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ADOPTING A SERVICE-DOMINANT LOGIC TO PREDICTION OF PREGNANCY COMPLICATIONS: AN EXPLORATORY STUDY OF MATERNAL HEALTHCARE IN UGANDA

Research paper

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Abstract

The United Nations listed maternal mortality as a major problem especially in developing countries. Predictive models that predict pregnancy complications have been suggested as an intervention to reduce maternal mortality but at the moment, many are not used in clinical practice. This study proposes a service-dominant perspective as an alternative use of predictive models to create value for maternal healthcare. We conducted an exploratory study in south-eastern Uganda in which we held semi-structured interviews with health practitioners to understand how the maternal healthcare system in Uganda works and how pregnancy complications are predicted. Results were analyzed using components from the service innovation framework. We find that overall, ICT has not been fully exploited to improve access to quality care, improve predictions and to improve collaboration among different practitioners in Uganda. Our findings suggest that by adapting a service-dominant perspective, we can enable predictive models and other technologies to assume an active role in maternal healthcare thereby supporting health practitioners with different skills and knowledge to predict pregnancy complications and hence trigger collaborative value creation. We believe that such an intervention will reduce maternal mortality.

Keywords: service-dominant logic, maternal healthcare, predictive models, pregnancy complications.

1 Introduction

In 2015, about 830 women died every day from pregnancy or childbirth-related complications, with 99% reported from developing countries (WHO, 2015). Despite improvement activities, the United Nations' fifth Millennium Development Goal (MDG 5) of a 75% reduction in the maternal mortality ratio (MMR; number of maternal deaths per 100 000 livebirths) has not been met. Worldwide, the number only dropped by 43% (WHO, 2015). The slow progress in reducing maternal mortality in developing countries is explained by limited access to healthcare and shortage of medically trained maternal and child healthcare professionals (Nabudere et al., 2011). Furthermore, specialized professionals are devoted to urban areas; this leads to very limited access to high quality healthcare in rural areas where most of the population resides (World Bank, 2010; MoH, 2012). In order to achieve the MDG5 goals and extend maternal healthcare to rural areas, many countries have implemented a task shifting strategy (WHO, 2007). In a task shifting strategy, less trained and qualified community healthcare workers organized in village health teams (VHTs) (WHO/PEPFAR/UNAIDS, 2008) become the first point of contact for pregnant women. It is perceived that VHTs need predictive models to predict pregnancy complications and to identify women with the highest risk of adverse maternal outcomes (Payne et al., 2014). However, rural level healthcare workers experience major problems to predict pregnancy complications (Okuga, et al., 2014) and cannot use predictive models because they are too

complex and require computer support (James, 2001; Payne et al., 2014). The problem with too complex models seems to be a general one (Kleinrouweler et al., 2016) and there is little evidence of their impact and usefulness in practice (ibid, Moons et al., 2012).

The way VHTs are supposed to predict pregnancy complications reflects a traditional healthcare system, designed for highly qualified healthcare professionals and with limited focus on patient involvement. The patients cooperate by accepting information provided by the doctors without questioning it (i.e. passive compliance), which can lead to a low quality of life (McColl-Kennedy et al., 2012). Increasingly, systems are transformed to more actively involve patients in the co-creation of healthcare service experiences (McColl-Kennedy et al., 2012). The transformation reflects a vital shift in perspective from a goods-dominant logic perspective, with healthcare management based on outdated managerial science practices (Joiner and Lusch, 2016), to a service-dominant (S-D) logic in which service providers and customers are co-creating value (Vargo and Lusch 2004, 2008).

To improve healthcare management and services, at the individual, organization or system level, patients and healthcare workers need to co-create value (McColl-Kennedy et al., 2012). Such a patient's activation approach (Joiner and Lusch, 2016) requires interactional resources including knowledge, technology and institutions (Srivastava and Shainesh, 2015). However, there are few studies on IT processes and structures that are needed to actively embrace patient participation in the improvement of healthcare services at the organizational or system level (Sharma et al., 2014).

To better understand how IT can support value co-creation in predictions of pregnancy complications in Uganda, we suggest an analysis based on a service-dominant logic perspective. The purposes of this exploratory study are to describe value co-creation in rural Ugandan healthcare and to explore how the maternal healthcare system in Uganda can be transformed by actively involving the pregnant women in the use of IT to predict, prevent and manage pregnancy complications. The practical contribution is to improve the predictions of pregnancy complications to meet the MDG5. Furthermore, the results aim to support the task shifting strategy by increased quality of maternal healthcare in low resource settings. The theoretical contribution is to identify how the S-D logic framework may inform the design and use of IT for healthcare value co-creation in a low-resource setting. Our study of village health teams in rural areas partly addresses the calls for S-D logic based research at the micro levels of abstraction and aggregation (Hardyman et al., 2015; Joiner and Lusch, 2016) and contribute to the knowledge base since "the concept of S-D logic as applied to health care is new" (Joiner and Lusch, 2016, p. 28). To the latter we would like to add that S-D related research of healthcare customers' changing roles seems to focus on developed country contexts (McColl-Kennedy et al., 2017).

