A THEORY OF INFORMEDNESS AND BUSINESS NETWORK CO-PRODUCTION

Robert J. Kauffman
W. P. Carey School of Business, Arizona State University
rkauffman@asu.edu

Ting Li and Eric van Heck
Rotterdam School of Management, Erasmus University
{tli, evanheck}@rsm.nl

Abstract. In this theory-building research, we develop a set of propositions to examine the existence, the essential workings, and the conditions for value created and borne by business network co-production. We use transaction cost economics and informedness theory to explain why business network co-production exists; how informedness enhances value; and why customers, a network orchestrator and open standards add value to co-production. We use multiple observations from the public transport industry to validate the theoretical perspectives we develop. Triggered by liberalization and enabled by IT-based innovations and the data they generate have changed the nature of businesses. Technologies such as ubiquitous computing devices and applications, smart cards and biometrics, global positioning systems (GPS), radio frequency identification (RFID), and enhanced information search and discovery services allow firms to achieve fine-grained observations of consumer behavior. They also can rapidly customize their marketing strategies by identifying individuals at particular points in time and under particular demand conditions. This has resulted in improved information endowments, which have also affected consumer behavior and corporate strategy [10]. With this, we see the potential to alter existing markets and transform industry structures. Generating value from information is an increasingly important part of modern business enterprises, but one that needs more study [32].

There are two critical aspects to this transformation. The first is the importance of information. On the one hand, firms increasingly use advanced IT and information to support “competing on analytics” strategies to engage customers [18]. Firms are learning how they can extract value at the point of exchange. On the other hand, improved information availability provides a data-enabled research environment [3]. As such, information’s role in enabling business capabilities deserves a distinct place in the IT value research agenda [32]. This is because information can improve and create new business capabilities [10, 34].

The second is the focus on business network value. IT affects the boundaries of transaction-making [9], and the location of service process activities, and has impacts beyond the firm’s boundaries [14, 37] at the level of the business network [52]. IT value is increasingly being created and realized through actions of multiple parties in flexible business networks. Recent research argues that the next generation of IT value studies need to focus on the co-creation of value through IT rather than on IT value alone [32].

Our objective is to theorize in ways that help us understand how markets are impacted by improved information for business network co-production. We argue that business network co-production will be observed when IT offers a first-best opportunity for participating firms to produce value-maximizing products and service transactions for customers, through the selective use of process resources across the boundaries of multiple firms, rather than just on their own. We ask: What theories can inform us of how informedness enables business network co-production? What are the conditions for value creation in a business network? Under what circumstances will value be borne by the network? Our view is motivated by theories from institutional economics, IS and marketing, particularly the theories of transaction cost economics, coordination theory and resource dependency theory. We address: why business network co-production exists; how informedness enhances value; and why customers, a network orchestrator, a value-sharing mechanism and open standards add value.

We employ a case study approach [19] for theory-building and examine multiple cases where smart cards and mobile devices have been implemented in the public transport industry in the past decade. Though we contend that it is yet to develop to maturity, this under-explored market has demonstrated how firms use new IT to develop information capabilities for business network value co-production. We argue that all the information sharing capabilities and the impetus to create and bear value this way for informed consumers are a basis for business network-based production.

In §2 we develop a new theory of business network co-production. In §3, we discuss the research context and methods. In §4, we analyze three cases of smart card adoption in the public transportation industry to evaluate the efficacy of our theoretical perspective. §5 concludes.

2. THEORY AND PROPOSITIONS

We introduce the concept of a business network and explain the role of interorganizational systems (IOS). We develop propositions for business network co-production, including its existence, essential workings,
and the conditions under which it will be value-bearing.

2.1. Business Networks and The Role of IOS

Firms increasingly are entering into buyer-supplier relationships, alliances, and informal collaborations. Such interfirm relationships create the basis for a business network, a mixed mode between markets and hierarchies [38]. This industrial organization is an important current means of accessing valuable resources and information [50], whose form may vary based on the degree of coordination [22]. Kambil and Short [30] refer to a business network as the structure of interdependent relationships between the activities of a given firm and other firms in its competitive environment that influence each other’s strategies. Performance improvements occur with business networks, ranging from organizational learning and innovation [48] to improved financial results [26].

The development of IOS has contributed to the development of business networks. IOS lowers transaction costs among business partners [14, 37] and changes process boundaries [8]. IOS also makes it easier and more efficient to use modular design to decompose the production of services with vertical disintegration, which results in more outsourcing and increased customization [49]. And IOS creates the ability to couple to and decouple from other network nodes [29]. These are quick connect and disconnect capabilities [52].

