The Concept of Infra-Services: Toward a Definition?

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Purpose

Described as the world's larges machine, large technological infrastructures embrace us with its services. Those infrastructure-based services enable communication, energy utilization, financial transactions, transportation, etc. In this paper we will label those services *Infra-Services* and argue that Infra-Services is a special class of services which falls into the intersection of the wide service domain and the domain of industrial/technology management. The aim is to take a first step toward a research agenda by demarcate, define and illustrate what we refer to as an Infra-Service.

Design/methodology/approach

The papper is based on selected literature, illustrated by examples from Energy and Telecom services

Findings

In the Conclusion section a tentative definition on Infra-Services is presented based on two illustrative cases.

Research and Practical Implications

The research implication is that future research within Service Science need to focus on segments of services, where Infra-Services is one specific type of services following a specific business logic.

Originality/value

The novelties of the paper are: (i) the approach to focus on a specific category of services – Infra-Services and (ii) to link service research to past research on large infra-systems (LTS).

Introduction

Beneath us above us and around us, Infra-Service operations embrace us living in the modern society. Hidden, invisible operating 24-7 the all-embracing services that we take for granted is providing us with: energy available for usage almost everywhere, communication opportunities connecting us with anyone any time, and travel connections taking us where ever we want. The modern society relies on those partly invisible operations, and when they fail they are as most wanted. When there is an electric outage, when the connection to the internet fails or, when the credit card does not connect to the bank, these services become visible and our dependence on them becomes clear. For example, during the great electric outage in New York in 2002, the most frequent question to police officers was "How do I get cash?" In an instant, the society went back to an earlier stage of development without credit cards and electronic payment systems. Moreover, the importance of the Infra-Service operations for the modern society is also manifested in the attention given by authorities that for monitoring and regulating them. In addition, currently there is also a continuing transfer of ownership of Infra-services, from the public to the private sector. This transfer and deregulation (or re-regulation) is to a large extent driven by political ambition to increase the productivity, reduce cost and enhance innovation in these sectors. However, it is also driven by technology development changing the competitive factors within some Infra-services.

Due to the complexity of the services provided, including the business logic, we will in this paper argue that Infra-Services is a special class of services which need particular attention from multiple disciplines. To enable an interdisciplinary focus on Infra-services the specific aims of this paper is to demarcate, define and illustrate what we refer to as an Infra-Service.

The ambition of the paper is to contribute to the emerging field of Service Science (e.g. Maglio and Sphorer, 2008) and Service Dominat logic (e.g. Vargo and Lusch, 2008) in two ways. First, the paper focuses on a specific category of services – Infra-Services. By delimiting, illustrating and defining this type of services, the paper contributes to the field of service science by demarcating a specifically important area of services, an area that follows specific service business logic and an area which has specific inter-disciplinary research needs. The aim of the paper is however not to link all findings from the fields of Service Science and Service-Dominant logic to the area of Infra-Services – this is a task for future research. However, the aim is to sketch out a tentative definition of Infra-services which can function as a focal point for future research. Second, the paper exploits one theoretical link between service science and other fields of studies. In this case the field of Large Technical Systems (LTS).

Theoretical Frame: Integrating Service Science and Large Technical Systems (LTS)?

Within the overall field of service management parallel streams of thought has emerged such as Service Science (e.g. Maglio and Sphorer, 2008) and Service-dominant-logic (e.g. Vargo and Lusch, 2004, 2008). These streams can be interpreted as the search for, or re-start of services studies. In the core of such a re-start lies an ambition to exploit what is already known about the customer-service provider interface, however broaden the scope of service studies to include other issues such as technology, operations and business related issues. For example, Maglio and Sophrer (2008, p18) state that: “Service Science would combine organizational and human understanding with business and technological understanding”.

To focus research within Service Science, the concept of *service systems* has been introduced as a focal concept. A service system is defined as: “value co-creations of people, technology, value propositions connecting internal and external service systems and shared information (e.g., language, laws, measures and methods)”, Maglio and Sophrer (2008, p18). Central in this definition are the ideas about: co-creation of value, an implicit idea of a value constellation (Normann and Ramirez, 1993), structure of service (co-)production as well as hard and soft system components such as a technical infra-structure and person-to-person interaction, all packaged within a systems perspective.

