December 2006

Multitechnology Interactions in Mobile Telecommunications Markets

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ABSTRACT

The convergence of telecommunications, IT, media, and entertainment (TIME) industries in the last decade has led to the simultaneous existence of multiple competing and substituting technologies addressing similar customer needs. The resulting complexity is increased by additional complementary technologies and services. In three case studies, we show the associated problems and ambiguities from a modeler's perspective. The major contribution of this paper is a comprehensive multitechnology interaction framework which aims at aiding modelers and strategists in analyzing complex markets with multifaceted dependencies. We classify interaction cases, possible measures, as well as intensity factors.

Keywords

Multitechnology Interaction, Complement, Substitute, Forecasting, Mobile Telecommunications

INTRODUCTION

The history of the telecommunications industry is a history of change. Three major trends can be identified within the last decade.

First, liberalization and deregulation led to competition which in turn induced a stronger consumer focus. In the monopolistic past consumers had only the choice between adoption and non-adoption. In a competitive environment consumers have the choice among different alternative products to adopt (e.g., Loomis and Taylor, 1999).

Second, previously separated industries gradually converge (Gerpott, 2003). Convergence in turn may be observed in several respects. On the one hand, technologies from different industries addressing different customer needs are recognized to be complementary and thus integrated on a joint platform. On the other hand, technologies from different industries addressing similar consumer needs start competing for customers.

Third, consumer behavior has changed. As a result of competition and reduced product lifecycles consumers have the option to switch to a competitor or "leapfrog" to a future technology (e.g., Schilling, 2003). Besides, new services give rise to new behaviors which extend the scope of substitution. For example, a messaging service like SMS (Short Message Service) has the potential to partly substitute voice telephony.

All the identified trends render the problem domain more complex to the analyst/modeler because more technologies and products interact with each other and do that in more intricate ways. That is, products are situated in a complex network of competitive, substitutive, and complementary relations (Bayus, Kim, and Shocker, 2000). These interdependencies make it increasingly difficult to draw a boundary for a given forecasting problem (e.g., Fildes, 2002).

Generic interaction relations like complements or substitutes are not new in the scientific literatures. Most explicit treatises have arisen in the economics and the marketing field. The former are mostly normative (e.g., Bulow, Geanakoplos, and Klemperer, 1985; Klemperer, 1987) while the latter comprise a wider spectrum of both empirical as well as theoretical works. In a sense, each model addressing the relation of two or more products refers to interaction such as bundling, competition, etc. However, the relations are usually simplified and rarely examined at an abstract level. An exception is the diffusion literature which spawned a lot of models for different but very specific interaction types (e.g., Peterson and Mahajan, 1978, Bayus et al., 2000). Kim, Chang, and Shocker (2000) is a rare instance of a model for multiple simultaneous interactions (i.e., intergenerational, complementary, and competitive effects). Besides, the topic has also been addressed in the conceptual marketing literature (e.g., Srivastava, Leone, and Shocker, 1981; Bayus et al., 2000; Shocker, Bayus, and Kim, 2004). These are the major precursors of our research. Finally, the strategic management literature treated the subject in terms of competitive opportunities and threats (e.g., Porter, 1980) as well as from the perspective of success and failure, obsolescence as well as attack and defense (e.g., Christensen, 1997; Pistorious and Utterback, 1997).

The major deficit of all these works is their focusing on partial aspects. None of them accounts for the multidimensionality of the problem. Still missing is a comprehensive concept setting terms, factors, measures and dimensions in one common context (Shocker et al., 2004, p. 30).

In the next Section we review three important interaction cases from the telecommunications industry. They shall illustrate the complexities associated with today's technology markets. As a solution we present a meta-model in the subsequent section which provides a generic structure and terminology for such industry settings.

MULTIPRODUCT INTERACTIONS – 3 CASE STUDIES

Generally, there are four large communication network types in most European countries: (1) fixed-line telephony and data networks (PSTN[1]/ISDN[2] with ADSL[3]), (2) mobile telephony and data networks (GSM[4]/UMTS[5]), (3) cable television (CATV) networks, and (4) wireless computer networks (WLAN). Judging by their market penetration (1) and (2) are the dominant network types in many European countries. However, both are threatened by other networks. In addition, irrespective of the network type, telephony services are threatened by data services. This yields three major cases to be analyzed in this section: (1) the competition of GSM/UMTS and WLAN/WiMAX[6], (2) the partial substitution of PSTN by other networks, and (3) the substitution of voice services by data services. Note that although our case studies refer to Europe, this does not affect the generic nature of our framework.