The remainder of the paper is organized as follows. In the next section, we review existing literature on predicting pregnancy complications and S-D logic perspective on healthcare services. We explain how semi-structured interviews were conducted in Uganda with healthcare practitioners and analyse the findings by applying the S-D logic framework. In the concluding section, we discuss the implications of the study, limitations and future research directions.

2 Literature review

2.1 Predicting pregnancy complications

In developing countries, a risk approach has been used to screen pregnant women who are at greater risk of pregnancy complications and maternal death. However, risk factors are normally non-medical and poor indicators of maternal risk (Yuster, 1995). Using factors such as age, parity and booking status to predict or prevent complications is not reliable. Hence, all pregnant women are at risk of maternal death throughout pregnancy, delivery and puerperium regardless of categorization (Ochejele et al., 2011). In addition to the risk approach, health professionals rely on simple heuristics to diagnose patients, which leads to variations in quality of care (Gigerenzer and Gaissmaier, 2011). For example, Yoong et al. (2010) reports the inaccuracy in visual estimation of blood loss by healthcare profession-

als, which hinders preparation for appropriate resuscitative measures and may eventually lead to maternal death due to haemorrhage, the largest individual cause of death (Say et al., 2014).

To support healthcare professionals in obstetrics, computerized predictive models have been developed for use in clinical practice to serve as an alert in case of the need for immediate care, make decisions on treatment based on the risk status of the patient and aid in organizational planning based on available resources (Moons et al., 2009b). Some of the models widely used in clinical practice include the Apgar score which is used for immediate assessment of the new-born's condition after birth (Apgar, 1952) and the Bishop score which is used for the assessment of cervical ripeness before and during induction of labour (Bishop, 1964). It is reported that 263 predictive models have been developed to predict pregnancy outcomes for over 40 different complications, but few are used in practice (Kleinrouweler et al., 2016). Predictive models are too complex for daily use in a clinical setting (ibid) and computer support is another reason for the low usage (James, 2001). Furthermore, clinicians do not trust the model probabilities, since they lack well known predictors of the outcome (Moons et al., 2009a) and lack generalizability (Reilly and Evans, 2006; Moons et al., 2009a; Altman et al., 2009) due to differences in the healthcare systems and patient characteristics (Payne et al., 2014).

The models are designed to be used by healthcare professionals who inform patients about the status of developing an illness (Moons et al., 2009b), which implies that patients have little or no participation in the process. Treatment plans and related activities do not only include interactions with health professionals but rather extends to the individual lifestyle and beliefs (Michie et al., 2003). We suggest that involving patients in predictions, prevention and management of pregnancy complications may reduce maternal mortality. Evidence has shown that involvement of the patients in their treatment creates value as they actively seek and share information with health professionals, friends, family, support groups and colleagues to redesign their treatment programs (McColl-Kennedy et al., 2012) and prevent diseases through proper diet and exercises (Groves et al., 2013).

2.2 Service-Dominant Logic on healthcare services

Service-Dominant (S-D) logic is based on four theoretical foundations: actor-to-actor networks, resource liquefaction, resource density and resource integration (Lusch and Nambisan, 2015). The foundations form the service innovation framework, which includes the service ecosystems, service platforms and the value co-creation elements (ibid). The service ecosystem includes actors such as individuals and organizations who co-create value as they integrate resources and exchange services (Vargo and Lusch, 2011). The service platform enables the actors to interact with resources and exchange services and value is co-created as actors integrate resources (Lusch and Nambisan, 2015). Resources can be either operand, whereby they are static and tangible, or operant, whereby they can be intangible (Vargo and Lusch, 2004). Service is defined as when an actor applies knowledge and skills through processes and performances to benefit another actor or itself (Vargo and Lusch, 2011).

Healthcare organizations are shifting practices to involve patients more in order to improve healthcare outcomes as they participate in clinical encounters (McColl-Kennedy, et al. 2012). This shift is aligned to the S-D logic in which customers are co-creators of value (Vargo and Lusch, 2004, 2008). Healthcare service innovation requires active participation of patients in the redesign of healthcare services (Sharma et al., 2014). This patient activation approach will improve the outcomes of interactions with health care providers and the system (Joiner and Lusch, 2016). Active participation of patients requires integration of resources from health providers, self-generated activities and accessible third party resources (McColl-Kennedy et al., 2012). Third party resources are seen as a value constellation included in the health ecosystem. This includes co-creation activities with family and friends (Joiner and Lusch, 2016, p. 32). Value co-created, through active participation of patients, include enhanced quality of life (McColl-Kennedy et al. 2012), intellectual, cultural (Seraj, 2012) and social values (Seraj, 2012; Loane, et al., 2014, Goh et al., 2016). The level of patient participation is constrained by the knowledge of the illness (Berry and Bendapudi, 2007) and, thus, affects the value that can be created.