In this paper we also take the starting-point in a system perspective, however, from another stream of research – the field of Large Technical Systems (LTS). LTS literature has investigated what in their terminology is referred to as *Infra-Systems* where LTS studies focuses on the interaction between technical, institutional and social factors influencing the development of technology in society Hughes (1983,1993). Typically the LTS field assembles researchers from disciplines such as: innovation management, industrial dynamics, history of technology, science and technology studies (STS) as well as specific engineering disciplines. For example, Kaiser (1994) has conceptualized some aspects of similarity between different types of Infra-Systems. He stress that not only the purpose of a system, but also its specific design is of importance to understand the systems. One particular contribution from the LTS field is the discussion about flows in networks. Flows in networks of Infra-Services can be described as: diverging (e.g. electricity, gas, water), converging (e.g. sewage systems, waste handling systems), point-to-point (e.g. transport and telephony), one-to-many flows(e.g. internet services) and area covering (e.g. broadcasting services)[1]. The different characteristics of these flows illustrate some fundamental aspects of these services as well as providing a framework for analysis.

The concept of system and infrasystem has also been explored by Hughes (1983,1993) in his great exposé of the electrification of society. The concept of system in his setting means, from a general point of view, a set of components and a network connecting the components, similar to definitions of systems made by general system theorists (e.g. Churchman, 1988; Miser 1985; von Bertalanffy 1998).We will not elaborate further on the definition of systems, however, it is worth noticing that the system theorists, including the LTS-approach, often stress the system boundary. In their terms something is either is inside or outside the system and a component outside the system is said to reside in the environment of the system. Using this approach, the actual service delivery process – the co-production phase – is not covered as it lies on the outside of the (technical) system. One reason for the omission or non-interest in the interface between customers and service delivered has to do with the historical fact that the infraservice were monopolies. The interaction between the customers and the service delivery organisation was simple and black-and-white; either you bought the service or you did not.

In addition, literature in the LTS-field focuses and discusses the infrasystems, the historical roots and growth, the institutional settings, however most often fails, or does not include, the business aspects of the service, a weakness pointed out by for example Lagergren (2004) and Jonsson (2006). Nevertheless, business related aspects of Infra-services are discussed, for

[1] Adapted from Kaiser (1993).

example in research journals published by engineering organisations e.g. IEEE or ASME. However, in this case the debate is held in journals related to a particular field of engineering. In addition, from a service management perspective, it is interesting to notice that the service encounter including the interaction with the customer is omitted in LTS studies. Instead LTS focuses on the technical structure which delivers the services.

To conclude, there is a large established research fields that to some extent describes and analyse Infra-Services mainly from a historical perspective. Although the area of LTS is established there are few, if any, studies that make a cross-industry-analysis of Infra-Service, that includes the business and innovations aspects or that addresses the customer as co-produces of a service. One reason for this lack of interest can be that many models and research perspectives originate from the traditional industry-based managerial approach where the logic of industrial mass-market manufacturing dominates. Another reason might be that Infra-services for a long time have been monopolies and in a monopoly there has been little interest in customer related issues. Nevertheless, the LTS literature provides the further studies of Infra-Services with a number of potentially fruitful concepts. In LTS the physical network is central, including the flow of something in the network. In the following section we will give two examples of Infra-Services that illustrate this specific type of service.

Infra-Services: Two Illustrative Examples

Infra-Service comprises service systems in the form of a large network with the consumer as end user and with parts of the system regarded as public goods. Examples of Infra-Services are:

- Electric Utility Services
- Telecom Services (including internet services)
- Transportation (including railways, airlines and public transportation)
- Banking (e.g. payment systems, mortgage and credit operations etc)
- Media

In the following sections we will take a closer look at two of these services: Electric Utility Services and the Telecom Services. In the presentation of these two services we will highlight: the technology network structure, ownership structure, regulations, the customer interface and trends and developments.

