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# THE ROLE OF TECHNOLOGY IN VALUE CO-CREATION OF MATERNAL HEALTHCARE: A SERVICE-DOMINANT LOGIC PERSPECTIVE

*Research paper*

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## **Abstract**

*The need for improved quality of healthcare has led to transforming ways in which healthcare is delivered. The role of information technology (IT) in the transformation is moving towards active participation of patients in healthcare. Active participation of patients in healthcare aligns with the service dominant (S-D) logic in which customers are co-creators of value. Technology has been identified as a key driver for value co-creation however the question of how technology can drive value co-creation in healthcare has not been fully explored. This exploratory study investigates ways in which IT has supported value co-creation in maternal healthcare ecosystem. The study was conducted in Gothenburg Sweden in which mixed research methods were used. Interviews were held with midwife healthcare managers and IT managers, a survey questionnaire was sent out to all midwives in Gothenburg. Results were analyzed using S-D logic value co-creation model. Overall findings show that technology has been used as an operant and operand resource to support value co-creation but mainly for healthcare professionals. Practices are identified on how technology has been used in maternal healthcare. Further investigations on how IT can support pregnant women to actively participate in maternal healthcare especially as an operant resource are suggested.*

*Keywords: service-dominant logic, value co-creation, the role of technology, maternal healthcare.*

## **1 Introduction**

Improving quality of clinical care requires a transformation of healthcare delivery (Sahni et al., 2017). Information technology (IT) can transform healthcare by: making data collection easier as the task of collecting information is shifted from clinicians to patients (passive data collection), turning data into actionable information for clinicians through analytics and forging new operating and business models (ibid). The role of IT in healthcare is moving towards active participation of patients (Rozenblum et al., 2015), which improves quality of life (McColl-Kennedy et al., 2012). Although active participation has received increasing attention in the last decade (Armstrong et al., 2013), little is known about how technology-enabled patient engagement systems work in clinical settings (Danis et al., 2015).

Hardyman et al. (2015) elaborates on the need to understand patient engagement in healthcare service interactions at the micro-level through value co-creation. The application of value co-creation underscores the need to apply service dominant (S-D) logic (Vargo and Lusch, 2004, 2008) to the healthcare domain (Hardyman et al., 2015). S-D logic provides a theoretical lens of value co-creation in service systems (Maglio and Spohrer, 2008; Vargo and Akaka, 2009) such as healthcare. S-D logic advocates customers as co-creators of value (Vargo and Lusch, 2004, 2008) and to actively involve patients in the healthcare experience, there is need for interactional resources such as knowledge, technology and institutions (Srivastava and Shainesh, 2015). In the S-D logic perspective, IT plays a dual role by triggering service exchange (operant role) and enabling or facilitating actors to share resources within the service platform (operand role) (Lusch and Nambisan, 2015). Although technology is the central component for service systems and a key driver for value co-creation, its nature and role has not been fully explored (Akaka and Vargo, 2014). Few studies have focused on the operant role of IT in organiza-

tions (Frey et al., 2017) and on IT processes and structures needed to actively embrace patient participation in the improvement of healthcare services at the organizational or system level (Sharma et al., 2014).

Improving maternal healthcare is high priority for the world health organisation (WHO, 2016). The unacceptably high maternal mortality rates can be reduced through strengthening healthcare systems and addressing inequalities in access to and quality of healthcare services (ibid). Countries with the lowest maternal mortality rates include Sweden, Denmark and Netherlands (WHO, 2015b). The countries are frontrunners in eHealth and have well-developed ICT infrastructures and mature health, social and information systems (Currie and Seddon, 2014), which is seen as an indication that IT plays a vital role in reducing the rates. Therefore, to gain insights into the role of technology for value co-creation, this study investigates practices of maternal healthcare in which information technology as an operand and operant resource has been used to benefit maternal healthcare. Data from the maternal healthcare ecosystem in Gothenburg, Sweden allows the exploration of the research question: How does information technology contribute to value co-creation in a best practice maternal healthcare setting?

The study addresses the call for value co-creation studies in complex environments such as healthcare (Ostrom et al., 2010) and on how IT innovations improve quality and safety of care (Blumenthal and Tavenner, 2010). In the following section, literature on S-D logic, the role of technology in value co-creation and healthcare is reviewed. Then research methodology is described, findings are presented and discussed, and finally the paper concludes by summarizing findings, provide limitations and directions for future research.

## **2 Literature**

### **2.1 Service dominant (S-D) logic, Value co-creation and healthcare**

Service dominant (S-D) logic provides a theoretical foundation for studying service ecosystems and value co-creation (Beirão et al., 2017). Vargo and Lusch (2016) articulate the narrative of value co-creation in S-D logic which is composed of: institutions and institutional arrangements, service ecosystems, actors connected by shared institutional arrangements, resource integration and service exchange. Institutions are defined as “rules, norms, meanings, symbols, practices, and similar aides to collaboration” and institutional arrangements as interdependent assemblages of institutions (Vargo and Lusch, 2016). The service ecosystem is defined as “relatively self-contained, self-adjusting system of resource-integrating actors connected by shared institutional arrangements and mutual value creation through service exchange” (Vargo and Lusch, 2017). Actors are “resource integrators in a network of other actors” (Lusch and Nambisan 2015, p.6). Resource integration is the process of combining or bundling of resources for usefulness or value (ibid). Service exchange is the process of coordinating, sequencing and integrating tasks and activities (Lusch and Nambisan 2015, p.13).

