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Engineering innovative mobile data services: Developing a model for value network analysis and design

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Abstract

Purpose – The aim of this study is to analytically develop a reference model for engineering (i.e. analysis, design, development, evaluation, delivery, maintenance, modification, and management) powerful value networks capable of creating innovative mobile data services.

Design/methodology/approach – The paradigm followed is that of design-science research (DSR) which incorporates two main iterative processes: build and evaluate. For building the model (i.e. the design science artifact in this research), the authors followed three iterations: literature review analysis; semi-structured interviews analyzed through content analysis; and examination of real-life case studies. But for evaluating the model, the authors utilized the NTT DoCoMo's i-mode case.

Findings – This paper puts forward a novel model for engineering value networks of mobile innovations. This model is composed of seven design constructs and their relationships. The developed model is argued to provide significant utility for telecoms in helping them to identify and design powerful value networks following a systematic and practical approach.

Research limitations/implications – The data sources is somewhat limited and the sample is somewhat small which may result in lack of sufficient statistical power. Moreover, the analysis may have overlooked some important concepts and theories related to innovations and value networks.

Originality/value – This study contributes to the current body of knowledge about how telecoms can best analyze and design their value networks in an approach that maximizes the potential of developing innovative mobile data services.

Keywords Value network, Innovation, Mobile data service, Mobile communication, Telecommunication, Business model, I-mode, Mobile communication systems

Paper type Research paper

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1. Introduction

The emergence of 3G and beyond mobile (cellular) systems has facilitated the development of innovative mobile data services (MDS). With the saturation of the voice market and the recent recession mobile telecommunication providers (from now on shortened to telecoms) are increasingly placing their emphasis on providing MDS rather than voice services, as they seek new sources of revenue to improve their profitability (ITU, 2009). Flexibility of data is another reason for this emphasis as telecoms consider that the number and types of services that can be developed on the basis of data is significantly greater than those that can be created on the basis of voice. Consequently, such services are expected to generate more revenues than voice services in the near future (Funk, 2007).

There is no agreed definition of MDS in the literature. Olla and Atkinson (2004) classify such services as mobile entertainment systems, mobile messaging systems, location-based information systems, mobile commerce systems, and any other mobile data systems. Hong *et al.* (2006) provide a simpler classification categorizing MDS as communication, information content, entertainment, and transaction services. This paper adopts an even simpler definition of MDS as any service that includes the communication of data and information, in various formats, excluding sole voice services, over mobile networks and telecommunications channels (e.g. text, audio, video, etc.).

The term "engineering" is used in this paper to refer to a broad range of activities associated with MDS. These activities are analysis, design, development, evaluation, delivery, maintenance, modification, and management. Engineering MDS is a complex undertaking (Lyytinen and Yoo, 2002; Bouwman *et al.*, 2008; Al-Debei and Fitzgerald, 2010a), and usually requires the involvement of multiple parties with different strategic agendas, rather than a single telecom. These parties form the so-called value network for innovation (Funk, 2009). The main aim of the value network actors is to collectively create enhanced utilitarian, hedonic, and/or social value (Kim and Han, 2009) to customers to maximise the captured value for each party involved. Developing successful value networks in the mobile telecommunications industry is not easy as it requires coordination and collaboration mechanisms between heterogeneous actors whose strategic goals and objectives are not necessarily aligned (Yoo *et al.*, 2005; Al-Debei and Fitzgerald, 2010b). This lack of alignment is one of the major issues facing telecoms and often prevents them from achieving effective MDS (Tee and Gawer, 2009). The current low level of MDS revenues being generated is an important indication of the difficulties (Tilson and Lyytinen, 2006; ITU, 2009). To help overcome and address these difficulties this paper describes a novel model and a methodical approach to help telecoms develop powerful value networks to maximise the development and engineering of their MDS. Developing a powerful value network in the mobile telecommunications industry is a multifaceted process that requires an understanding and alignment of a number of critical concepts, along with their interrelationships.

The paper is structured as follows. First, a background of the telecom industry and value networks is provided. Then the innovation concept is discussed showing its relevance and significance in the mobile telecommunications industry. Next, the research design is described demonstrating the research approach as well as showing the data collection and analysis methods. Thereafter, the proposed model for value network design is presented together with its design constructs. This is followed by an illustrative case concerning Nippon Telephone and Telecommunications (NTT)

DoCoMO's i-mode service, providing a real-life explanation and evaluation of the model. Finally, a summary and outline of the paper's contributions is provided.

2. Background

2.1 Industry shifts and the emergence of value networks

The mobile telecommunication business is undergoing a major revolution, driven by innovative technologies and other issues related to globalization. Recent technological advances in wireless and mobile telecommunications are changing people's personal life styles as well as business functions and practices. At the same time, globalization is radically reducing legacy telecommunications barriers, with new entrants forcing national carriers to compete globally. This provides an increasingly competitive environment for the telecoms.

These changes in the operating environment have led to a shift from focusing on technology to emphasizing content and services. Telecoms are moving from offering just one simple voice service to providing portfolios of convergent services that integrate voice, data, and internet technologies. This shift towards mobile data communication services, such as location-based services and mCommerce, is closely linked with the shift from individually developed telecom services to multiple partnerships, and from simple and linear links to complex relationships between the parties (Peppard and Rylander, 2006; Basole, 2009). In addition changes related to the market and customers (i.e. users) of such services are occurring. These changes are shown in Figure 1 and they are affecting the business rules of the telecommunications industry. For instance, cellular infrastructure deployment is no longer a major problem, but how to cooperate to launch services efficiently and effectively is much more of a concern (Olla and Patel, 2002; Al-Debei and Avison, 2011).

Traditionally, the value chain (Porter, 1985) is used as a strategic tool to analyse different industries and understand how enterprises create value and competitive advantage in their markets. The widespread use of the value chain concept has proven its effectiveness. But recently it has been argued that analyzing many modern industries (e.g. telecommunications, banking, news, entertainment) in terms of a value chain is no longer an appropriate or suitable mechanism (Peppard and Rylander, 2006;

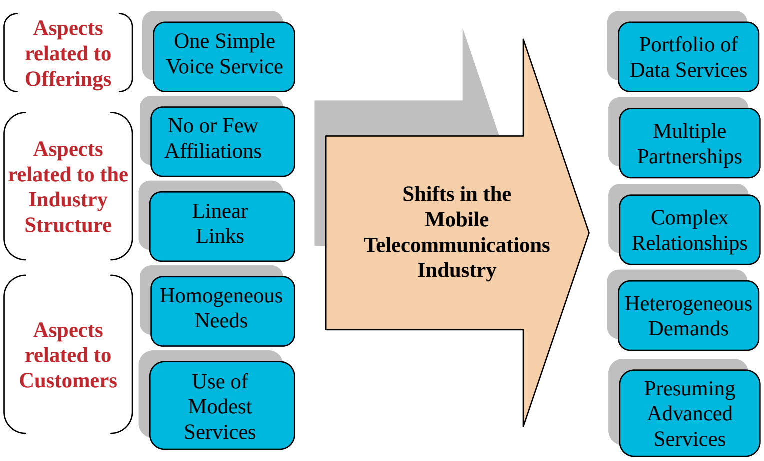

Figure 1.
Shifts in the mobile telecommunications industry

Ballon, 2007; Funk, 2009). These arguments are relevant to the mobile telecommunications industry due to the changes taking place, as outlined above, and as its structure is shifting from an "autocratic" to a more "democratic" state, i.e. one where a more complex and open system, including extensive collaboration, communication, and co-ordination, is prevalent. In this new environment, developing an effective value system has become more challenging as it includes actors and issues not necessarily under the control of the telecom.

