Visualizing Service Operations

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Abstract

Service Operations Management (SOM) has a rich history of important but not widely recognized contributions to research and practice. There also seems to be some uncertainty about how SOM fits in the broader fields of Operations Management and Service Management. This article addresses those concerns by introducing a visual framework called Process-Chain-Network (PCN) Analysis. This PCN framework (a) clarifies fundamental concepts of SOM, (b) demonstrates how SOM fits in broader contexts of business management, (c) facilitates documenting and communicating business-process networks and (d) provides a useful means for analyzing those process networks and identifying opportunities for innovation. The PCN framework illuminates managerial insights of SOM and related disciplines.

Introduction

What are service operations? How do service operations fit within a broader landscape of business operations such as product manufacturing? What roles do service operations management (SOM) professionals perform? What is the distinctive contribution of SOM research? This article addresses these issues by showing how service operations can be conceptualized, visualized, and analyzed.

We begin by outlining some key elements from the history of SOM research. We then review some stereotypes of SOM that have caused confusion that we will rectify in a subsequent discussion section. That rectification will be accomplished through a visual SOM framework known as PCN Analysis. We will review prior visualization frameworks, discussing strengths and weaknesses of each. We will show how PCN Analysis encompasses major features of prior frameworks, succinctly depicting firm-customer interactions, customer co-production, interdependencies between front-office and back-office operations, application of technology in service delivery, and so forth. PCN Analysis will allow us to identify and visualize value propositions, depict key tangible elements of service delivery, and identify operating characteristics of the current process and process alternatives. Along that line, we will review the use of PCN Analysis in service innovation and strategic process positioning. We will discuss how the PCN framework clarifies the position and roles of SOM within business management, and how the framework can help advance future SOM research.

SOM Background

The history of SOM as a distinct topic in academic literature dates back to the 1970's (Johnston 2005; Nie and Kellogg 1999), although there are references to the service economy prior to that time (e.g., Pearce 1957; Penrose 1959). Nevertheless, the field of SOM has languished in relative obscurity, at least relative to traditional Operations Management (OM) that focuses on manufacturing management (Smith, Karwan and Markland 2007). This SOM obscurity is a bit surprising, given that the vast majority of economic activity in developed nations involves service operations (Smith, *et al.* 2007).

It is also a bit surprising to see how many of the major defining elements of SOM have come from researchers outside of the OM and SOM communities. One major topic of OM is quality management, but the most widely used model of *service* quality, the gap model and accompanying SERVQUAL instrument, came from Service Marketing (Parasuraman, Zeithaml and Berry 1985; Parasuraman, Zeithaml and Berry 1988). Another major topic of OM is facility layout, yet the preeminent reference to *service* layout, or "servicescapes," also came from Service Marketing (Bitner 1992). Perhaps most disconcerting is that the recent "repositioning" of service management from an intangible product focus to a process focus was instigated largely by marketers (Vargo and Lusch 2004), despite process-focus being a major theme of OM.

This is not to suggest that SOM researchers coming from the OM perspective have sat silently on the sidelines. For example, in 1978 Chase published an article titled, "Where Does the Customer Fit in a Service Operation" that introduced the Customer Contact model for service design (1978). His model differentiates high-contact operations from low-contact operations and he reviewed a variety of implications pertaining to facility organization, job design, quality measurement, and so forth. In 1986, Schmenner published the "Service-Process Matrix" which described how customer interaction and customization were key drivers of service design characteristics (1986). In 2000, Sampson established the service operations concept of customer-supplier duality, which holds the expanded role of customers as the defining feature of all service processes (2000). That concept is the basis for the Unified Service Theory (Sampson 2001), which provides many operational distinctions of service processes (Sampson and Froehle 2006). These are just a few that have been regularly cited in the literature, with other SOM researchers publishing similarly valuable models (e.g., Frei 2006; Heim and Sinha 2001; Heskett, *et al.* 1994; Roth and Menor 2003).

Admittedly, one major problem may be that SOM researchers have not done a good job at disseminating research models and findings outside of the SOM community. Service marketers seem to be quite good at presenting research models in forums that increase awareness outside of service marketing, for example, by contributing to the Service Science movement, but SOM researchers seem more likely to develop models in the back office, and leave them there.

This paper will attempt to bring SOM out of the back office and show how SOM can be easily conceptualized and clearly visualized. A purpose is to synthesize and summarize thoughts pertaining to SOM that have been floating around for more than three decades, and present them in a visual model (or framework) that is rigorous, intuitive, and easily applied. In other words, a goal is to help those outside of the SOM community see and understand fundamental concepts of SOM.

SOM Stereotypes to Rectify

A major purpose of our PCN framework is to dispel some of the misconceptions that often permeate discussions of service and SOM. In particular, the PCN framework is designed to address some unfortunate stereotypes people have about service operations and about what SOM is founded upon. We will review these stereotypes in this section and revisit them in the penultimate section.