Value co-creation is defined as “the processes or activities that underlie resource integration and incorporate different actor roles in the service ecosystem” (Lusch and Nambisan, 2015). According to Vargo and Lusch (2016, p.8) ‘value co-creation is coordinated through actor-generated institutions and institutional arrangements’. The role of institutions in value co-creation has moved to the forefront of the S-D logic perspective (Vargo and Lusch, 2017) and therefore the service ecosystem has been considered as the unit of analysis for value co-creation (Vargo and Lusch, 2011). In the S-D logic perspective, the service ecosystem is not only limited to technology but a common environment that facilitates value co-creation by diverse set of actors (Lusch and Nambisan, 2015).

Customer value co-creation and S-D logic have gained attention in healthcare (Krisjanous and Maude, 2014), as a result of the demands for active patient participation in healthcare experiences rather than passively complying to healthcare professionals recommendation (McColl-Kennedy et al. 2012). Such active participation improves quality of life (ibid). Value co-creation in healthcare is a complex process and not necessarily linear due to the wide range of providers with different roles, skills and competences involved in (Hardyman et al., 2015). Healthcare value can only be analysed through the pa-

tient's lens (Elg et al., 2012). However, little is known of what customers do in order to co-create value in healthcare (McColl-Kennedy et al., 2012) and according to Hardyman et al. (2015), there are few studies that have explored value co-creation in healthcare. Hardyman et al. (2015) advocates for more research of an ethnographic nature on how value is co-created in healthcare based on the healthcare customer value co-creation practice styles proposed by McColl-Kennedy et al. (2012).

## **2.2 The role of information technology in value co-creation and healthcare**

In S-D logic, IT plays a dual role of operand and operant in enhancing resource density in the service platform (Lusch and Nambisan 2015). As an operand resource, IT enables actors to mix and match resources within and across service platforms, hence facilitating service exchange (ibid). As an operant resource, IT initiates or triggers service exchange or innovation in the service ecosystem, hence creating opportunities for resource integration (Lusch and Nambisan, 2015). Operand resources require action taken upon them to be valuable while operant resources act on other resources to contribute to value creation (Vargo and Lusch, 2004). Technology is a means of innovation as well as an outcome of innovation and, contributes to value co-creation by enabling the sharing of information within and across service systems (Akaka and Vargo, 2014). The role of technology in service innovation depends on the heterogeneity of actors and shared resources, and the intention of the organization to standardize transactions (Frey et al., 2017). Combinations of three interactional resources (knowledge, technology and institutions) across the provider and user service systems provide value creating mechanisms in healthcare service innovation (Srivastava and Shainesh, 2015). Value creating mechanisms include resource exploitation, resource combination and value reinforcement (ibid).

Research on electronic health records (EHR) identified value co-creation factors including the availability, accessibility and reliability of information and actor's collaboration and communication which lead to broader healthcare coverage, better healthcare provision, cost and time savings and healthcare decision support management (Pinho et al., 2014). Healthcare services require full collaboration between the different actors including healthcare professionals, patients, families and the community (Beirão et al., 2017, Apesoa-Varano et al., 2011), which can be facilitated by technology. The Internet and health communication technologies including virtual communities, hospital web portals, blogs and "apps" provide a channel to enhance value co-creation in healthcare (Caridà et al., 2013).

IT as an operand resource enables: 'access to information and knowledge acquisition, which empowers patients to actively participate in clinical encounters, understand the service orientation, and suggest options in relation to the treatment plan' (Osei-Frimpong et al., 2016). In addition, IT enables electronic transfer of patient data and health information between healthcare providers and with patients (Esmailzadeh and Sambasivan, 2016), which supports coordination and continuity of care (Kooij et al., 2017). IT enables patients to seek for health information to get knowledge, reduce uncertainties, understand and control co-creation environments (Osei-Frimpong et al., 2016).

IT plays an operant resource through online health communities, which are a form of social networks facilitated through electronic media (Eysenbach et al., 2004) that allow participants to support each other. They enable sharing of knowledge and experiences among healthcare professionals and patients (Goh et al., 2016). Websites support patient participation through healthcare information portals that bring together healthcare providers, physicians and patients and enable them to access resources such as medical literature, physician skills and personal data, hence co-create value (Caridà et al., 2014).