Wireless Radio Network Interaction

The first case concerns the interaction of WLAN/WiMAX with GSM/UMTS. Today, more and more mobile phones and most notebooks are equipped with WiFi. Furthermore, many households operate small home networks based on a wireless WiFi router. WiMAX may be considered as an extension to WLAN. It was originally designed to connect rural areas to the internet with high data rates. Thus, both WLAN and WiMAX are primarily computer network standards and are not – at least in their initial specifications – intended for mobile applications[7] or voice telephony.

GSM, on the other hand, is the European second generation, digital mobile network standard. It is designed for national carriers. Contrary to WLAN, the designated radio spectrum requires a license for operations. GSM was originally optimized for voice telephony. Although data services were offered, too, the demand was low because of small data rates and high prices. However, new application areas emerged such as SMS, a messaging service which was originally included in the specification for the communications of network engineers. The providers did not foresee the success of this service among the population. Finally, UMTS is a third generation, digital mobile network standard. The primary objectives have been higher data rates for multimedia services and worldwide interoperability.

Because of their different original purposes WLAN and GSM have different strengths. The first was geared to almost stationary network nodes and high bandwidths while the second emphasized mobility with data transmission being an inferior service. However, in the course of time this has changed. Today, there are many WLANs installed at public places, especially where people spend a longer time like hotels, airports, stations, etc. In some cities complete areas have already been or are

[1] PSTN: Public Switched Telephone Network. The fixed-line telephone network. Commonly this is the analog network of the (former) monopolist.

[2] ISDN: Integrated Services Digital Network. A digital extension of analog telephony which offers new and better services.

[3] ADSL: Asynchronous Digital Subscriber Line. A digital broadband data channel.

[4] GSM: Global System of Mobile Communications. The first global standard for digital mobile networks.

[5] UMTS: Universal Mobile Telecommunication System. A global standard for broadband digital mobile networks.

[6] WiMAX: Worldwide Interoperability for Microwave Access. A broadband wireless network standard with larger coverage than WLAN. At the time of this publication the technology is not yet available for the mass market.

[7] That is, where the user is in motion or frequently changes his/her location.

intended to be covered by a mesh of WLAN networks. There are several concepts associated with this: (1) provision of a public good, (2) provision of a commercial service, or simply (3) a loose network of private households. In all three cases WLAN is a partial substitute to GSM as well as UMTS (Lehr and McKnight 2003). The degree largely depends on the technological deficits of WLAN in comparison with GSM/UMTS in terms of mobility such as (1) the availability of WiFi-enabled handsets, (2) a standardized roaming system, and also (3) network availability under high usage loads. Thus, as a perfect substitute WLAN may be inappropriate. But at public places it is a viable alternative. In addition, it provides higher data rates than first-generation UMTS[8]. Many mobile network operators have therefore included WiFi in their technology portfolio. Now WLAN may be regarded as a complement to GSM/UMTS for data services at public places. It is apparent now that the type of interaction is not clear. If WLAN just substitutes GSM/UMTS data services but has the same price level, then – ignoring costs – the overall substitute effect (in terms of revenues) is zero. If a telephony service is used over WLAN, it depends on the relation of voice telephony rates and data transmission rates whether the overall effect on revenues is negative or positive. But WLAN may also generate more demand for data transmission or even give rise to new services. For example, WLAN can be used as an additional sales or advertising/promotion channel.

Including WiMAX and UMTS in our considerations the deficits of WLAN/WiMAX in terms of mobility blur even more. In fact, the WiMAX specification treats stationary as well as mobile application scenarios. The latter increases the substitute potential of WiMAX and may possibly lead to market entries. However, there may be regulatory restrictions in terms of the used spectrum band. The substitute degree also depends on the cost of infrastructure installation. If WiMAX achieves larger economies of scale than UMTS technologies, new entrants could offer services at lower prices.

In sum, we showed that the sign as well as the magnitude of interaction between these network technologies is unclear at first sight. WiFi/WiMAX may influence GSM/UMTS both positively as well as negatively. This seeming ambiguity is due to a lack of structure of the problem domain.