The first stereotype to dispel is that the operations function of firms is simply (or primarily) about managing physical products and product inventories. Although physical products (goods) are essential resources passing through and transformed by the operations of firms, the term "operations" is more closely aligned with the "processes" of firms than the products of firms. Indeed, a primary definition of "operation" is "performance of a practical work or of something involving practical application of principles or processes" (Merriam-Webster 2011). Vargo and Lusch (2008c) suggest that the plural term "services" implies intangible products or "intangible goods," which is why they favor the term "service" that, to them, implies an application of competencies. The "intangible product" perspective on services was refuted by SOM researchers some time ago (Morris and Johnston 1987, p. 16; Sampson 2000, pp. 349-350), and more recently verified with empirical data (Sampson and Snow 2011). A service is a type of process, and "services" are multiple service processes. As Chase declared, "*creation of the service* refers to the work process that is entailed in providing the service itself" (1978, p. 138, emphasis in original). As such, the PCN service operations framework will assume a process perspective rather than a product perspective.

Second, there is a stereotype that service operations are an unscientific type of operations, which is sometimes based on the observation that traditional manufacturing operations models do not often fit well in service contexts. For example, something as basic as identifying process bottlenecks becomes confounded when stations have arbitrary processing times due to the whims of customers at those stations. Some may therefore conclude that service operations are a flawed form of manufacturing operations. As we will see in the PCN framework, service operations are often more complex than non-service[1] operations due to the involvement of customers in the production system (Frei 2006). The PCN framework will show how these complexities can be analyzed in a systematic way.

Third, there is a traditional assumption that there is some dichotomy between goods and services (Greenfield 2002; Hill 1977; Zeithaml 1981). That is and always will be confusing (Sampson and Froehle 2006). A service is a type of process, and a good is a type of resource. All productive systems involve both resources and processes that act on those resources, and it would be difficult to find a service process that does not involve goods. The PCN framework clarifies this issue by depicting service as a specific type of resource/process configuration.

Fourth, some have asserted that service is inherently customer oriented and solution focused (Grönroos 2000, p. 46; Vargo and Lusch 2010, p. 138). While that is true, it is easy to argue that <u>all</u> "productive" processes are or should be customer focused, meaning that they attempt to provide solutions to real needs of customers (Edvardsson, Gustafsson and Roos 2005, p. 111). "Customer focus" and "solutions focus" is just good management, but not exclusive to the domain of service. The PCN framework provides a balanced perspective and is equally customer-focused and provider-focused, emphasizing the process relationship between customers and providers.

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[1] In this article we use the term "non-service" to refer to an operational process that is not a service process. Make-to-stock manufacturing will be described as the quintessential non-service operation. However, since manufacturing sometimes involves service processes, we cannot equate non-service with manufacturing.

Fifth, we seek to overcome the confusing idea that service is adequately defined by what it is not. Some, especially governments, have classified services as "nonmanufacturing," which is a residual definition (Morey 1976). Judd (1964) proposed a non-ownership definition of service wherein the "object of the market transaction is other than the transfer of ownership of a tangible commodity," which has gained renewed attention in recent years (Lovelock and Gummesson 2004). However, even Judd criticized any such "definition by exclusion" as being defective in that "from the definition itself, nothing can be learned about what are the essential characteristics of a service" (1964, p. 59). The PCN framework defines service in a positive way, according to observable process characteristics.

How does SOM define "service?"

The defining construct of service embodied in the PCN framework is the participation of the customer in a service-delivery process of a firm, which is to say that the customer interacts with the firm in the business process by a) providing resources that are essential to the process, and/or b) participating in the actual execution of the process (Sampson 2000; Sampson and Froehle 2006). Customer interaction and influence on operations has been identified as a key construct by various SOM researchers over the years. For example, in an article titled "How Professors of Operations Management View Service Operations," Nie and Kellogg report on a survey of 167 operations management academicians (1999). They criticize the "product-oriented thinking" of traditional operations management (OM) and report: "The survey… revealed that customer influence has the greatest impact on service OM strategies and decisions."

Earlier SOM researchers have spoken about this customer-interaction perspective. Sasser (1976, p. 133) discussed how "a high degree of producer-consumer interaction in the production of service" had major implications for how they were managed. As mentioned previously, Chase espoused customer contact as being a (or the) managerially relevant differentiator of service operations, which he relates to "the degree of interaction between [firm and customer] during the production process" (1978, p. 138; 1981; 1983). Fitzsimmons espoused the importance of the customer-involvement characteristic of services (i.e., service processes) and concluded that, "service productivity can be improved by enlarging the role of the customer" (1985, p. 66). As mentioned, Schmenner (1986) presented a Service-Process Matrix model that suggested that the degree of customer interaction and customization were the key differentiators of services, a twist on the Product-Process Matrix that is considered a staple of operations management (Hayes and Wheelwright 1984, p. 209). Morris and Johnston also rejected the idea of an intangibility distinction of service operations and instead differentiate according to the customer involvement in service operations, which they show has major implications for process variability (1987).

In other words, when we clear the clutter of false stereotypes of SOM we observe that service operations are producer-consumer interactive operations, which has been verified empirically (Sampson and Snow 2011). Sometimes it is direct interaction, as in Chase's Customer Contact construct (1978; 1981; 1983). Other times it is indirect interaction, where employees or customers (or their technologies) are acting on the information or physical resources of the other. The PCN framework will show that visualizing service operations means visualizing interactive processes.

Previous Visualization Tools and Frameworks

Process documentation and analysis tools have been in use for many years. Flowcharts, or "flow process charts," date back to at least 1921, when the legendary Frank Gilbreth gave a presentation titled “Process Charts—First Steps in Finding the One Best Way” at the Annual Meeting of the American Society of Mechanical Engineers (Graham 2004). Flowcharting and the various flowcharting tools have been useful in their own right, but limited in depicting distinguishing elements of service operations. In this section we will review some common flowcharting frameworks and, in anticipation of the PCN framework, consider strengths and weaknesses of each.