IT plays both an operand and operant role in mobile health based services (mhealth), which is the use of mobile phones and tablets to offer health related services (Qiang et al., 2012). IT as an operand resource, increases access to healthcare through 'mhealth apps, which provide patients with access to information in different local languages' (Sondaal et al., 2016) in form of advice, real time health news, patient personal records, patient education, therapies and medication requirements (Caridà et al., 2014). IT as an operant resource support patient monitoring, emergence responses and provides patients with educational information and reminders through mhealth (Ormel, 2013). In maternal healthcare, mhealth has supported pregnant women during antenatal, birth, postnatal period in order to reduce maternal mortality (Qiang et al., 2012) especially in low and middle income countries with in-

adequate funding, poor access to information and limited human resources (World Economic Forum, 2011). IT enables communication between pregnant women and healthcare practitioners which leads to prompt referrals in cases of maternal complications (Sondaal et al., 2016).

The nature and role of technology in service innovation has not been fully explored (Akaka and Vargo, 2014). IT applications have been developed to support healthcare processes, however few publications analyse the added value of IT in a controlled study (Kooij et al., 2017). Research on how online health information can influence the consultation process and co-creation of value is scarce (Osei-Frimpong et al., 2016). In addition, there is limited research on value creation in technology-mediated health communities (Goh et al., 2016) and on the role of internet for the development of value co-creation in a healthcare context (Caridà et al., 2014).

### **3 Method**

In this section, the method used to conduct the study on maternal healthcare in Gothenburg, Sweden is described. The research approach, study setting, selection of participants, data collection and analysis procedures are described in the following subsections.

#### **3.1 Research approach and choice of study setting**

A case study approach was used to examine the maternal healthcare in Gothenburg Sweden in-depth and within its real-life context (Yin, 2009). The maternal healthcare ecosystem is the unit of analysis viewed from a value co-creation model (Vargo and Lusch, 2016) based on S-D logic.

This study is inspired by an earlier exploratory study of the maternal healthcare system in Uganda (with high maternal mortality rates) (Nyende et al., 2017). That study recommended the need to adapt S-D logic to enable technologies to assume an active role in maternal healthcare. This would support health practitioners with different skills and knowledge to predict pregnancy complications and hence trigger value co-creation. Therefore, there was need to select a case of a maternal healthcare system from a country with low mortality rate and a well-developed eHealth infrastructure, hence the reason to select Sweden. Sweden is a frontrunner in eHealth with well-developed ICT infrastructures and mature health, social and information systems (Currie and Seddon, 2014). The developed infrastructure enables citizens and health professionals to access eHealth services such as searching and retrieving health information for both clinical and non-clinical purposes (ibid). In addition, Sweden had a low maternal mortality rate of 4 per 100,000 live births in 2015 (WHO, 2015a).

Gothenburg, the second largest city in Sweden, was chosen. The healthcare structure in Gothenburg does not differ from other counties within Sweden and it was anticipated that data collected from Gothenburg would make up a good representation of Swedish maternal healthcare practices. Another reason for the selection was ease of access to midwife healthcare managers through the contacts of a professor from the University of Gothenburg. In addition, Gothenburg was selected because of convenience and easy accessibility to maternity clinics.

#### **3.2 Data collection**

##### *Selection of participants*

As a pre-study to get an overview of the organisation structure and IT systems used in maternal healthcare, a visit was made to Trollhättan (a city in the same county as Gothenburg), Sweden. During the visit, a meeting was held with an obstetrician and a professor who was supervising students on developing a mobile based app for predicting pregnancy complications. The information received from the meeting informed the development of an interview guide and a survey questionnaire for data collection. As a follow up from the visit, a meeting was held with the professor from the University of Gothenburg who contacted midwife healthcare managers for interviews and further discussions. Follow up discussions were held with the midwife healthcare managers in which a proposal to send out a survey questionnaire to all the midwives in Gothenburg was sought. The questionnaire was discussed

and translated into Swedish before it was sent out. To get a better understanding on the IT systems used in maternal healthcare, IT managers were interviewed. In addition, to understand how IT supports the predictions of pregnancy complications, an interview was conducted with an obstetrician.

Thus, participants in the study include: midwife healthcare managers, IT managers, an obstetrician and midwives. Obstetricians are medical specialists in maternal healthcare and are always consulted by the midwives in providing services to pregnant women. Midwives are well trained professional nurses and are responsible for all maternal healthcare services at maternity clinics. Midwife healthcare managers are professional midwives with additional administrative tasks of managing processes, designing programs and rules that govern maternal healthcare. IT managers are responsible for developing and maintaining IT systems for use in maternal healthcare.

*Data collection methods*

Mixed methods of data collection were used in the study as shown in Table 1. Qualitative methods involved:

- Interviewing midwife healthcare managers on activities that take place when midwives engage with pregnant women, including resources used and information collected and how it is utilized.
- Interviewing IT managers about the information systems support provided to midwives and obstetricians
- Interviewing the obstetrician about interactions with midwives and models used to predict pregnancy complications.

As a compliment to the interview data, a survey was sent out to get a deeper understanding of practices in the maternal healthcare ecosystem. The survey questionnaire was sent to midwives in Gothenburg. The questionnaire focused on collection, storage and use of the information for predicting pregnancy complications, methods used to predict complications, mechanisms used to communicate with obstetrician and pregnant women and resources used by midwives in the pregnancy process.

To further understand the work environment and activities that take place in the pregnancy process, a visit was made to a “typical” maternity clinic to observe the activities that take place in the clinic.