Fixed-Line Substitution

The second case, which is also of major relevance to the industry in the present time, is the substitution of fixed-line telephony and data (transmission) services by alternative networks. Traditionally, voice telephony has been provided via the fixed-line network PSTN. There are two technologies, analog telephony and digital telephony (called ISDN). ISDN offered more network services and higher data rates. Yet, due to higher prices it remained only a partial substitute to its analog predecessor. With ADSL it is also possible to offer high-bandwidth data transmission services via PSTN.

However, PSTN has competitors meanwhile. There are alternative networks with substitution potential in terms of both voice telephony and data. First, mobile telephony can be used instead of fixed-line telephony. However, this requires similar costs for the consumer. Hence, many mobile operators have introduced differentiated price schedules in order to make telephony and data services at home more attractive and affordable. For example, a consumer may telephone in all (PSTN/mobile) networks on weekends for a certain fixed markup or (s)he has a certain allowance of voice minutes for calls in arbitrary fixed or mobile networks. Some mobile operators have invented location-based pricing by charging less when the consumer is at home. Finally, flat rate tariffs are offered for mobile telephony and data services. With the advent of UMTS and a downward trend in prices mobile data transmission services gain significant substitution potential, too. However, there are also factors reducing the substitute threat from mobile networks like health concerns because of radiation or worse conversation quality.

Besides mobile networks there is a cable television (CATV) network in most countries. These networks have been digitized and are now able to transmit data at high rates. Thus, both voice telephony and data transmission services are possible and may substitute PSTN.

A further substitute network may be WLAN/WiMAX networks as described in the last section. WiMAX is still in its infancy as are large-scale WLAN networks. However, "WLAN sharing" is a phenomenon with significant proliferation. That is, several persons in a neighborhood share a broadband network connection via WLAN. Some operators prohibit such usage cooperatives.

Finally, a threat may also arise from telephony services via data connections. We will study this scenario separately in the next subsection. This case also shows that the threat may be different for different market actors and integration degrees. A pure mobile network operator will try to convince customers to cancel their fixed-line connection. An integrated network operator which operates both a fixed-line network and a mobile network has to counterbalance a possible shift from previous

[8] Indeed, there are several generations of UMTS.

home-telephony revenues to mobile-telephony revenues. There is a danger that the latter "cannibalizes" the former[9]. The same applies to data services when offered at competitive prices.

To summarize, this case describes the multitude of interactions in the industry. The case of mobile data transmission services further shows that price decisively influences the substitution potential. There is always a difference between technology-level and market-level substitution potential, i.e., the technological capability of interaction does not necessarily implicate actual interaction. Furthermore, different market actors may be affected distinctly by the same interaction relation. Especially, when an organization is affected both negatively as well as positively by the same interaction relation the overall outcome is not immediately clear and depends on the amount of revenue shifts as well as the cost structures of the different profit centers of the firm.

Voice – Data Substitution

A final prominent substitution case has already been mentioned above. With digitization all the above networks (PSTN, CATV, GSM/UMTS, WLAN/WiMAX) allow both voice telephony as well as data services. There is a substitution potential between these two service types in several respects. First of all, both satisfy communications needs. Data services allow asynchronous messaging services like SMS or e-mail as well as instant messaging services which draw a part from voice telephony demand.

Second, there are services for voice transmission via data services. Such services are generally called VoIP (Voice over Internet Protocol) when one of the underlying protocols is IP. The voice signal is digitized and the resulting binary data stream is transmitted via data packages over the network. In principle, this service can be offered via all of the above network types. The only restriction is a minimum bandwidth which is, however, generally available in all four cases. For a pure provider of voice services this represents a substitute. For a provider of both voice and data it is a kind of arbitrage as an existing differential pricing scheme for voice is circumvented. For a consumer it is beneficial if his telephone bill is higher than the price of transmitting the corresponding voice data via VoIP. The substitution potential thus depends primarily on the relation of the prices of the two services.

A FRAMEWORK FOR MULTITECHNOLOGY INTERACTIONS

In the last section we showed that interaction relations can assume multiple different modes, i.e., that the effects may be positive, negative, or neutral and that they may be symmetric and asymmetric. Further, we pointed out that the effect depends on the applied measure and that the intensity of the effect may vary according to different factors. Finally, as all products are interdependent to some degree through the human system of needs, it could be showed that it is necessary to differentiate levels and scopes of interaction. These considerations lead us to the four dimensions depicted in Figure 1.