Flowcharting tools and frameworks

Initially, flowcharts were primarily used in repetitive manufacturing processes, but have been adapted to other contexts such as data processing and services. The original process charts included symbols for operation (i.e., processing step), transportation, inspection, delay, and storage. Process chart paper came pre-printed with all five symbols down the left side and room for writing process steps to the right, and symbols were connected with lines to represent process flow. Subsequently, instead of list form the process charts were drawn on blank paper with annotated process symbols connected by arrows, which allows for easier representation of non-linear processes. For example, the diamond represents decision steps with arrows pointing to different steps for different decision outcomes.

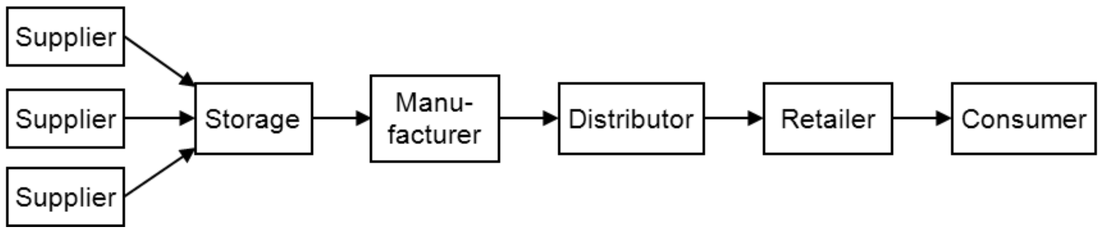
Flowcharting has taken other forms over the years. For example, IDEF0 (Integration Definition for Function Modeling) is a modeling language that describes processes in terms of inputs and outputs, as well as mechanisms for enabling and means for controlling the process. Computer scientists use a tool called an Event-driven Process Chain (EPC) which is a flowcharting method used in business process modeling and is often used in enterprise resource planning (ERP) implementations. EPC flowcharts are valuable in representing not only processes but also events that precipitate process execution as well as entities responsible for specific processes (van der Aalst 1999). However, neither IDEF0 or EPC are particularly good at capturing processes that involve interaction between entities, or the networks in which entities exist.

Another flowcharting tool used primarily in computer science is Business Process Modeling Notation (BPMN), which uses flowcharts that are similar to activity diagrams of the Unified Modeling Language (UML). BPMN organizes flowchart elements (process steps) into “swim lanes” that represent the entity that is performing the particular process step. A similar approach is used in “deployment flowcharts” of the Six Sigma tool set. For example, a sales process might be divided up into customer, salesperson, fulfillment, and billing swim lanes. However, by convention, each process step exists within one and only one swim lane, although it is conceivable that a step could span the border between adjacent swim lanes. Instead, interaction is depicted by dashed lines connecting corresponding steps in different swim lanes, which are referred to as cross-entity “messages” (White, Miers and Fischer 2008).

Supply-Chain Diagrams

Supply-chain diagrams, such as shown in Figure 1, are particularly suited to show relationships between entities that are involved in a given supply chain. Most supply chains are represented linearly, with products flowing from “upstream” entities to “downstream” entities. However, service supply chains are unique in that they are bidirectional, having product flows that go both directions (Sampson 2000). For example, car owners provide their broken cars to repair shops, and subsequently the repair shops provide fixed cars back to the car owners. A supply-chain diagram could, in theory, represent bidirectional flows, but they generally do not.

Figure 1: A typical manufacturing supply chain (e.g., Stevenson 2012, p. 664)