How do IOS impact benefits in business network? A number of recent studies have provided evidence. Wiggand et al. [54] studied an industry-wide IOS adoption in the mortgage industry, which creates a level playing field for small companies and helps large companies become more agile, changing the industry structure. Another study looked at how benefits are created through the assimilation of business process standards [2]. The authors demonstrated that the accrued benefits are different for dominant firms versus the non-dominant firms. Rather than examining the direct relationship between IOS adoption and firm performance, Rai et al. [46] argued that IOS improves the supply chain process integration, which affects firm performance. This is achieved by improving information flow, physical flow, and financial flow integration.

2.2. Existence of Business Network Co-Production

IT changes the coordination of economic activities within and between the firms, shifting the boundaries of the firms. These changes affect the boundaries of transactions and impact the business network, which has the potential to reshape industries and the market structure. The impact of IT on process boundaries is determined by the degree to which the costs of internal coordination, external coordination, and production change [14, 27, 37]. Based on the transaction cost economies [16, 55, 56], Malone et al. [38] argue that, by reducing the cost of coordination relative to production, IT will lead to an overall shift to more use of markets rather than integrated firm hierarchies to coordinate economic activities. Clemons et al. [14] argue that, in addition to lowering the transaction cost part of the external coordination cost, IT also reduces transaction risks and opportunism risks. These support outsourcing, but with a set of specialized suppliers. Other studies indicate that IT reduces the degree of vertical integration and the size of the firm [27].

Firms thus can use IT to make strategic choices to reengineer key business processes and relationships, and transform firms’ business scope [30]. Firms can selectively access and use the valuable resources and information across the boundaries of multiple firms in their business network, as a basis for co-producing value-maximizing products and services for customers. This leads us to assert:

- Proposition 1 (The Business Network Co-Production Proposition). Business network co-production will be observed when IT offers an opportunity for participating firms to produce value-maximizing products and service transactions for customers, through the selective use of process resources across the boundaries of multiple firms, rather than just on their own.

Co-production in a network also can be characterized as inter-temporal, or occurring over time. This includes two aspects: first, firms flexibly come in and drop out of the network over time; and second, the network has a sequence of actions, and network participants can change their sequence of participation over time. So to provide services to customers, the number of firms and the order of their actions may change over time.

A network’s success will come from a firm’s “ability to couple to, and decouple from the network of knowledge nodes” [29] to produce value. When a set of firms forms a coalition to co-produce products and services that meet consumer demand, they will do so only so long as the combination of their production capabilities bears sufficient value for their marketplace. Firms can join or leave flexibly. An important dynamic of a business network is the recognition of the marginal costs and value that individual members bring to the coalition. Since firm costs and the details of product and service transactions will change over time, it is natural that participating firms will evaluate whether they can achieve a value margin and make their participation value-bearing. Firms also operate at different points on the value chain, which suggests that they may only add value for a given short or medium-term business activity, depending on the product or service. This helps the network to be tuned into consumer demand better, and may mitigate the need for longer-term relationships [14].

What are the intertemporal conditions under which a business network will be a sustainable strategic entity? Resource dependency theory suggests that a firm will enter into an interorganizational relationship to fill a resource need [42]. We assert that this need is more than a
one-time phenomenon: it will have to be an intertemporal resource need, where other firms are in a better position to contribute (e.g., cost-wise, access-wise, value-added-side, etc.) Another driver will be profitability and growth. Consumer willingness-to-pay for value-maximizing products and services will need to cover the participation costs for product or service delivery, and still provide a margin of value that can be split among firms in the business network, with residual value left over for customers. Financial economics suggests that a business network will need to have immediate value from its co-production activities, and also generate present value from growth opportunities (PVGO), which will make the growing pains of coordination acceptable from more than just a very short-term perspective [5]. Firms will need incentives from network PVGO to invest themselves.

Economic theory suggests that interorganizational relationships may increase the firm’s ability to deliver services efficiently and decrease competition in an industry [44]. Firms are not forced to be part of a network; instead they will enter an interorganizational relationship or continue to participate if the all-in strategic benefits exceed the strategic costs.