IT as an operant resource triggers service exchange and as an operand resource enables actors to share resources within the service platform (Lusch and Nambisan, 2015). Patient's use of IT enables them to gain knowledge about diseases and enhances their active participation in healthcare. Such "conversations" taking place outside the formal healthcare system are being facilitated through the growth of social media, according to Joiner and Lusch (2016, p. 32). Online health communities enable rural and urban patients to interact and share knowledge about the nature of diseases and treatments, which creates social value (Goh et al., 2016). In addition, e-health kiosks have enabled illiterate villagers to understand complex ideas about infant healthcare, which improves practices (Venkatesh et al., 2016). The design of the service platform that enables actors to exchange resources is determined by the nature of the contributions and the affordances of digital components (Lee and Berente, 2012). In addition, the design of IT interventions need to understand the kinds of social networks that promote wellness behaviours, preventive healthcare and timely seeking of corrective healthcare (Venkatesh et al. 2016).

Based on the patient activation approach (Joiner and Lusch, 2016), we assume that pregnant women may co-create value when they use IT to actively seek and share information about pregnancy complications from support groups, family, health professionals or other actors. The information can guide pregnant women how to actively engage in complementary health activities such as diet and exercises, which help to prevent and manage complications. On the other hand, predictive models can assume an operant role to trigger the exchange of skills and knowledge from health professionals to the mid-level health workers and VHTs. In this vein, pregnant women can work with the VHTs via a partnership-participation style (McColl-Kennedy et al., 2012) to accurately predict pregnancy complications. To explore value co-creation at the micro-level is important for strengthening healthcare participation initiatives (Hardyman et al., 2015) and to view healthcare as a part of an ecosystem will support a better healthcare service systems design that focus on the value proposition for the consumer (Joiner and Lusch, 2016; McColl-Kennedy et al., 2012; Nambisan and Nambisan, 2009). However, few studies have investigated the co-creation of health value specifically in relationship to support from family and friends and IT interventions (Higa and Davidson (2017).

3 Method

In this section, we describe the method used to conduct the study on maternal healthcare in Uganda. We describe the study setting, selection of participants, data collection and analysis procedure.

3.1 Study setting and data collection

The study was conducted in the Iganga/Mayuge demographic and health surveillance site (IMDHSS) that is located at Iganga and Mayuge districts in south-eastern Uganda. The IMDHSS works with 65 villages, 18 parishes and 12,000 households. It also works with 15 health centers, one government hospital, 24 private clinics, and other informal health providers, mainly traditional birth attendants (TBAs) and drug shops. The IMDHSS was selected as a case study because for 15 years, the site has worked closely with different households, and health practitioners to improve healthcare services in Uganda. IMDHSS is the only place in Uganda with clearly defined boundaries of the 65 villages and good knowledge of the 12,000 households to whom they provide healthcare services. This made access for research easier, than any other "un-defined" area. The area is mainly rural with subsistence farming as the main economic activity. Mayuge district has 97% of the population in rural settings (UBOS, 2012). There is no government hospital nearby and the available health centers are understaffed and not easily accessible (ibid). About 43% of the households are located within 1 to 5 km from the nearest health facility and 34% are located 5 km or more from the nearest health facility (UBOS, 2012 p. 20). Iganga district has one government hospital and four health centers with the nearest health facility between 1 to 3 kms (UBOS, 2009). About 69% of the population is within 5 km radius of the health center which leads to only 27% of the pregnancy deliveries taking place at the

health centers and a maternal mortality rate of 90 to 100,000 mothers (ibid). Midwife to pregnant women ratio in Iganga district was 1 to 5,000 by 2009 (UBOS, 2009).

It was anticipated that information provided by health workers associated with the IMDHSS would provide us a good understanding of the maternal healthcare service delivery in the rural and urban areas. In addition, IMDHSS has collected demographic health data for 12,000 households including data on maternal healthcare. This data was used to understand the magnitude of maternal deaths in south-eastern Uganda, the causes of these deaths and how pregnancy complications are identified.

The study was also conducted in Mulago referral hospital in Uganda, because it is where the gynaecologists who have the skills and knowledge to predict pregnancy complications are located.

Selection of participants

Our study focused on health practitioners working closely with IMDHSS at the different levels of healthcare because different levels are equipped differently in terms of medical facilities and therefore provide different maternal healthcare services. Participants included VHTs who have no medical background but are the first point of contact for pregnant women at the village level, the mid-level health practitioners (Nurses and mid-wives) who are located at the HC III and IV and offer maternal healthcare services such as antenatal care, postnatal care, immunisation and family planning services to the pregnant women at the sub-county and county level, and the gynaecologists are medical experts in predicting pregnancy complications and carry out caesarean sections at Mulago referral hospital at the national level.