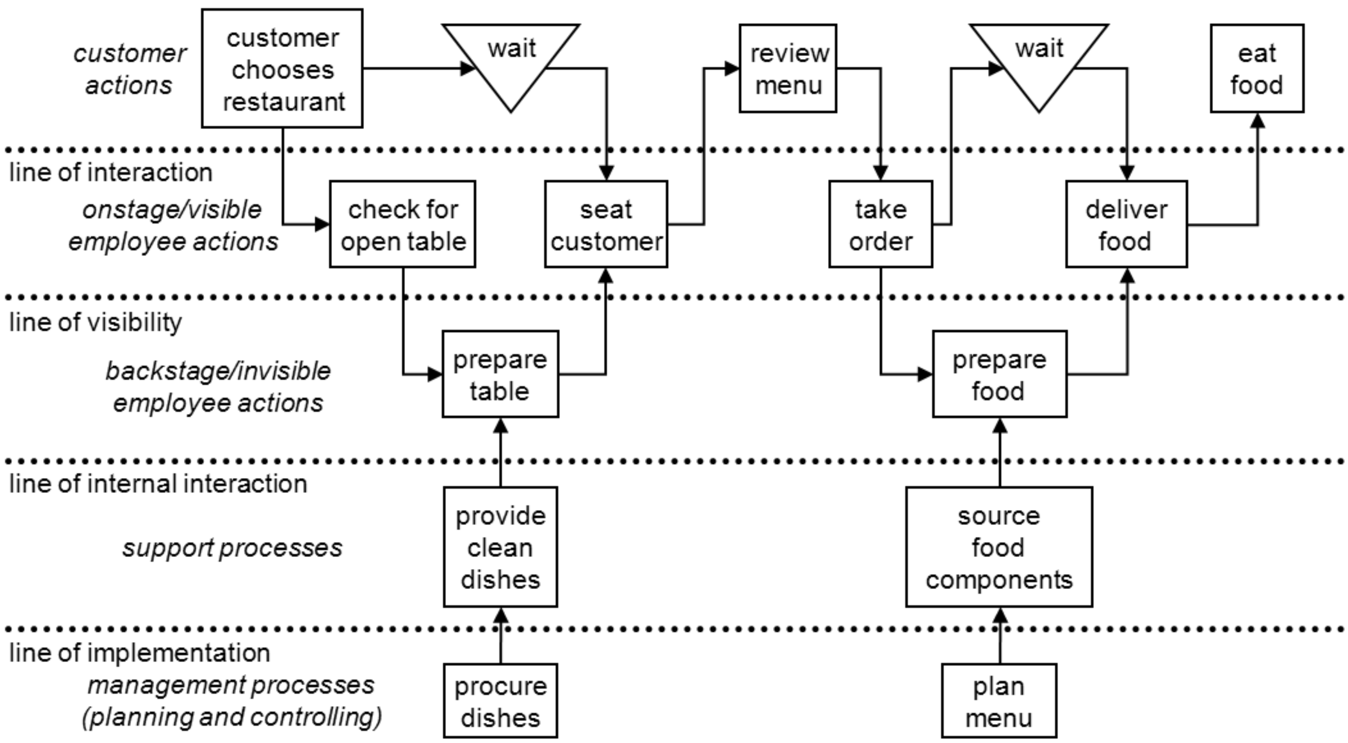
Supply-chain diagrams are very good for showing relationships between the various players that take part in a given process. The arrows of a supply chain document "a network that describes the various paths by which goods and services can flow through a supply chain" (Hopp 2008, p. 6). This implies that somehow "services" flow along the arrows of a supply chain from one entity to another until they are finally "delivered" to customers (Stevenson 2012, p. 664), which is a confusing perspective. Unfortunately, that idea seems to perpetuate the "service is an intangible good" mentality.

Supply-chain diagrams are weak in service contexts in that they do not represent the interactive processes that occur *between* entities (Sampson and Froehle 2006). Also, supply chain diagrams are silent in documenting the *nature* of interactions between entities. It is assumed that there is some transfer of materials from one entity to the next, without specifying what actually takes place in the interactions.

Service Blueprints

An adaption of flowcharting that is well-known to service researchers is Service Blueprinting, introduced by Shostack (1984; 1987), who comes from the field of marketing. At a fundamental level, Service Blueprints differentiate between service process steps that customers can see – "above the line of visibility" – and those they cannot see. As depicted in Figure 2, a service blueprint categorizes process steps according to customer actions, visible employee actions, invisible employee actions, support processes, and managerial functions (Fließ and Kleinaltenkamp 2004). Service Blueprinting has been expanded over the years to consider issues such as organizational structure, physical evidence, and depiction of customer roles in service delivery (Bitner, Ostrom and Morgan 2008). The Service Blueprinting methodology does a tremendous job of documenting process actions and interactions at and around the customer-firm interface.

Figure 2: Service Blueprint example – sit-down restaurant



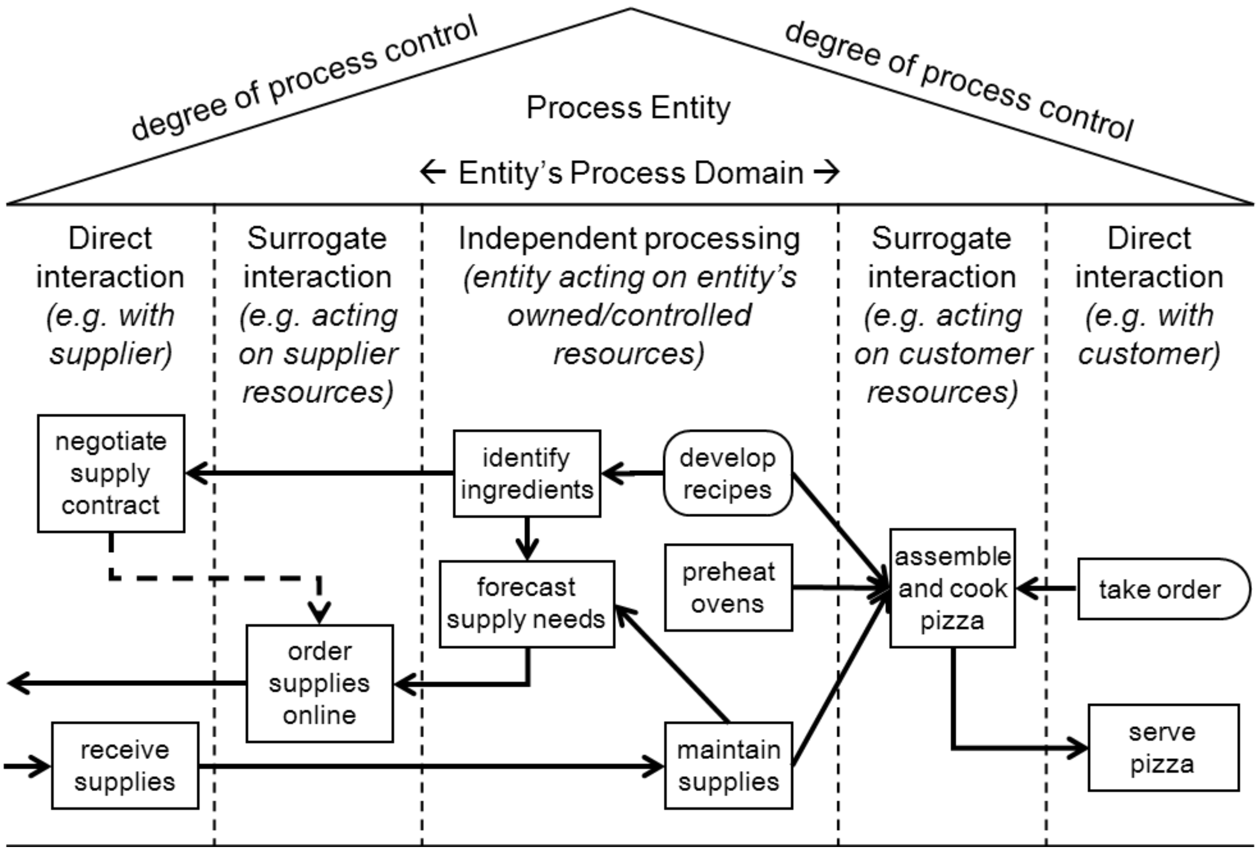
The visualization framework described in the next section will improve on traditional Service Blueprinting in three fundamental ways. First, the new framework considers *the nature of interaction*, rather than process visibility, to be the primary basis for differentiating process steps. Actions are categorized according to involvement of one or more parties in interaction, regardless of whether the actions are visible to others. Second, the new framework depicts all entities—providers and customers—as having distinct regions of interactive and independent processing. Eichentopf *et. al.* recognize that in traditional Service Blueprinting customer actions are often treated as "a black box," and propose "mirroring [the service blueprint] structure on the customer's side" to give customers their own line of visibility, line of interaction, and so forth (2011). The new framework achieves a similar effect, but in a way that is less cumbersome and that easily accommodates processes that span more than just a single provider and single customer.

