Business Models for Telemedicine Services: A Literature Review

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Abstract
Telemedicine has been acknowledged to improve the quality of healthcare. However, many telemedicine services fail beyond the pilot phase. A literature review on business model components for telemedicine services was conducted. Based on specified inclusion criteria, 22 publications were included in the review. To facilitate the analysis of literature, a business model framework with value as its central focus was proposed. Improvement in quality, efficiency and accessibility of care were identified to be the outcomes of telemedicine with patients and healthcare personnel being the main users of the services which are delivered through home, institutional and community-based care. Patients, health providers, vendors, payers and government agencies are actors involved in the delivery of telemedicine services which require investments in resources like videoconferencing technologies, home monitoring devices and other IT infrastructure. Subscriptions, reimbursements and pay per use revenue streams were identified as feasible for commercializing telemedicine services.
Keywords: Telemedicine service, Business model, Value

Introduction

The potential of information technology as a tool to improve the delivery of healthcare is indisputable for its contribution to enhancing the provision of care and administrative efficiencies through the automation of manual processes. The healthcare industry has witnessed a surge in technological innovations including decision support systems, electronic health records and other consumer health informatics applications which are increasingly being patronized by healthcare providers and patients. Healthcare systems are under intense pressure due to a growing demand for quality and affordable care; a situation driven by an ageing population with chronic diseases and comorbidities, demographic and lifestyle trends, shortage of healthcare personnel, and the move towards patient-centric care (Braganca et al, 2010; Saliba et al, 2012; Mars, 2013). In the light of these challenges, telemedicine, the provision of healthcare to patients over a distance through the use of information and communication technologies to access and exchange medical information and expertise has been acknowledged particularly to improve accessibility of healthcare for underserved communities. It could be as simple as health personnel discussing the medical condition of a patient and seeking advice over a simple telephone to as complex as transmission of clinical

information including diagnostic tests such as ECG through remote devices from a patient's home, and carrying out real time interactive medical video conference with the help of information technologies (Nayak et al, 2012). Telemedicine complements existing healthcare systems to enhance accessibility to healthcare, timely exchange of health information between healthcare providers, quality care for patients, and efficient and cost-effective provision of care for healthcare organizations (Ekeland et al, 2010). Telemedicine also enhances the empowerment of patients to actively participate in their own healthcare (Sarela et al, 2009).

In spite of the words spoken and ink spilt, the commercialization of many telemedicine services may not become sustainable and successful. van Limburg et al. (2011) attribute this to the notion of a "jump on the eHealth bandwagon" mentality without clear predetermined goals that embed a technology in its intended practice to create value. The development of a sustainable business model enhances the successful commercialization of a telemedicine service because it addresses all relevant development and implementation issues to help accelerate its market (Broens et al., 2007; Fielt, 2008; Spil & Kijl, 2009; Huis in't Veld et al., 2011). A business model defines who the customers are and what value they seek and how an organization can generate revenue by delivering this value. However, according to the eHealth Initiative 2011 (eHealth Initiative, 2011) report on Health Information Exchange, majority of respondents to the survey reported that developing a sustainable business model and defining value are their biggest challenges. In the absence of a sustainable business model, it is unlikely that a telemedicine service will advance past the development stage. This is due to the fact that many telemedicine services start as pilot projects with external funding (Spil and Kijl, 2009) and the lack of profitable revenue streams for the services will cause commercial failure.

While extensive research has been conducted with a focus on the clinical outcomes (Giordano et al., 2007; Nikus et al., 2009; Winkler et al., 2010;, Shacham et al., 2010), user adoption and attitudes (Roblin et al, 2009; George et al, 2012; Zanaboni and Wootton, 2012;), challenges or barriers to implementation, adoption and evaluation of telemedicine services (Gamble, 2009; Cushman et al, 2010; Wynia and Dunn, 2010; Weitzman et al, 2011) relatively fewer studies have described the underlying business models of such telemedicine services. The aim of this study is to explore and examine business models for the provision of telemedicine services in existing literature to help determine patterns in development of business models in telemedicine while uncovering gaps in research.

Telemedicine Services

The American Telemedicine Association defines telemedicine as "the use of medical information exchanged from one site to another via electronic communications for the health and education of the patient or healthcare provider and for the purpose of patient care" (American Telemedicine Association, 2013). Telemedicine could be described as synchronous or asynchronous.

In ***synchronous telemedicine***, there is real time interaction between both parties and mainly involves audio and video conferencing technologies and may be augmented by other medical peripherals including remote monitoring devices. Synchronous telemedicine services are predominantly used for live and interactive patient consultations and for large group continuing education (Verhoeven et al, 2010; Gackowski et al, 2011; Bergrath et al, 2012).

Asynchronous or store-and-forward telemedicine involves acquiring clinical data such as diagnostic images, to be securely stored and transmitted to other health personnel for assessment later as seen in for instance teleradiology (Ng et al, 2009; Coulborn et al, 2012). The technologies used in asynchronous telemedicine services include medical imaging devices, personal digital assistants and wireless communication (Anker et al, 2011). It is often used in instances where presence of the patient is not required. Some telemedicine services may employ both synchronous and asynchronous technologies and may be described as hybrid.

Remote monitoring represents a developing area of telemedicine and involves data acquisition, storage and interpretation occurring synchronously or asynchronously from remote devices, smart clothes that acquire and transmit physiological data and smart homes that monitor people's activity (Mars, 2013). Remote observation of a patient's condition has been acknowledged particularly in the management of chronic diseases to improve the quality of healthcare, reduce hospitalization and emergency visits (Scherr et al, 2009; Mortara et al., 2009; Takahashi et al., 2010; Bowles et al., 2009; Winkler et al., 2010; Martin-Lesende et al., 2011; Seto et al, 2012; Baig et al, 2013; Chronaki and Vardas, 2013).

Telemedicine holds many potential benefits including improved access to information for both patients and healthcare professionals; reduced healthcare cost; provision of care not previously deliverable (Hjelm, 2005); improved accessibility to healthcare services for underserved populations; and improved quality of care (Bashshur, 2011).

Business Model: Definition and Components

The term business has been used with varied connotations to mean such things as components of a business model (e.g. subscription model), types of business models (e.g. consumer-consumer model), or real world instances of operating business models. In this paper, business models are used as an abstract overarching concept comprising of components and their relationships that can describe all business entities. Expectedly, there have been numerous definitions for business models in existing literature emanating from diverse perspectives including e-business, strategy and information systems. The concept has also been denoted as a blueprint, description, statement etc. A widely cited definition is that of Chesbrough and Rosenbloom (2002): "a blueprint for how a network of organizations co-operates in creating and capturing value from technological innovation". Due to the varying contexts under which business models are discussed, there exists no generally accepted definition of business model (Zott et al, 2011).

Adding to this apparent lack of consensus on its definition is the issue of the elements or components of the business model. Again, many authors have proposed various frameworks and models to describe the constituents of business models. Chesborough & Rosenbloom (2002) describe value proposition, market segment, structure of the value chain, position in the value chain and cost structure to be the elements of a business model. Faber et al. (2003) developed the STOF framework which describes four components of a business model namely service, technology, organization and finance. Osterwalder and Pigneur (2002) describe a business model ontology comprising of nine components: key activities, key resources, cost structure, key partnerships, value proposition, customer segments, customer relationships, distribution channels and revenue streams. Again, there is no consensus on the components of a business model.

What constitutes a business model for a telemedicine service?

Shafer, Smith and Linder (2002) reviewed definitions of business models from existing literature and identified four dimensions shared by all or most of the definitions: creating value, capturing value, value network and strategic choices. Additionally, based on their literature review, Zott et al. (2011) argue that extant business model literature appears to have moved from an isolated firm perspective towards a firm centricity that spans across different boundaries with a focus on activity system view and an interest toward value creation instead

of capturing value. From these and previous literature on business models, we conclude that an important dimension to the business model concept is value and thus conceptualize business model for telemedicine service as an archetype with value as a central focus in which the benefit been offered (value creation), activity systems (value delivery) and financial structures (value capturing) are presented as seen in figure 1. On this premise, we explain a business model for telemedicine as a description of the outcomes, delivery facility, actors and roles, user groups and resources required for an organization to provide IT-supported healthcare over a distance with the aim of improving the quality of healthcare while making and sustaining profits for other stakeholders.

In our framework, the value creation is defined by a unique benefit that a telemedicine service offers. This benefit is expressed in outcomes and a defined user group. In telemedicine, outcomes represent effects like improved quality of life, enhanced accessibility, patient empowerment etc. According to a 2008 European Commission's report, the benefits of telemedicine are derived from three levels. At the individual level, patients' health outcomes and their quality of life could be enhanced. At the health system level, efficiency, cost reduction and accessibility to healthcare for rural and underserved communities due to shortage of health staff could be improved. Lastly at the societal level, with an expanding global market, telemedicine could make substantial contributions to the economy (Saliba et al, 2012). . Essentially, the significance of a telemedicine service is to improve the quality of healthcare for the patient (individual level), improve efficiency of healthcare systems while reducing cost (organizational level). User groups denote the end users who the telemedicine service is aimed at and actually use the service. Some services are patient-centric e.g. remote monitoring of patients' from their homes through devices that acquire and transmit physiological data, while others are provider-centric and used to exchange information or medical expertise between healthcare professionals at different locations (Ramesh et al, 2013). Depending on the user group, the mode of delivery of the service could be different.