Data collection

Articles were reviewed to understand the magnitude of maternal mortality, the maternal health care system in Uganda, the approaches used to predict pregnancy complications, and the health care service innovation through patients' involvement. In addition, semi-structured interviews were conducted to explore the maternal healthcare services provided to pregnant women and how the prediction of pregnancy complications is done in Uganda.

A total of nine respondents including eight healthcare practitioners associated with the IMDHSS and the operations manager of IMDHSS participated in the study. The eight healthcare practitioners included two village health team members (VHTs), a nurse and a midwife from each of the health center III and health center IV and two gynaecologists at the national referral hospital. Interviews were held with five healthcare practitioners and the operations manager of IMDHSS. In addition, conversations were held with three healthcare practitioners. Table 1 shows the details of the respondents and the levels in the healthcare system where they belong. Although respondents were fewer than the district population, it is assumed that the findings were informative enough to reflect on the maternal healthcare services provided in Uganda and the challenges faced by the health workers, at least for the exploratory purpose of this study.

As can be seen from Table 1, the selection of interview respondents was based on different levels of the healthcare system with variations in the availability of resources including health facilities, equipment, technology infrastructures, professional experience, and maternal healthcare. The selection brought out different views regarding the experiences and challenges faced by health practitioners when providing maternal healthcare services including the identification of pregnant women with pregnancy complications. The three conversations held with the health practitioners were focused on discussing how maternal health care data was recorded at the health centers and at the household levels. It also involved looking at the registers at the health center such as the antenatal care register, the postnatal care register and the mother's passport.

Level of Health facility	Person interviewed	No. of respondents	Duration of interviews (Minutes)
Mulago National Referral hospital	Gynaecologists	2	38.2 and 30.32
District health offices (IMDHSS)	Operations coordinator	1	65.09
Health center IV (Busesa HC IV)	Nurse and Midwife	2	53.37 and 50.21
Village or Community level	Village Health Team Coordinator	1	31.08
	Conversations held		
Health center III (Busowoobi HC III)	Clinical officer and Midwife	2	
Village or Community level	Village Health Team Coordinator	1	
TOTAL		9	

Table 1. Details of interview respondents and the level of the health care system in Uganda

We situated ourselves into the study context by introducing ourselves and the research study to the managers of the IMDHSS. Then, we prepared a semi-structured interview guide and the expected categories of participants, which was discussed in a meeting with the Program Manager and the Operations Manager of IMDHSS. The Operations Manager set up appointments with the participants for interviews at three locations: the Iganga district health offices where the office of the IMDHSS is located, the health center III and Mulago referral hospital. During the interviews, we explained how each interview will be anonymized and secured and presented an informed consent letter from the Makerere University in Uganda, which aided to build trust. To build rapport, the respondents introduced themselves and talked about their roles in maternal healthcare. Furthermore, they described collaboration with each other and the pregnant women and challenges they encounter when providing maternal healthcare services. For clarification purposes we asked additional questions when necessary. During the interviews, we took notes and audio recorded responses. The notes and the tape recordings were later transcribed for further scrutiny and analysis.

After the interview with the Operations Manager of IMDHSS, we were given access to digital pre-coded health data that was captured by IMDHSS for the period between 2002 and 2008. Using the information system at IMDHSS, the operations manager generated statistics about the number of maternal deaths related to pregnancy complications that had occurred between 2002 and 2008 in the 65 villages in which the IMDHSS operates.

3.2 Data analysis

For data analysis, we adopted a grounded theory approach with an abductive method (Charmaz, 2006; Strauss and Corbin, 1990) which is not free of researcher's previous knowledge and experience (Charmaz, 2006). During the analysis, we conducted a moderate literature review on the service-dominant (S-D) logic perspective. This review enabled us to gain an initial understanding of the service innovation framework from the S-D perspective and enabled us to name categories that emerged in the iterative process of data analysis.

The initial coding of the data started during data collection and from the interview transcriptions where open coding (Strauss and Corbin, 1990) was used to identify, name and categorize phrases and words. The second round of coding happened after the generation of the initial codes and it involved using axial coding (ibid). Through axial coding, we used patterns and relationships to group codes together into sub-categories and later into categories. We moved back and forth between the interview transcripts and the literature on S-D logic, in order to relate the identified categories to the concepts in S-D logic. The categories that emerged out of the analysis included: human resources for health, ma-

ternal health care services, relationship between different health care practitioners, pregnancy complications, the referral system and use of ICT tools for provision of maternal healthcare services. The categories were related to the components of the service innovation framework which include the service ecosystems, the service platform and the value co-creation.

Under the service ecosystem, we had categories of human resources for health and maternal health care services. Under the service platform, we had categories of the referral system and the relationship between different health care practitioners. Under the value co-creation component, we had the categories of pregnancy complications and use of ICT tools for provision of maternal healthcare services.

4 Results

This section presents the results from the study that have been analysed using the components from the service innovation framework.