Third, the new framework thus improves on traditional Service Blueprinting by easily accommodating a network representation of service processes—or what Normann and Ramirez call "value constellations" (1993)—including multiple entities that each can operate independently or interactively with other entities. Patricio *et. al.* address this blueprinting deficiency by identifying the value constellation network at one phase of analysis then subsequently and separately designing specific dyadic service encounters with enhanced Service Blueprints (2011). Our framework will take an integrated approach by simultaneously depicting the network and the interactions. In essence, the new framework combines useful features of supply-chain diagrams with useful features of Service Blueprinting to allow us to clearly and easily depict complex interactive processes that span networks of entities. That is why the new framework is called a Process-Chain-Network Diagram, or PCN Diagram.

Process-Chain-Network Diagrams

Our purpose in this section is to introduce the PCN framework in a logical way so that we can subsequently describe its use in visualizing SOM processes, networks, and issues. Figure 3 shows a simple example of a PCN Diagram involving a "full-service" sit-down pizza restaurant. The following are key concepts and elements of the PCN framework as depicted in that example.

Figure 3: PCN Diagram example – pizza restaurant



We define a **process** as a sequence of steps. The base grammatical identifier of a process step is a verb. Processes are performed by entities and act on resources, often multiple resources from multiple sources. Resources, and entities, are identified by nouns. Herein we use the term *resource* in a general sense, including physical items, knowledge, energy, and so forth. Even entities such as people or machines can be resources.

A **process chain** is nothing more or less than a sequence of process steps with an identifiable purpose. Figure 3 shows a process chain with a purpose of serving pizza. In general, the purpose of process chains is ultimately to improve the state of well being of some entity or set of entities, which is the concept of **value** (see, e.g., Grönroos 2008, p. 303). In usual flowchart manner, the sequence of a process chain is indicated by arrows that connect one process step to another. The arrows generally represent a state dependency, meaning that one process step depends on some resource being in a state provided by another process step. This is different from the way arrows in supply-chain diagrams represent the flow of materials or information, although movement of materials and information is an example of a state change. The dashed line between "negotiate supply contract" and "order supplies online" suggests a loose temporal dependency, meaning the supply contract could have been negotiated a long time before an instance of ordering supplies.

A **process entity** is any entity that participates in a process. Examples include firms, departments within firms, customers, agents of customers, and so forth. The key feature of a process entity is the ability to make *decisions* about the initiation or progress of some portion of a process chain. Figure 3 considers only one process entity, which is illustrative but not very interesting. Subsequent examples will be more useful by describing how process chains span multiple process entities.

There are some useful ways of characterizing process entities. Some process entities control certain process steps – functioning as "operant resources" that act on other resources (Constantin and Lusch 1994). Such is a surgeon, who acts on a patient. Other process entities are acted upon, as "operand resources," such as the surgery patient. It is common for an entity to be an operant resource during some parts of a process chain, and an operand resource in other parts of the same process chain.

All entities participating in a process chain—producers and consumers—are beneficiaries of the process chain, meaning that they participate with the expectation of value (see Sampson 2001, p. 330). We do not advocate eliminating the distinction between consumers and producers as others have done (Vargo and Lusch 2008a, p. 257; Vargo and Lusch 2010, p. 146), but instead recognize that entities engage in interaction with two distinct types of value motivations. Process chains tend to be configured to accomplish one or more specialized purposes. Entities that stand to benefit from a specific purpose of the process chain are **specific beneficiaries** of the process chain, and are generally called **customers** or **consumers** (differentiated in Sampson and Froehle 2006, p. 332).