According to Zott and Amit (2010) a business model could be perceived as an activity system that describes the set of activities that a firm performs, how they are performed who performs them. The activity system in the framework represents how the value to be created is delivered. The type of facility describes the delivery channel of the telemedicine service. Healthcare can be delivered through home-based, community-based and institutional care (Wysocki et al, 2012).

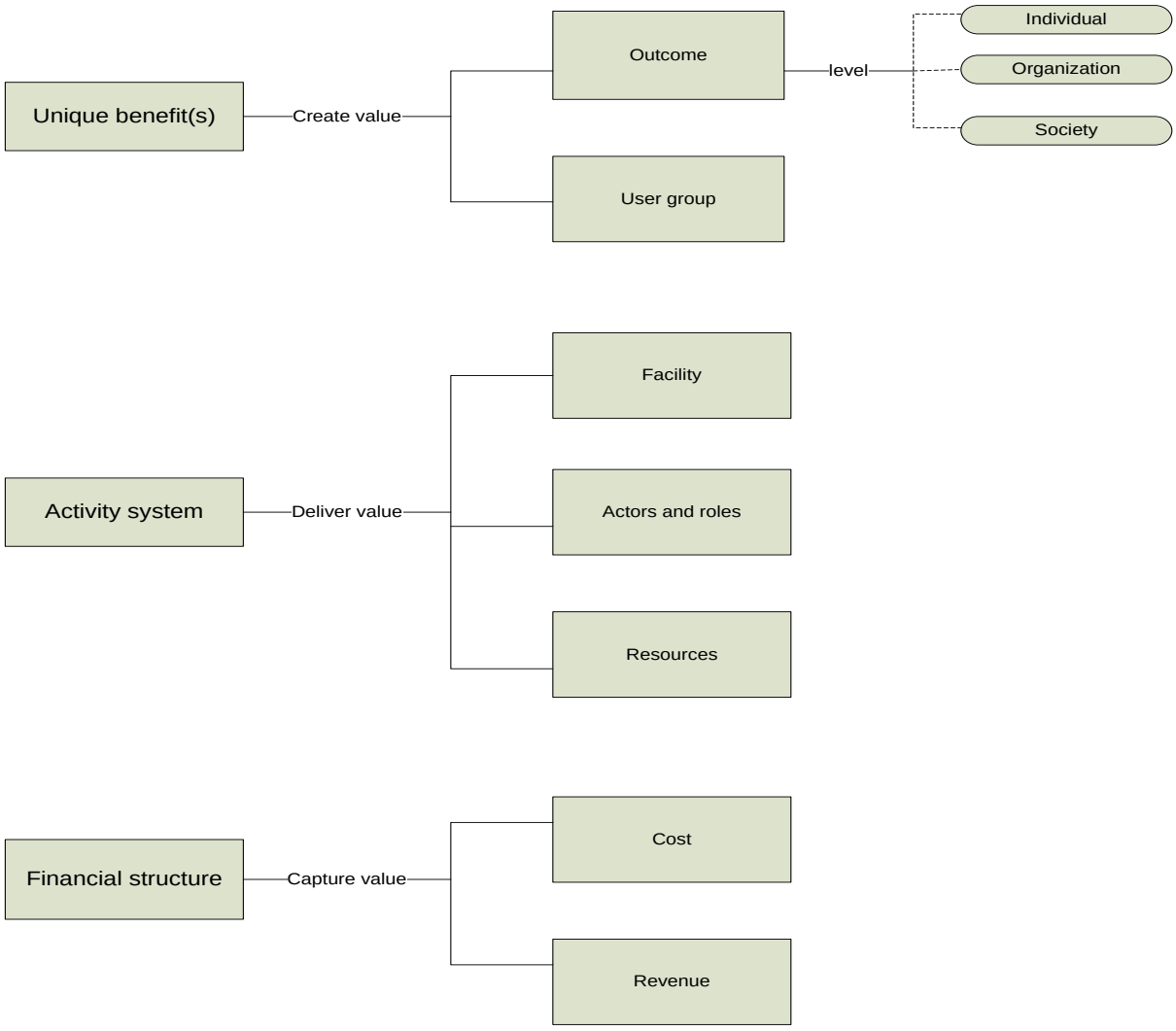

Figure 1: Framework of business model components for telemedicine service

As the name implies, home-based care is delivered at the patient's home or other settings like the work place. Community-based care involve healthcare delivered through community group living settings like adult residential care facilities. Institutional care involves healthcare delivery through licensed facilities that provide boarding and medical management under the supervision of skilled healthcare personnel. An activity system also describes a chain of activities performed by actors with specified roles. The type of telemedicine service being offered determines which actors and roles required to provide the service. For instance, in a provider-centric service, the patient may not have a direct role. In the chain of activities in telemedicine, actors may include patients, healthcare personnel, vendors, payers and so on. In telemedicine new roles are created. For instance, in remote monitoring, a patient may be required to record and wirelessly send physiological data from monitoring devices to a physician's office. This means that patients must be willing to adopt such new roles to

actively participate in their own healthcare. In the same vein, healthcare personnel may also take on new roles e.g. online consultations or regularly checking for physiological data sent in by patients, and must also be willing to assume the new roles created by the introduction of telemedicine (Nordgren, 2009). The resources component describes the infrastructure required to realize a telemedicine service. These may include communication and network infrastructures, data transmission, clinical back-end systems and vital physiological monitoring devices in the instance of remote patient monitoring. Important considerations for the technological infrastructure include factors such as interface usability, computing performance, network availability and security (May et al, 2011).

The financial structure in the framework consists of the cost of delivering the service and revenue streams for the providing organization to capture monetary value. Sources of cost, funding and pricing are critical considerations when embarking on the development of business models for telemedicine services. Many telemedicine programmes are financed through grants especially during the pilot phase (Hansen et al, 2011; May et al, 2011; Spil and Kijl, 2009; Kobb et al, 2008). For telemedicine services to be successfully commercialized there should be sustainable revenue streams to capture monetary value. There are various approaches to healthcare financing. In countries like the United Kingdom and most of Scandinavia, healthcare is mainly financed by the government or its agencies through taxation and implies a single-payer system. In France, Germany, Belgium, Netherlands and Japan, healthcare is partly paid for by the government through taxes and employers' and citizens' insurance and involves a multi-payer system (van de Ven et al, 2013). In market–based healthcare system as evident in USA, healthcare is paid for by employers and citizens and thus involves different payers (Woolhandler and Himmelstein, 2007). In out-of-pocket system, patients pay for healthcare directly to the care provider and this system is common in most part of African and other developing countries in Asia (Mills et al, 2012). A revenue model deployed for a telemedicine service thus to a large extent depends on the type of existing health system – public or private and how healthcare provision is financed.

When all these components of the business model work in concert with other external factors that influence the provision of the service it is possible to achieve and sustain commercial success. We use this framework to describe and analyze the business models presented in publications selected for this study.

Method

Electronic literature searches were performed using the following databases: Medline, Embase, Scopus, PubMed Central, Cochrane Library, CINAHL, EBSCO Business Source Complete and Web of Science. The search strategy consisted of the AND combination of two main concepts: telemedicine and business model. Relevant keyword variations of these concepts were used resulting in the following search combinations: "telemedicine" OR "telehealth" OR "telecare" OR "electronic health" OR "mobile health" OR "telemonitoring" OR "remote monitoring" OR " teleconsultation" AND "business model" OR "value model" OR "market model" OR "service model" OR "financial model" OR "resource model" OR "revenue model" OR "payment model". Multiple keyword sets were used to optimize results from the searches depending on the consulted database. Google Scholar and SCIRUS were used to help identify grey literature. In addition, citation searching and visual scanning of the reference list of relevant studies were performed to identify further studies of interest as suggested by Wellington et al (2005). The searches were conducted from February to May 2013 and occasionally iterated to ensure that no recent publications were missed.

Initial selection of studies was made by reviewing the title and abstract of every record retrieved. In the instance where a decision on inclusion could not be made solely on title and abstract, the full article was retrieved. In order to exclude non-relevant studies from the review, the following inclusion criteria were used: (1) peer reviewed studies in English published between 2007 and 2013; (2) original research on a telemedicine service; (3) a study must deal with the business model construct in a non-trivial manner and centred on the provision of a telemedicine service(s) being examined. Letters, news reports, editorials, overviews, rejoinders and comments were all excluded. Papers where business models are just a minor section of the study or mainly used for educational or administrative purposes were excluded. Papers reporting hypothetical business model analyses for telemedicine without empirical assessment were also excluded in order to focus on actual telemedicine services or projects. In the occurrence of a telemedicine service resulting in multiple publications, the main study focusing on business models was reviewed.

The selected studies were classified according to themes using an iterative constant comparative thematic coding whereby texts were read, highlighted, compared and classified based on the type of telemedicine service and business model components examined using the framework described in figure 1. From the selected articles, information about study design,

country setting, and type of telemedicine service examined were also retrieved. Below is a flow diagram of the study selection process.