4.1 The service ecosystem

In maternal healthcare, healthcare practitioners are viewed as actors in the service ecosystem because they provide maternal healthcare services. Depending on the level of sophistication of the required service, some services can easily be provided at the household level while others only at the HC level. HCs are equipped differently in terms of medical facilities and human resources. Sophisticated services such as caesarean surgery can only be handled by skilled professionals at HC IV. Table 2 shows the maternal healthcare services provided, when services are provided, who provides them and they are provided, as explained to us by the health workers.

Who provides the service	Maternal health care Service	How are the services provided	Timing
VHTs at village level	<ul style="list-style-type: none"> Guiding mothers to plan for delivery, seek antenatal care, visit health centers for care. Observing mothers and new borne for danger signs. Referring women in case of danger signs. Providing health education such as breast feeding, cord care, keeping the baby warm. 	Through home visits which are planned based on distances between households	Home visits conducted in first 3 months and last 3 months of pregnancy Day 1, 3 and 7 after birth
Health workers and health professionals	<ul style="list-style-type: none"> Antenatal care Health education: proper nutrition, plan for delivery 	Community outreach activities.	Twice a year for community outreach activities
Health Center II (only provides antenatal care and health education)	<ul style="list-style-type: none"> Delivery Caesarean surgery Postnatal care 	At the health center through: Health education	Antenatal care is given 4 times throughout the pregnancy
Health Center III (no caesarean surgery)	<ul style="list-style-type: none"> Immunization of mother and new borne Post abortion care 	Individual Examination	Postnatal care is given 3 times (after 6 hours, 6 days and 6 weeks)
Health Center IV (all services)	<ul style="list-style-type: none"> Family planning 	Individualized counselling in case of HIV or family planning	

Table 2. Maternal health care services provided to pregnant women

As can be seen from Table 2, VHTs are located at the village level and health workers are distributed to different health centers depending on the services delivered. For instance, deliveries are only done at HC III and HC IV. VHTs educate mothers on better health practices and observe the pregnant women, newborns and mothers for danger signs. As stated by one of the VHTs:

“...we teach women the danger signs such as vaginal bleeding, swollen body or feet, severe lower abdominal pain, severe headache and paleness...in case we identify the danger signs, we refer the women to the nearest health facility such as HC III and HC IV”

The provision of maternal healthcare services is greatly hindered by three delays; 1) delay in deciding to seek maternal healthcare, 2) delay in reaching a health facility to access maternal healthcare, and 3) delay in receiving adequate maternal healthcare. They result from the inability to change attitude of women and poor planning and coordination of resources. The delay in deciding to seek maternal healthcare has been attributed to the late arrivals in health facilities. As stated by one of the gynaecologists:

“Sometimes the women arrive at the facilities too late and health workers do not know the status of the mother when she is at home”

In addition, some women visit the health centers as a backup plan, just in case they develop a complication. As stated by one of the health workers (midwife):

“Women wait for 7 months to come for Antenatal care just in case they get complications, it is just a by the way just in case but they resort to Traditional birth Attendants for delivery”

The delay in reaching care has mainly been attributed to the lack of transport to reach the health facilities. As stated by the VHT:

“I sometimes use my money to help women reach the HC III to pick up medicine, but sometimes the return dates become a challenge because every time we need to return we need transport.”

The delay in receiving adequate care has been attributed to the lack of resources at the health facilities as stated by one of the gynaecologists:

“The quality of care in the facilities is not good because of lack of required medical supplies due to poor funding and poor leadership at the facilitiesthe health facilities have no capacity to handle”

Limited access to adequate health care is as a result of the limited number of skilled medical professionals to reach out to pregnant women in the community. The maternity section of HC IV has seven health workers with one male and six females. The health workers include two specialists who conduct caesareans, one enrolled mid-wife and four nursing officers/mid-wifely. The health workers provide maternal healthcare services to a total of about 170 women in a week. Of the 170 women, approximately 120 are pregnant women who seek antenatal care services and approximately 50 women seek post-natal care services. As stated by the Nurse:

“Not all staff is available at the same time, some are off duty, others are on night duty, and others are on study leave. We normally get support from VHTs who help us to provide health education to the mothers during home visits, people from organizations also called expert clients such as Marie Stopes Uganda assist on some of the tasks such as family planning.”

Another cause of limited access to health care is the maldistribution of human resources for health in which qualified health care professionals are located at the regional and national level of healthcare and in urban areas whereas, mid-level health workers and VHTs with limited knowledge and skills are located in the rural areas where the majority of pregnant women reside.

The limitation and maldistribution of human resources has partly been addressed through the task shifting strategy but requires that mid-level health workers and VHTs are trained and supervised by the more qualified health professionals if it is to be effective. VHTs are community volunteers with no medical background but are trained by the professional health workers to provide basic health care services including immunization, family planning, health education and promotion of deliveries at the health centers. However, it should also be noted that the existence of the VHTs does not fully solve the

human resource problem because they are not in all villages and need to be trained and supervised. As quoted by the nurse:

“VHTs are not in all sub counties and those that exist are demotivated because they do not receive regular supervision but in areas where they are active, they can facilitate referral.”