Data collection method	Participants
Meetings and talks (to get an overview of the organisation structure and IT systems used in maternal healthcare)	In Trollhättan: 1 Obstetrician and 1 Professor In Gothenburg: 1 Associate Professor
Interviews (to explore practices in which IT has supported value co-creation in maternal healthcare ecosystem)	3 Midwife healthcare managers
	1 Obstetrician
	2 IT Managers
Visit to a maternity clinic (to understand the day-to-day operations and use of IT)	1 Maternal clinic for 2 hours
Survey (to get a general picture on how IT is used to co-create value in maternal healthcare ecosystem)	55 responses of 165 possible i.e. 33.3% response rate
Documents ( to get a better understanding of the resources available and how they support actors to co-create value)	Presentations PDF files of guidelines, checklist, educational documents and prediction model

*Table 1. Summary of data collection methods used*

**3.3 Data analysis method**

To analyse the qualitative data, thematic analysis method was used to “identify, analyse and report patterns within the data” (Braun and Clarke, 2006). A step-by-step guide (ibid) was followed during the analysis. The steps were familiarizing with the data, generating initial codes from the data, searching for themes, reviewing themes, defining and naming themes and producing the report. Interviews

were recorded and transcribed. Transcriptions were used to identify, name and categorize phrases and words in order to develop the initial codes. Initial coding enabled the generation of inductive codes which were later grouped into themes. Themes were reviewed iteratively with reference to initial codes. Themes were refined and named with a service ecosystems view of value co-creation and then compared and matched with the components of the value co-creation model (Vargo and Lusch, 2016). Under the institutional arrangements, the theme of standardised processes was placed, under service ecosystem, the theme of digital infrastructures was placed, under actors, the theme of actors that support value co-creation was placed. Under resource integration, the theme of a resource rich environment was placed. Under service exchange, themes including: accessibility of resources and information, sharing of information and collaborations among actors were placed.

SPSS was used to analyse quantitative data from the survey respondents. Questionnaires were coded and variables were created in SPSS based on the codes. Data was captured and descriptive analysis was used to generate frequencies from the data which were used to provide a better understanding of the practices and to complement responses from qualitative data.

## **4 Results**

Results are structured based on the components of the value co-creation model (Vargo and Lusch, 2016), which includes the institutions and institutional arrangements, the service ecosystem, actor involved, resource integration and service exchange.

### **4.1 Institutions and institutional arrangements**

Results show that IT as an operand resource enables the documentation of institutional conventions and standardisation of procedures in maternal healthcare through a ISO quality standards system called the 'Basprogram'.

*"The quality system in ISO is a standard we have for the quality of maternal healthcare. The whole Gothenburg has the same system and midwives see the same things"* (Midwife healthcare manager 1).

The basprogram has to be followed by midwives and obstetricians as they provide services to pregnant women. The basprogram outlines antenatal care visits (organized by weeks of pregnancy) that are needed, durations for each visit, measurements and tests for each visit, guidelines on why tests or measurements are done and documents that have to be filled in by midwives for each visit. In addition, the basprogram specifies compulsory and optional check-ups that need to be done by midwives.

*"Compulsory check-ups or tests in the basprogram are coded in the system as black. Additional check-ups are coded in the system as green"* (Midwife healthcare manager 2).

IT as an operand resource enables standardisation of data collection procedures by providing access to screening forms used by all healthcare professionals to collect data from pregnant women during antenatal visits. The forms are referred to as MHV (mödrahälsovårdsjournal) and include MHV1, MHV2 and MHV3. MHV1 and MHV2 have specific fields that have to be filled in by midwives while MHV3 is a blank form used by obstetricians and midwives to more "freely" record clinical notes.

### **4.2 Service ecosystem**

Results show that from the service ecosystem view, IT as an operand enables transparency of activities through a digital infrastructure in maternal healthcare which includes an obstetric system and a central registrar referred to as the "Melior". The obstetric system is an intranet-based system used by all midwives and obstetricians in Gothenburg to access and use patient journals in form of MHV forms.

*"The patient journals are computer based. If you visit a midwife at Munkeböck, I can see if you have been in other areas of Gothenburg and the whole region."* (Midwife healthcare manager 1).

IT as an operand resource enables healthcare professionals to have a shared view of the status of the pregnant women by healthcare professionals at hospitals and clinics.

IT as an operand resource provides flexibility to integrate new resources in the obstetrics system by triggering healthcare professionals to complement pregnant women's information in the obstetrics system. 77% of the respondents reported that they complement information rather than the one specified in MHV forms. Complemented information includes information on previous pregnancies especially if the pregnant woman is from another region or country, hereditary diseases and life style related to diet, sleep and exercise.

Melior is used by all professionals in primary healthcare who provide services to patients. IT as an operand resource enables midwives and obstetricians to access blood test results in Melior through the patient journal in the obstetrics system.

