not have anticipated that districts will adapt differently in the use of an internet-based HIV and AIDS surveillance system [35,36]. Evidence from this study points to
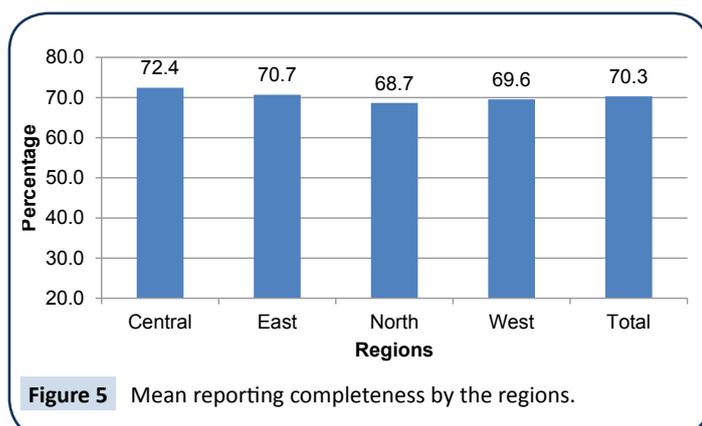
**Table 2** Dependent variable: Tests of between-subjects effects on reporting completeness.

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|
| Corrected Model | 25719.121[a] | 9 | 2857.680 | 17.117 | 0.000 | 0.639 |
| Intercept | 373844.644 | 1 | 373844.644 | 2.239E3 | 0.000 | 0.963 |
| Client visits | 5056.523 | 2 | 2528.261 | 15.144 | 0.000 | 0.258 |
| Number of NGOs | 4632.008 | 2 | 2316.004 | 13.872 | 0.000 | 0.242 |
| Number of health units | 3839.449 | 2 | 1919.724 | 11.499 | 0.000 | 0.209 |
| Region | 257.352 | 3 | 85.784 | 0.514 | 0.674 | 0.017 |
| Error | 14524.728 | 87 | 166.951 | | | |
| Total | 519584.400 | 97 | | | | |
| Corrected Total | 40243.849 | 96 | | | | |
| [a]R Squared=0.639 (Adjusted R Squared=0.602) | | | | | | |

a need for increased support for districts that have higher client volumes, more health units, and fewer NGOs involved in HIV and AIDS programming. The allocation of PEPFAR implementing partners (IPs) does not follow any standard criteria for apportioning NGO support among Ugandan districts. The NGO support received by districts should be rationed to all Uganda's districts proportionately to address the imbalance created by NGOS being attracted to some districts over others. This uneven distribution of resources directly impacts performance related to accurate and complete reporting of a HIV and AIDS in Uganda.

## Acknowledgements

# References

1   Bartholomew GS, Parcel GK, Gottlieb JB (2006) Planning Health Promotion Programs: An Intervention Mapping Approach 143-165.

2   Bechky BA (2003) Sharing meaning across occupational communities: The transformation of understanding on a production floor. Organization Science 14: 312-330.

3   Bowker GC, Timmermans S, Star SL (1995) Infrastructure and organizational transformation: Classifying nurses work. Information technology and changes in organizational work 344-369.

4   Bødker S (1998) Understanding representation in design. Human Computer Interaction 13: 107-125.

5   Briers M, Chua WF (2001) The role of actor networks and boundary objects in management accounting change: A field study of an implementation of activity-based costing. Accounting, Organizations and Society 26: 237-269.

6   Burke MB, Buntin MF, Hoaglin MC, Blumenthal D (2011) The benefits of health information technology: A review of the recent literature shows predominantly positive results. Health Aff Millwood 464-471.

7   Carlile PR (2002) A pragmatic view of knowledge and boundaries: Boundary objects in new product development. Organization Science 13: 442-455.

8   www.infodev.org/infodev-files/resource/infodevDocuments_84.pdf.

9   Clissett P (2008) Evaluating qualitative research. Journal of Orthopaedic Nursing 12: 99-105.

10  Coovadia H, Jewkes R, Barron P, Sanders D, Diane McIntyre D (2009) The health and health system of South Africa: historical roots of current public health challenges. Lancet 374: 817-834.