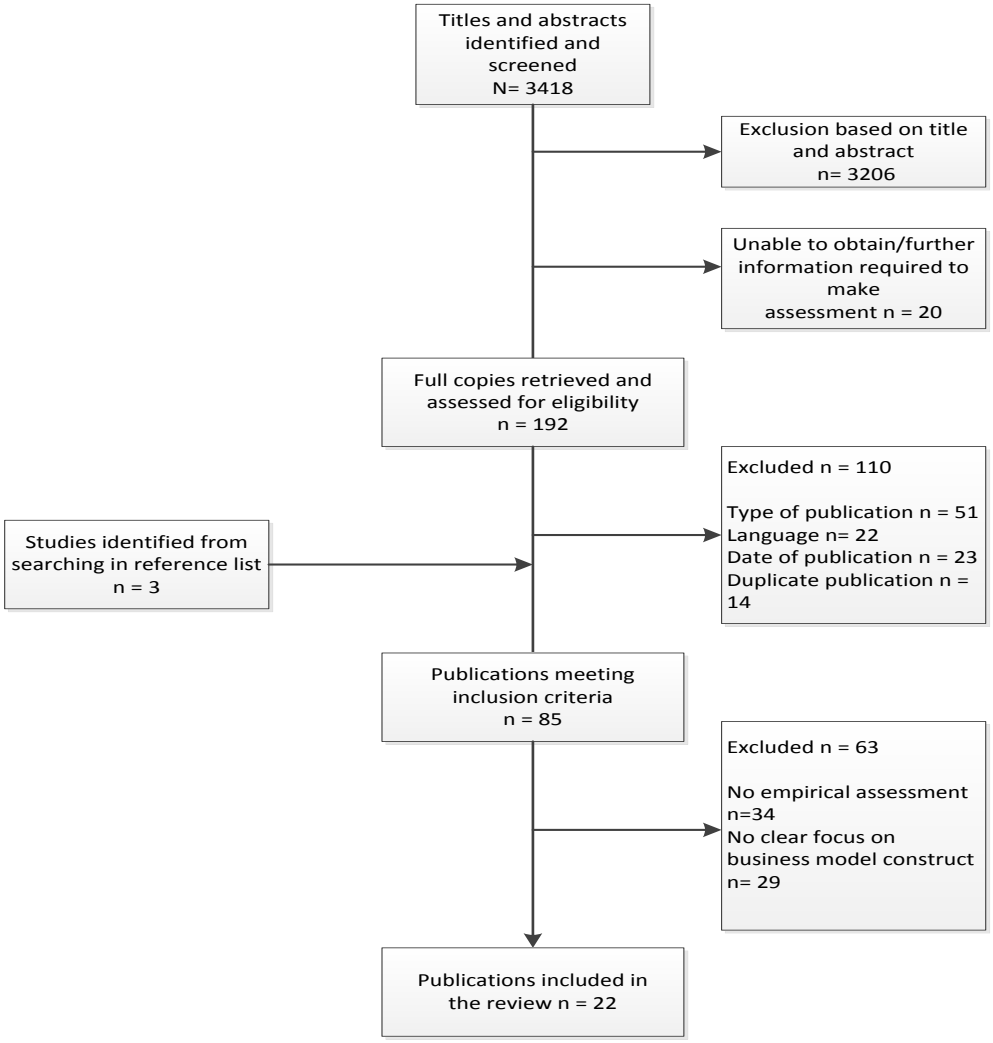

Figure 2: Flow chart of study selection process

Results

A total of 3418 abstracts were screened to select relevant studies with 192 papers retrieved and assessed for the review. Based on predetermined inclusion criteria, 22 articles were included in the review. Majority (15) of the articles were case studies, 4 were surveys and 3 used action research approach. 10 of the articles studied telemedicine services offered in Europe, 6 in North America, 6 in Asia and 1 in Australia. 8 of the articles were on synchronous telemedicine services, 4 focused on asynchronous services while 10 examined remote patient monitoring. These findings are presented in table 1.

Table 1: Description of studies

Year of publication	Study	Country	Study design
	Synchronous Telemedicine		
2013	Chen et al.	USA, Canada, Netherlands, India, Pakistan, China	Case study
	Pruthi et al.	USA	Survey
2012	Fanale & Demaerschalk	USA	Case study
	Spil & Kijl	Netherlands	Case study
2010	Wickramasinghe et al.	Sri Lanka	Action research
2009	Cho et al.	USA	Case study
2008	Maffei et al.	USA	Survey
2007	Van Ooteghem et al.	Belgium	Case study
	Asynchronous Telemedicine		
2013	Krupinski & Weinstein	USA	Case study
2010	Visser et al.	Netherlands	Case study
2009	Ganapathy & Ranindra	India	Case study
2008	Postel et al.	Netherlands	Survey
	Remote Monitoring		
2011	Huis in't Veld et al.	Netherlands	Action research
	Lin et al.	Taiwan	Case study
	Van Ooteghem et al.	Belgium	Case study
2010	Chiu &Yang	Taiwan	Case study
	Kijl et al.	Netherlands	Action Research
	Lin et al.	Taiwan	Case study
2009	Sarela et al.	Australia	Case study
2008	Malliopoulos et al.	EU community	Case study
	Tamošiūnienė & Naumčik	Lithuania	Case study
2007	Tseng & Cheng	Taiwan	Survey

Based on the framework from figure 1, table 2 illustrates business model components discussed in the selected articles and are summarized according to the type of telemedicine service.

Table 2: Characteristics of studies: business model components of telemedicine services

Year of publication	Study	Outcome/ Level of outcome	User group	Facility	Actors	Resources	Cost	Revenue
			Synchronous telemedicine services					
2013	Chen et al.	Cost –effective and improved efficiency Organizational level	Healthcare providers	Institutional care	Healthcare providers Government Vendors	Network infrastructure, Web space, HTML coding, and a secure network for storing and transmitting data	ICT investments and operations, Maintenance of online platforms	Full membership charged annually, monthly premium, subscriptions, pay per consultations
	Pruthi et al.	Accessibility to counselling, consultation and individualized management plan for underserved patients. Individual level	Breast cancer patients	Institutional care	Patients Healthcare providers from referring site and providing site	Video conferencing technologies A personal computing based voice over internet protocol application e.g. Skype	Not discussed	Referring site as third party payer and bill to patients' payer Patients subscribe to service Providing site charges per consultation and bills to referring site

Table 2 (continued)

Year of publication	Study	Outcome/ Level of outcome	User group	Facility	Actors	Resources	Cost	Revenue
			Synchronous telemedicine services					
2012	Fanale & Demaerschalk	Simultaneous communication resulting in significant time savings on decision making. Individual level	Cardiovascular patients	Institutional care	Patients Healthcare providers from hub and remote hospitals	Smartphones (through iPhone 4 Face Time function and Tweet function)	Not discussed	Spoke/remote and/or hub hospital subsidization Spoke subscription–based revenue stream Health insurance reimbursement (public and private insurers)
	Spil & Kijl	Cost-effective simultaneous communication resulting in significant time savings on decision making. Individual and Organizational levels	Cardiovascular patients	Institutional care Home care Community-based care	Patients Healthcare providers Social workers Vendors (service, device, network) Government health insurers	Audio and video conferencing technologies	Not discussed	Free of charge Pay per usage Subscription

Table 2 (continued)

Year of publication	Study	Outcome/ Level of outcome	User group	Facility	Actors	Resources	Cost	Revenue
			Synchronous telemedicine services					
2010	Wickramasinghe et al.	Provide a uniform service of specialized healthcare services Individual level	Underserved patients	Institutional care	Patients Healthcare providers from referring site and providing site Vendors	Independent framework that can be easily used with any EMR/EHR system Video conferencing tool Mobile reminder system	Not discussed	Not discussed
2009	Cho et al.	Increased efficiency of stroke diagnosis to reduce mortality risk of permanent disability. Individual level	Cardiovascular patients	Institutional care	Patients Neurologists from hub hospital Healthcare providers from rural hospital System developer, State funding agency Commercial firms	Audio and video conference technologies	Initial government funding and research grants	Market-based revenue streams through rural hospitals

Table 2 (continued)

Year of publication	Study	Outcome/ Level of outcome	User group	Facility	Actors	Resources	Cost	Revenue
			Synchronous telemedicine services					
2008	Maffei et al.	Easy and efficient access to specialty care Individual level	Uninsured or marginally uninsured patients	Community-based care	Patients Public and private safety net health providers Social service providers Vendors	Audio and video conference technologies	Not discussed	Direct payments by patients Reimbursements
2007	Van Ooteghem et al.	Enhance independent living for the elderly and invalids Individual level	Limited mobility Physical handicaps Mental handicaps Long term invalids.	Home care Institutional care	Patients Healthcare providers Social workers Vendors (service, device, network operator) Government Health insurers	Audio and video conference technologies	Not discussed	Reimbursement from patient's health insurance Government subsidies for public agencies (eg Social service department) Direct subscription to network operator

Table 2 (continued)

Year of publication	Study	Outcome/ Level of outcome	User group	Facility	Actors	Resources	Cost	Revenue
			Asynchronous telemedicine services					
2013	Krupinski &Weinstein	Provides telemedicine support services to healthcare centres Organizational level	Health personnel from private and public hospitals	Institutional care	Healthcare providers Government Vendors	IT platform, internet, Database and storage infrastructure	Investment in IT infrastructure	Fixed cost subscription
2010	Visser et al.	Improve quality of care through cooperation and synchronizing of integrated care Organizational level	Network of health professionals working with children with posture and movement disorders.	Institutional care (primary care based video consultation)	Healthcare providers Insurance company Technology provider Government	Web application Video devices Integration with patient information systems	Not discussed	Reimbursement through patient's insurance
2009	Ganapathy & Ravindra	Cost and time-effective access to specialty care Organizational level	Health personnel	Institutional care	Specialist healthcare providers	IT platform, Satellite communication, video technologies	Not discussed	Direct patient charge per consultation Government and adopting health provider pay total network usage fees