Other process entities participate in a process chain in order to be able to meet well-being-improvement needs by other process chains. Usually, these process entities benefit from the process chain by receiving a generic resource – money – that can be subsequently deployed to meet specific needs from *other* process chains. Producers such as "manufacturers" and "service providers" often fall into this category. They participate in a process chain not so much for specialized benefits of the process, but for the generic resource that can be used in other process chains. As such, **producers** are generally considered to be **generic beneficiaries** of the process.

Of course, hybrid entities exist – being both a specific beneficiary and a generic beneficiary. For example, consultants are paid to engage in consulting projects (thus being generic beneficiaries), but also may desire to gain expertise in the business of a given client (thus also a specific beneficiary), and may therefore be willing to reduce the consulting fee charged that client.

Each process entity has a **process domain**, which is the set of process steps that are initiated, led, performed, and, to some degree controlled by the process entity. In other words, an entity is an operant resource for process steps that fall within its process domain. A driving construct of a process domain is control, as symbolically noted by the triangle at the top of Figure 3. Entities can and do influence process steps outside of their process domains, but do not lead or directly control those process steps.

Three Regions of a Process Domain

Within a process domain the degree of control varies dramatically, as do the appropriate managerial considerations. Based on a study of major process classification taxonomies from the SOM literature, Wemmerlöv observed that “Contacts between a service system and a customer/client can be of three basic kinds” including direct contact, indirect contact, and no contact (1990, p. 28). We will build on these three distinctions in a way that will help us visualize major managerial issues. As an example, Wemmerlöv observed that “a restaurant faces direct contact with its patrons in the dining area, has only indirect contact with them during the food preparation processes in the kitchen, and has no direct contact with them during its purchasing and maintenance activities” (1990, p. 29), as we depict in Figure 3.

Figure 3 will be used to define the three process regions, and subsequent figures will demonstrate important managerial and strategic issues. At the extreme edges of the process domain in Figure 3 are process steps that involve **direct interaction** with other entities, such as suppliers and customers. This direct interaction means that people are interacting with people in some way, negotiating contracts, taking orders, etc. A manufacturing example of a direct-interaction step is a salesperson negotiating the sale of a manufactured resource. A hospital example is drawing blood from a patient, or consulting with the patient about the need to draw blood.

Adjacent to the direct interaction regions are areas of **surrogate interaction**, meaning that an entity is performing process steps that involve a non-human resource of another entity (see Chase 1978, p. 139). Examples are ordering supplies via a supplier website and assembling a pizza according to a customer order. The website and order are not the supplier and customer, but are surrogates of those other entities. A manufacturing example is make-to-order production, where the order is a surrogate representation of the customer preferences (Sampson 2001, p. 142-144). A hospital example is analyzing a patient’s blood in a laboratory.

At the center of an entity’s process domain is the region of **independent processing**, which means processing that does not involve either direct or surrogate interaction with other entities. Make-to-stock manufacturing is a common example of independent processing. A hospital example is cleaning the facility, unless the cleaning function has been outsourced.

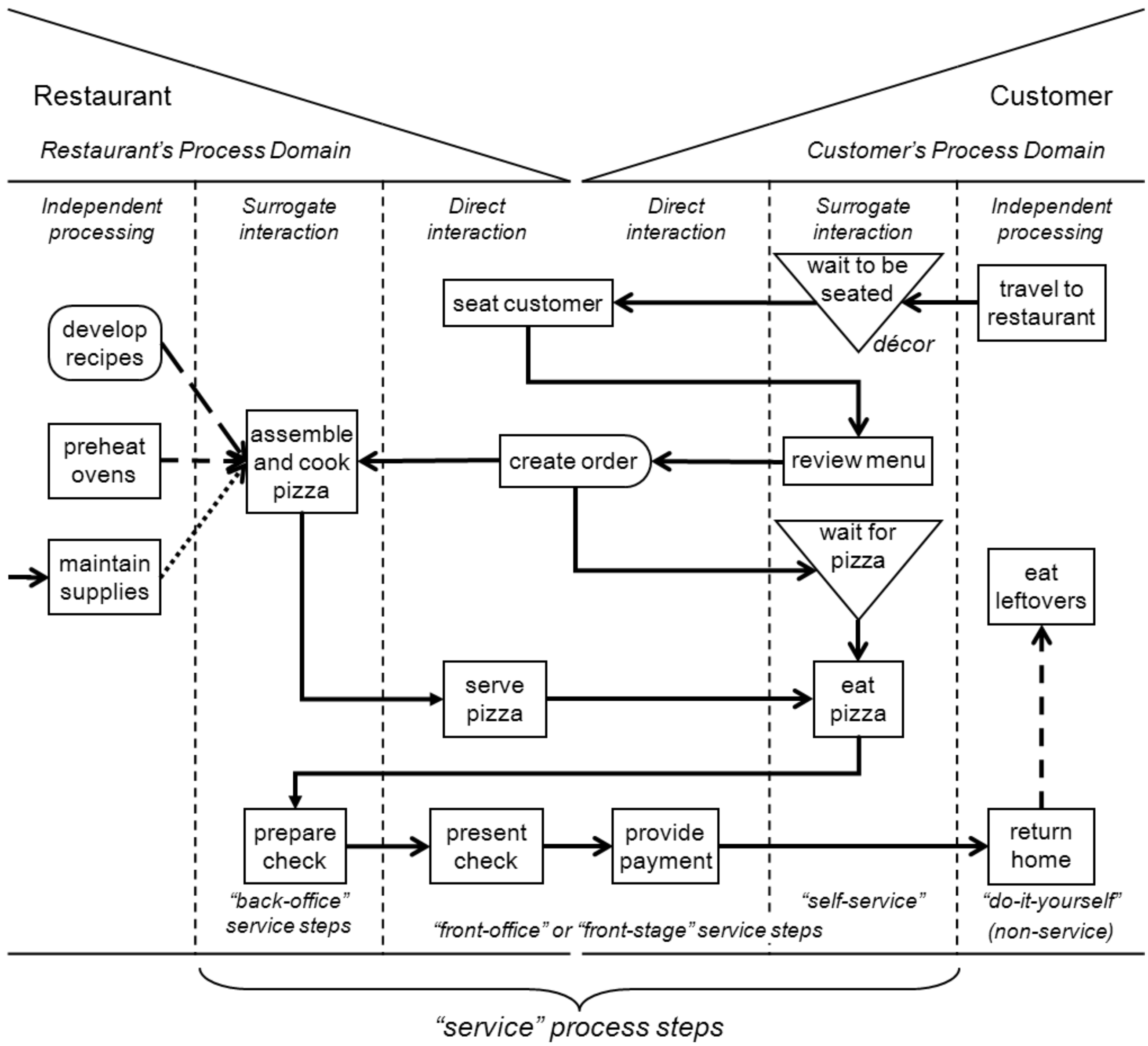
In Figure 3 it just so happens that the supplier-facing processes are shown on the left and the customer-facing processes are on the right, but it does not have to be that way. PCN Diagrams differentiate suppliers from customers according to beneficial relationships, not by relative positioning in and between process domains. In barter arrangements (see Normann 2001, p. 36) both entities may be suppliers and/or customers, and either can be on either side of the diagram.