To address these challenges and changes in many industries, the value network concept has been developed, based on the foundations of the value chain concept. It is argued to be a more appropriate analytical lens to cope with this more complex, open, and collaborative environment (Normann and Ramirez, 1993; Allee, 2008) and is a more appropriate strategic tool for analyzing and understanding industries that are composed of constellations in continuous flux, rather than in static linear chains (Vesa, 2005; Peppard and Rylander, 2006; Funk, 2009; Al-Debei and Avison, 2011; Eaton *et al.*, 2010). Designing powerful value networks is critical to the success of MDS and innovations (Campanovo and Pigneur, 2003; Bouwman *et al.*, 2008; Tee and Gawer, 2009; Al-Debei and Fitzgerald, 2010b). Indeed, Takeshi Natsuno, NTT DoCoMo's Managing Director for i-mode services, argues that the reason why the i-mode service is generating high revenues in Japan, while MDS in Europe and the USA are struggling, is related to market arrangements and structure (Natsuno, 2003; NTT DoCoMo, 2010). Thus, effective and powerful value networks are one of the key enablers of innovation in the mobile telecommunications industry. However, a comprehensive and effective model for helping telecoms and others to analyse and develop their value networks to create innovative services is lacking. This paper proposes and evaluates such a model.

2.2 The innovation concept and its role in MDS

Innovation can be defined as the implementation of a new or significantly improved product (i.e. good or service), process, marketing method, or organizational method in business practices, workplace organization or external relations (OECD-Eurostat, 2005). Innovations usually lead to significant value creation at the level of an enterprise, network of enterprises, society, or globally (Urabe, 1988). Innovation implies bringing something new or significantly improved into use (Badawy, 1988) by fulfilling a particular need better, faster, and/or cheaper (Yovanof and Hazapis, 2008). Interestingly, Van De Ven (2005) argues that in complex technology systems such as MDS, innovations are collective achievements generated by multiple rather than individual enterprises. He also proposes that enterprises should follow a "running in packs" innovation strategy where each enterprise within the network contributes and adds to the network based on its knowledge domains and expertise.

The terms invention and innovation although closely related, as the former may lead to the latter, are different. Whilst invention is a new idea for improving something, innovation only occurs after the successful implementation and introduction of this new or significantly improved service, process, product, or method in the marketplace (Freeman, 1982; Twiss, 1992). The process of invention requires creativity and open minds. In the context of MDS, creativity and intelligence are normally generated through joint research and development (R&D) amongst harmonized players in the value network. This discussion indicates that the innovation process encompasses all of these three related concepts, as shown in Figure 2.

Innovation in terms of its impact can be categorized as sustaining or disruptive. Sustaining innovations seek to maintain or strengthen the current core competencies of a particular enterprise in its current market. This kind of innovation usually creates value by accumulative or incremental effect (Abernathy and Clark, 1985) and is normally developed by enterprises holding a leadership or strong position in their industries (Yovanof and Hazapis, 2008). Disruptive innovations on the other hand change the rules and bases of competition of an existing business market and redefine the marketplace. Frequently, such innovations are developed by mature enterprises bringing their own knowledge and entering new markets due to market expansion strategies. Hence, such organizations along with their innovations tend to be disruptive to incumbents. Examples from the mobile telecommunications industry include Apple with its iPhone and Google with its Nexus one. Disruptive innovations normally begin in a niche market and eventually grow to dominate the business market (Christensen, 1997). Disruption is a process (i.e. not an event) that may take some time, even decades, to find their way through an industry (Christensen and Raynor, 2003). The failure to recognise the differences between sustaining and disruptive innovations can lead successful well-established enterprises to lose their markets (Christensen, 1997).

In the context of MDS, types of innovation can also be classified based on the strategic advantage(s) a particular type of innovation delivers to the enterprise or group of enterprises possessing them. In this sense, five types, which are normally distributed amongst value network actors, can be distinguished: novelty, competence-shifting, complexity, robust design, and continuous incremental innovation (Karrberg and Liebenau, 2007) as shown Table I. In the next section, the design-science research (DSR) approach, which followed in this research, along with the carried out design iterations are explored.

3. Research design

3.1 Research paradigm: DSR

The paradigm followed, to analytically develop a model for creating powerful value networks relevant to the design and engineering of MDS, is that of DSR. DSR is primarily

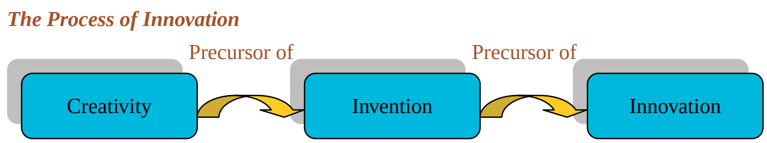

Figure 2.
The innovation process

Innovation types	Strategic advantages
Novelty	Offering something which no one else can offer
Competence-shifting	Redefining the rules of the competitive game in the marketplace
Complexity	Difficulty of learning about the used technology or business model keeps entry barriers high
Robust design	The service/product/process models can be stretched over an extended life; reducing overall cost
Continuous incremental innovation	Continuous movement of the cost/performance frontier

Source: Karrberg and Liebenau (2007)

Table I.
Innovation types

a problem solving paradigm (Hevner *et al.*, 2004) that seeks to create artifacts addressing so-called wicked problems (Pries-Heje and Baskerville, 2008). In principle, DSR attempts to design, develop, and evaluate design artifacts characterised as novel, innovative, and purposeful. Purposeful implies that these artifacts would potentially provide organizations and humans with recognizable utility since they should address unsolved problems (Hevner *et al.*, 2004), or provide better solutions and enhance existing practices (Kuechler and Vaishnavi, 2008). Hence, these artifacts aim to provide additional improvements to real-world phenomena (Iivari, 2007; March and Storey, 2008). In the context of this design research, the tackled wicked problem (i.e. the problem space) is formulated as follows:

> How telecoms can best analyse and design their value networks in an approach that maximises the potential of developing innovative mobile data services?

This problem is highly relevant and significant in the mobile telecommunications industry. The telecommunications industry is rapidly shifting and changing, and this change has substantially reduced the effectiveness of the traditional strategic tool (i.e. Porter's value chain) in analyzing and understanding the industry. This has led to major adverse effects on telecoms' performance and ability to develop innovative MDS. Addressing this problem, this research aims, by utilizing DSR, to produce an artifact in the form of a model (i.e. the solution space) to help telecoms develop effective and powerful value networks. This aim is consistent with the general aim of DSR because research in information systems and computing is considered to be DSR research, if the main aim is to change a current situation related to organizational or social systems into a more desirable one, through the development of novel artifacts (Hevner *et al.*, 2004).

Not only the aim, but also the type of artifact developed in this research is consistent with DSR artifacts. This is because design artifacts are classified by March and Smith (1995), and anchored by Hevner *et al.* (2004), into constructs of vocabulary and symbols, models representing reality, methods in the form of algorithms and practices, and instantiations which are implemented systems and/or their prototypes developed as proof-of-concepts. The model developed in this paper represents a model artifact which includes seven design constructs.