Table 2 (continued)

Year of publication	Study	Outcome/ Level of outcome	User group	Facility	Actors	Resources	Cost	Revenue
				Asynchronous telemedicine services				
2008	Postel et al.	Professional counselling with efficiencies and reductions in cost. Individual and organizational levels	Addiction patients	Home care Institutional care	Patients Healthcare providers Vendors Government Health insurers	Online treatment platform	Not discussed	Patient subscription Franchising and resale
				Remote patient monitoring				
2011	Huis in't Veld et al.	Efficient and cost-effective extramural care for improved quality of care Individual level	Chronic lower back pain patients	Home/work care	Patients Health providers Employers Vendors (Software, hardware network service)	User-end vital sign monitoring devices Mobile communication for data transmission Clinical back-end infrastructure	Not discussed	Reimbursement from public health insurance Reimbursement from employer health insurance Commercial sales
	Lin et al.	Improve quality of care Individual level	Diabetes and cardiovascular patients	Home care Institutional care Community-based care	Patients Health care providers NGOs Vendors	Body area network (BAN) Data transmission Service terminal Call center	Partnership to reduce cost	Free for rural low-income customers

Table 2 (continued)

Year of publication	Study	Outcome/ Level of outcome	User group	Facility	Actors	Resources	Cost	Revenue
				Remote patient monitoring				
2011	Van Ooteghem et al.	Efficient and cost-effective care through reduced number of hospital visits Individual and organizational levels	The elderly	Home care Institutional care	Patients Healthcare providers Vendors (hardware, software, data storage, call center, network connectivity, sales channel) Public and private insurers)	User-end vital sign monitoring devices Clinical back-end systems Mobile communication for data transmission Video consultation technologies	Not discussed	Direct monthly subscription by patients to the service most feasible Patients pay directly to the connectivity provider of their choice Reimbursements
2010	Chiu & Yang	Improve quality of care through enhanced emergency mechanisms for patients Individual level	The elderly	Community – based care	Patients Healthcare personnel from providing hospital Staff from community religious center as end-user site	User-end vital sign monitoring devices Clinical back-end systems Mobile communication for data transmission	Financed through subsidies and funds from volunteers	Free for the elderly

Table 2 (continued)

Year of publication	Study	Outcome/ Level of outcome	User group	Facility	Actors	Resources	Cost	Revenue
				Remote patient monitoring				
2010	Kijl et al.	To provide continuous feedback on muscle relaxation on patients suffering from work related shoulder and neck problems. Individual level	Patients with whiplash or neck and shoulder pain	Home/ work care	Patients Healthcare provider Myofeedback service provider Insurers Vendors Network provider	Sensors and actuators in a wearable garment connected to a PDA, front end systems, back end systems and communication infrastructure	IT investments, IT operations, Healthcare provider investments and operations	Payments by employers and their health insurance companies is the most feasible
	Lin et al.	Emergency mechanism for spontaneous intervention. Improved quality of care Decrease in after-surgery mortality Individual level	Cardiovascular patients	Home care	Patients Health care providers at cardiology department and providing hospital	Portable EKG device Mobile data transmission Clinical back-end infrastructure	Sharing of on-call schedule for doctors to reduce cost	Patients are charged directly (subscription) Patients are charged for service and not device

Table 2 (continued)

Year of publication	Study	Outcome/ Level of outcome	User group	Facility	Actors	Resources	Cost	Revenue
				Remote patient monitoring				
2009	Sarela et al.	Effective and cost-efficient cardiac rehabilitation and improved quality of care Individual and organizational level	Cardiovascular patients	Home care	Patients Healthcare providers Private and public health insurers Mentors Vendors (device, content, software, web-service, training) Telephone operator	Body area network Mobile communication for data transmission Clinical back-end infrastructure	Not discussed	A one-off set –up fee per organization An annual fee per mentor A weekly fee per patient based on a standard mobile phone, scales and blood pressure devices. Monthly data and communication charges billed from the health care organization
2008	Malliopoulos et al.	Improved quality of care through ubiquitous monitoring of physiological parameters Individual level	Cardiovascular patients	Home care	Healthcare providers Vendors (Portable patient unit and garment, software) HealthWear service provider Software provider	Sensing garments, portable patient unit Wireless data transmission Clinical back-end systems	Not discussed	Reimbursement from patients‘ health insurance organization Adopting hospital pays for the garment and portable units from the different vendors

Table 2 (continued)

Year of publication	Study	Outcome/ Level of outcome	User group	Facility	Actors	Resources	Cost	Revenue
				Remote patient monitoring				
2008	Tamošiūnienė & Naumčik	Provide efficient, cost-effective and timely quality care Individual and organizational levels	Cardiovascular patients	Home care	Patients Healthcare provider Service provider Payer (e.g. insurer)	User-end vital sign monitoring devices Clinical back-end systems Mobile communication for data transmission	Not discussed	The healthcare provider pays service provider Reimbursement from patient's payer organization
2007	Tseng & Cheng	Provide improved care through constant monitoring Individual level	The elderly	Institutional care Home care	Patients Healthcare provider Service provider Vendors Network operator	Front-end patient systems including household test equipment, backend systems, communication systems	Not discussed	Not discussed

Analysis

In this study, we examined business models and their components for telemedicine services. We base our analysis on a framework for business model components that focuses on value creation, value delivery and value capturing as shown in figure 1. Value creation is expressed through the health outcomes the service provides for particular user group(s). Value is delivered through a description of the type of facility from which the service is offered, actors and their roles and resources required to provide the service. Value capturing is expressed through a description of sources of cost and revenue streams through which the providing organization generate monetary inflows.

Outcomes

The outcomes of telemedicine are diverse; it can be monetary value e.g., revenues, cost reductions or clinical benefits e.g., reduced treatment time, number of patients, improved quality of life. From table 2, the value gained from telemedicine services include accessibility to healthcare (Pruthi et al, 2013; Maffei et al., 2008; Wickramasinghe et al, 2010; Ganapathy and Ranindra, 2009); emergency mechanism for spontaneous intervention for patients (Lin et al, 2010; Chiu and Yang, 2010; Tamošiūnienė and Naumčik, 2008); efficiency in the delivery of care through time and cost savings (Fanale and Demaerschalk, 2012; Cho et al, 2009; Spil & Kijl, 2012; Chen et al., 2013; Postel et al, 2008; Ganapathy and Ranindra, 2009; Sarela et al, 2009; Huis in't Veld et al, 2011; Malliopoulos et al. 2008), more tailored care (Spil & Kijl, 2009; Huis in't Veld et al., 2011; Kijl et al., 2010); enhanced physician-patient communication (Maffei et al., 2008); enhanced collaboration between healthcare personnel (Visser et al, 2010), and enhanced independent living (Van Ooteghem et al, 2007).

Furthermore, most of the publications discussed the level of outcome from telemedicine at the individual level whereby clinical measures like quality of care are examined and were mostly in remote patient monitoring and synchronous telemedicine services. Four of the studies (Chen et al., 2013; Krupinski & Weinstein, 2013; Visser et al, 2010; Ganapathy and Ranindra, 2009) focused on organizational outcomes and were mostly asynchronous provider-centric telemedicine services directed at healthcare personnel. Some also discussed outcomes from both individual and organizational levels (Spil & Kijl, 2012; Van Ooteghem et al, 2011; Sarela et al, 2009; Postel et al, 2008; Tamošiūnienė and Naumčik, 2008). None of the publications studied the outcomes of telemedicine from the societal perspective.

The benefits or value from telemedicine services are often complex to address, especially when these benefits are on a social level. Such social benefits are difficult (or perhaps even impossible) to quantify or monetize towards. However, it is imperative to assess what benefits are possible and thus what value a telemedicine service can offer to its entire network of stakeholders, the meaning of this value to each stakeholder, the need for stakeholders to be inspired to collaborate and co-create value for themselves and each other and the significance to discover how this co-created value can be properly divided among the stakeholders (van Limburg and van Gemert-Pijnen, 2011).

User Group

Another significant component of a telemedicine service business model is the definition of who the customer and end-user of the service is. From table 2, aside the mostly asynchronous telemedicine services geared toward healthcare personnel (Chen et al., 2013; Krupinski & Weinstein, 2013; Visser et al. 2010; Ganapathy and Ranindra, 2009), the end-user of most of the telemedicine services examined is the individual patient. These patient-centric services were mostly remote patient telemonitoring. Most of the telemedicine services were provided for patients with chronic diseases particularly cardiovascular diseases (Lin et al, 2011; Lin et al, 2010; Sarela et al. 2009; Malliopoulos et al. 2008; Tamošiūnienė and Naumčik ,2008; Spil & Kijl, 2012 Fanale and Demaerschalk, 2012; Cho et al, 2009), whiplash (Kijl et al. 2010; Huis in't Veld et al. 2011; and the elderly (Van Ooteghem et al, 2011; Tseng and Cheng, 2007; Chiu and Yang, 2010). Other services while not specific for a particular disease were offered for underserved communities to improve accessibility (Maffei et al. 2008; Wickramasinghe et al, 2010; Ganapathy and Ranindra, 2009).