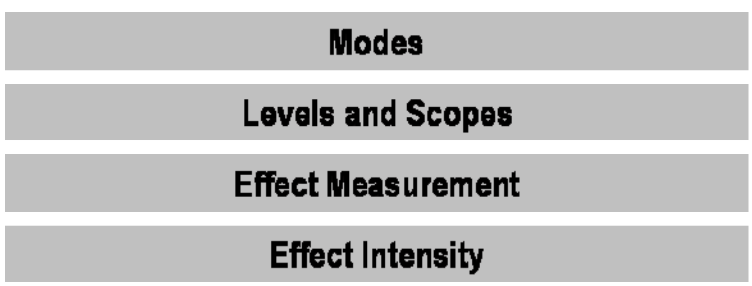

Figure 1. Dimensions of the Interaction Framework

Before we discuss the details of this framework a final note is necessary concerning applicability. Each party in a value chain may be affected in a different way by interaction. For example, the competition character between WLAN and UMTS may affect equipment manufacturers as well as operators but does not affect content providers at all. Hence, our subsequent analyses refer to a generic supply side actor. In a real study they are specific to each individual market actor.

[9] Cannibalization denotes the negative influence of an own product on an own product.

Modes of Interaction

Above, we described three modes of interaction. Substitution denotes a negative influence of one product on another product, e.g., intergenerational replacement (unilateral negative influence) or competition (bilateral negative influence). Complementation denotes a positive influence of one technology/product on the benefit or market outcomes of another. Finally, contingency means that one product/technology has no benefit without another product. It is a special form of complementary relation.

These generic types are just a subset of the set of possible relations. For two technologies/products each of them may have no, negative (–), or positive (+) influence on the other. Regard the interaction cube in Figure 2 which is an extension of Bayus, Kim and Shocker (2000).

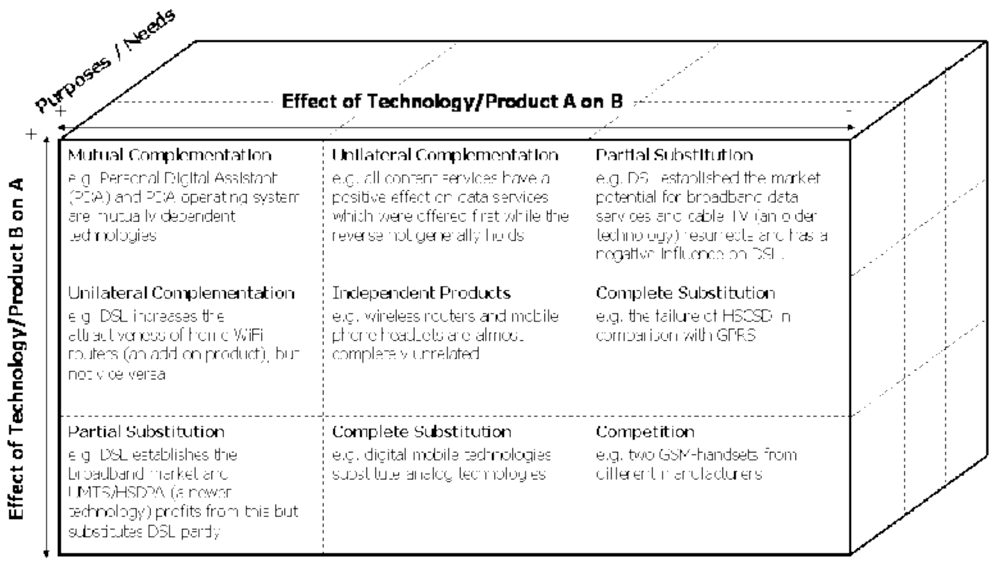

Figure 2. Interaction Cube[10]

For each of the nine categories an example from the telecommunications industry is given. Note that partial substitution means that both products are in a symbiotic relation, i.e., prosperity of one requires the other.