Electric Utility Services

The electric utility industry appeared towards the end of the 19th century and made a fast growth during in the USA and the Western world during the early 20th century. The first stage of development was to a large extent coloured by individual inventors that formed the industry structure, designed the business models and made the industry grow fast. Inventors like Edison developed the first general model for large-scale electric power business. The idea was to sell electric lighting which included: installation, maintenance and replacement of lightbulbs, the electric energy needed and the technical, financial and institutional network "behind" to provide the service. The resulting industry "idea" was the city-based energy company with a central power plant selling th electric light service to wealthy citizens. Hughes (1983,1993)

The next stage of development was the universal electric power service. Fuelled by the invention of the electric transformer it became possible to serve a large number of different electric equipment in industry, service and homes. This lead to a rapid expansion of power networks, power plants and electricity usage. The economy of scale became the dominant idea for the development of the electric power industry. From the 1930ies until the 1990ies this idea dominated the development of the power industry. In order to create even greater economy of scale, the governments had to be employed one way or the other. In the US it took the shape of FERC (Federal Electric Rate Commission), a federal institution that on one hand regulated the price and service level to consumers, on the other hand provided a sort of financial guarantee which was necessary to provide economic stability for the large long-term investments. During this era the industry in general was dependent on stable and low prices on electric power to provide a foundation to rapid expansion of mass-production manufacturing industry.

The recent stages of development, the deregulation and opening of markets for electricity, have first turned electricity into a tradable commodity and second forced the industry into a new regulatory regime as a means to increase productivity in industry, and third, moved the industry into a large technology shift to curb global warming.

The recent development above have over the last decade put the industry literally upside down with new challenges to meet: Branding, Service development, shake-out of old structures, values and practises and bringing in new, Shifting key knowledge from technology, construction and production into marketing, trading and finance, only to end-up in new huge technological challenges.

Technology network structure

The technology structure has developed over decades into very large power networks with centralised power production in ever increasing power plants. The centralisation of power production has been driven by economy of scale and by stable financial conditions; government loans, government ownership monopoly and/or regulated prices, - besides all the technical advancements with larger power plants, e.g. emission control, logistics regulations etc.

The build-up of the electric grid system has also been following the centralisation idea with one-directional flow of power from production to users. The grid systems are centrally planned and centrally controlled. Until now.

Since many new electricity generation equipment is installed , e.g. windpower, is installed at the perimeter of the existing grid system. Also other types of new generation equipment e.g. solar-photovoltaics and small “on-site” gas-fired generation facilities are installed closer to the customers making the old centralisation idea obsolete. This new trend clashes with technology and culture of the old central system.

The technology issues, e.g. that there are design details that obstruct and prohibit connections far out in the network can be countered by new technology in the form of communication technologies. Today, one large “buzz-concept” of the electric power industry is the “smart-grid” concept whereby new means of communication are integrated ion the power network management, opening new ways of building, monitoring and interacting within the power system. The first steps towards a smart grid has already been taken in Sweden where all 4,5 million meters in homes have been changed into new digital devices with built-in communication capabilities. These new meters measure electricity by the hour or at least monthly, enabling a more accurate billing. But the new capabilities also open up a spectrum ogf new service opportunities linked to the metering information, e.g. when does a household use electricity, to what purpose, how effectively etc. This information can then be of use with tailored energy efficiency services such as: energy surveillance, marketing of energy efficient home appliances etc.

Ownership structure

The ownership structures varies a bit between countries, but in general a large public ownership in the form of nations or states is very common in continental Europe. In the US there are large privately held companies alongside state-owned utilities. We are gradually approaching a convergent ownership scheme in which public and private owners act similarly on a market.

Governments who in the past were owners by necessity, nobody else would invest in large scale infrastructure development, are now shifting over to other ways of controlling and developing the market. The art of governance without direct ownership is developing all the time. Fine-tuning of regulations to force energy companies to reach the publicly decided goals are getting better and better.