*"For the blood test results such as HIV and syphilis, we can link from the patient obstetrics journal to the central register"* (Midwife healthcare manager 2)

### **4.3 Actors connected by shared institutional arrangements**

Actors in the maternal healthcare service ecosystem include professionals (midwife healthcare managers, midwives, obstetricians) who integrate resources as they provide services to the pregnant women. IT as operand resource provides a mechanism for cognitively distant actors to connect to each other through the digital infrastructure, in this case the obstetrics system. Midwives are located at the maternity clinics, midwife healthcare managers are located at hospital and maternity clinics, and obstetricians are in hospitals. The actors have different knowledge, skills and competences. Of the surveyed midwives, 35% have worked in maternal healthcare for less than 5 years, 25% have worked in maternal healthcare for 5 to 10 years and 36% have worked in maternal healthcare for more than 10 years. All midwives are been trained to primarily handle all maternal healthcare activities at the clinics. Midwives are fully registered nurses and work as nurses for some years before becoming midwives.

*"I worked for 8 years as a nurse before becoming a midwife."* (Midwife healthcare manager 1)

Midwife healthcare managers are also midwives and have additional administrative skills.

*"I have worked for 2 years as the coordinator for the all midwifery clinics in Gothenburg for 80% and I work 20% with the computer system support and development"* (Midwife healthcare manager 2).

Obstetricians are specialized healthcare professionals who provide support to midwives. They handle pregnant women with pregnancy complications who have been referred by midwives.

*"We meet women only if the midwife says that something is wrong. If everything is okay, we don't meet the women at all"* (Obstetrician)

Pregnant women are the main beneficiaries of the system and receive services during antenatal care visits. 47% of the respondents reported that they meet 4 to 6 pregnant women (on average) and 43% reported that they, on average, meet 7 to 9 pregnant women in a normal working day.

*"Usually, 99.8% of women come to all the visits. When they come they tell us everything and open up"* (Midwife healthcare manager 1)

Other actors of the ecosystem include partners, who accompany women to the antenatal care visits.

### **4.4 Resource integration by actors**

Results show that there exists a resource rich environment, which supports actors to integrate resources. Resources include: instructions and information within a specified maternal healthcare field referred to as a Promemoria or PM, a checklist, educational documents in multiple languages, a model used to identify pregnancy complications, a time list, a nutrition site and a health information site referred to as 1177. IT as an operand resource enables healthcare professionals to convert knowledge from tacit to explicit, making it easier to share knowledge with other actors in the ecosystem. A PM is an information resource within the basprogram that is developed by medical head adviser/doctor. It includes explicit knowledge on how midwives should act based on results from tests and measurements taken. For midwives with a lot of experience in maternal healthcare, the PM is also used as a reference resource especially in cases of rare results.



*“Everything we do has a PM documented in the system in which, the doctor has told us how to think, how everything works and the tests that need to be done.”* (Midwife healthcare manager 1)

In addition, IT as an operand resource enables healthcare professionals and pregnant women to access knowledge about pregnancy conditions, nutrition and pregnancy complications through educational documents, nutrition sites and prediction models. Educational documents in multiple languages explain reasons for test and/or measurement results. They can be printed and shared where necessary.

*“When we do something for instance an HB test and see that it is quite low, we go in the system and get the information on why it is low and print it out to the patient.”* (Midwife healthcare manager 2)

A nutrition site is a web-based resource that provides nutrition-related information to pregnant women.

*“Almost everyone has access to the internet. They are told to visit the nutrition site with a section on pregnancy that advises them on what to eat during pregnancy.”* (Midwife healthcare manager 1)

A model used to identify pregnancy complications is a highly structured document that contains guiding paths to follow for each complication. It has links to different sections which enable midwives to quickly and easily assess the pregnancy status and to identify any complications.

*“To check for high blood pressure, we check test results against the standard program. If it is normal, it is documented in the obstetrics systems under mhv2, if abnormal; we follow another path to check if the woman has protein in urine. This is the model used by everyone.”* (Midwife healthcare manager 1).

IT as an operand resource supports the referral process by triggering decisions to be taken by midwives through the use of checklists. A checklist is a resource within the basprogram that enables midwives to capture information about a pregnant woman including her family history, earlier complicated deliveries and any pregnancy fears suffered by the woman. The checklist is used by midwives to make decisions on whether pregnant women should be referred to the obstetrician or not.

*“If everything on the checklist is normal, the pregnant woman stays with the midwife otherwise we organize the visit to the obstetrician”.* (Midwife healthcare manager 2)

In addition, IT as an operand resource alerts obstetricians in case of emergencies and triggers actions from them based on the information posted on the time list by midwives. A time list is a resource within the obstetrics system, enabling midwives communication with obstetricians. In case of emergencies, midwives post women’s information on the time list in order for obstetricians to take action. Action is taken either by specifying in the obstetrics system that the woman is okay and can follow the basprogram or by proposing a time for a meeting with the woman. In addition, the time list supports communication among the midwives by showing what midwives are doing at a particular time in a day.

Furthermore, IT as an operand resource triggers actions from midwives based on the pregnancy related questions posted by the pregnant women on the health information site 1177. 1177 contains information in form of videos and text and enables pregnant women to ask midwives specific questions related to pregnancy and maternal healthcare. On the other hand, IT as an operand has enabled pregnant women to seek for health related information through 1177.