2.3. Essentials of Business Network Co-Production

Improved Information Provision. Information, with or without IT, improves and creates new business capabilities [32], and is a source of competitive advantage for firms [15]. Improved information availability creates the possibility for firms and consumers to achieve a new level of informedness. We extend Clemons [10] consumer informedness theory to include both firm informedness and consumer informedness. Firm informedness has three levels. An informed firm knows about customer information (e.g., purchases, demographics, preferences) and can capture, store, analyze and interpret this information. It also can learn what customers want to satisfy them and achieve high willingness-to-pay [33]. Informed firms know about the resources and competences of other firms too, and may wish to engage them in co-production networks, through alliances and strategic partnerships. An informed firm also will know about its value centrality in co-production, and the value-adding capabilities of its business network partners.

Clemons [10] defines consumer informedness as the degree to which consumers know what products or services, and their precise attributes and prices that are available in the market. Consumer informedness plays an important role in determining consumers’ aggregate willingness-to-pay. A consumer’s lack of information, the resulting uncertainty discount, and reduction in willingness-to-pay diminishes the motivation to innovate, as well as the profits of innovative firms. More information diminishes consumer uncertainty about a product, and thus changes consumer willingness-to-pay. Consumers will experience a sense of “delight” in the presence of more information, and not just the usual “utility.” Instead of choosing the cheapest product – trading down – the consumer will consider choosing the product with the best fit – trading out [10, 11, 31]. The latter is determined by the utility for a consumer’s ideal product or service and by how closely what they obtain from a firm matches this ideal. This suggests:

- Proposition 2 (The Business Network Information Provision Proposition). When IT supports information provision and sharing, product and service co-production will be most highly valued when (a) consumption requires a high degree of customer informedness for knowing what the alternatives are, and (b) production requires a high degree of information for the business network to construct it.

Demand-Driven Value Co-Creation. Nowadays, a customer is no longer someone who only buys products and services. Instead, a customer is a business partner whose problems organizations attempt to solve. Customers are at the core of the relational capital of network organizations [23]. This is consistent with comments by Fung et al. [21], who state that “[c]ustomers are the new axis of the flat world” and “[t]he route through this flat world begins with a customer need and ends with a customer solution.”

Two aspects are essential for a business network to be value-bearing, or able to deliver value in a general sense. First, firms need to develop the capability to fulfill customer needs by effectively using network resources. They must understand customer requirements and anticipate future needs. Second, firms may wish to support value production by including their customers in production. Value co-creation refers to the idea that value is not created only by the firm and then delivered to the consumer; instead, the consumer participates in a process that bears value [45]. Traditionally, the market was viewed as a locus of exchange, and firms decided what products and services to produce for customers. Customers were segmented for the ease of exchange and separated from the value creation process. This situation is changed with connected, informed, and active consumers [10]. Informed customers contribute to firm productivity too [4, 35].

Value co-creation may vary for different product and service delivery activities. Some activities are complex, unstructured, and highly customized to meet a particular customer’s unique needs (e.g., IT consulting, technical engineering, and software design). These knowledge-intensive activities require firms to develop customized service solutions and customers to serve as natural solution co-producers. Customers will be more likely to do this if they receive higher benefits than the costs of effort involved in co-production. Thus, we propose:

- Proposition 3 (The Business Network Customer Co-Production Proposition). Co-production involving business network firms and customers will be observed in settings where (a) business network resources are required to
2.4. Business Network Co-Production Value Sources

Network Orchestrator. Business networks manage dependencies among activities and resources within a firm, as suggested by coordination theory [17], as well as across firm boundaries in a business network. The a value-bearing business network requires effective coordination through structuring and integrating different activities for effective business network co-production [36].

In our context, a network orchestrator is an intermediary that coordinates business processes and transactions among network participants [21, 26]. It provides a basis for a network of activities that can potentially create new markets. A network orchestrator focuses on designing processes across a business network to deliver the right product to the right place at the right time and price [21].

A network orchestrator can play any or all of three roles. First, information orchestration includes improving network-level firm informedness and market-level customer informedness. Enhancing firm informedness may guide a firm’s partner selection to enhance the value of its network position. Informed consumers know what is available and the service attributes and prices, and have a higher willingness-to-pay. Second, a network orchestrator may also handle business network configuration by selecting the right partner firms and coordinating their involvement to meet the customer demand. It can mitigate consumer concerns of different network partners having different product and service quality capabilities. Third, business network management involves coordinating production of product and service transactions utilizing optimal resources and offering fair value appropriation to ensure the success of the overall process. A network orchestrator fosters trust and develops strategies to configure business networks that are difficult for competitors to imitate [43] and highly defensible [12]. We thus assert:

- **Proposition 4 (The Business Network Orchestrator Proposition).** A business network orchestrator will increase the value and sustainability of a business network, by providing mechanisms to (a) coordinate network actions to promote business network-level firm informedness and market-level consumer informedness, (b) orchestrate the involvement of firms in the business network to maximize value, and (c) manage a mechanism that offers a “fair” means for sharing network costs and revenues.