In addition to the task shifting strategy, community outreach programs are organized by health workers to take maternal healthcare services such as immunization, health education, family planning and antenatal care to the community. During the outreach programs, more than one service is provided at the same time. Outreach programs are usually conducted for those districts, which lack healthcare centers, medical facilities and human resources. The programs are costly for the government due to the transport and accommodation costs for health workers to move to different communities. In addition, the programs create a human resource gap at the health centers since most of the health workers move to the communities.

Results show that although the task shifting strategy helps to reduce the human resource gap in maternal healthcare, there is still a shortage of skilled professionals in the ecosystem. The shortage leads to a fragile service ecosystem with cognitively distant actors who provide services depending on their skill and knowledge levels. However, the actors are challenged with the poor attitudes of pregnant women towards timely access to services and, the poor planning and coordination of the limited resources at the health centers.

4.2 The service platform

Health practitioners have different knowledge and skills of providing maternal health care services to pregnant women, with VHTs having the least and gynaecologists having the most. Despite the level of knowledge and skills of the VHTs, they are closer to the pregnant women than the mid-level health workers and professionals. Being the first point of contact, they interact with the pregnant women and are up-to-date with information regarding the status of the pregnant women in the villages. In addition, health workers depend on VHTs to provide health information to the pregnant women.

Based on the explanations from the health workers who were interviewed, VHTs identify mothers with danger signs through home visits. Once the women are identified, they are advised and referred to health workers at the health centers where they can receive the required services. In addition, referrals occur from one health center to another or to a hospital depending on the risk status and the availability of resources at different facilities. Figure 1 shows how the referral process works in Uganda. The higher the receiving units, the more equipped they are in terms of health facilities and human resources.

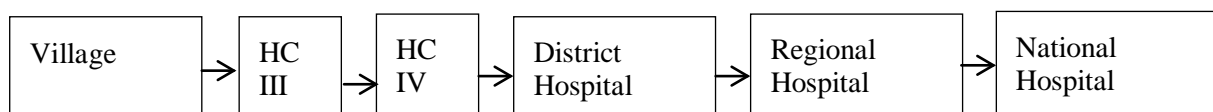


Figure 1. The referral process in the Ugandan healthcare system

Referrals are challenged by women's attitude to accept referral and lack of transport for women to reach the health centers, capacity of the receiving health facility to handle referrals and communication between the sending and the receiving health facility. As stated by one of the gynaecologists:

“..a woman who has got a hemorrhage type of complication at birth may need blood, however, she may be referred to a health center which does not have blood ...this is because we do not know if the receiving health center has blood before we refer...so the woman ends up dying in the process.”

Also as stated by the nurse:

“..Sometimes the mothers refuse to be referred because of fear of transport costs and others may refuse to be operated on because they think the operation can only be done at the hospital but not at HC IV”

The referral process relies on collaborative activities between the different health practitioners and pregnant women as shown in Table 3. As can be seen from Table 3, VHTs are the first point of contact

for the women in the villages. VHTs provide services in collaboration with health workers. In addition, VHTs collaborate with community and church leaders to provide health information to the community. Health workers also communicate with the health professionals especially in case of emergency or referrals. In addition, VHTs hold meetings among themselves both at the parish level and at sub-county level to discuss referrals given out and any challenges faced while providing services.

Relationship	Purpose	Timing
VHT – Pregnant women	VHTs visit households to provide maternal health care services to the women in the households	Allocate days to women depending on distance
VHT – Health workers	VHTs bridge the gap between the community and health workers. VHTs: <ul style="list-style-type: none"> • meet with health workers to discuss challenges and improvements to maternal health care at the community level, • work with health workers to provide outreach services whereby VHTs mobilize the community to participate in the activities, • refer pregnant women from the community level to health workers at the health centers 	Continuous based on health needs Quarterly meetings with health workers
Health workers – Pregnant women	Health workers help to provide antenatal care services (HC II) and to deliver the babies at HC III and HC IV.	Continuous, usually referred by the VHTs to health centers
Specialists - Pregnant women	Specialists usually work on pregnant women (high risk mothers) who have been referred to them by the mid-level health workers. They also handle cesarean operations	Continuous especially in case of emergencies and referrals
Health workers - professionals	Health workers communicate with specialists in case of referrals	Continuous especially in case of emergencies and referrals

Table 3. Activities carried out in collaboration among health practitioners

Since VHTs are part of the community, pregnant women find it easier to approach them than the health workers. As explained by one of the health workers:

“VHTs help to identify pregnant women and refer them to the facility... they also identify women and babies with danger signs the women are in the community but health workers are at the facilities, women fear the health workers and hence the VHTs help to bridge the gaps because they are part of the community”

Results show that the referral process provides a service platform in which different actors physically interact and relate to each other. However, at the moment, the process is challenged with the way in which the different actors collaborate both at the community level and the health facility level. IT has not been used to support the collaborations and interactions among different actors.