Shocker, Bayus, and Kim (2004) further extend this static classification with dynamic aspects allowing for order of entry and intergenerational effects. This is useful as the nature of an interaction between two technologies/products is usually not static but may change in the course of time. For example, several years ago, mobile telephony was an additional service to fixed-line telephone networks. But in the course of time, driven by price declines, domestication, technological improvements, and diffusion effects a growing part of fixed-line calls has been replaced by mobile calls. Former complements ultimately became substitutes. Likewise, WLAN and GSM/UMTS were originally no substitutes. Over the years new uses emerged giving rise to a certain substitution potential. These changes of the interaction mode may be caused by both consumers as well as suppliers. The former may find a new use case for an existing product. The latter, on the other hand, may develop a new product for an existing market and thus change existing interactions.

Levels and Scopes of Interaction

The terms “product” and “technology” remained unclarified as yet. In line with the common understanding in the marketing literature we construe a *product* as a bundle of perceived characteristics which are linked with utility expectations (Kotler, 1991). On the other hand, a *technology* is an application/implementation of scientific knowledge for the resolution of a specific problem. A product also aims at the resolution of a certain problem but it relates to the fulfillment of a certain need or objective of a person, it serves a certain “purpose”. As an example for what is meant by “purpose” consider SMS and MMS (Multimedia Message Service). While in normal life SMS and MMS may be considered as substitutes (both have a text

[10] HSCSD: High Speed Circuit Switched Data. A technology for mobile data transmission in GSM.
HSDPA: High Speed Downlink Packet Access. The second generation UMTS data transmission standard.

messaging capability), MMS could become a complement when travel photos shall be communicated instantly. In one case both products are substitutes since they serve the same purpose, in the other case they serve different purposes because MMS can handle multimedia contents in addition to pure text and thus do not compete but rather supplement one another. This suggests that the mode of interaction is purpose or use cases specific since one product can be appropriate for several purposes (e.g., Ratneshwar, Shocker and Cotte, 1999). This is indicated by the third dimension in Figure 2. A specific need may be fulfilled by different products. Different products, in turn, may be based on the same or different technologies. Although consumers generally perceive products instead of technologies, the latter may influence a product's qualities.

Now, interaction may take place at the technology or the product *level*. In the first case, two technologies are able to solve the same problem, i.e., they have the potential. In the second case, two products, based on the same or a different technology, really do interact on a market. If a consumer perceives two products as largely identical, he is indifferent in terms of the underlying technologies and competition occurs at the marketing level instead of the technology level. If WLAN, for example, offered the same service quality (coverage, roaming, handover, voice quality, security) as GSM/UMTS, people will most probably base their purchase and usage decisions on marketing factors like price. Otherwise, they will look at technological product qualities, i.e., product qualities mediated by the underlying technology. Furthermore, there may be the case that two technologies interact but there are no corresponding products (in which these technologies are implemented) on a market. For example, from a technological point of view it is possible to cover a restricted metropolitan area by WLAN and thus install a substitute to GSM/UMTS networks. However, due to cost reasons, among others, such concepts are hardly realized as yet.

Furthermore, interaction also depends on the regarded *scope*. In order for a specific need to be satisfied many product categories may be appropriate and within these categories there may be several subcategories or brands which possibly act as substitutes. The more specific a need is, the smaller the scope. For instance, the need for “communications” may be satisfied by mail, meeting, telecommunications, etc. Telecommunications, in turn, offers voice telephony or messaging. Messaging, in turn, comprises substitutes like e-mail, SMS, or MMS which in turn are offered by different suppliers (implying different brands). If the need is more specific, say “interactive telecommunications”, SMS is inappropriate and hence no substitute to fixed-line or mobile telephony. In Figure 2 a wider scope is represented by an aggregation along the “purposes” axis.

Effect Measurement

The third dimension of the framework pertains to measures of the strength of an interaction.

Generally, interaction may precipitate in a company's economic results in three ways: (1) revenues (e.g., via diffusion rates, the adopter base, usage volume, or the market potentials), (2) costs (e.g., via economies of scale), and ultimately (3) profits.

In any case, owing to complexity there are no general rules or categorizations for the extent and sign of all these effects. Remember the case of GSM/UMTS vs. WLAN and the question of whether to integrate an interacting technology. Integrating substitute technologies includes the danger of cannibalization. It depends on the margins of the substitute whether overall profits rise or fall. Nevertheless, overall revenues may rise. On the other hand, not integrating a substitute technology includes the danger of customer churn but leaves costs unaffected. Thus, both profits and revenues may drop. Integrating an intrinsically complementary technology may lead to higher revenues but does not exclude overall losses if the additional costs are disproportionately high. For instance, cameras are considered as complements of mobile phones from mobile network operators (as fostering the usage of data transmission services) as well as from handset manufacturers (as fostering handset sales owing to the bundle's higher utility to many consumers) since both expect higher revenues and profits from this combination. Finally, not integrating a complementary technology includes the risk of customer churn, especially if product bundles are highly demanded.