Fair Value Sharing. A business network’s sustainability depends on how business value is distributed among participating firms. Business networks exist to service various kinds of demand from their consumers and business partners. But not all requests for products and services from a given business network are likely to require identical resources for co-production. This is because multiple participating firms are involved in co-production. They will have heterogeneous cost structures and may contribute differently to product and service transactions. Also consumer demand is likely to exhibit content variation. Previous studies have examined how technological progress affects value appropriation [1, 13, 24]. Han et al. [24] examine howIOS ownership structure influences IOS joint investment among participants to maximize value that the participants can appropriate. There is a need for new knowledge that applies value sharing and property rights theory [25].

Business network firms may receive fair value based on a Nash bargaining solution [39] for the incremental business value produced. For a coalition of firms in a co-production setting, Nash bargaining produces splits of the incremental value produced. They make unique contributions of value, albeit with different costs, which may not be properly taken into account. This may cause some firms to be unwilling to participate or continue, based on perceptions of unfair value allocations relative to effort, leading to network instability.

Other theoretical perspectives explain the motivation that firms have for leaving a business network related to value sharing [7, 24]. Disagreement payments are the payoffs participants receive when they fail to reach an agreement, and include threat points and outside options [7]. In a business network, a threat point refers to the value that network firms receive when the bargaining process continues with no agreement. This does not rule out the possibility of future cooperation, but maximum value can only be achieved when an agreement is reached between network firms. Outside options are defined as the payoffs participants receive when the bargaining is terminated permanently. Taking an outside option means giving up the original opportunity with the bargaining partner in one network and pursuing other opportunities with other networks. Firms that take an outside option may suffer from the specificity of IT investment, but can do better if they adopt open standards.

An improvement is a Shapley value-based bargaining solution [7]. This is calculated by multiplying the expected marginal value that a firm creates for the business network, with the probability of each such network’s occurrence. Because each firm’s contribution for a given network cannot be predicted, the Shapley value solution at least creates a basis for responsive value sharing when consumer demand, network co-production and network formation are all stochastic. We assert:

- **Proposition 5 (The Business Network Participant Value Sharing Proposition).** Business networks exist to service various kinds of demand from consumers in the marketplace, but not all requests for products and services are likely to require identical resources or the same business networks for co-production, so the value contributions of individual firms will be stochastic, requiring fine-tuning of any cross-network value sharing mechanism that is used.
The Impetus for Moving to Open Standards. Standards reduce switching costs and opportunism costs, and enhance interoperability [54]. In contrast to proprietary standards, the development of open standards increases the available network effects, creates greater value for the network users, and decreases complementarities between IT assets. Firms involved in technology and process standards often develop and migrate to open standards. This mitigates their risk of lock-in, reduces operating costs of integration, allows firms’ own IT assets to easily connect with otherwise incompatible technologies, and benefits all participants in the business network. Further, adopting open standards facilitates information and infrastructure integration, and process integration among multiple firms. We propose:

- Proposition 6 (The Open Standards Support Proposition). Firms that adopt open standards have a higher likelihood of being tapped to participate in business network co-production, since their operating costs will be lower, thus enabling greater capacity for marginal value production in the business network.

3. RESEARCH CONTEXT AND CASES

3.1. Research Context

We use a multi-case study method. Our context, public transportation, is important in today’s economy: sustainability issues are on every country’s agenda. The increased adoption of smart cards and mobile ticketing technologies has allowed providers to deliver seamless travel services in different cities, regions, and borders with the support of a single channel: smart cards. Service providers need to understand impacts of new IT on their markets and service production process.

Mobile payments have potential to impact the existing market and engender widespread adoption [6, 57]. Mobile SUICA was introduced in Tokyo in January 2006, and signed up more than 20,000 subscribers in the first week. For the Olympics, Beijing introduced smart cards in May 2006 and had 1.5 million first-day adopters. There are a number of benefits associated with using smart cards in public transportation. Key benefits are shown in Figure 1.

Figure 1. Enhanced Experience of Using Smart Cards

We chose three cases. The Octopus Card in Hong Kong was the first and most successful adoption in the world so far. The second is the OV-chipkaart (Public Transport Chip Card) in the Netherlands. It was the first nation-wide implementation and is developing rapidly. The third is the Oyster Card in London, which achieved a high penetration rate in a relatively short period of time. We obtained case study information through field study data collection. We conducted interviews with managers in strategy, pricing and revenue management, and business development in three geographically different locations between 2005 and 2008. We also used archival data, including company websites, newspapers, magazine reports, and corporate brochures.