Customers are the individuals or organizations paying for the service. The customer paying is not necessarily the same as the consumer who uses the service. Although one entity may purchase the service, the benefit of the service may reach beyond the customer to a separate consumer. For instance from the results, in the business model of the Myotel service that provides continuous feedback on muscle relaxation on patients suffering from work related shoulder and neck problems, the end-user is the patient but the customer who pays for the service is the employer or its health insurance organization (Kijl et al., 2010). In essence, this creates a situation where there is a high dependency on other stakeholders whose business models need to cooperate.

Facility

The type of facility or channel of delivery of telemedicine services determine the actors that will be involved in the provision of the service. Due to the prevalence of chronic diseases and increasing life span, many patients especially the elderly suffer from comorbidities which means that they need long-term care. Institutional care includes health and social care provided at residential and nursing homes for the aged and disabled. Some patients also receive care in their homes and may need to be supported to live independently through assisted living systems. From our results, most of the services are offered to the patient in an institution and were mostly synchronous and asynchronous (Chen et al., 2013; Pruthi et al, 2013; Krupinski & Weinstein, 2013; Spil & Kijl, 2012; Fanale and Demaerschalk, 2012; Van Ooteghem et al, 2011; Visser et al, 2010; Wickramasinghe et al, 2010; Visser et al, 2010; Cho et al, 2009; Ganapathy and Ranindra, 2009; Postel et al. 2008). Most remote patient monitoring services were offered to patients in their homes (Lin et al, 2011; Huis in't Veld et al. 2011; Lin et al, 2010; Sarela et al. 2009; Tamošiūnienė and Naumčik, 2008; Kijl et al. 2010; Malliopoulos et al. 2008; Tseng and Cheng, 2007).

In community-based care, patients receive healthcare at a designated centre in particularly underserved and rural communities where accessibility to health care is limited (Chiu and Yang, 2010; Maffei et al. 2008) In telemedicine services delivered as community-based care, specialty care that may not be available may be referred to a providing site at a distance. Patients also get to interact with other patients who may suffer from the same condition to provide support and education on disease management. Unlike home care which may require minimal support from health and social workers, in institutional and community-based care telemedicine services are led by healthcare personnel.

Actors and Roles

Actors and their roles form an important component of a business model for telemedicine services. It includes a description of actors, roles, interactions, and activities. From the results in table 2, telemedicine services may involve a combination of the following actors: patients, healthcare organization and personnel, employers, insurance companies, telemedicine service provider, hardware vendor, software developer, network operator, government and medical research and development organizations (Lin et al., 2011; Lin et al, 2010; Sarela et al., 2009; Huis in't Veld et al., 2011; Kijl et al., 2010; Chiu and Yang, 2010; Tamošiūnienė and Naumčik, 2008; Motamarri et al, 2011; Malliopoulos et al., 2008; Tseng and Cheng, 2007).

From the findings, while the patient is involved in most of the telemedicine services which is consistent with the fact that the outcomes of telemedicine were examined from the individual level, in the mostly asynchronous provider-centric telemedicine, the patient may not have an active direct role (Chen et al., 2013; Krupinski & Weinstein, 2013; Visser et al. 2010; Ganapathy and Ranindra, 2009). Generally, patients receive the telemedicine service while healthcare organization and personnel implement and execute the service. Diverse vendors provide the infrastructure and support to deliver the service. Payers including insurance companies pay for the telemedicine services. Government and its agencies make and ensure policies and regulations e.g. data protection, provide funding and in some cases pays for the service (Fanale and Demaerschalk, 2012; Van Ooteghem et al. 2007; Cho et al, 2009).

Resources

Telemedicine services often involve technologies that normally elicit reorganization of care processes and newly defined roles. The technological infrastructure of a telemedicine service constitutes a description of the technical functionality required to realize the service offering. It includes the description of technical architecture, service platforms, devices and applications. The technology may be simple as observed in telephone consultation or a complex myriad of systems. From the results in table 2, the resources required to provide synchronous telemedicine service often include audio and video conferencing and other applications (Pruthi et al, 2013; Van Ooteghem et al. 2007; Fanale and Demaerschalk, 2012; Cho et al, 2009; Maffei et al. 2008; Wickramasinghe et al. 2010; Spil & Kijl, 2012; Chen et al. 2013). In asynchronous services, online web applications, IT platforms, communication, database and storage infrastructure were identified to be necessary (Visser et al, 2010; Krupinski & Weinstein, 2013; Postel et al. 2008; Ganapathy and Ranindra, 2009).

The results from the review indicate that remote patient monitoring services make use of body area network (vital signs monitoring equipment, wearable sensors), mobile communication for data transmission, back-end infrastructure (servers) and end user devices including mobile phones and PDAs (Lin et al., 2011; Lin et al, 2010; Sarela et al., 2009; Huis in't Veld et al., 2011; Kijl et al., 2010; Chiu and Yang, 2010; Tamošiūnienė and Naumčik, 2008; Malliopoulos et al., 2008; Tseng and Cheng, 2007). In the remote patient monitoring usage scenario, portable and easy to use medical devices are positioned at the patient's home, allowing the collection of medical data such as ECG, glucose level and weight from the patient on the regular basis. The medical data is sent to the carrier data centre and stored in an

encrypted database as a personal report. When defined thresholds are exceeded, SMS and e-mail alert notifications may be sent to the physician responsible in order to stage a timely intervention.

Cost

Cost constitutes a description of the financial structure and includes funding sources, cost sources, risk sources, and pricing. Interestingly, majority of the articles reviewed for this study did not examine or discuss the cost component of delivering a telemedicine service. The results indicate that two of the telemedicine services were initially funded by government and other developmental agencies especially during the pilot phase (Chiu and Yang, 2010; Cho et al, 2009). The cost involved in the provision of telemedicine services could be accrued from IT investments, IT operations, healthcare provider fees, service provider fees; maintenance costs (Chen et al. 2013; Kijl et al., 2010; Krupinski & Weinstein, 2013). Other studies discussed strategies for reducing cost in the delivery of telemedicine services: partnership (Lin et al, 2011) and sharing of on-call schedule for doctors (Lin et al, 2010).

The explicit design of the pricing model for telemedicine services is of great importance to entice customers to pay for the offering and to continuously monetize the offering as well as creating value for the customer. Pricing mechanism must also be clearly defined in the cost structure of telemedicine business model. However, pricing was barely discussed in the reviewed publications. Only Visser et al (2010) and Pruthi et al. (2013) mention pricing and suggest the same pricing for face-to-face physician consultation for teleconsultations.

Revenue

Revenue defines the sources of income generation and as such the capturing of value for the organization offering a service. According to Kindström (2010) the type of revenue mechanism selected for an e-service depends on a number of variables, primarily customer maturity and these mechanisms can range from basic (such as hourly-billed) to more advanced mechanisms like profit sharing regime. However, in telemedicine service, the choice of revenue stream (s) is highly influenced by the type of healthcare funding system. The results from the review as presented in table 2 indicate that in nine of the studies, revenue was generated through reimbursement and from Nethelands (Huis in't Veld et al, 2011; Kijl et al., 2010;, Visser et al, 2010; Malliopoulos et al, 2008) Belgium (Van Ooteghem et al., 2011; Van Ooteghem et al. 2007), USA (Fanale and Demaerschalk, 2012; Maffei et al. 2008), Lithuania (Tamošiūnienė and Naumčik, 2008). These countries have multi-payer health care

systems and the reimbursements were mostly from a patient's insurance company or his/her employer's insurance company. In other telemedicine services, the subscription model was used to generate revenue (Spil & Kijl, 2012; Pruthi et al, 2013; Van Ooteghem et al. 2007; Fanale and Demaerschalk, 2012; Chen et al. 2013; Lin et al, 2010; Van Ooteghem et al., 2011; Krupinski and Weinstein, 2013, Postel et al. 2008). Again these telemedicine services were offered mostly in countries with multi-payer and market-based health systems. In the subscription revenue model, patients could subscribe to the telemedicine service instead of being charged per use (Pruthi et al, 2013; Postel et al. 2008; Van Ooteghem et al., 2011; Spil & Kijl, 2012; Kijl et al., 2010). The subscription or membership model offers users content or services and charges a subscription fee for access to some or all of its offerings. Fees vary based on the differentially accrued value to each stakeholder. The subscription model also was applicable to the case of telemedicine service being offered by a hub hospital to a remote hospital (Krupinski and Weinstein, 2013; Fanale and Demaerschalk, 2012; Sarela et al., 2009) and the remote hospital pay the hub hospital for the services.

Other studies employed pay per usage revenue stream (Maffei et al. 2008; Chen et al. 2013; Visser et al .2010; Pruthi et al. 2013; Ganapathy and Ranindra, 2009). The out-of-pocket payments (pay per usage and subscription) and reimbursements were feasible in multi-payer and market-based healthcare systems. In three studies, Lin et al (2011), Spil & Kijl (2012) and Chiu and Yang (2010), the telemedicine service was delivered free of charge to low-income or elderly patients. This model is the least feasible in the long-term. Mettler and Eurich (2012) assert that a freemium model (basic services are offered for free while a premium is charged for an advanced service) and a multi-sided approach whereby value creation is based on the interaction among parties could be promising for telemedicine services. In majority of the studies, a combination of revenue mechanisms was employed to achieve commercial sustainability. None of the studies focused on the provision of telemedicine services in a single-payer or largely government-funded healthcare system. Furthermore, there was no significant difference between the revenue streams and the type of telemedicine services reviewed as reimbursements, subscriptions, pay per usage were utilized for synchronous, asynchronous and remote patient monitoring services.