In summary, there are directly observable measures (revenues, costs, and profits) but also unobservables (e.g., the affected market potential). These measures relate to a certain organizational unit (e.g., a profit center, a company, a group of companies). Finally, different measures (with different organizational reference) may lead to different statements regarding the mode and intensity of interaction.

Effect Intensity

The last dimension of the meta-model pertains to the intensity of an interaction relation. First, we examine substitutes, then complements.

Intensity of Substitutability

Concerning the demand side the most important factor for substitutability seems to be the degree of perceived problem-solving congruence of products, i.e., the higher the perceived congruence is, the higher the substitutability. Thus, the degree depends on individual characteristics as well as the purpose of the usage. *Purpose* has already been discussed above. With *individual characteristics* we mean (1) idiosyncrasies as well as (2) the consumer's current adoption status. If the consumer is already invested, the substitution power of another product depends on his/her switching costs, caused by network effects, depreciations, uncertainties, etc.

The supply side may influence the degree of substitutability through the market positioning decision. Whether a potential substitution relation becomes a real substitution relation depends on the competitive environment. A special intertemporal kind of substitution may be controlled by preannouncements. For consumers it is often difficult to fully assess the usefulness of a new technology because of a lack of knowledge and uncertainty regarding the future. This can lead to cancellation or postponement of the purchase process, a phenomenon which is called “leapfrogging” and which may be augmented by “preannouncements” of suppliers (Farrell and Saloner, 1986; Schilling, 2003). Thus, a future generation interacts with the market potential of a current generation in a negative, unilateral way. As the current competitive environment can change, the degree of substitutability is also determined by the level of market entry barriers or more generally by the degree of “market structure rigidities”. We denote by this term factors which keep the market structure from changing. The major categories are: demand side rigidities (e.g., consumer switching costs), resource based rigidities (e.g., scarce resources like spectrum, capital) as well as production cost rigidities (e.g., economies of scale, learning effects). As an example of resource based rigidities, regulatory policy often limits the amount of spectrum licenses and thus the amount of substitutes.

Intensity of Complementarity

Complementary relations, on the other hand, are characterized by net utility gains from the joint purchase, consumption or usage of different products. Product bundles, for instance, are marketing based complements and need not necessarily be technological complements, too. Here, price and other marketing-mix measures are decisive factors. Technology based complementarity is characterized by compatibility.

The relation's strength depends on the attractiveness of the complementary product. The more attractive the complement is, the higher the attractiveness of the primary product. Furthermore, the larger the range of complementary products for a focal product is, the larger the potential usage scenarios and thus, the higher the attractiveness of the focal product. This is often referred to as network effects or increasing returns from variety of complementary products (Katz and Shapiro, 1985). This way, a firm may influence interaction by its compatibility decision as well as by fostering complementary products. An example for the former is interconnection between fixed-line networks and mobile networks so that phones from all networks can connect to each other. For the latter, a case in point is the ecosystem of service providers established within NTT Docomo's popular *i-mode* platform/portal. The attractiveness of this service in Japan is frequently attributed to the large variety of contents offered, among others.

CONCLUSION

In this article we showed the complexities associated with multitechnology interactions. We developed and described a meta-model which is to resolve complexity by introducing a terminology and structuring the various dimensions of the problem domain. All components of the framework are illustrated by real cases (technologies and services) from the telecommunications industry. We emphasized the framework’s usefulness. Apart from contributing to the ill-structured theoretical domain of multitechnology dependencies, it assists modelers in domain analysis and managers in strategic thinking.

We see three directions for further research. First, it is desirable to have a similarly clear substructure for each of the meta model dimensions. Second, as outlined above, the diffusion model literature still lacks studies of more complex multitechnology interactions. We may have prepared the conceptual foundations for new studies. Third, more empirical analyses from other industries should be conducted in order to support the robustness of our concept.

ACKNOWLEDGMENTS

The author thanks Deutsche Telekom Stiftung for the financial support.

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