As suggested previously, the triangle at the top of the entity’s process domain symbolically represents the **degree of process control**, with less control occurring with more direct interaction (Morris and Johnston 1987). Thompson explained this concept by distinguishing between “uncontrollable work” such as “when customers and employees interact,” and “controllable work” which “does not require the presence of customers” thus “management has some degree of temporal control” (1998, p. 23). He described how service processes (i.e. process chains with interactive elements) contain both types of work, and managers can leverage the characteristics of each in order to improve labor utilization while meeting customer needs.

A single-entity service process diagram like Figure 3 is not much more than an entity’s process flowchart (with categories). It is much more interesting to study process chains that involve multiple entities, as shown in Figure 4 and subsequent figures. The essence of PCN

Diagrams is documenting the interactions between steps within the process domains of multiple entities in a service system, and considering the roles of various entities in the unfolding of the process.

Figure 4: Interactions between process entities (pizza restaurant and customer)



Notice in Figure 4 how some steps occur between the direct-interaction regions of the entities. Seating customers involves direct interaction, but the step is executed primarily by the restaurant employee, therefore is more within the restaurant's process domain. In this example, creating the order is jointly led by the employee and the customer. Serving the pizza and presenting the check are led by the employee, and the customer leads the step of providing payment. Each of these direct interaction steps are, by our definition, "service" steps. Further, all surrogate interaction steps are considered "service" steps. Note that both entities in Figure 4 are also engaged in some independent processing steps, which are "non-service" steps by our reckoning. Were one to ask, "is a restaurant a service?" the answer would be "no, a restaurant is an organization that is engaged in both service (i.e., interactive) and non-service (i.e., independent) processes." This emphasizes that the focus of analysis is the process segment, not the firm and certainly not the industry (Sampson and Froehle 2006, p. 333-334). Firms are aggregations of resources and processes, including some service (i.e. interactive) process segments and some segments that are independent processing.

It is important to understand the use of grammatical constructs in a PCN Diagram. The subject, or predicated noun, of any step is always assumed to be the entity or a representative of the entity whose process domain the step falls under. In Figure 4, "develop recipes" is under the restaurant's process domain, therefore implying that "restaurant employees develop recipes." If the recipes are developed by customers then the box should be under the customer's process domain. If an outside entity like a cookbook publisher develops the recipes then the process step should be under the publisher's process domain.

Since the subject of each process step is implied by the position on the diagram, the process steps can and should always start with verbs, reminding us that we are studying chains of process steps. The action verb is followed by the object noun(s), which is the resource(s) being acted upon. Note that, by definition, object nouns under independent processing are always resources owned and controlled by the given process entity.[2]

Research literature refers to service concepts of co-production and value co-creation (e.g., Vargo and Lusch 2010, p. 143). Co-production is where customers participate in the development of the core offering of the firm, presumably in conjunction with the firm (Vargo and Lusch 2008b, p. 8). Co-production means the customer is assuming some responsibility for production, implying that the co-productive steps exist within the customer's process domain either through direct interaction or surrogate interaction (e.g., using self service technologies). Subsequent process steps in the customer's region of independent processing are not co-production in the strictest sense, but may involve value co-creation, which phrase has been used broadly to describe a realization of value by customers (Grönroos 2008, p. 299). Although co-production always takes place in regions of interaction, the realization of value (i.e., "value co-creation") can occur in interactive (service) process steps or independently (such as using a product that was purchased from a firm).