Comments

The adoption and commercialization of telemedicine services to a large extent depends on their business models. The definition of a business model and its components are shrouded in

a lack of consensus in literature. Various business models and their components have been described in literature. We argue that for telemedicine services defining outcomes, user groups, type of facility through which the service will be delivered, actors and their roles, resources required to offer the service, cost and revenue represent significant constitute key components to consider in developing a business model for telemedicine service. The value of a telemedicine service represents an important component of its business model. It expresses user needs, expectations and experiences, and is driven by a desire to purchase a service of a certain quality in return for a certain sacrifice including price, but also intangible costs such as inconvenience costs and access time (Baida et al, 2005). Value also captures knowledge about economic value from a user point of view.

An important issue that concerns value creation is co-creation. Zolnowski et al. (2011) assert that value co-creation is a crucial characteristic of services and its impact on the business logic should be represented comprehensively. Value creation in telemedicine is a shift from organizational centricity towards patient-centered healthcare where they are part of the value creation process. This indicates that essentially, the patient is just not a consumer but an active participant of value creation in the delivery of telemedicine service. This perspective emphasizes the understanding of patients as part of value creation to tailor a service to their needs based on user-specific knowledge (Zolnowski et al. 2011). The specification of the end-user during the development of a business model for a telemedicine service is imperative in order to design specific functionalities, assess delivery channels and develop better stakeholder relationships.

Value delivery of a telemedicine service is captured through activity systems that describe actors, roles, type of facility (channel) and resources. The description of actors is important in acquiring access to the resources and capabilities needed to realize a telemedicine service and openness between the different actors indicates the degree to which new business actors can join the telemedicine service and are allowed to provide services to customers. In addition, it is important that value is defined for each actor in the provision of the telemedicine service. Ultimately the adoption of telemedicine services is dependent on the willingness of patients and their carers to adapt to a new role of actively managing their health; and the willingness of healthcare personnel to practice medicine at a distance, i.e. to devolve a large part of the physical contact between themselves and the patient to devices and software. Both factors rely on certain technological factors such as ease-of-use, network availability and security.

According to de Reuver (2009), the performance of the technological architecture in delivering the technical functionalities has a profound impact on the quality of service and perceived user value, making it imperative to strike a balance between quality of a service and costs. Furthermore, the adoption of a new service is in part determined by the extent of system integration of new functionalities into existing technological infrastructure including electronic health records. Accessibility for end-users is influenced by the choice of platform, devices and architecture and to allow for personalization of services, management of user profiles must be created and maintained (de Reuver and Haaker, 2009).

Many telemedicine projects are initially financed through funds and grants. Lack of funding means that these projects may not develop beyond the initial pilot phase (Gupta et al, 2009; Spil and Kijl, 2009). Lin et al (2011) note that initial funding remains a barrier to the development of telemedicine services and recommend partnership among value network to reduce cost and risk. Spil & Kijl (2009) assert that many eHealth projects are too technology driven that they accrue high cost. Hawk (2011) avers the use of economies of scale to reduce cost. The revenue streams and thus profit of a product-based business entity are usually based on unit sales, but service offerings have revenue mechanisms based on other parameters. Subscriptions, reimbursements, pay per use, freemium models are feasible in generating revenue and capturing value from a telemedicine service for the providing organization in multi-payer and market-based healthcare systems. There is no "fit-for-all" revenue mechanism for telemedicine services because every service is different and may depend on other factors like the type of existing healthcare financing system, regulations and market environment.

Conclusion and Future Research

Value creation, value delivery and value capturing are important components of a business model for telemedicine services. Value creation is expressed through the benefits or outcomes for the users of the telemedicine service. Value in telemedicine is diverse and more often than not is to improve the quality, accessibility and efficiency of care. It is also important to identify the customer and end-user of the service. The end-user of most of the telemedicine services is the patient or healthcare personnel. The specification of the end-user during the development of a business model for a telemedicine service is imperative in order to design specific functionalities based on user needs. The delivery of value from a telemedicine service is expressed actors, type of facility and resources needed to deploy the service. This

component includes a description of actors, roles, interactions, and activities. Patients, healthcare provider, payers, third party vendors, and regulators form key actors in the provision of telemedicine services. The type of facility (institutional, home and community based) through which a telemedicine service is offered is important in determining the actors and their roles. Body area network, mobile communication for data transmission, clinical back-end infrastructure, end user devices including mobile phones and PDAs, web applications, video conference devices, data storage, and network infrastructure represent common technological resources deployed in telemedicine services. Actors and roles, type of facility and resources represent an activity system through which value is delivered.

Finally, the financial component remains an important part of a business model for telemedicine services. Cost is a description of investment sources, cost sources, revenue sources, risk sources, and pricing. Many telemedicine projects are initially funded through grants and fail to develop beyond the pilot phase for lack of funding. The cost involved in the provision of eHealth services could be accrued from IT investments, IT operations, healthcare provider fees, maintenance costs and so on. Revenue describes sources of income generation and value capture for the providing organization. Reimbursements, subscriptions, and pay per usage are revenue mechanisms that could be feasible in most telemedicine services. Patients in poor rural communities may be offered the service free of charges. Freemium and advertisements may also be feasible revenue streams for telemedicine services offered through web portals.

The studies reviewed in this paper were mostly conducted in contexts with multi-payer and market-based healthcare financing systems and revenue models like pay per usage, subscription and reimbursements were found to be feasible for the commercialization of telemedicine services. Given that a telemedicine service is not funded by a third party nor its use compulsory but provides an alternative form of care, further research investigating feasible revenue models for telemedicine services provided in countries where healthcare is funded through mainly public taxes need to be conducted to strengthen the field. Also the studies included in the review did not examine pricing mechanism used in telemedicine services even though it represents an important element of the financial component of a business model and therefore further research needs to be conducted in that area as well.

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References

AFUAH A and TUCCI C L (2001). *Internet business models and strategies: Text and cases*. New York: McGraw-Hill.

ANKER SD, KOEHLER F, and ABRAHAM WT (2011) Telemedicine and remote management of patients with heart failure. http://www.thelancet.com vol 378 accessed 22 October 2013

AMERICAN TELEMEDICINE ASSOCIATION (2013) What is telemedicine. Accessed on 15th May 2013 from http://www.americantelemed.org/learn/what-is-telemedicine

AMIT R and ZOTT C (2001) Value creation in e-business. *Strategic Management Journal*, 22: 493-520.

BAIDA Z, GORDIJN J, SÆLE H, AKKERMANS H and MORCH AZ (2005). An Ontological Approach for Eliciting and Understanding Needs in e-Services. *Proceedings of the 17th International Conference on Advanced Information Systems Engineering* (CAiSE), Porto, Portugal 2005.

BAIG MM, GHOLAMHOSSEINI H, CONNOLLY MJ (2013) A comprehensive survey of wearable and wireless ECG monitoring systems for older adults. *Med Biol Eng Comput* 51(5):485-95

BASHSHUR R, SHANNON G, KRUPINSKI E, and GRIGSBY J (2011). The Taxonomy of Telemedicine. *Telemedicine and e-Health* Vol. 17(6): 484-494

BERGRATH ET AL, (2012) Feasibility of prehospital teleconsultation in acute stroke--a pilot study in clinical routine *PLoS One.* 7(5):e36796

BOWLES, K.H., HOLLAND, D.E. and AND HOROWITZ, D.A. (2009). A comparison of in-person home care, home care with telephone contact and home care with telemonitoring for disease management. *Journal of Telemedicine and Telecare*. Vol. 15(7) pp: 344–350.

BRAGANCA E.O.V. et al. (2010) Validating a New Quality of Life Questionnaire for Atrial Fibrillation Patients. *International Journal of Cardiology*, Vol.143, No. 3, pp 391-398

BROENS T.F., HUIS IN 'T VELD M.H.A., VOLLENBROEK-HUTTEN M.M.R., HERMENS H.J., VAN HALTEREN A. and NIEUWENHUIS L.J.M. (2007) Determinants for succesful telemedicine implementation: a literature study. *Journal of Telemedicine and Telecare* 13, 303-309.

BROUSSEAU E and PENARD T (2006) The economics of digital business models: A framework for analyzing the economics of platforms. *Review of Network Economics*, 6(2): 81-110.

CHEN S, CHENG A AND MEHTA K (2013). A Review of Telemedicine Business Models *Telemedicine and e-Health*. April 2013, 19(4): 287-297.

CHESBROUGH H and ROSENBLOOM RS (2002) The Role of the Business Model in Capturing Value from Innovation: Evidence from XEROX Corporation's Technology Spinoff Companies http://www.hbs.edu/dor/papers2/0001/01-002.pdf Accessed 18 April 2013

CHIU KH and YANG YY (2010). Remote monitoring of health status of the elderly at home in Taiwan. *Telemedicine Journal and E-Health* 16(6):717-26

CHO S, MATHIASSEN L AND GALLIVAN M (2009). Crossing the diffusion chasm: from invention to penetration of a telehealth innovation. *Information Technology and People* Vol. 22 No. 4, pp. 351-366

CHRONAKI CE and VARDAS P (2013) Remote monitoring costs, benefits, and reimbursement: a European perspective *Europace.*15 Suppl 1:i59-i64.

COMMISSION OF THE EUROPEAN COMMUNITIES (2008) 'Telemedicine for the Benefit of Patients, Healthcare Systems and Society'. Brussels: COM 689. http://ec.europa.eu/ information_society/activities/health/ policy/telemedicine/index_en.htm. Accessed on 13th April 2013

COULBORN ET AL (2012) Feasibility of using teleradiology to improve tuberculosis screening and case management in a district hospital in Malawi. Bull World Health Organ 90: 705[711].