#### **4.5 Service exchange enabled and constrained by institutions**

Results relating to service exchange include accessibility of resources and information, sharing of information and collaborations among actors.

##### ***a) Accessibility of resources and information***

Results show that IT as an operand resource enables professionals and pregnant women access to information and other resources. All midwives have access to a computer connected to the internet, which they use to access information. Information and knowledge accessed by midwives from the resources is used to provide services to pregnant women including basic assessment of their condition, predicting pregnancy complications, advising pregnant women and for medical references, such as possible hereditary diseases. In addition, midwives can easily access health information for pregnant women including that from previous pregnancies through patients’ journals in the obstetrics system. 58% of the respondents reported that they can easily access information collected in the obstetrics sys-

tem. 75% of respondents reported that they are satisfied with the method used to access the collected information however; other respondents reported that they would like to have all medical records in one information system since it takes extremely a long time to get copies from other healthcare units. 67% of respondents reported that they have access to all information perceived as necessary to predict pregnancy complications but 33% reported a lack of access. Information missed includes: medical records from other healthcare units, previous pregnancy records for those pregnant women from other regions within Sweden or health units outside Sweden, missing narratives from women who do not disclose all the significant information. Respondents reported that pregnant women have access to their health related data and other pregnancy related information through 1177.

**b) Sharing of information and collaboration among actors**

Results show that IT as an operand and operant resource enables and triggers sharing of information among professionals and pregnant women. As an operand, IT enables women to share information about their pregnancy via phone, email and 1177 with midwives.

*“When women carry out the pregnancy test, they call midwives and ask what they should do. They are advised to start taking folic acid, stop alcohol and tobacco”* (Midwife healthcare manager 2)

IT enables midwives to share knowledge about pregnancy risks and blood test results with pregnant women. IT also enables midwives to share information about historical family diseases with other professionals, which guides them on the tests to be taken. In addition, IT enables healthcare professionals to share pregnant women’s health information including diagnostic and treatment notes.

*“When I meet a woman, I always write down what she says, what was the problem and what was my suggestion. This information can now be accessed by the midwives in the system.”* (Obstetrician)

However, institutional arrangements restrict midwives to share health information outside obstetrics.

*“We can read each other’s notes and the next midwife can take over a patient from another health clinic within the region. Other information outside obstetrics is not shared and cannot be seen unless it can affect the pregnancy”* (Midwife healthcare manager 3)

Collaborations between midwives and pregnant women mainly take place during antenatal care visits. As an operand, IT enables healthcare professionals to share information from visits. In addition, IT enables midwives to fill in a health plan together with pregnant woman, which is posted to the child care centre. The plan includes information on the needs of the pregnant woman including a translator and the need to breastfeed after birth. Communication between obstetricians and pregnant women take place in case of pregnancy complications and when women are referred by midwives. Conversation among midwives and obstetricians take place both formally and informally including discussions about pregnancy complications and deaths of either the woman or the child.

*“If there is a complication at a maternity clinic, there is half an hour where obstetricians discuss with midwives about what was done and how to do it better next time.”* (Midwife healthcare manager 3)

IT enables midwives to communicate with fellow midwives and obstetricians as they consult and make appointments for pregnant women at hospitals. 76% of the respondents reported that they first communicate with other midwives in case of a pregnancy complication while only 5% first communicate with obstetricians. Midwives always consult with colleagues and obstetricians especially in cases of pregnancy complications where they are not sure of the decision to take.

*“Midwives are never alone. They talk to colleagues and other midwives and look at the patient journal together”.* (Midwife healthcare manager 3)

There is always an obstetrician on call for consultation by the midwives in maternity clinics. In case of emergency and the obstetrician is not available at the clinic, the midwives call other midwives at the hospital to discuss what to do with the patient. 51% of respondents reported that they consult with other midwives to identify and predict complications while 65% of respondents reported that they consult with obstetricians to identify and predict complications.

*“Midwives are coming to me very much ...they ask questions every time”* (Obstetrician)

IT as an operand resource triggers actions from midwives at the hospitals based on the integrated summaries from other midwives. At the time of delivery, midwives at maternity clinics prepare a summary in the obstetrics system on how the pregnancy process has been for a specific woman, including information on how the woman feels and what she expects for delivery. This summary is used by the midwives at the hospital to make decisions.