3.2 Design iterations: data collection and analysis

Developing artifacts in DSR requires the utilization of two main iterative processes: build and evaluate. Building design artifacts demonstrates feasibility and then they need to be evaluated to ensure utility, quality, and efficacy (Hevner *et al.*, 2004). The value network model, as discussed in this paper, has been developed within a research program that started in, 2007. This research program has developed a business model ontology which covers various facets related to the design and engineering of MDS (Al-Debei and Fitzgerald, 2010a, Al-Debei and Avison, 2010), including value network models as one of its major facets. Within this research program, the model for value network analysis and design has been developed following three iterations, each one utilizing different sources of data.

The first iteration was a literature review/analysis where data were collected from relevant literature and analysed using a content analysis method and a deductive reasoning approach (Al-Debei and Avison, 2010). This first iteration defined the business model ontological structure of which the value network is one of its key dimensions.

Based on this iteration, four design constructs within the value network dimension have been established: ACTOR, FLOW-COMMUNICATION, CHANNEL, and GOVERNANCE. Nevertheless, the literature review adds very little to the theoretical content of the model given the paucity of research tackling value networks within the context of innovative MDS. It was therefore important and desirable o carry out an empirical research throughout the next iterations whilst utilizing and building on the model foundation that has been established at this stage.

In the second iteration, a qualitative approach was employed in which semi-structured interviews were used as the principal data collection method. The use of semi-structured interviews is preferred to fully structured or un-structured interview techniques because they allow the researcher to focus on the main aspects related to the phenomenon under consideration while at the same time enabling the researcher to open up and respond to any new idea that may emerge during the interview process. The empirical data was collected through 21 semi-structured interviews with key practitioners and managers in the mobile telecommunications industry and other related stakeholders (Table II).

The primary themes discussed with the participants were communication and collaboration with value network actors including benefits and challenges as well as the design, analysis, and evaluation of value networks along with their sustainability in the context of MDS. Interviews were recorded and on average lasted about 90 min. The interviews were transcribed, verified, and then analysed. After transcribing the interviews, the data were analysed thematically by utilizing ethnographic content analysis (Agar, 1980). The ethnographic content analysis was employed in this iteration to classify and code textual material (i.e. transcribed interviews) semantically and provide more relevant and manageable data (Weber, 1990). Strauss and Corbin (1998) suggest that such a coding process assists in building conceptualization and that the comparison between elements ensuing from the coding helps in identifying patterns and relationships between the constructs as well as strengthening the final model.

In this second iteration, documentation analysis and observation was also used as further sources. In line with Orlikowski (1993) this "triangulation" is argued to be useful as it allows "cross-checking" which strengthens data validity. Analysed documents included annual and internal reports, market research, internal presentation material, companies' web sites, and other documents related to the design of MDS and value networks.

The findings of this iteration not only support the prior results, but also enhance the value network model. The analysis conducted within this iteration adds RELATIONSHIP and ROLE design constructs to the value network model. Moreover, this iteration primarily provides detailed semantics and fruitful theoretical content about the model including its design constructs and relationships.

Table II.
Semi-structured interviews

Involved actors from the mobile telecommunications industry	Number of interviewee
Mobile telecommunication providers	14
Content providers and aggregators	5
Telecommunication regulatory commission	2
Total	21

In this DSR research, real-life case studies constitute the third iteration. This iteration is primarily used for evaluating and practically validating the constructed model. In this paper the case of NTT DoCoMo's i-mode service is used to illustrate the developed model, although some of the data collected and analysed relate to other case studies conducted as a part of the broader research program. Hence, a real-life illustration of the developed model is provided by mapping its design constructs and relationships to their counterparts in the NTT DoCoMo's i-mode case to show its practical utility and significance. This iteration not only evaluated and empirically validated the constructed model, but also it improved it. It added NETWORK-MODE as a new important design construct to the value network model and further enhanced its theoretical content.

The data collected and analysed through the three design iterations is then combined and integrated into one unified knowledge base. In this research the knowledge base contained seven mutually exclusive design constructs including their sub-classes and relationships. The knowledge base is represented using the Unified Modelling Language (UML) as a notation to provide a comprehensive view and logical representation of the conceptual model. The UML notation has been chosen as it facilitates the production of visually rich and easy to use models. Indeed, UML has been described as almost a *de facto* standard for modelling businesses and their computational support systems (Burton-Jones and Meso, 2002). Eriksson and Penker (2000) have also demonstrated how the UML modelling language is very useful in representing business models in the same way as their software models.

4. Results: a model for value network analysis and design

According to Gordijn and Akkermans (2001) the value network concept is best perceived and presented as a "multi-party stakeholder network" because of the importance of the cross-company and inter-organization perspective required for creating, delivering, and capturing value. The value network highlights the way in which transactions are enabled through the coordination and collaboration amongst parties, multiple companies and stakeholders, within and outside the mobile telecommunications industry (Campanovo and Pigneur, 2003; Al-Debei and Avison, 2008).

This research argues that if telecoms are to effectively design powerful value networks capable of developing and engineering MDS they need to methodically examine seven design constructs and their interrelationships. The identified design constructs are as follows:

1. NETWORK-MODE;
2. ACTOR;
3. ROLE;
4. RELATIONSHIP;
5. FLOW-COMMUNICATION;
6. CHANNEL; and
7. GOVERNANCE.

These constructs and their interrelationships are shown in Figure 3.

The construct of NETWORK-MODE examines whether the telecom needs to follow an open or closed business model for developing mobile innovations, whilst the

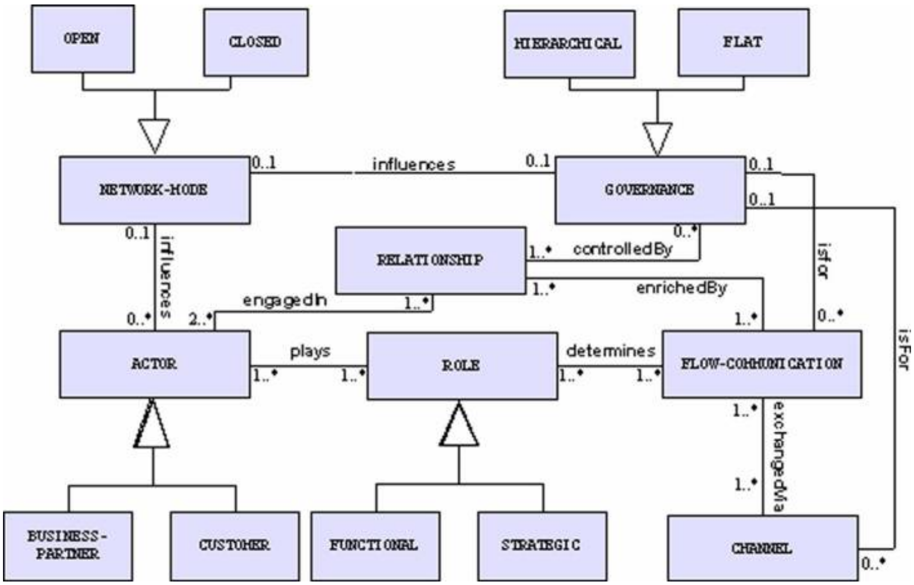

Figure 3.
A UML representation of the developed value network model

ACTOR construct is about identifying possible actors to participate in the value network. Also the telecom needs to identify the functional and strategic ROLE(s) of actors and determine their contribution and eligibility to participate. Further, appropriate RELATIONSHIP(s) need to be established with the selected actors in accordance with their roles, and suitable CHANNEL(s) are required for material flows amongst actors, including customers. It is also important to look at and analyse the GOVERNANCE of the network as it reveals important information related to power and control aspects.