3.2. Orienting Background on the Three Cases

Octopus in Hong Kong. With the idea of developing an automated fare collection system based on contactless smart cards, Hong Kong’s underground railway operator Mass Transit Railway Corporation (MTRC), together with four local public transportation operators, formed a joint venture on June 1994 that came to be Octopus. It was introduced to the public in 1997 and expanded to other transport services such as bus, ferry and taxi.

In 2001, Octopus entered various retail markets. Stores in Hong Kong began to accept Octopus, including 7-Eleven, McDonalds and other fast food restaurants, Starbucks coffee shops, and convenience stores. Continuing its expansion, Octopus successfully replaced all of the Hong Kong government’s 18,000 parking meters with a new Octopus-operated system in 2004. It further expanded to government facilities, including public swimming pools and sports facilities [41].

Octopus is the world’s most successful contactless smart card with 13+ million cards now in circulation and 9.2 million transactions each day, amounting to a total of US$3 billion a year. Today 95% of the population between ages 16 and 60 possess the Octopus Card in Hong Kong, with over 2,000 accepting service providers and over 50,000 Octopus readers deployed [41].

OV-chipkaart in The Netherlands. The public transport industry in the Netherlands is run by semi-governmental organizations and will soon be privatized. Established by five major public transport operators in the Netherlands, Trans Link Systems (TLS) delivers a seamless ticketing and fare collection solution for the entire Dutch public transportation network. TLS [51] “was established in 2002 by Connexxion, GVB (Amsterdam), HTM (The Hague), the NS (Dutch Railway Company) and the RET (Rotterdam). [They] provide 80% of public transport services in the Netherlands … [and] also work in partnership with the remaining public transport companies, united in the trade association MOBIS.”

The system was initially rolled out in major cities such as Rotterdam and Amsterdam in 2008 and will extend to cover the whole country. Using smart cards and reader technologies, this all-encompassing contactless ticketing infrastructure will cover trains, metro, trams and buses, providing travelers with increased conveni-
ence and added satisfaction. When fully implemented, it will support 1.5 billion transactions each year.

**Oyster Card in London.** Oyster Card is the smart card used within the Greater London area of the UK. Supported by Transport for London (TfL), it is valid on a number of different travel systems: the London tube, buses, trams, light railways, and national railway services. The card was issued to the public in July 2003 with limited features, phased introduction of further functions. By March 2007, over 10 million Oyster cards had been issued, and more than 80% of all journeys on services run by TfL used the Oyster card. In September 2007, TfL has partnered with Barclaycard ([www.barclaycard.com](http://www.barclaycard.com)) and launched a new card – Barclay OnePulse ([www.barclay-onepulse.co.uk](http://www.barclay-onepulse.co.uk)) – combining credit card functionality with an Oyster card [53].

### 4. CASE ANALYSIS

We will use our observations from the three cases to evaluate our theory of business network co-production.

#### 4.1. Existence of Business Network Co-Production

Travel services have been a discontinuous process for most customers; providers have not supported a customer’s entire journey. Different providers use different operational standards, fare media, and price structures. So customers are required to be in contact with multiple providers for each part of their journey, including getting access to separate timetables and purchasing different types of tickets. The information customers receive is generic and not aligned with their desired journey.

This situation has changed since the introduction of mobile ticketing technologies enabled by smart cards and mobile devices. It allows customers to travel across all modes of transport with one fare media. It also enables multiple service providers to co-produce travel services across the boundaries of multiple firms. An example is the Business Card in the Netherlands. It is a travel product that is made available by Netherlands Railways [40]. A cardholder can make a call and inform a provider when she needs to arrive at her final destination. The provider will send a taxi to bring her to the departure railway station. Another taxi will be waiting for her upon her arrival at the destination railway station. This true door-to-door service will be billed to this customer’s Business Card account, and the cardholder will get a monthly bill, and not pay in advance.

This home pick-up and destination delivery service is organized based on the needs of the customer. Requests vary though, so the service is only organized after the customer issues the request. Netherlands Railways then pulls together the transport service providers from different cities and regions to compose a service to meet each customer’s needs. The selection of business network firms is based on the desired departure time and arrival time of the customer, the providers’ operating schedule, and the availability of the providers. A senior transport consultant whom we interviewed commented that “in the long run, transport service providers will abandon rigid schedules in favor of more adaptive and on-demand services.” This shows the existence of business network co-production for travel services produced with selective use of process resources across firm boundaries: Business Network Co-Production Proposition (P1).