*“If during the pregnancy there were some fluctuations for instance in the blood pressure, we note this in the summary on the system so that the delivery midwife can help them in a better way.”* (Midwife healthcare manager 2)

## **5 Discussion**

The study has outlined six practices in which IT supports value co-creation in the maternal healthcare system in Gothenburg, Sweden. Practices are elaborated below and shown in Table 2:

### ***Practice 1: Standardization of procedures through institutional arrangements***

IT as an operand resource supports standardization of procedures in the maternal healthcare service ecosystem through documenting institutional conventions in the ISO quality standards system called the basprogram. The standardization provides shared meanings among midwives and enables quality provision of services to pregnant women. Institutions enable actors to accomplish a level of service exchange and value co-creation under time and cognitive constraints (Vargo and Lusch, 2017). Service ecosystems require common organizational structures and sets of principles to facilitate resource integration and service exchange among actors (Lusch and Nambisan, 2015). Evidence shows that institutional arrangements in the maternal healthcare ecosystem enable midwives to exchange services and co-create value through holistic shared meanings. The institutional arrangements provide information about tests and measurements that are needed and hence provide better healthcare through better diagnosis and treatment during antenatal visits. In addition, they enable midwives to prioritize activities by outlining compulsory and optional tests per visit, which saves costs and time associated with unnecessary tests. Better healthcare provision and time saving are value co-creation outcomes for both patients and healthcare providers (Pinho et al., 2014). However, further research is recommended on how institutions support active engagement of pregnant women in maternal healthcare ecosystem.

### ***Practice 2: A well-developed digital infrastructure***

The maternal healthcare ecosystem is facilitated by a well-developed digital infrastructure that includes the intranet-based obstetrics system and the Melior. IT is used both as operand and operand resource in the service ecosystem by enabling patient journals in the obstetrics system to be shared between hospitals and maternity clinics in the entire region. The obstetrics system contains complete information about pregnant women, including earlier pregnancies, which leads to better healthcare provision. Therefore, IT as an operand provides professionals with a shared view of the status of pregnant women. Having all patients information available enables broader coverage of healthcare services because it facilitates care continuity and enables patients to feel more secure since they don't have to remember all their health data (Pinho et al., 2014). In the S-D logic perspective, a shared worldview ensures that actors can interpret resource integration opportunities coherently and come quickly together to exchange resources (Lusch and Nambisan, 2015). Therefore, IT facilitates the development of the coherent view of changes in the health status of pregnant women, which can be used by midwives and obstetricians to exchange services that improve service provision and support value creation. IT as an operand resource supports midwives to complement information which enables new resources to be integrated in the ecosystem.

### ***Practice 3: Heterogeneity of actors***

Results show the existence of cognitively distant actors with diverse knowledge, skills and competences. Actors include midwife managers, midwives and obstetricians with different experiences and pregnant women, sometimes supported by their partners. The S-D logic perspective requires a diverse set of actors and IT plays an operand role as the digital infrastructure holds together diverse actors and enables them to collaborate in the ecosystem (Lusch and Nambisan, 2015). IT enables different actors

to communicate different value propositions and IT as an operand enables professionals with different knowledge and experiences to collaborate and integrate resources as they serve pregnant women. In doing so, midwives will get more knowledge and can gain collective meanings to provide better support to pregnant women. The digital infrastructure enables actors to convert knowledge from tacit to explicit (Lusch and Nambisan, 2015) and therefore the explicit knowledge becomes a key resource for other actors in the service ecosystem for value co-creation. However, results show much higher resource exchange among professionals than between professionals and pregnant women, which may hinder active participation of women. IT can support women to get access to the explicit knowledge and gain skills to enable them to actively participate in the maternal healthcare resource exchange, an issue that needs further research.

***Practice 4: A resource- rich environment***

Results show the existence of various resources which can be integrated by different actors to support value co-creation. IT as both an operand and operant resource avails resources and supports integration and exchange among all actors within the ecosystem. As an operand resource, IT service platforms support actors to access and exchange the resources. IT platforms provide a channel to enhance value co-creation in healthcare (Carida et al., 2013). IT enables knowledge exchange through online health communities, which leads to social value (Goh et al., 2016), broader healthcare coverage and better healthcare decision management (Pinho et al., 2014).

IT as an operand resource enables conversion of tacit to explicit knowledge through resources such as the PM, nutrition sites, educational documents, prediction models and 1177. The PM provides guidelines in form of explicit knowledge on how to think and work, which support midwives in resource integration. Prediction models enable midwives to quickly and easily assess the pregnancy status and to identify any complications. Hence saving time and costs. IT enable professionals to translate educational documents to many languages. IT as an operant resource triggers actions of professionals through time lists, checklists and 1177. Time lists trigger actions from professionals about emergencies based on information posted by midwives on the status of pregnant women. Checklists trigger decisions from midwives concerning referrals. 1177 triggers actions from midwives based on information posted by the pregnant women.

It is evident that the ecosystem is 'not only limited to technology but a common environment that facilitates value co-creation by diverse set of actors' (Lusch and Nambisan, 2015) as they interact with resources and exchange services in the ecosystem. However, results show that most of the resources are actively used by professionals with the exception of the nutritional site and 1177, which is mainly used by pregnant women. Further research is needed on how IT can support pregnant women to tap into the resource repositories in maternal healthcare ecosystem in order to improve their knowledge and actively participate in the process.