This model proposes a set of constructs along with their relationships (including aspects, tasks, and their options) that are needed to be understood and analysed so as to generate information useful for designing powerful value networks capable of producing MDS. The defined constructs and tasks within the model do not necessarily follow a linear sequence; rather a set of tasks for collecting, processing, and analyzing relevant data and information are identified that can fruitfully guide processes and decisions related to mobile value network creation. The model is argued to be useful in a number of ways:

(1) in guiding telecoms on how to design and develop value network for new MDS;
(2) analyzing, understanding, and then modifying existing value networks so as to match the requirements of new MDS;
(3) evaluating existing value networks of existing MDS for identifying and exploring new opportunities and threats; and
(4) managing existing value networks of MDS in a systematic and disciplined approach.

A detailed description of the model and its functions are now described.

(1) NETWORK-MODE

The construct of NETWORK-MODE explains the way in which the value network for innovation is created and expanded. Understanding which formation mechanism of the value network is appropriate in the mobile telecommunications industry is very important. This is because network modes differ in terms of requirements, functions, and methods. Additionally, their level of appropriateness differs across telecoms' cultures and settings as well as the context in which the telecoms are operating.

In this context telecoms can create either open or closed value networks. Open networks mean that any actor can participate through offering ideas, whereas closed networks mean that ideas and contributions can only come from a selected number of actors who are considered eligible to participate. In special circumstances the mode of the value network is neither totally open nor fully closed. This is normally the case when the initial value network establishes certain criteria and rules for participation and if actors meet these criteria then their participation in the network becomes possible. Such value networks are normally called walled-garden. In this research, the walled-garden mode is considered as one type of closed network given that the rationale behind this model is consistent with closed networks.

Choosing the best mode for a network is challenging as different settings and requirements call for different configurations. Some argue that open networks (Chesbrough, 2006) is the only way to thrive in the new innovation landscape because open networks allow enterprises to harness external ideas, whilst at the same time leveraging their in-house R&D. On the other hand, others such as Pisano and Verganti (2008) argue that there is no one single approach that is successful at all times and in all situations. The analysis in this research indicates support for the latter view. For example, SMS and WAP have both been developed following an open mode. Whilst SMS is recognised as being a great success WAP is largely considered a failure (Kivimaki and Fomin, 2001). On the other hand, i-mode services and the iPhone have been developed following a closed mode and are both considered successful, although the i-mode service is not successful outside Japan (Hung and Yeh, 2006). Thus, it seems that each network mode has its own trade-offs and so each telecoms must choose what best suits their settings.

Open networks do attract a wide range of ideas from varied domains and perspectives, but screening them is time-consuming and expensive (Pisano and Verganti, 2008). Moreover, aligning interests and goals of participant actors is challenging when an open network mode is followed. It is also harder to manage and coordinate with open networks. On the other hand, when a telecom understands the required knowledge domains; users and market requirements; and which parties and actors to draw on, then a closed network model is considered to be effective as it would facilitate the development of the best possible solution or innovation. However, it is more difficult for a telecom to form a closed network when the number of needed actors is large and when these actors are coming from different knowledge domains. Moreover, a closed network model may lead telecoms to lose valuable opportunities and ideas available outside the scope of the selected actors.

The decision whether to follow an open or a closed network mode is clearly important and is likely to have a significant impact on the revenue of a telecom, but neither a closed nor an open mode guarantees success. It is the best match between the telecom's attributes and the features of one of the two network modes that allows telecoms to engineer more innovative MDS. Some of the issues for consideration are illustrated in Table III.

Mode	Advantages	Challenges	When to use
Open	Attract a wide range of knowledge domains	Screening ideas is time-consuming and expensive Aligning different objectives of participants is more challenging Harder to manage and coordinate	You can evaluate the proposed solutions cheaply The requirements are not well-defined
Closed	You receive the best solution easier and quicker as contributions are most likely to be more qualified and trusted	You have to know how to identify the right knowledge domains and pick the right actors You have to fully identify user and market requirements	You need a small number of problem solvers You know the needed knowledge domain You have the requirements well-defined You know which actors to draw on You can afford the possibility of losing valuable opportunities

Source: Compiled after Pisano and Verganti (2008)

Table III.
Network modes

(2) ACTOR
This design construct is concerned with identifying the core actors the telecom needs to collaborate and cooperate with in order to engineer, launch, and deliver a particular MDS effectively. This construct is important as it makes clear who is participating for the creation of the required innovation as well as their positions within the value network. Dealing with the ACTOR construct normally follows the analysis of the NETWORK-MODE construct as the procedure to follow is quite different across the two network modes defined in the previous section (Table III).

In the case of an open network, the telecom is first required to screen all received ideas and decide which ones to implement. The parties providing the ideas that are to be implemented are regarded as the network actors. If the telecom is pursuing a closed network mode then the telecom would be able to immediately identify the actors to be involved based on the defined requirements for the required innovation. In both cases, the next step is to explicitly define the knowledge domain(s) of each actor and link the actor with the requirement(s) it would contribute to. This would eventually identify the positions of actors in the entire value system and their possible contributions. Examples of business actors include engineering equipment and cellular infrastructure vendors, IS-IT application vendors, manufacturers of cellular devices, content providers and aggregators, telecoms retailers, intermediaries, distributors, and ISPs.

The "ACTOR" construct does not only include immediate business partners, but extends to customers, institutions, government bodies, and even competitors. These other actors which might provide complementary services also need to be identified. For example, in the case of provisioning mCommerce services, telecoms establish relationships with actors from the financial sector (e.g. banks) to handle and manage payments and billing issues. Telecommunication regulatory commissions are playing key roles in deriving and shaping the telecom sector and thus these legal bodies are also considered key actors with which telecoms need to interact (Campanovo and Pigneur, 2003). Regulatory bodies are particularly relevant actors as they manage issues related to privacy, security, radio spectrum availability, licenses, patents, and intellectual property (IP).

The benefits arising from participating in such value networks are not achieved easily; as actors might pursue different business logics and different strategic goals and objectives within the collaborations (Yoo *et al.*, 2005; Bouwman *et al.*, 2008; Al-Debei and Fitzgerald, 2010b). For example, misalignment of strategic interests is likely to occur between telecoms (who prefer to provide their customers with exclusive and unique content, data, handsets, and services), and content providers, content aggregators, and mobile handset manufacturer (those prefer mass production of data, content, services, and handsets that can be used by multiple telecoms and reach more customers). Indeed, the latter actors prefer mass production to reduce their operational costs and maximise the reach of their services-products, whilst telecoms prefer customised and exclusive services and handsets so as to differentiate their offerings in their markets. Hence, if the network is going to successfully capture value from the collaboration, actors need to align their strategic outcomes and ensure consistency.

(3) ROLE

Identifying the main role(s) of each actor is the theme of this design construct. Analyzing this construct is significant in assuring that the telecom is meeting all the defined requirements for the required innovation by matching them with the roles and contributions of actors. The analysis of this construct also gives a clearer picture about positions and importance of actors within the value network.

The role of customers as an actor within the value network could be simply described as service supplicants, but they could also play different roles in service development (Lacucci *et al.*, 2000) such as requirements engineering. The roles played by other enterprise actors (e.g. business partners and other organizational stakeholders) are much more varied; thus the current research places more emphasis on this issue to enhance the understanding in this context and help telecoms develop more powerful value networks.