The ownership of certain bottle-necks of the infrastructure has been a difficulty. Who should be allowed ownership of power transmission within countries? Who should be allowed to have ownership of power transmission between countries? Who should own gas network infrastructure?

These unsolved issues are debated and the regulation is evolving.

Another bottleneck is the access to end-users. Various regulations of the end-user transmission/connection fees are put in place while separating the energy trade from the usage of the power lines. This regulation works fairly well although problems occur when new small scale power is about to be connected to the distribution network. The pricing schemes are designed for electricity consumers, not for small scale producers.

Regulations

Today, most of Europe has been through the deregulation phase and the new competitive environment is in place. This is something new and radical to many. E.g. in France, the right to electricity was seen almost as a “right” for citizens and not a tradable commodity. The price was set in parliament and considered more or less as a legislation. Having a price that varies by the hour according to a power exchange was considered an odd idea.

Alongside competition regulators are struggling with harmonizing the European electricity market and also to enforce new regulations that steer the technological development and the investments towards “green” technologies which is a difficult task.

Various tax-schemes and tax-incentives are given to promote certain investments and make other investments obsolete.

Customer interface - from unified tariffs to unregulated pricing.

In the early years of electrification, electricity was primarily used for electric lighting. The entrepreneur Edison adapted his business model to this fact and started to compete with other forms of lighting by offering a superior service for a high price, i.e. he reached for the top-end of the market. His business model was to offer customers electric lighting for a price per installation regardless of the usage. The price was a few cents per day per installed lamp. This pricing model worked well and led to a rapid expansion on the Edison electric system. Similar business models are in use today for selling mobile broadband, IPTV, Cable TV and similar communication services.

As the markets developed more and more applications for electric lighting and electricity usage were developed. New innovative pricing schemes were developed based on the value creation for the customer. Electric lighting used for illuminating advertisement boards were charged with a higher price than usage in homes etc.

This development came to an end when a measurement for electricity was developed; the kilowatthour. The base for the pricing principles switched from the value created for the user to the resources used. On one hand the standardised pricing scheme was a result of the

innovations and rapid growth of electricity usage, on the other hand the prices were now set based on metering of an abstract parameter.
This led to further standardisation and an increased focus on the production/generation side of the power system. The power industry became a tool for rapid growth of the national economies. There was a link between the economic growth and the amount of power generated in a country. This link between power and economy created a power race in which western economies raced to build up power plants in a rapid pace.
During the 1980ies and 1990ies, the link between economic development and power was broken and the internal efficiency of the utilities was questioned. By introducing competition the productivity was to be increased and hence provide lower prices on power. Among all things appearing in the wake of the deregulation, two things have concerned customers more than anything else: the idea of a market price and the re-awakened interest among the power companies in the customer.

Different types of power exchanges have appeared in different countries. They both provide spot-prices on electricity and futures contracts. The spotprices vary depending on supply and demand just like any commodity. The spotprices also function as an indicator for other contracts which are not traded. The function of the power exchange is to provide a structured way of meeting between power supply and power demand. What it also gives is a continuous valuation of the electric energy which is important to relate to in a number of situations.

Rediscovering customers

When the power companies re-discovered customers the industry started to develop advanced communication and marketing strategies. The challenge was to brand and give an identity to a service which had been stripped from identity a few decades earlier. The earlier core idea behind the standardised tariffs, measurements of kilowatthours, etc, when they were introduced, was to take away all identity connected to electricity, and now the opposite strategy was enforced.
The core issue became: How to brand an "invisible" service? So far various strategies have been applied: Local branding – "Buy from your local dealer", production type branding – "Buy green electricity", "Buy windpower", Affinity branding – "Buy all your energy needs from us and get a discount", Service bundling schemes – "We offer energy-efficiency service along with our electricity", Value branding – "Our profit goes to charity" as the company "Godel" (good electricity) markets itself.
The communication with customers and interest groups around the energy companies have also increased due to the climate change debate. In most countries huge investments in new carbon dioxide free power productions needs to be taken in order to reduce the climate change.