In contrast to standard operations using fixed timetables, services like this are accomplished by a coalition of transportation service providers, delivering flexible network operations on an as-needed basis. Transport firms in different geographical locations may join together to provide transport services for one particular customer order. Their participation may change depending on the availability of different firms. The sequence of their participation may also change depending on each customer’s specified origin and destination city, preferred departure and arrival time, and preferred mode of transport. This is consistent with the idea that business networks of firms will flexibly form and disintegrate over time. Such a network can tailor travel services for changes in customer demand. This bears value based on customer willingness-to-pay and is shared among service vendors based on the contributions they make. This is also reflected by Netherlands Railways’ strategy to shift from a national unimodal transport company to a customer-oriented European multimodal service provider. This operator seeks to achieve integrated mobility management via value creation, service orientation, product development, and profit management.

#### 4.2. Essentials of Business Network Co-Production

Smart cards and mobile ticketing technologies provide a high degree of information and support information sharing. Service providers are much better informed today through IT. In the past, information concerning customer identities, what type of travel products they used, and when they used them were outdated, usually inaccurate, and even unknown. With smart cards, service providers learn about their customers’ travel behavior. This includes information on locations to and from which they travel, what times they travel, what tickets they purchase, and what mode of transportation they use – with more accuracy. Three examples illustrate how this information provision allows providers to adjust their operations to better accommodate customer demand.

First, in 2007, Octopus began focusing on individual customers via targeted marketing using data mining, business intelligence, and data analytics. Octopus’ Managing Director, Richard Warland commented: “[This] enhances our … database to provide a more accurate and comprehensive view of current and potential customers” [20]. The goal is “to delight customers whenever they encounter Octopus” [41].

The second effort we observed as a result of the increased information provision is service providers’ active...
engagement of employing more flexible tariff structures given the opportunity the smart card data may provide. A senior manager at Netherlands Railways said: “We see the rich customer data provided by smart cards can help us to design a better fare policy that ensure financial targets, manage demand, ensure effective use of resources, and maximize social benefits.” This provider has spent a considerable amount of time and effort in understanding and learning their customers’ needs and preferences.

The third example is TfL’s use of Oyster card data to gain insights into passenger travel behavior for strategic research purposes, on interchange behavior, fare policy changes, and measurement of service quality [47]. These new insights can permit transport firms to develop new products and adjust their services and operations to better accommodate their customers, thus, improving service levels and customer satisfaction.

These three examples provide strong support of the firm informedness aspect of the Business Network Information Provision Proposition (P2). Yet customers increasingly demand real-time travel information to make informed decisions. A collaborative initiative of all public transport companies in the Netherlands is 9292 (www.9292ov.nl). See Figure 3.

---

**Figure 3. 9292 Travel Information Search Interface**

9292 offers real-time integrated travel information across all modes of transportation to individuals and corporations. It covers bus, tram, metro, rail, ferry, taxi, and also car route and P+R travel. Customers can access this information by Internet, telephone, and mobile devices. Consider this: a customer tells the system about the departure time/ location and arrival time/ location, and specifies the travel preferences among different transport modes. 9292 suggests a set of alternative journeys that satisfy the customer’s requirements. The alternative journeys are different combinations of the specified transport modes, time, and location. The system will inform the customer about the tariff, real-time delays, rerouting caused by track maintenance for rail travel, traffic information for car travel, and weather. This is in line with the consumer informedness aspect of the Business Network Information Provision Proposition (P2).

The examples represent the information and demand-driven propositions. The industry has moved from segmented travel to multimodal networked travel, which suits customer requests for hassle-free and seamless travel, which should support higher value. See Table 1.