Within this construct a distinction is made between functional and strategic roles played by enterprise actors in telecoms value networks. The functional roles of actors are diverse based on their knowledge domain, experience, and specialty, as illustrated in Table IV. For example, the functional role of content providers may be defined as creating and supplying original content in the form of text, audio, graphics, and/or video, whereas the functional role of equipment vendors could be defined as, for example, providing cellular radio infrastructure, devices, network applications, and/or handsets. Furthermore, actors in the value network might also play contributing functional roles in service-product provisioning, and mediating roles between the telecom and its target segment in which they provide channels and conduct functions such as distribution, delivery, sales, and marketing. They might also perform after-sale functions. Banks may provide a source of finance in terms of loans and credits to establish, run and expand the telecom business. They can also have a role as payment gateways in which they manage issues related to payments and reconciliations. Regulatory bodies could play major roles concerning pricing, entry to market, competition regulations, patents, and intellectual properties.

Category	Actor	Functional role
Hardware vendors	Access device manufacturer	To provide the physical cellular devices, such as cellular phones, personal digital assistants (PDAs), and smartphones
	Network engineering equipments vendors	To provide the physical cellular network and telecommunication infrastructure and access equipment, such as transceivers, backbone switches and routers
	Computing equipment vendors	To provide computing equipment along with their network-oriented and security hardware, such as servers, workstation, computers, switches, firewalls, and routers
Content and technology application providers	Network engineering application vendors	To provide the soft infrastructure, such as network and telecommunication management and control, network diagnostic, and optimization systems
	Middleware and integrators (software interfaces)	To provide software for telecom's hardware, such as software interfaces for different switches and routers, remote access applications to maintain distant infrastructure, and operating systems to be installed on handsets for content management
	Software and application providers	To provide software such as operating systems, development platforms, and simulation software
	Portals	To enable telecoms customers to access different services through multiple virtual communication channels
	Content providers	To provide data, information, graphics, and applications to be communicated to cellular customers
	Content aggregator	To syndicate and fuse the provided content information which includes "customization-to-fit" process
Third parties and payment gateways	Payment gateways	When mobile commerce is offered, payment gateways represent an intermediary (third party) which provides different methods of payments for cellular users
	(Wireless) application service providers	To remotely host and manage applications and services for telecoms
	Finance and billing services	Mobile networks and telecom operators frequently rely on a third party to manage the billing services
	Retailers and distributors	To perform distribution, marketing, and sales operation for telecom services
Network and service providers	(Wireless) internet service providers (ISPs)	To provide internet accessibility to cellular customers using mobile internet services
	Other mobile telecommunication providers (competitors)	To provide additional services to their customers such as access and roaming
	Mobile virtual network operators	Buying or (leasing) network capacity which is then utilised to provide services under telecoms' own brand name
Regulation authorities and bodies	Government, telecommunications regulation commissions	To manage issues related to privacy, security, spectrum availability, licenses, patents, and IP

Table IV.
Main actors and their functional roles

On the other hand strategic roles refer to what key objectives and benefits a telecom is achieving by having a particular actor within its value network. The combined strategic roles played by all actors signify the main motives for telecoms to create and form their own value network. The research identifies eight main strategic roles as follows:

(1) *Resource allocation.* Telecoms may not have sufficient resources to offer competitive and novel MDS. Thus, they establish relationships with different actors to get access to external resources and link them to their own assets. Sometimes, building relationships with particular actors is not a choice but a necessity, for example when scarce resources are required, such as patents, or the existence of technological fabrication secrets (Campanovo and Pigneur, 2003).

(2) *Efficiency.* Consistent with transaction-cost theory (Williamson, 1985) telecoms may find it more efficient to collaborate with other business actors to acquire needed resources and specialised skills rather than possessing all resources itself. This role is particularly important for developing sustaining innovations as it can help in reducing the costs of the service.

(3) *Risk mitigation.* When the cost of investment is very large and success is not guaranteed it may be advantageous for telecoms to cooperate with partners to create new services rather than going it alone. This factor has become an important motive after the current economic downturn.

(4) *Effectiveness.* When designing a new data service, telecoms may recognise that this would require additional resources and capabilities to make it unique and competitive which they may be unable or reluctant to provide. In such cases they may find it more effective to add a new actor possessing distinctive resources and capabilities so as to launch a more competitive and high quality service. Co-branding is an example of the core competencies resulting from collaboration in this context. Similar to the efficiency role, this role can help in the development of sustaining innovations. But instead of helping in reducing the cost of the service this role can assist in improving the performance of the MDS.

(5) *Time-to-market.* The telecommunication sector is highly competitive and time-to-market has become one of the main strategic drivers. Many ideas for new services are shared amongst telecoms where the role of each is not only to find the most appropriate ideas to implement, but also to enable their successful implementation before other rivals do. Thus, telecoms may approach new actors if they are able to help shorten the services' time to market. This role is specifically significant in developing innovations characterised as disruptive as it can contribute to the novelty innovation type.

(6) *Agility.* In the dynamic and fast growing telecommunication sector, value network formation might be the best way of achieving flexibility and providing faster response to changing needs. Agility is vital when telecoms are seeking to redefine the rules in the marketplace by delivering MDS characterised chiefly as disruptive innovations. Indeed, agility of telecoms can facilitate their ability to shift their core competencies in accordance with market variations.

(7) *Intelligence and creativity.* Telecoms through collaboration, cooperation and joint R&D can create a collective mind (Fontana and Sørensen, 2005) and facilitating intelligence and creativity in relation to new opportunities is important.

Creativity is very important for developing successful MDS as it is one of the main prerequisites needed for producing innovations (Figure 2).

(8) *Enlarging customer base*. By collaborating with other organizations, telecoms may aim to expand the size of their customer base by creating the opportunity to access and interact with the customers of the actors they collaborate with. For a telecom, this is an easier, faster, and more effective way of acquiring new customers compared with undertaking this on their own.

Understanding the functional and strategic roles of actors is very important. It allows a telecom to identify its position within the network and also the positions of others. This is pertinent as it gives a better indication of the possible value to be captured by a telecom. It is also essential in matching the kinds of value anticipated by the value network actors with the type of innovation the telecom is seeking to deliver. Role is also crucial as it helps telecoms in understanding, managing, and controlling its links with the various actors included in its value network. Indeed, this method of analysis allows a telecom to accurately identify the functional and strategic contributions of each actor. The size of each actor's contribution should be reflected in its proportion of the generated value, so as to keep the network healthy and sustainable. For example, one of the important reasons that the i-mode in Japan has been successful is related to NTT DoCoMo not exploiting its position of power and allowing other actors to capture fair value based on their contributions (Ratliff, 2002).

(4) RELATIONSHIP

This design construct is about identifying the sorts of links telecoms need to establish with their value network actors. Establishing appropriate relationships with value network actors is important given that actors follow different approaches with different types of relationships. The differences include the level of information exchange, the level of change they would accept to be taking place, and the level of willingness to collaborate and cooperate. The kind of relationship telecoms establish and maintain with various players within the value system is critical to success.

The relationships between telecoms and value network actors could, for example, take the form of strategic alliances and partnerships, affiliations, joint ventures, mergers, acquisitions, transactional (e.g. cost/revenue share). The type of role and its importance indicates the appropriate kind of relationship the telecom needs to build with that actor. For example, a sourcing relationship seems sensible for acquiring middleware and other software systems, whilst a more strategic partnership might be more rational when establishing an association with actors like content or ISPs, as their roles are more substantial in MDS.