4.3 Co-creation of value

In the maternal healthcare context, value can be viewed as; better health outcomes through accurate predictions of pregnancy complications, change in attitudes and behaviour of pregnant women and cost saving through improved planning for limited resources. It has been noted that, in Uganda, pregnancy complications cannot be accurately predicted and this has led to maternal deaths.

An analysis of data collected by the IMDHSS from the 65 villages in Iganga district showed that of the 525 women who died between 2002 and 2008, 16 of them had died as a result of pregnancy complications. It is anticipated that the methods used by VHTs and health workers to predict complications lead to missed danger signs and the inability to predict pregnancy complications without early warning

signs. This is further supported by Okuga et al. (2014) who indicate the lack of success by the VHTs to identify pregnancies among high-risk groups of older and younger women through house to house visits.

The gynaecologist from one of the National referral hospitals in Uganda, highlighted the five most common pregnancy complications in Uganda and ways they use to predict them as shown in Table 4

Common pregnancy complications	How predictions are made
Haemorrhage before or after birth	Predicted based on whether the mother has had any bleeding during her pregnancy, whether bleeding has occurred before in previous pregnancies or after an operation, and if the mother has multiple pregnancies
Obstructive labor (where mother contracts but there is no progress)	They consider the height of the mother, physical examination of the baby size or if the mother has a disability.
Abortion complications (can be either induced or automatic)	Predicted based on the status of mother after abortion
Sepsis where the mother gets an infection before or after delivery.	Bad odour
Hypertensive diseases (where the woman is normal but develops pressure during pregnancy or had pressure before that but it escalates during pregnancy)	Predicted based on the physical examination of the mother, the size of the baby, number of pregnancy and the age of the mother.

Table 4. Common pregnancy complications and how they are predicted

When asked about the effectiveness of the way predictions are done, the gynaecologist replied:

“... The methods do not tell us about all the mothers likely to develop complications because there are mothers (about 15%) who have no early warning signs of these complications but end up with complications during labor. These are usually missed out ... May be these can be identified through computational predictive models which improve the predictions...”

As seen from Table 4, a risk approach is used to identify mothers with the risk of a pregnancy complication. This approach is based on variables such as the height of the pregnant woman, the number of births had by the mother, if the pregnant woman is having a twin pregnancy, if the woman has had previous caesarean operation and if the mother has previously lost a baby. Women that fall under any of these categories are termed as high risk mothers. However, every pregnancy can get complications even if they are not categorized under high risk. As stated by one of the gynaecologists:

“...15% of pregnancies are likely to develop complications, every pregnancy can potentially get complications, but we still use the risk approach...”

On the other hand, at the community level, VHTs observe pregnant mothers for any complications based on a list of danger signs provided by the health professionals. These danger signs for the pregnant woman include headache, lower abdominal pains, bleeding, swelling of the feet and paleness. The danger signs for the newborn include convulsions, low birth weight, inability to breastfeed and dirty umbilical cord. This observation process makes it difficult for the VHTs to predict pregnancy complications for women who do not show any danger signs during pregnancy. As stated by the gynaecologist:

“... VHTs are less qualified health workers who miss out on danger signs especially those which are not evident, if a complication occurs at the last minute, they cannot do anything about it and it is usually too late for referral”

According to the health workers, at the health centers, ultra sound scans (USS) and the Doppler are used to physically examine pregnant mothers for any complications that may arise. However, not all health centers have access to this equipment and therefore rely on danger signs to identify pregnancy complications. As stated by one midwife:

“...we took Ultra Sound Scans to Luuka District to help us identify mothers likely to develop pregnancy complications. This was done because the district does not have a hospital and has only one health center IV with only one doctor and with no ultra sound scan. This helped to identify mothers early enough and refer them to other districts such as Iganga and Jinja for services “

Value in the maternal healthcare context is viewed as accurate predictions of complications. Results show that patients are not engaged in the value co-creation process and that not all healthcare providers can accurately predict pregnancy complications. In addition, results indicate that IT has not been fully used by the different actors to predict pregnancy complications. The inaccurate predictions of pregnancy complications have led to maternal deaths.

5 Discussion and Conclusion

The study has outlined the aspects that affect and shape how the prediction services are provided in maternity care in rural Uganda. A key aspect is the fragile service ecosystem, a second aspect is the inadequate service platform, and thirdly the imperfect co-creation of value. Despite these aspects that negatively affect maternity care, we suggest from a S-D perspective that there are possibilities to improve the current situation.

The fragile service ecosystem

Results show that actors play different roles in the pregnancy process depending on their knowledge and skill levels. Access to quality care is hindered by the limited knowledge and skills of VHTs to predict pregnancy complications yet they are the first point of contact for the pregnant women in rural communities. In addition, the limited number of actors is challenged by the attitudes of pregnant women who are not actively involved in the prediction of pregnancy complications. This leads to a fragile maternal healthcare service ecosystem that reflects a traditional system in which, resources for health are viewed as tangible and, thus, has affected access to quality maternal healthcare.