---

**Table 1. From Segmented to Networked Travel**

<table>
<thead>
<tr>
<th></th>
<th>SEGMENTED TRAVEL</th>
<th>NETWORKED TRAVEL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Networked Technology</strong></td>
<td>Individual transport service provider</td>
<td>End-to-end multi-modal transport service</td>
</tr>
<tr>
<td><strong>Media</strong></td>
<td>Paper ticket, magnetic card</td>
<td>Smart card, mobile Interoperability, joint settlement / clearing, security requirements, privacy</td>
</tr>
<tr>
<td><strong>Application</strong></td>
<td>Individual transaction processing with each operator, not interoperable</td>
<td></td>
</tr>
<tr>
<td><strong>Networked Information</strong></td>
<td>Different info source, unpredictable vehicle state</td>
<td>Smart card data about customer travel</td>
</tr>
<tr>
<td><strong>Firm Information</strong></td>
<td>Survey by different providers</td>
<td>Travel info via a single interface, real-time update on the move</td>
</tr>
<tr>
<td><strong>Customer Information</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Note:** This is a snapshot of the public transportation information service portal 9292’s search results for traveling from Amsterdam airport to Erasmus University in Rotterdam. For a specified departure time / location and arrival time / locations, 9292 provides detailed travel advice, including travel time, number of interchanges, alternative journeys with different transport modes (bus, tram, metro, rail, ferry, and walking).

So service providers use data captured by smart cards to understand customer travel patterns and tailor services for their requirements. Consumer informedness and one-stop-shopping at mobility hubs push providers to collectively offer integrated travel and real-time updates of travel and traffic information. This matches the Business Network Customer Co-Production Proposition (P3).

### 4.3 Business Network Co-Production Value Sources

Octopus in Hong Kong, TLS in the Netherlands, and TfL in London act as network orchestrators to coordinate and manage the smart card implementations in their environments. The benefits of smart cards will not be apparent until their transaction volumes reach critical mass, and are able to drive down initial investment costs. These network orchestrators coordinate and manage the process of smart cards roll-out: implement technology infrastructures, set standards, issue cards, manage integrity, process data, and allocate revenue. There are different network orchestrators for different networks. With Business Card, Netherlands Railways is the network orches-
trator in networked travel service production. It selects local service providers that can fulfill part of the journey, shares schedule information among different parties, and manages revenue appropriation. This supports the Business Network Orchestrator Proposition (P4).

Fair value sharing among network participants is possible now. Formerly there was limited information on how much revenue each service provider made because accurate data on patronage were not available as a result of different ticket fulfillment mechanisms across different service providers. After the implementation of smart card systems, all service providers are able to link their IT systems to a central data clearing house. It does revenue apportionment and fund transfers among participating firms, as we suggested in the Business Network Participant Value Sharing Proposition (P5).

One of the key success factors for large-scale smart card implementations is to allow interoperability. Earlier implementations of transport smart cards used proprietary smart card ticketing scheme. So, London’s Oyster card does not work outside the city because cards in other areas follow non-interoperable scheme-specific designs. This limits flexibility, convenience, and usefulness of the smart cards. Joint work by industry and government has created an interoperable smart media standard – the Integrated Transportation Smart Card Organization (ITSO) specification – that covers the entire system [28]. It includes smart card, point-of-sale data, data formats, transfer, platform/ticketing applications, product descriptions, and security. It opens the way to simplify ticketing and seamless travel for the individuals. They are more flexible to support wide-ranging multimodal services by the providers. This gives evidence for the Business Network Open Standards Support Proposition (P6), though we cannot conclude the causality between firms that adopt ITSO standards and their likelihood to engage in network co-production.

Still, there is no industry-wide smart card standard. To date, standards development has been restricted to local or regional areas. In Europe now, we see VDV in France, Intercode in Germany, and SODA in the Netherlands.

5. CONCLUSIONS

We conclude with our main contributions, and an assessment of the limitations and the generalizability of our propositions to other industry contexts beyond public transportation. Table 2 shows our findings on the theory.

5.1. Contributions

We have developed a new theoretical perspective on business network co-production. We explain why it exists, and the intertemporal nature of it; how informedness and customer co-production enhance network value; and why a network orchestrator, value sharing mechanisms, and open standards add value to co-production. We reported on three different cases from Europe and Asia that have gone through significant IT-driven changes from smart card implementations in the last decade. They resulted in various outcomes that enable business network co-production with customers. The extent of this transformation differs across the cases.

Based on our theory development and empirical analysis, we offer three implications. First, the development of fare media technology and platform applications depends on different industries and standards. Technologies used in public transportation have high requirements for speed, privacy, reliability, and security that are stricter than most others. Modern smart media such as smart cards and smart phones meet these tough requirements. Based on the Open Standards Support Proposition (P6), we expect that transport firms will continuously and collaboratively develop open standards for technology, information, and processes to meet the requirements.

Second, we expect that, in the long-run, public transport firms will eliminate rigid schedules in favor of a more adaptive and on-demand hyperdifferentiated public transportation service. Third, based on the Business Network Customer Co-Production Proposition (P3), we foresee that more and more transportation service providers will tailor customized multimodal services to “delight” the individual customer and enhance her travel experience. Evidence of this trend is already appearing. We expect this will change the nature of the market competition to competition among networks.