The kind of relationship telecoms develop and maintain with their customers represents another facet in this construct. Customers are the main source of revenue; thus creating positive relationship with them is vital. This helps create intimacy and positive relationships with customers (Hamel, 2000). Telecoms however need to collect relevant information concerning their customers based on the established relationship. Based on analyzing the collected customer details, telecoms need to profile and segment their different kind of customers and provide them with customised services that fulfil their needs.

Telecoms could start building their relationships with their target customers at a very early stage. Customers could be utilised as a source of ideas. In this sense, telecoms are respondents to customers' requests and needs. Telecoms could brainstorm a new service idea with its potential customers, listen to their wishes and expectations, and collect important information that could help in later stages of the service development. Before the roll-out stage of a service customers could be utilised as service testers, and after the provision of the service they could be employed as service evaluators. Customer involvement at different stages is very helpful to telecoms not only because it could improve the service offered but also because it might give customers the feeling that they are important and playing a part in the process. This might lead to the enhancement of intimacy, satisfaction, and loyalty of customers.

(5) FLOW-COMMUNICATION

This construct addresses the objects communicated between various actors connected in value networks. Analyzing this construct is important as it helps service designers and engineers to represent value exchange streams amongst the actors so as to make them more controllable, manageable and effective. The importance of this construct also comes from the fact that relationships with different actors are enriched by materials communicated between them. These materials can take the form of information, knowledge, money, products, services, hardware, software, documents, agreements, and any other objects. These different kinds of flowed materials or objects can be classified in three categories:

(1) goods/services;
(2) intangible benefits; and
(3) monetary or economic benefits (Hanbo, 2008).

There are two types of object flows. First, objects flowing between:

(1) telecoms and customers; and
(2) telecoms and enterprise actors.

In the former case telecoms may, for example, create intelligence by collecting information from potential customers. Based on analyzing the collected information, they would provide them with purposeful services. In response, customers allow telecoms along with other network actors to capture value through communicating money and providing other intangible benefits such as feedback information. In the latter case content may flow from content provider to content aggregators. The aggregators cleanse, format, edit, customise and combine relevant content and communicate it to telecoms to be used by services. After revenue is generated by customers paying for delivered services, each participating economic actor (i.e. business partner) receives its share from the captured value, whether it is economic, societal, or other form of value.

The use of graphical maps is one of the main tools that can be utilised to enhance the understanding of the flows and communications amongst various actors within the value network. This method provides a simplified manner to view object flows within the network by exploiting visual aids possibilities. For example, to understand the object flows and communications in the case of Apple App Store amongst multiple actors (i.e. mobile operators, Apple, developers, and end-user devices), Eaton *et al.* (2010) used a graphical map to demonstrate the flows in terms of:

- goods/services (S); and
- monetary benefits (M).

Unfortunately, there are as yet no standard tools and notations for mapping value networks. Thus, researchers and practitioners create their own customised maps developed using their own notations but to improve communication in this respect a unified method, tool, or even ontology is required.

(6) CHANNEL

Examining the communication mediums or ports used to communicate materials and objects amongst actors as a result of their relationships is the theme of this design construct. An enterprise employs channels to show their environment and more specifically other actors in the value network that it is prepared to communicate and exchange required objects for innovations. The importance of this construct comes from the fact that it enables enterprises to focus on the required communication and collaboration with external actors and at the same time abstract it from the internal business processes (Gordijn and Akkermans, 2003; Panagiotopoulos *et al.*, 2012).

Within the value network of MDS, employed channels could be physical or electronic, and can range from being manual to fully-automated where technological systems talk directly to each other. The versatility of channels depends on the characteristics of the channel on one hand and the attributes of the objects to be communicated with value network actors on the other. Thus, a channel could be limited in a sense that only one kind or class of objects can be communicated through that channel, or versatile in that more than one class of objects can be flowed through the particular channel. From another perspective, channels can be distinguished based on the number of objects that can be communicated or flowed through the channel at the same time, i.e. concurrently. If only a maximum of one object can be communicated through a channel at a single point of time, then this channel is regarded as atomic, where if the channel is able to carry a number of objects (more than one) simultaneously, then the channel is considered gigantic. Given the complexity of mobile value networks and the variety of actors and relationships and the diversity of objects to be exchanged it is important that a variety of different channels are employed. Different communication channels used with different actors for different functions might relate to design and engineering, customer relationship management, collaboration and communication, distribution and logistics, customer service, marketing, etc.

Channel arrangements in value networks include constructing interfaces with customers. In addition to physical communication channels telecoms are exploiting the internet and other associated technologies such as portals and CRM tools to develop valuable virtual communication mechanisms with their customers. The number, type, customer reach capabilities, and the quality of communication channels that telecoms build and maintain with their customers and other network actors are critical to success.

This CHANNEL design construct is closely related to the former one, i.e. FLOW-COMMUNICATION, as designers and engineers need to select the most appropriate channel for each single flow of materials. For example, information concerning potential customers could be communicated virtually to telecoms using software agents as channels; whilst to communicate particular mobile services to customers, special handsets maybe used as communication mediums, as in the cases of Apple iPhone and i-mode.

(7) GOVERNANCE

The GOVERNANCE construct defines the actors who are managing, controlling, and directing the value network of MDS. Examining this construct and keeping track of this sort of information about the value network governance is very significant. This is because telecoms could utilise it to:

- identify new opportunities, where they can have more power and control;
- evaluate risks associated with existing configuration of governance; and
- establish reference points for accountability purposes.

The concept of governance can be viewed at two levels:

(1) the mobile telecommunications industry; and

(2) the value network.

At the level of a mobile telecommunications industry, governance is managed and tackled by regulatory commissions and other legal bodies. These regulative bodies are in charge of setting the rules and regulations for the industry as a whole. For example, they may issue licenses for telecoms concerning different mobile standards and technologies; manage telecoms' patents and intellectual properties; control radio spectrum and allocate frequencies for different services, standards, and technologies; deal with prices and pricing methods; control and manage the number of players within the industry along with competition concerns. Normally telecoms simply adhere to these rules and regulation set out by the regulative bodies but in some circumstances they can influence the regulators. They can play active roles where they initiate a campaign and collaborate with regulative bodies to change existing rules and norms. For example, in the UK mobile telecommunications industry, British Telecom (BT) and 3UK have initiated the so-called "mobile termination rate" (MTR, www.terminatetherate.org/) campaign and submitted in October, 2009 a petition in this regard to the regulatory body Ofcom. So far, more than 135,000 signatures have been collected to support this petition. The main aim of MTR is to reduce MTRs so as to reflect their actual cost and subsequently reduces the price per minute for mobile users.

Governance relates to whom within the value network, has control and power over what kind of objects and resources, e.g. data, relationships, channels, functions, patents, brands, and transactions. For analyzing governance issues and examining where and how actors can extract value, the control points concept is utilised (Eaton *et al.*, 2010). Control points are areas in the value network where power and control can be applied. They normally result from the various roles played by actors in the value network (as discussed in the ROLE construct). Thus, control points are not only functional but are also strategic, and the more control points an actor has the more important they are in the value network. Typically, actors try to achieve more power and control in order to augment the value they can capture.