Adopting the S-D perspective, helps us to shift the focus from maternal healthcare services to processes that are involved and how these processes benefit different actors. The shift in focus enables IT to assume an active role as an agent in the service ecosystem and thus initiate service innovation (Lusch and Nambisan, 2015), by supporting and strengthening the limited number of actors in maternal healthcare. In addition, the shift enables predictive models to assume an operant role by supporting the exchange of skills and knowledge from health professionals to the mid-level health workers and VHTs. However, the shift requires understanding the social interactions and structure since it brings about exchange of the application of operant resources (knowledge and skills that one possesses) for other operant resources (skills they do not have) (Vargo and Lusch, 2004). We suggest further research on how social capital theory can enable us to better understand the interactions between actors including health practitioners, pregnant women and their families. It is anticipated that this shift will bridge the human resource gap for maternal healthcare.

The inadequate service platform

Results show that the referral process provides a service platform in which cognitively distant actors relate and interact with each other. However, the process lacks a shared view of: the existing resources at the health center level and the health status of the pregnant women at the community level. The lack of a shared view leads to poor coordination and collaboration among actors at the different levels of healthcare and makes it difficult for the VHTs and the health practitioners to refer pregnant women to the resourced health centers. This leads to frustrations by the pregnant women who sometimes object to referrals. IT can improve the referral process by enabling health practitioners to coordinate easily at different levels and to have a shared view of the available resources and health status of the pregnant woman. An improved referral process improves social interactions among actors and hence improves health behaviour as reported by Okuga et al (2014).

S-D logic enables cognitively distant actors to establish informal and formal communication mechanisms to develop a shared worldview with other actors in the service ecosystem and support their val-

ue co-creation activities (Lusch and Nambisan, 2015). Service platforms such as online health communities (Goh et al., 2016) and e-health kiosks (Venkatesh et al., 2016) have supported the exchange of complex health related information among actors. The S-D logic perspective provides us an opportunity to explore how IT can enhance the referral process to support the cognitively distant actors to mix and match resources as they co-create value (Lusch and Nambisan, 2015). Such enhancement can provide a shared view of the status of the pregnant woman at the community and healthcare level. However, designing a service platform requires an understanding of the different roles and social interactions of the actors in the referral process and how they can support each other to create value. We need to further investigate how service platforms can be designed to coordinate and facilitate interactions among different actors including pregnant women to create value for maternal healthcare. Such a platform can enhance the referral process and support pregnant women to access and share information on pregnancy complications.

Imperfect co-creation of value

Results show that every pregnancy can develop a complication regardless of whether the woman shows danger signs or not, a finding also reported by Ochejele et al. (2011). However, pregnant women are not actively involved in the prediction process and not all the involved actors can accurately predict pregnancy complications hence, an imperfect co-creation of value. To predict complications, VHTs observe pregnant women for danger signs through house to house visits. In addition, results indicate that a risk approach is used at the health centers to predict complications. The visual method and the risk approach used to predict are ineffective, as has also been reported by other researchers (Okuga et al., 2014 and Yuster, 1995). A solution would be to use computerized predictive models to predict complications (Kleinrouweler et al., 2016) however, results show that computerized predictive models have not been used in Uganda to predict pregnancy complications. In addition, IT has not been fully exploited to support the prediction process of pregnancy complications in Uganda.

The S-D perspective views patients as co-creators of value in healthcare services and thus provides us an opportunity to further explore the potential barriers and facilitators of value co-creation (Hardyman et al., 2015). In addition, it enables us to further explore how IT can be used both as an operand and operand resource to support value co-creation through initiation of service exchange and through provision of an efficient and effective collaborative value creation process ((Lusch and Nambisan, 2015). Predictive models can be customized to take on an operand role in order to trigger the transfer of knowledge from the health professionals to the VHTs, which can be used to accurately predict pregnancy complications at the community level. In addition, IT can support pregnant women to change their attitude and behaviours especially if it provides them access to information concerning health care practices such as improved hygiene, diet and exercises that would improve their wellbeing and prevent complications. Value can be created through better health outcomes and costs can be saved through targeting resources for women at high risk well before complications occur. We therefore suggest further studies on how IT can support value co-creation in the predictions of pregnancy complications using the healthcare customer co-creative practices model (McColl-Kennedy et al., 2017).

We conclude that findings from the study provide an opportunity to improve the predictions of pregnancy complications. Using the S-D Logic perspective, IT can play an important role to actively involve the actors in the service ecosystem including VHTs, health professionals, pregnant women, families and friends to predict pregnancy complications and thus create value for maternal healthcare. The S-D logic gave both rigor and relevance and proved to inform the micro-level approach that we took.

The study is limited by a small number of interviews from south-eastern Uganda whose views may vary from other health practitioners. In addition, due to time and resource constraints, it was not possible to have an in depth study of the interactions between the different actors.

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