CUSHMAN R, FROOMKIN AM, CAVA A, ABRIL P and GOODMAN KW. (2010) Ethical, legal and social issues for personal health records and applications. Journal of Biomedical Informatics. 43(5 Suppl):S51-5. doi: 10.1016/j.jbi.2010.05.003.

DE REUVER M (2009). Governing mobile service innovation in co-evolving value networks. Accessed on 1st October 2013 from http://resolver.tudelft.nl/uuid:e9e31abe-440b-4440-a5bb-f6760251601f

DE REUVER M and HAAKER T (2008). Designing viable business models for context-aware mobile services. *Journal of Telematics and Informatics.* 26(3): 240-248

DUBOSSON-TORBAY M, OSTERWALDER A and PIGNEUR Y (2002) E-business model design, classification, and measurements. *Thunderbird International Business Review*, 44(1): 5-23.

EHEALTH INITIATIVE (2011) Report on Health Information Exchange Sustainability. http://www.cfrhio.org/images/2_2011_Report_on_Health_Information_Exchange_-_Sustainability_Report.pdf Accessed 25th May 2013

EKELAND AG, BOWES A, FLOTTORP S (2010) Effectiveness of telemedicine: a systematic review of reviews. *International Journal of Medical Informatics* 79(11):736-71.

ERNSTMANN N, OMMEN O, NEUMANN M, HAMMER A, VOLTZ R and PFAFF H. (2009). Primary care physician's attitude towards the German e-health card project--determinants and implications. *Journal of Medical Systems* Jun;33(3):181-8.

EUROPEAN COMMISSION (2009), Telemedicine for the benefit of patients, healthcare systems and society, Commission Staff Working Paper EC (2009)943 final, 2009.

FANALE CV and DEMAERSCHALK BM (2012) Telestroke network business model strategies. *Journal of Stroke and Cerebrovascular Diseases* 21:530–534

FIELT E, HUIS IN 'T VELD M.H.A. and VOLLENBROEK-HUTTEN M.M.R. (2008) From R&D prototype to market: mobile health services for chronic lower back pain patients. In BOUWMAN, DE VOS and HAAKER (Eds): *Mobile service innovation and business models*, Heidelberg , Germany: Springer-Verlag: 269-283.

GACKOWSKI ET AL (2011) Development, implementation, and multicenter clinical validation of the TeleDICOM--advanced, interactive teleconsultation system**.** *Journal of Digital Imaging.* 24(3):541-51.

GAMBLE KH (2009). Just a tweet away. *Healthcare Informatics*. 26(5):30, 32, 34

GANAPATHY K, RAVINDRA A.(2009) Telemedicine in India: The Apollo story. *Telemedince Journal and E- Health* ;15:576–585.

GEORGE G and BOCK A J (2009) The business model in practice and its implications for entrepreneurship research. Working paper, Imperial College, London. Accessed on 18th May 2013 from http://dx.doi.org/10.2139/ssrn.1490251

GEORGE S, HAMILTON A and BAKER SR (2012). How Do Low-Income Urban African Americans and Latinos Feel about Telemedicine? A Diffusion of Innovation Analysis. *International Journal of Telemedicine Application*. 2012: 715194

GHAZIANI A., and VENTRESCA, M. J. (2005). Keywords and cultural change: Frame analysis of business model public talk, 1975-2000. *Sociological Forum*, 20(4): 523-559.

GIORDANO A. ET AL (2009) Multicenter Randomised Trial on Home-based Telemanagement to Prevent Hospital Readmission of Patients with Chronic Heart Failure. *International Journal of Cardiology*, Vol.131, No. 2, pp 192-199

GUPTA M, CHOTARD L, INGÞÓRSSON O, BASTOS J, and BORGES I (2009). Health@Home – An e-Service Model for Disease Prevention and Healthcare in the Home. D. *Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering* Volume 0001, 2009, pp 17-24

HAMEL G (2000) *Leading the revolution*. Boston: Harvard Business School Press.

HEDMAN J and KALLING T (2003) The business model concept: Theoretical underpinnings and empirical illustrations. *European Journal of Information Systems*, 12: 49-59.

HANSEN D, GOLBECK AL, NOBLITT V, PINSONNEAULT J, CHRISTNER J (2011). Cost factors in implementing telemonitoring programs in rural home health agencies. *Home Healthcare Nurse*. 29(6):375-82.

HAWK P (2011). Teleradiology: Friend or Foe? What Imaging's Now Indispensable Partner Means for Radiology's Future and for the Quality of Care. *Journal of Health Care Finance* 37(4):71–92

HJELM N M (2005) Benefits and drawbacks of telemedicine. *Journal of Telemedicine and Telecare,* 11: 60–70

HUIS IN 'T VELD R, FIELT E and VOLLENBROEK-HUTTEN M (2011) Moving tele-monitoring and tele-treatment from promise to practice : a business model approach for a chronic lower back pain application. *International Journal of Healthcare Technology and Management,* 12(3/4), pp. 333-349.

KIJL B, NIEUWENHUIS LJ, HUIS IN 'T VELD RM, HERMENS HJ and VOLLENBROEK-HUTTEN MM (2010). Deployment of e-health services - a business model engineering strategy. *Journal of Telemedicine and Telecare* 16(6):344-53.

KOBB R, CHUMBLER NR, BRENNAN DM and RABINOWITZ T (2008). Home telehealth: mainstreaming what we do well. *Telemedicine Journal and E-Health* 14(9):977-81.

KINDSTRÖM D (2010). Towards a service-based business model—Key aspects for future competitive advantage. *European Management Journal* Vol. 28, No. 6, pp. 479–490

KRUPINSKI EA and WEINSTEIN RS (2013) Telemedicine in an academic center--the Arizona Telemedicine Program. *Telemedicine Journal and E -Health* ; 19(5):349-56.

LIN SH, LIU JH, WEI J, YIN WH, CHEN HH and CHIU WT (2010). A business model analysis of telecardiology service. *Telemedicine Journal and E-Health* 16(10):1067-73

LIN T, CHANG H AND HUANG C (2011) An Analysis of Telemedicine in Taiwan: A Business Model Perspective. *International Journal of Gerontology* 5 (2011) 189e192

LINDER J and CANTRELL S (2000) Changing business models: Surveying the landscape. Working paper, Accenture Institute for Strategic Change. Accessed on 18th May 2013 from http://course.shufe.edu.cn/jpkc/zhanlue/upfiles/edit/201002/20100224120954.pdf

MAFFEI R, BURCIAGO D AND DUNN K (2009) Determining Business Models for Financial Sustainability in Regional Health Information Organizations (RHIOs): Review *Population Health Management* Volume 12, Number 5,

MAGRETTA J (2002) Why business models matter. *Harvard Business Review*, 80(5): 86-92.
MALLIOPOULOS ET AL. (2008) Continuous Mobile Services for Healthcare: The HealthWear Project. *Journal on Information Technology in Healthcare* 6(5): 344–355

MARS M (2013) Telemedicine and advances in urban and rural healthcare delivery in Africa. *Progress in Cardiovascular Diseases* 56(3):326-35

MARTIN-LESENDE ET AL, (2011) Assessment of a primary care-based telemonitoring intervention for home care patients with heart failure and chronic lung disease. The TELBIL study. *BMC Health Service Research*. 8;11:56.

MAY CR, FINCH TL, CORNFORD J, EXLEY C, GATELY C, KIRK S, JENKINGS KN, OSBOURNE J, ROBINSON AL, ROGERS A, WILSON R and MAIR FS (2011). Integrating telecare for chronic disease management in the community: what needs to be done? *BMC Health Services Research*. 27;11:131. doi: 10.1186/1472-6963-11-131.

MILLS A, ATAGUBA JE, AKAZILI J, BORGHI J, GARSHONG B, MAKAWIA S, MTEI G, HARRIS B, MACHA J, MEHEUS F and MCINTYRE D (2012). Equity in fi nancing and use of health care in Ghana, South Africa, and Tanzania: implications for paths to universal coverage. *The Lancet* 14;380(9837):126-33

MORTARA ET AL (2009) Home telemonitoring in heart failure patients: the HHH study (Home or Hospital in Heart Failure) *European Journal of Heart Failure*. 11(3):312-8.

METTLER T and EURICH M (2012) What is the business model behind e-health? a pattern-based approach to sustainable profit . *ECIS 2012 Proceedings*. Paper 61. 10-13 June Barcelona, Spain

MOTAMARRI M, PRADEEP R and POULOS CJ "Cost Models for mHealth Intervention in Aged Care Diabetes Management" (2011). *ACIS 2011 Proceedings.* Paper 7. Accessed on 4th January 2013 from: http://aisel.aisnet.org/acis2011/7

NAYAK S NAYAK VC MENEZES R (2012) Telemedicine: The Future of Healthcare Delivery *International Journal of Computer Science and Management Research* Vol 1 Issue 1

NG M, NATHOO N, RUDNISKY CJ, TENNANT, MT. (2009). Improving access to eye care: teleophthalmology in Alberta, Canada. *J Diabetes Sci Technol*, 3(2) 289-96

NIKUS K. ET AL (2009) The Role of Continuous Monitoring in a 24/7 Telecardiology Consultation Service--a Feasibility Study. *Journal of Electrocardiology*, Vol. 42, No. 6, pp 473-80

NORDGREN L (2009). Value creation in health care services - developing service productivity: Experiences from Sweden. *International Journal of Public Sector Management*, 22, pp.114–127.