Value networks can be governed hierarchically or in a flattened mode. A hierarchical governance mode means that there is one, or a few, actors that dominate the power and control. The motive for this mode is that the dominant actors can enlarge their share of the captured value. However, this approach is risky and may lead to catastrophic results if dominant actors do not have the necessary capabilities and knowledge to define problems and evaluate proposed solutions (Pisano and Verganti, 2008). A flattened mode implies that all actors are sharing costs, risks, knowledge, capabilities, etc. more equally to collectively address innovation (Pisano and Verganti, 2008). This is normally the case when the innovation requires a wide range of knowledge domains scattered across various actors from different backgrounds. This governance mode usually means that the share of the value captured is approximately the same across the actors. Although such an approach may lead to better innovations, it can be time-consuming as all actors need to agree on mutually beneficial actions. This may increase the innovation time-to-market which might negatively affect the competitiveness and the disruption effect of the proposed innovation. Therefore, the appropriate choice between hierarchical and flattened governance is considered as one of the elements contributing to the success or otherwise of mobile data innovations.

Having discussed the value network design constructs above along with their relationships and semantics, the next step is to validate and illustrate the model by applying it.

5. Illustration and evaluation: the case of NTT DoCoMo i-mode service

5.1 Introduction

In this section, the NTT DoCoMo i-mode case in Japan is analysed to illustrate and practically evaluate the proposed model. Analyzing real-life cases is well used in the field of information systems as it allows researchers to capture knowledge from practice (Cavaye, 1996; Walsham, 2002). Moreover, the use and analysis of real-life cases is considered an appropriate method for answering "how" and "why" questions (Benbasat *et al.*, 2002; Yin, 2009). The validation of the model involves understanding how and why the i-mode service has been effective and successful in practice, whilst the majority of MDS have been struggling.

The data relating to the case is mainly from Ratliff (2002) and a quantitative content analysis approach is used which is defined as "an approach to the analysis of documents and texts that seeks to quantify content in terms of predetermined categories and in a systematic and replicable manner" and is argued to be transparent, objective, and systematic (Bryman and Bell, 2007). The process of quantitative content analysis involves data coding and analysis of the text to generate subjects and themes. The coding procedure is characterised as "targeted", since it relied on mapping the generated data to the predetermined constructs and relationships within the model. Nevertheless, the research at this stage remains open to any new concepts that may emerge to enrich the model. Based on this approach, the research developed an illustration and analysis of the NTT DoCoMo i-mode case.

5.2 The NTT DoCoMo i-mode service: analysis of its value network

NTT DoCoMo is a telecom with a powerful market position in Japan with the highest market share (around 51 percent). Before market liberalization in Japan NTT DoCoMo was part of NTT which was a well-known brand with a good reputation and a nationwide installed base. In 1992, NTT DoCoMo spun off from NTT inheriting the strong reputation and customer base from its mother company. Interestingly, NTT DoCoMo decided not to follow NTT's long and traditional engineering approach to the development of services, but favoured a more flexible approach which was based on experimentation and prototyping along with their risks or benefits. This new flexible and creative approach was driven by NTT DoCoMo's first president, Koji Oboshi, along with Takeshi Natsuno (internet entrepreneur) and Muri Matsunaga (marketing and promotion entrepreneur). As a result, i-mode was developed to test a new business model related to MDS.

NTT DoCoMo launched the i-mode service in Japan on the 22 of February 1999. Despite its low-band mobile technology (i.e. a dedicated packet network (PDC-P) with an average rate of 9.6 kbps) i-mode was the first mobile provider to succeed, with the number of current users exceeding 48 million. The i-mode data platform contains a portfolio of bundled and well-balanced services: entertainment, information, database, transaction, and other services (e.g. e-mail).

In developing the i-mode service, NTT DoCoMo has adopted a closed network mode, given that user and market requirements were clearly defined following the market research they had conducted, led by marketing specialists Muri Matsunaga and Takeshi Natsuno. A closed model was also deemed appropriate as the telecom was able to determine the required knowledge domains for the i-mode service and the parties they needed to collaborate with, given their long relationships with many and different types of actors inside and outside the telecommunications sector. Further, NTT DoCoMo's extensive R&D capacity, as well as its deep knowledge of telecommunication standards, infrastructure, services, and devices, provided another reason to justify the appropriateness of a closed network mode.

NTT DoCoMo utilised its existing technologies and its dedicated packet network (PDC-P) for the i-mode service. This eliminated the need to add cellular infrastructure providers to its value network. Nonetheless, the telecom recognised the need to build close cooperative relationships with other actors such as platform and equipment providers, as well as content providers so that mobile technology, content quality, and customer experience could evolve jointly. Within its value network, NTT DoCoMo is playing the central role coordinating the innovation value network as seamless integration amongst actors is critical to success. From NTT DoCoMo perspective, this synchronization through close collaborations ensures that their interests along with partners, customers, and other stakeholders are all aligned. Subsequently, the value delivered to each of these parties is maximised.

NTT DoCoMo has built close links with content providers to feed the service with different forms of useful and innovative content. They both have made joint efforts on the functionality and operability issues of i-mode web sites as well as marketing and distributing the service. Thanks to these collaborations, more than 95,000 web sites are accessible through the i-mode menu making the service effective with this critical mass, and thus attracting a wider variety of customers. i-mode web sites need to be developed using Compact Hyper Text Markup Language (cHTML) and run on a micro-browser so adding handset providers and manufacturers to the i-mode value network was essential to take full advantage of this service potential. To this end, NTT DoCoMo created an environment for sharing R&D with a selected group of handset manufacturers (e.g. NEC, Sony, and Fujitsu) enabling technologies to be improved in an incremental and continuous manner, e.g. the development of Java-enabled handsets in 2001. This sort of collaboration allows the telecom to bring appropriate channels (i.e. handsets) to the market quickly enabling users to successfully communicate with the i-mode service.

For NTT DoCoMo, it was more efficient and more effective to collaborate with content and platform providers as well as handset manufacturers than to play these roles itself. This is because the latter calls for huge investments and a learning curve that would most likely have:

- prevented the telecom from gaining first mover advantage; and
- eliminated the advantage of employing the existing PDC-P as a network infrastructure, that was good enough to make the service successful at the time.

For NTT DoCoMo, building collaborative relationships has extended beyond the telecommunication sector to include actors from outside. Although NTT DoCoMo is the actor handling the billing function within the i-mode value network and rewarding itself for this extra role (a 9 percent commission on service subscription) it has also partnered with leading banks and developed new forms of payment and money collection systems. In terms of external collaboration one of its most innovative has been partnering with Coca-Cola, allowing i-mode users to use their handsets with Coca-Cola vending machines and charge transactions to their i-mode bills.

With the intention of making i-mode the de facto standard worldwide, NTT DoCoMo built a number of strategic partnerships with telecoms in Asia (e.g. 3 Hong Kong and Smart in the Philippines), in Europe (e.g. KPN Mobile in The Netherlands and Wind in Italy), and in the Middle East (e.g. Cellcom Israel). NTT DoCoMo even bought a substantial share of one of the telecoms it collaborates with (15 percent of KPN) aiming to sustain the relationship and make it more effective. To build a strong base for these international collaborations NTT DoCoMo established in 2000 a strategic alliance with AOL-Time Warner to provide rich content and marketing in the English language.

The i-mode value network is hierarchical in its governance. NTT DoCoMo is the dominant actor directing and managing the innovation and its value creation. For example, to qualify for official status which includes having their web site accessible directly through the i-mode menu, content providers are required to undergo a lengthy qualification process fully controlled by NTT DoCoMo. Another example is that NTT DoCoMo specifies in detail what kind of handsets are required to meet the requirements of the i-mode services, its updates, and developments, rather than modifying the service to meet the requirements of existing handsets.