5.2. Generalizability and Limitations

We studied the public transportation industry and conducted exploratory case studies to validate our research propositions. In an exploratory sense, this study offers theory that is potentially applicable across multiple product and service domains (e.g., airlines, hotels and rental cars, or realtors, lenders and home repair services) – to firms that have a will to compete with IT innovations. A good example is Li & Fung, a trading company based in Hong Kong [21]. It had US$10 billion revenues in 2007, yet does not own a single factory! Instead it works with 8,300+ suppliers in 26 counties to organize flexible supply networks for each customer order it receives. Its expertise lies in collecting the most up-to-date information on how to best manufacture a product for a customer. It acts as a true network orchestrator.

This study has a number of limitations that need to be addressed in the future research. First, our case studies are exploratory in nature, so future research might benefit from in-depth case studies that follow business network technology implementations. This will yield better insights about how business network co-production evolves. Second, we can further validate additional aspects of our theoretical propositions. Our cases could not cover all of their aspects, so this will be worthwhile. Third, there are other important issues related to network co-production that warrant further investigation, such as network stability and sustainability.


<table>
<thead>
<tr>
<th><strong>BUSINESS NETWORK</strong></th>
<th><strong>THEORETICAL PROPOSITIONS</strong></th>
<th><strong>EMPIRICAL EVIDENCE</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Existence</strong></td>
<td>Network Existence Proposition (P1): IT offers a first-best opportunity for firms to produce service transactions, through selective use of resources across firm boundaries.</td>
<td>A service provider organizes multimodal transport services beyond firm boundaries. Examples: Octopus in Hong Kong, OV-chipkaart in the Netherlands, and Oyster card in London.</td>
</tr>
<tr>
<td></td>
<td>Information Provision Proposition (P2): Observed where (a) consumption requires a high degree of customer informedness, and (b) production requires a high degree of information for the business network to construct it.</td>
<td>Multimodal search service informs customers about tariffs, real-time delays, rerouting for rail travel, traffic information for car travel, and weather. Example: 9292 in the Netherlands.</td>
</tr>
<tr>
<td></td>
<td>The Business Network Customer Co-Production Proposition (P3): Observed where (a) business network resources are required to meet customer demand, and (b) customer involvement yields better benefits beyond the costs expended.</td>
<td>Consumer informedness and requests for one-stop shopping services at mobility hubs push service providers to collectively provide integrated travel experiences and real-time updates of the travel and traffic information. Examples: Business Card and 9292 in the Netherlands.</td>
</tr>
<tr>
<td><strong>Essentials</strong></td>
<td>Network Orchestrator Proposition (P4): Network orchestrators does (a) information coordination, (b) orchestrate network firms’ involvement, and (c) manage “fair” sharing network costs and revenues.</td>
<td>Octopus in Hong Kong, TLS in the Netherlands, and TfL in London are responsible for coordinating and managing the process of smart cards roll-out: implementing technology infrastructures, setting standards, issuing cards, managing integrity, processing data, allocating revenue.</td>
</tr>
<tr>
<td></td>
<td>Value Sharing Proposition (P5): Fine-tuning of cross-network value sharing is required in the case of stochastic value contributions from network firms.</td>
<td>All providers link their IT to a central data clearing house, which does revenue apportionment and fund transfers among participating firms. Examples: Hong Kong, the Netherlands and London.</td>
</tr>
<tr>
<td><strong>Source of Added Value</strong></td>
<td>Open Standards Proposition (P6): Firms that adopt open standards have a higher likelihood to participate in business network co-production.</td>
<td>Interoperability allows customers to use travel products, card value, applications, and media through a common interface. More and more service providers participate in interoperable smart media standards. Examples: Hong Kong, the Netherlands, and London.</td>
</tr>
</tbody>
</table>

**REFERENCES**


[23] Gulati, R., and Kletter, D. Shrinking core, expanding periphery: the relational architecture of high-performing or-


[40] Netherlands Railways. NS: Business card, 2009. [ns.nl](http://www.ns.nl)


**Acknowledgments.** This research was sponsored by Netherlands Railways and the Erasmus Research Institute of Management. Rob Kauffman acknowledges partial support from the W. P. Carey Chair in Information Systems, the Center for Advancing Business through Information Technology, the Rotterdam School of Management at Erasmus University, and the Shidler School of Business at the University of Hawaii. The usual disclaimers apply.