11  Curtis B, Krasner H, Iscoe N (1988) A field study of the software design process for large systems. Communications of the Association for Computing Machinery 31: 1268-1287.

12  Fujimura JH (1992) Crafting science: Standardized packages, boundary objects and translations. In A. Pickering Science as practice and culture 168-211.

13  Garrety K, Badham R (2000) The politics of sociotechnical intervention: An interactionist view. Technology Analysis & Strategic Management 12: 103-118.

14  He J (2004) Knowledge impacts of user participation: A cognitive perspective. Proceedings of SIGMIS 1-7.

15  Kapiriria L, Susan JB (2006) Health practitioners and health planner's information needs and seeking behavior for decision making in Uganda. International journal of medical informatics 75: 714-772.

16  Lintonen AI, Seedhouse KD (2008) Information technology in health promotion. Journal of Health Education Research 560-566.

17  Lyytinen K, Robey D (1999) Learning failure in information systems development. Journal of Information Systems 9: 85-101.

18  Lyytinen K (1987) Different perspectives on information systems: Problems and solutions. ACM Computing Surveys 19: 5-46.

19  Orlikowski WJ, Robey D (1991) Information technology and the structuring of organizations. Journal of Information Systems Research 2: 143-169.

20  Modell S (2006) Institutional and negotiated order perspectives on cost allocations: The case of the Swedish university sector. The European Accounting Review 15: 219-251.

21  Nastasi HJ, Jayasena N, Bernstein-Moore R, Sarkar S, Varjas K (2005) Illustrating a mixed-method approach for validating culturally specific constructs. Journal of School Psychology 43: 259-278.

22  http://heim.ifi.uio.no/~jensj/Nhampossa2005TechTransferTechTranslationHIS.pdf.

23  http://trove.nla.gov.au/work/10133037.

24  Pagliari AD, Anandan BK, Cresswell T, Bokun B, McKinstry R, et al. (2012) The impact of eHealth on the quality and safety of health care: a systematic overview. PLoS Med e1000387.

25  Peifer H, Fang KLJ, Chen JA, Rizzo (2011) Health information and technology and physicians perceptions of healthcare quality, Am. J. Manag Care e66-e70.

26  Robey D, Boudreau MC, Rose GM (2000) Information technology and organizational learning: A review and assessment of research. Accounting, Management and Information Technologies 10: 125-155.

27  Roth WM, McGinn MK (1998) Inscriptions: toward a theory of representing as social practice. Review of Educational Research 68: 35-59.

28  Schneider SS, Jones JL, Adams EJS, Ringel S, McGlynn E (2010) Electronic health record adoption and quality improvement in US hospitals. The American Journal of Managed Care SP64-SP71.

29  http://www.researchgate.net/publication/243455134_Transparency_beyond_the_individual_level_of_scale_convergence_between_information_artifacts_and_communities_of_practice.

30  Strauss A (1978) A social world perspective. In: Norman Denzin (ed) In studies in symbolic interaction, vol. 1, Greenwich, CT: JAI press.

31  http://www.unaids.org/en/dataanalysis/knowyourresponse/countryprogressreports/2012countries/ce_UG_Narrative_Report[1].pdf.

32  http://uganda.um.dk/en/~/media/Uganda/Documents/English%20site/Danida/National%20HIV%20prevention%20strategy.pdf.

33  http://www.unaids.org/sites/default/files/en/media/unaids/contentassets/documents/document/2011/JC2215_Global_AIDS_Response_Progress_Reporting_en.pdf.

34  Virga P, Bongguk J, Jesse T, Sergey V (2012) Electronic health information technology as a tool for improving quality of care and health outcomes for HIV AND AIDS patients. International journal of medical informatics 81 e39-e45.

35  Wastell D (1999) Learning dysfunctions in information systems development: Overcoming the social defenses with transitional objects. MIS Quarterly 23: 581-600.

36  Zhong J, Majchrzak A (2004) An exploration of impact of cognitive elaboration on learning in ISD projects. Information Technology and Management 15: 143-159.