OSTERWALDER, A., PIGNEUR, Y. An e-business model ontology for modeling e-business. In: 15th Bled *Electronic Commerce Conference*, Bled, Slovenia, pp. 17–19 (2002)

POSTEL M, HAAN HD, and JONG CD.(2008) Evaluation of an e-therapy program for problem drinkers: A pilot study. Substance Use Misuse *Telemedicine Journal and E- Health* 45:2059–2075.

POULOUDI A, VASSILOPOULOU K and ZIOUVELOU X (2003) A societal perspective on E-Business adoption. *Journal of Information, Communication and Ethics in Society* 1(3), 149–165.

PRUTHI S, STANGE KJ, MALAGRINO GD JR, CHAWLA KS, LARUSSO NF, KAUR JS. (2013) Successful implementation of a telemedicine-based counseling program for high-risk patients with breast cancer. *Mayo Clinic Proceedings.* 88(1):68-73

RAMESH N, PANKAJ A, ARCHANA J S, KAILASH A, MRIDULA T, PIYUSH P, NIKHIL B (2013). Teledentistry: knowledge and attitudes among dentists in Udaipur, India. *Oral Health and Dental Management* 12(3):138-44.

ROBLIN W ET. AL (2009) Disparities in Use of a Personal Health Record in a Managed Care Organization, *Journal of American Medical Informatics Association* 16:683-689

SALIBA V, LEGIDO-QUIGLEY H, HALLIK R, AAVIKSOO A, CAR J, and MCKEE M (2012) Telemedicine across borders: a systematic review of factors that hinder or support implementation. *International Journal of Medical Informatics* 81(12):793-809.

SARELA A, WHITTAKER F, AND KORHONEN I (2009) Service and Business Model for Technology Enabled and Homebased Cardiac Rehabilitation Programs 31st *Annual*

International Conference of the IEEE EMBS Minneapolis, Minnesota, USA, 2009:303-7. doi: 10.1109/IEMBS.2009.5333595

SCHERR ET AL, (2009) Effect of home-based telemonitoring using mobile phone technology on the outcome of heart failure patients after an episode of acute decompensation: randomized controlled trial. *Journal of Medical Internet Research.* 17;11(3):e34.

SETO E, ET AL (2012) Developing healthcare rule-based expert systems: case study of a heart failure telemonitoring system. *International Journal of Medical Informatics* 81(8):556-65.

SHAFER S M, SMITH H J and LINDER J. (2005) The power of business models. *Business Horizons*, 48: 199-207.

SPIL T and KIJL B (2009) E-health business models: from pilot project to successful deployment *IBIMA Business Review*, Vol. 1, No. 5, pp.55–66.

SPIL, A.A.M. AND KIJL, B. (2012) Business modeling: The recipe for e-health success in Africa. In: *ICT4Africa* 2012, Kampala, Uganda.

STÄHLER P. (2002) Business Models as a unit of analysis for strategizing, *Proceedings of 1st International Workshop on Business Models*, Lausanne, Switzerland. Accessed on 6th October 2013 from http://www.business-model-innovation.com/english/definitions.html

STERNBERG D. (2004) The new e-health. as technology matures, more sensible approaches to online healthcare are emerging. *Marketing Health Services*, Vol. 24, No. 1, p.46.

STEWART, D. W. and ZHAO, Q. (2000) Internet marketing, business models and public policy. *Journal of Public Policy and Marketing*, 19: 287-296.

SUBEDI ET AL (2011) K. Dremstrup, S. Rees, M.Ø. Jensen (Eds.): 15th NBC on Biomedical Engineering & Medical Physics, *IFMBE Proceedings* 34, pp. 117–120, 2011

TAKAHASHI PY, ET AL (2010) A randomized controlled trial of telemonitoring in older adults with multiple chronic conditions: the Tele-ERA study. *BMC Health Service Research* 1;10:255.

TAMOŠIŪNIENĖ R AND, NAUMČIK S (2008) Potential of remote patient monitoring in Lithuania. *Proceedings 5th International Scientific Conference Business and Management. 16-17May 2008, Vilnius, Lithuania.*

TIMMERS P (1998) Business models for electronic markets. *Electronic Markets,* 8(2): 3-8.

TSENG PTY AND CHENG HH (2007) Reinventing Healthcare Service through M-care Business Model: The Strategy Analysis of WiMAX Adoption. *Journal of Communications*, vol. 2, no. 5

VAN DE VEN WP, BECK K, BUCHNER F, SCHOKKAERT E, SCHUT FT, SHMUELI A and WASEM J (2013). Preconditions for efficiency and affordability in competitive healthcare markets: are they fulfilled in Belgium, Germany, Israel, the Netherlands and Switzerland? *Health Policy*. 109(3):226-45.

VAN LIMBURG A and VAN GEMERT-PIJNEN J (2010) Towards innovative business modelling for sustainable eHealth applications. *eTELEMED*. 2010, 10-16 February 2010, St. Maarten, Netherlands Antilles

VAN LIMBURG M., VAN GEMERT-PIJNEN J.E., NIJLAND N., OSSEBAARD H.C., HENDRIX R.M. and SEYDEL E.R (2011). Why business modeling is crucial in the development of eHealth technologies. *Journal of Medical Internet Research*, Dec 28;13(4):e124

VAN OOTEGHEM J, DE MAESSCHALCK S, BAMELIS K, DEVOS J, VERHOEVE P, COLLE D, ACKAERT, A., PICKAVET, M., DEMEESTER, P (2007) An eHealth business model for independent living systems. In: Proceedings (on CD-ROM) of e-Challenges 2007, The Hague, October 24-26 ISBN 978-1-58603-801-4

VAN OOTEGHEM J, ACKAERT A, VERBRUGGE S, COLLE D, PICKAVET M AND DEMEESTER, P (2011) Economic Viability of eCare Solutions. E-Health 2010, LNICST 69, pp. 159–166

VERHOEVEN F, TANJA-DIJKSTRA K, NIJLAND N, EYSENBACH G, VAN GEMERT-PIJNEN L (2010) Asynchronous and synchronous teleconsultation for diabetes care: a systematic literature review. *Journal of Diabetes Science Technology* 4(3):666-84.

VISHWANATH A and SCAMURRA S D (2007). Barriers to the adoption of electronic health records: using concept mapping to develop a comprehensive empirical model. *Health Informatics Journal,* 2007 Jun;13(2):119-34.

VISSER JJ, BLOO JK, GROBBE FA and VOLLENBROEK-HUTTEN MM (2010). Video teleconsultation service: who is needed to do what, to get it implemented in daily care? *Telemedicine Journal and E-Health.* 16(4):439-45.

WALKER J, PAN E., JOHNSTON D., ADLER-MILSTEIN J., BATES D. and MIDDLETON B. (2005). The Value of Health Care Information Exchange and Interoperability. *Health Affairs*, 24, 10-18.

WEILL P and VITALE, M R (2001). *Place to space: Migrating to e-business models*. Harvard Business School Press. Boston

WEITZMAN ER, KACI L, QUINN M AND MANDL KD (2011). Helping high-risk youth move through high-risk periods: personally controlled health records for improving social and health care transitions. *Journal of Diabetes Science and Technology*. 1;5(1):47-54.

WELLINGTON, J., BATHMAKER, A., HUNT, C., MCCULLOCH, G. & SIKES, P. 2005: *Succeeding with your doctorate*. Sage Publications. London

WICKRAMASINGHE ET AL (2010) BudhuDas: An eHealth Business Model for Emerging Countries. *IST-Africa 2010 Conference Proceedings. 19-21 May 2010. Durban, South Africa.*

WINKLER S ET AL. (2011) A New Telemonitoring System Intended for Chronic Heart Failure Patients Using Mobile Telephone Technology – Feasibility Study. *International Journal of Cardiology*, Vol. 153, No. 1, pp 55–58

WOOLHANDLER S and HIMMELSTEIN DU (2007). Competition in publicly funded healthcare system. *British Medical Journal.* 1;335(7630):1126-9.

WYNIA M and DUNN K (2010). Dreams and nightmares: practical and ethical issues for patients and physicians using personal health records. *Journal of Law, Medicine and Ethics.* 38(1):64-73. doi: 10.1111/j.1748-720X.2010.00467.

WYSOCKI A, BUTLER M, KANE RL, KANE RA, SHIPPEE T and SAINFORT F (2012). Long-Term Care for Older Adults: A Review of Home and Community-Based Services Versus Institutional Care. *Comparative Effectiveness Reviews, No. 81*

ZANABONI, P and WOOTTON, R (2012). Adoption of telemedicine: from pilot stage to routine delivery. *BMC Medical Informatics and Decision Making* 2012, 12:1

ZOLNOWSKI, A., SEMMAN, M., BÖHMANN, T. (2011). Metamodels for Representing Service Business Models. Proceedings of SIGSVC Workshop Sprouts: Working Papers on Information Systems, 11(163). Accessed on 1st October 2013 from http://sprouts.aisnet.org/11-163

ZOTT, C., and AMIT, R. (2010) Designing your future business model: An activity system perspective. *Long Range Planning,* 43: 216-226.

ZOTT, C., AMIT, R., and MASSA, L. (2011). The business model: Recent developments and future research. *Journal of Management, 37 (4), 1019–1042.*