Trends and developments

The next stage in development in the electric power industry in the western world is to continue the cross-border consolidation and form mega-companies. After a pause for a few years the merger-game is heating up again. Another development is the investments in large quantities of renewable energy. Windpower is expanding rapidly and wavepower is developing. Together with new investments in nuclear power and in carbon capture and sequestration of coal fired power plants, enormous investments are going to be made.

For the customers, the next stage of development will be the utilisation of the embedded information in the new digital meters and in the “smart grid” concept.

Telecom Services

The telecom industry started also for more than a hundred years ago. Similar to the power industry a number of local telecom networks grew which developed some similarities in their business models. Just as in the case of electricity the telecom was a bundled service. The business model was based on a fixed price per installation, but early on a fee for the utilisation was introduced. The further a call was made, the higher the fee. The fee was based on the assumption that the more you utilised the investments in the network, the higher the fee. The idea was to impose a kind of cost-based pricing in proportion to the extent of the investment that was used for making a call. There was also a bottleneck in terms of availability of phone lines between different parts of the network. The cost-based principle also required some sort of monopoly protection in order to shield the system from competition. The service charges were higher than the perceived value and lower than the customers willingness to pay in other parts. This structure opened a breach when new competition appeared. The new competitors could deliver some services (but not all) at a price lower than the cost-based pricing schemes. The old telecom operators had to react and make the prices reflect the value created for customers rather than the costs connected to the service production.

Technology network structure

Today, the telecom industry is increasingly dismantled by new technologies, and consolidated in new ways. One starting point is the customer and the access to the customer. Using telecom services today can involve mobile devices as well as fixed devices. The connections are often overlapping and possible to connect to many different infrastructures: a modern 3G mobile phone can connect through the 3G mobile network, older 2G mobile networks, Wireless networks at home or in office, and to a PC. A modern laptop computer can also connect through a fixed network or through Wifi or 3G networks. The infrastructure is overlapping and potentially converging.

What do we connect to? Historically we used phones to make phonecalls, today we use internet. Today, more or less all services are connected to the internet one way or the other. We use our phones and devices to connect to servers through various networks and layers of networks. Through the servers we reach banking services, webshops, ticket reservations, TV, Radio and social networks of various kinds.

The network structure consists of several layers that are invisible for the end-users. But in order to enable fast, reliable and global communication the interchange between technical layers and also between different network owners and operators has to be seamless. Despite the fact that there is a handover of a call between networks the users do not notice this. Handover procedures between different mobile networks while a call is made is seamless and invisible (or rather unhearable) for the end-user. The reason for this is a highly standardised procedure and communication protocols which enables seamless handovers.

Beside the technical aspects of seamless handover there are also intricate systems of payment between different operators and different communication layer owners.

Ownership structure

The ownership of telecom networks and operations have, as in other infraservice industries, changed from national and public to international and private. Also new actors financed from the beginning with private funding has entered the scene. The roll-out of generations of mobile communications networks have also opened the field for many different investors betting on different technology options.

In some cases, investors have entered the field only to participate in the early stages of infrastructure roll-out while other have specialised in later stages.

Regulations

A long series of regulative changes has been carried through during the 1990ies and the early 2000s. From unbundling of infrastructure service, from subscription to number portability. These measures have been taken to increase competition in the fields that can be opened for competition. At the same time, the telecom markets across the world have opened for international competition and international ownership. Today there are Asian telecom operators in Europe and European telecom operators in other parts of the world.

Customer interface

The number of customer interfaces to the internet is growing. Today we use several different devices to connect; mobile phones, laptops, desktop PCs, vending machines, I-pods, TVs etc to connect. More and more electronic devices are equipped with communication equipment.

Electronic communication is becoming an ubiquitous service for consumers, but also an infraservice for society since more and more activities are directly or indirectly connected to internet services. One development is the trust and security issues. If a user connects to a service, e.g. in order to download facts about the geographical location the user is at, it is important that the user can trust the source of the information. How can he/she be sure that the right server is sending the response? The large number of internet related frauds discovered each year indicates that the security is an increasing issue. The trust and faith put into the networks from the users is crucial for the future development and expansion of these services.