Another important reason for the creation of a sustainable and powerful value network is related to NTT DoCoMo not taking advantage of its position and power and allowing actors to capture fair values based on their contributions (Ratliff, 2002; Bouwman and MacInnes, 2006). NTT DoCoMo views its value network as an ecosystem where all share risks and rewards fairly. The i-mode value network actors were attracted to join the network for financial gain but also it is stated because of i-mode's novelty, and the opportunity to gain knowledge, experience, and other intangible benefits in relation to MDS engineering.

The reasons why the i-mode value network is successful and powerful has been explained by mapping the developed model to the case. This provides a practical and real-life illustration of the model's value and efficacy. Table V summarises the analysis by showing the mapping between the model design constructs and their counterparts in the case.

Applying the model to analyse the value network of NTT DoCoMo i-mode service has highlighted some important issues. At a high level the analysis helps develop

Design constructs	The case of NTT DoCoMo
NETWORK-MODE	"Closed" network mode. Only selected actors can participate. The choice was rational given that user and market requirements were clearly defined in addition to the fact that required knowledge domains and collaborators were available and identified
ACTOR	Content providers; handset manufacturers (e.g. NEC, Sony, and Fujitsu); ISPs; banks and financial institutions, Coca-Cola; mobile network operators; AOL-Time Warner
ROLE	"Functional" – content providers: provide various content for the i-mode platform in different formats; handset manufacturers: produce mode enabled handsets; banks: facilitate payments and billing; Coca-Cola: provides ways to utilise i-mode enabled handsets to pay through their vending machines; mobile network operators: distribute i-mode worldwide; AOL-Time Warner: provides rich content and marketing in the English language "Strategic" – resource allocation (e.g. content providers); intelligence (e.g. R&D with handset manufacturers); time-to-market and agility (e.g. mobile network operators); efficiency (e.g. content and handset providers)
RELATIONSHIP	NTT DoCoMo mainly adopts "strategic partnerships" with key actors. However, it also employs other types of relationships such as outsourcing and other agreements
FLOW-COMMUNICATION	Content for i-mode from content providers to NTT DoCoMo, money from customer accounts to NTT DoCoMo; Handsets from manufacturers to i-mode distributors; knowledge amongst different actors within the network;, etc.
CHANNEL	i-mode enabled handsets to communicate i-mode services to customers; software agents and interfaces to communicate data from one system to another;, etc.
GOVERNANCE	"Hierarchical": NTT DoCoMo is the dominant actor directing and managing the innovation and its value creation

Table V. Value network design constructs mapped to NTT DoCoMo i-mode case

successful value networks that will facilitate the development of innovative MDS. The case illustrates how good design, configuration, and market arrangements of the i-mode's value network has made it possible for NTT DoCoMo to develop innovative MDS, despite its initial modest technology.

The analysis has also shown that the developed model is comprehensive and complete as all the data from the case source fits easily and appropriately into the model, i.e. the seven design constructs and their relationships, without the need for new construct or relationships. This indicates that the model has structure validity and inclusiveness. The evaluation also shows the model's coherence because the details related to each design construct complement the other details belonging to other design constructs, i.e. there are no contradictions between constructs and their semantics and thus they are mutually exclusive. The developed model is also argued to be clear since precise definitions and detailed semantics are provided for the constructs and terminology used in the model and their relationships. Furthermore, the case evaluation suggests that the developed model is concise, given that only concepts that are regarded as significant and influential are defined.

Although some of these constructs are discussed in the literature it is noticeable that two are usually overlooked, despite their significance, when engineering MDS. These are FLOW-COMMUNICATION and CHANNEL constructs. This is probably due to their functional nature and the fact that they require detail at a greater level of depth than the other five constructs. Failure to address these constructs is regarded as a major drawback as it can have adverse effects on the network performance given their functional importance as well as their crucial relationships with other design constructs.

The analysis reinforces the idea that innovation is a collective achievement and that "running in packs" is an effective approach in this context (Van De Ven, 2005). It shows that the success of i-mode service is heavily dependent on jointly creating (by value network actors) the right combination of innovative mobile services, content, handsets and equipment, and reliable standards, platforms, and infrastructure. Indeed, i-mode actors have contributed to the innovation course of action by delivering compatible packages matching their core competencies and specialties.

6. Implications for theory and practice

The dynamic and rapidly changing nature of the mobile telecommunications industry has highlighted the need for an effective model that would help telecoms to develop powerful value networks capable of creating innovative MDS. This paper has proposed and discussed such a model and the theoretical and practical implications are now highlighted:

(1) *Relevant and purposeful.* The relevance of this model comes from that fact that it addresses a real-world problem that is very significant to its stakeholders. It is significant to:

- telecoms as designers and providers of mobile services;
- research communities concerned with the design and engineering functions of MDS; and
- individuals and society as users of such mobile technologies.

The developed model is also argued to be purposeful as it addresses, and hopefully improves, the current theories and practices related to MDS and innovation engineering functions; such as analysis, design, development, evaluation, maintenance, and change. The developed model enhances understanding of the issues and it provides a comprehensive approach to the analysis and/or design of effective MDS. Further, the developed model provides a common language and terminology which enhances communications and understanding amongst stakeholders.

(2) *Comprehensive and manageable.* The developed model provides a comprehensive and manageable method to develop powerful value networks creatively and sustainably. This is significant as the efficacy of MDS is enriched by creating well-balanced and sustainable value networks. The developed model is designed in a way that makes it easy to use in design and apply in analysis. It is organised in seven design constructs where constituent elements are identified within each construct. The relationships between the design constructs are also established and clear semantics are produced. The relationships between the constructs are required to show the interdependencies amongst the design configurations. They can also be used to control changes that happen to different design concepts by tracing their potential consequences.

(3) *Convenient and practical.* The developed model in this research is convenient and practical. This has mainly been verified by evaluating the model using case analysis methods. In this paper the developed model enabled the effective analysis

of a key MDS (i.e. NTT DoCoMo's i-mode) in the mobile telecommunications industry. The analysis of the case is argued to be useful to many stakeholders, such as telecoms and researchers, and should help them understanding the developed model and apply it in their contexts for their purposes.

7. Conclusions and future research

Mobile telecommunication industry is shifting from one that was all about voice transmissions to one that is increasingly about data communications. MDS are complex technological systems and their successful creation and maintenance is a collective achievement. Indeed, developing innovative MDS requires the involvement of many actors with various backgrounds, knowledge, and expertise. However, forming a powerful value network is complex, requiring deep understanding and alignment of many concepts and their interrelationships. This paper puts forward a novel model for the design and analysis of such value networks. This model is composed of seven design constructs and their relationships. The developed model is argued to provide significant utility for telecoms in helping them to identify and design powerful value networks following a systematic and practical approach. It is also useful as an analysis tool to analyse the telecom industry as well as the position of an individual telecom by showing how, when, and where value is created, delivered, and captured in a value network.

The model is also useful in understanding which actors a telecom should collaborate as it highlights the roles of different actors clearly, and shows explicitly how the value is exchanged amongst various stakeholders. Furthermore, it can be helpful in determining whether a telecom should follow an open mode, where ideas can come from anyone or a closed mode where only selected parties can participate. It is also valuable in explaining which governance mode to employ in which circumstances.

Future research will hopefully provide additional validation for the developed model in this research, including the utilization of the model to examine a wider range of MDS and innovations. It is also hoped to utilise the model to develop a value network for a new MDS provider following an action research approach.

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