***Practice 5: Accessing of health information and other resources by actors***

Results show that IT as an operand resource plays a facilitating role in the maternal healthcare ecosystem by providing access to information and resources. IT has enabled both healthcare professionals and pregnant women to have access to health related information. Midwives are satisfied with the methods used to access collected information. IT as an operand resource has enabled midwives to easily access historical and current pregnant women's health information through patients' journals in the obstetrics system. In addition, IT has enabled midwives to access blood test results in the central register or Melior. However, not all information is accessed especially that from other healthcare units within or outside Sweden yet it takes a lot of time to obtain the required information from other units. IT as an operand resource has enabled pregnant women to access: their health related data and other pregnancy related information through 1177 and nutritional data through nutritional sites. However, pregnant women cannot access their information in obstetrics system. Accessibility of information is a value co-creation factor in healthcare because it reduces on the time required to access records about patients before providing services and hence leads to broader healthcare coverage (Pinho et al., 2014) . IT enables patients to access information in order to acquire knowledge and reduce uncertainties which influences the consultation process and supports value co-creation (Osei-Frimpong et al., 2016).

Further research on how IT can be used by both healthcare professionals and pregnant women to access information from other health units for use in maternal healthcare is needed.

#### ***Practice 6: Sharing of health information and collaboration among actors***

Results show that IT has played both an operand and operant role to enable and to trigger conversations that support information sharing and service provision. IT as an operand resource enables midwives to rapidly share health information with other healthcare professionals and with pregnant women. Information shared among professionals includes health information of pregnant women (shared through the obstetrics system) and information about their daily tasks (shared through time lists) which leads to transparency. Transparency of activities through IT leads to value co-creation by clarifying actor roles (Lusch and Nambisan, 2015). Information shared between healthcare professionals and pregnant women includes blood test results and education documents on possible pregnancy risks.

In addition to information sharing, IT as an operand enables midwives to communicate with healthcare professionals as they consult and make appointments. Consultations mainly happen in cases of pregnancy complications where the actors are not sure of the decisions to take or if something wrong has happened as a result of complications. IT supports actors by enabling them to communicate and present their service offerings and to allow interpretations of existing knowledge (Lusch and Nambisan, 2015) a practice which enables value co-creation. Consultations support value co-creation as knowledge is shared among actors and ‘consultation time can be reduced with the use of IT’ (Beirão, et al., 2017). IT has enabled pregnant women to seek for pregnancy related information and acquire knowledge as they consult with midwives on 1177 hence co-learn. Co-learning leads to value co-creation ( McColl-Kennedy et al., 2012) and supports access to unstructured knowledge resources.

IT as an operant triggers actions from healthcare professionals depending on the diagnostic and treatment notes and integrated summaries posted by other healthcare professionals in the obstetrics system. This enables knowledge sharing and team decision making. The integrated summaries in obstetrics improves the service quality in maternal healthcare ecosystem by saving time that would be spent to gather information and to understand the status of pregnant women before providing required services. An integrated summary enables healthcare professionals to have the same level of understanding about the health status of the woman and hence provide better health services. Integrated summaries, collaborations and team decision making have been identified as activities that support value co-creation in healthcare (Beirão et al., 2017).

## **6 Conclusion and future work**

In conclusion, using the value co-creation model of S-D Logic enabled the identification of practices on the use of IT in value co-creation in maternal healthcare. The identified practices include: standardizing processes, well developed digital infrastructure, heterogeneity of actors, a resource rich environment, access to health information, sharing of health information and collaborations among actors. The role of IT as operant and operand in supporting value co-creation has been elaborated in each of the practices. Expected health outcomes from practices include: better healthcare provision, broader healthcare coverage, cost and time savings and better healthcare decision making.

A study limitation was that the study did not involve pregnant women who are the main beneficiaries of maternal healthcare. Therefore, an in-depth understanding on how IT has enabled pregnant women to actively engage in maternal healthcare from pregnant women’s perspective was missed. Studies on how IT supports pregnant women to co-create value in maternal healthcare are recommended.

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Value co-creation model component (Vargo and Lusch, 2016)	Practice in maternal healthcare	Role of IT in value co-creation	Expected value in terms of health outcomes
Institutions and institutional arrangements	1 Standardization of procedures through institutional arrangements	Operand	Better healthcare provision due to better diagnosis and treatment Time saving
Service ecosystem	2 A well-developed digital infrastructure	Operand and Operant	Broader healthcare coverage due to transparency of activities hence shared worldview, flexibility of the system to complement new resources Better healthcare provision due to availability of complete health information about pregnant women.
Actors connected by institutional arrangements	3 Heterogeneity of actors	Operand	Better healthcare provision due to differences in experiences and skills which are shared
Resource integration	4 A resource- rich environment	Operand and Operant	Broader healthcare coverage due to access to knowledge. Better healthcare provision due to knowledge conversion Better healthcare decision making due to triggering actions from healthcare professionals Time and cost saving
Service exchange enabled and constrained by institutions	5 Access to health information	Operand	Broader healthcare coverage due to access to information Time saving
	6 Sharing of health information and collaborations among actors	Operand and operant	Better healthcare provision due to improved transparency and integrated summaries and co-learning by pregnant women Time and cost saving due to improved information sharing and collaboration Better healthcare decision making due to integrated summaries and team decision making.

Table 2. Practices for IT support in value co-creation in maternal healthcare

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