Another trend/development is the convergence of different platforms or user interfaces. Today users can access mail and phone through several different channels and interfaces. This leads towards a standardisation and a reduction if the number of varieties of th eservices, but an increasing variety of the access to these services. It also challenges the established business models.
One example of this development is the internet telecom company “Skype” which developed software which was free to download from the internet and enabled users to make phone calls without using the conventional telecom system. It was free to make a call within the system, i.e. to another Skype user, but to make a call to a phone in the conventional telecom system a fixed monthly subscription fee applied. Although several new inventions appeared in the Skype case, one contrasts radically from the previous telecom business model. In the previous model all investments were made by the telecom company (including the phone up to 1980ies) and the service supplied consisted of the phone calls only for which the customer paid a fixed and a proportional fee for the usage. The Skype business model instead introduce a flat fee and shifts the investments from the operator (Skype) over to the user which has to have a PC and internet connection to utilise the service.

The continued growth of internet related services requires that large server facilities, “production plants” are built. Equipped with large amount of server capacity and electronic storage capacity and, above all, enormous connection capacity to the internet, these facilities are the backbone of the next infraservice industry. More and more of various service operations are now performed via internet rather than face-to-face. Consumers require a 24-7 availability of the service

Concluding remarks: Toward a Definition of Infra-Services?

The concept of dominant managerial logic as introduced by Prahalad and Bettis (1986) refers to a predominant view held by managers in a firm's dominant coalition regarding how central business activities are to be performed. In this paper, however, we will broaden the concept and talk about *business logic* and include not only managers' perception, but also preconditions in the market and technological environment which makes a business in an industry setting possible.

Within business and industrial management research the underlying business logic can be characterized as a focus on value creation in parts of the value chain. Core issues to be competitive are: focus on cost, productivity and quality. Generally there exists a private customer (either a consumer or an organization). The future challenge is to simultaneously manage productivity improvements and successively individualize an in its essence standardized physical product. Conversely, the business logic of an Infra-service is based on a network structure, often layered. The revenue models can be seen as subscription based and the consumers to different degrees co-produce the service. In addition, the historical development of Infra-Services attaches them with a general perception of being semi-public. Due to their importance for the society there is an interest above the individual utility. Finally, the calculation of Infra-services is not a cost plus calculation. Instead it is a calculation where a load factor on the investment should be optimized which leads to other pricing schemes e.g. marginal pricing of the last "units" of service produced.

Table 1. Manufacturing vs Infra-Service logic

	Manufacturing logic	**Infra-Service logic**
Product System Configuration	Value Chain	Network
Conceptualization of Operative organization	Sequential standardized process	Layered structure
Revenue Model	Cost + Margin	Subscription
Role of Customer	Consumer	Co-producer
Type of goods	Private goods	Semi-public goods ("right")
Production challenge	Massproduction, serial production, massmarket-individualisation	Yield + Load factor

Summing up, we propose that an Infra-Service is a specific class of services, where an Infra-service is defined as a standardized or automatically mass-customized service offering to a customer based on capital-intensive technical infra-structure often but not necessarily with a subscriber revenue model.

Toward a definition and a research agenda

The purpose of this paper was to introduce the concept of infraservice and present some related research areas and point to some interesting developments. As a new infraservice based on the internet evolves, new concept, models and theories linking the newer infraservices with the older infraservices. We have so far identified a number of interesting research areas that we will develop further:

- Cross-service analysis – identifying patterns and common denominators of different infraservices.
- Infraservice and service science concepts – exploring the concepts of "Service science and engineering and infraservices

- Extending the technology dimension – exploring in more detail the core technologies developments of various infraservices and their implications for business.
- Innovation in infraservices – How does infraservice development evolve in co-operation with customers?
- Infraservice and regulative economics – the influence of regulation on innovation in the infraservice industry.

These areas and others will be developed further as parts in a coming research initiative.

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