Figure 5 depicts a simplified PCN Diagram for a medical diagnosis process involving a patient who feels weak and needs a prescription based on a blood test. This example illustrates a process chain network involving four process entities: (1) a health clinic, (2) a patient, (3) an insurance company, and (4) a pharmacy. Standard flowchart connector symbols are used to show process dependencies that might span different pages or parts of the PCN Diagram. (Each connector has a letter followed by a number representing either the page, or in this example the entity number, where the step continues.) These and other flowcharting techniques can be used to depict PCN Diagrams of various levels of complexity.

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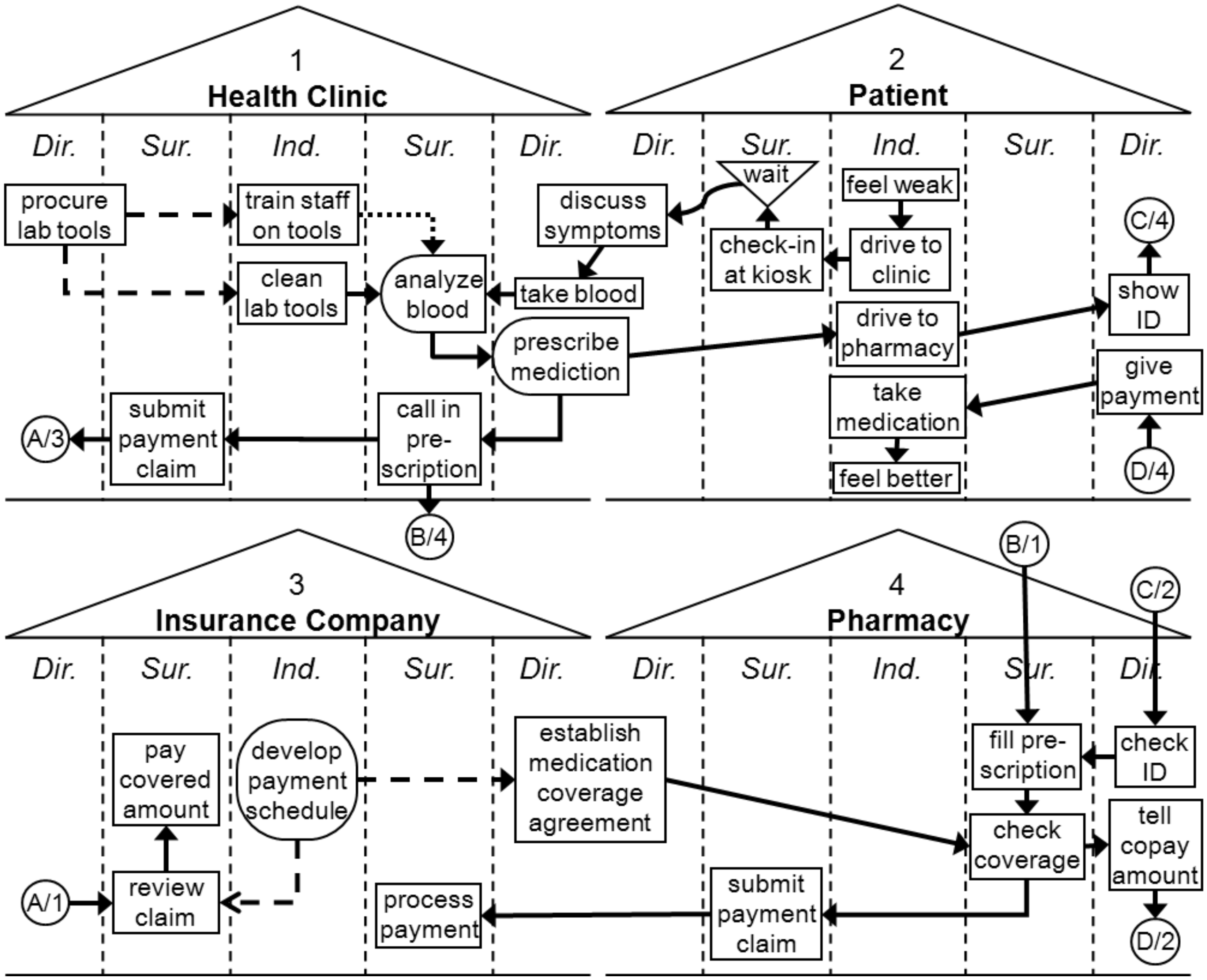
[2] For simplicity we sometimes allow steps that are outside of the scope of current analysis to be considered "independent processing" even if they are interactive. For example, Figure 4 shows "travel to restaurant" in the customer's independent processing, even though the travel may have involved a bus or a taxi. In that example, the interaction between the bus or taxi provider is outside of the scope of the pizza restaurant interaction being studied.

Figure 5: Healthcare PCN Diagram example



Identifying the Appropriate Region

Summarizing, the three regions of a process domain are:

- **Independent processing** steps are performed by a process entity acting on resources owned and controlled by that same entity.
- **Surrogate interaction** steps involve a process entity acting on the belongings or information of another process entity, but not with the person of the other entity.
- **Direct interaction** steps involve a process entity working in conjunction with one or more other process entities – people to people[3].

[3] Direct interaction occurs in degrees and may involve people using machines to interact with people, such as doctors using MRI machines to scan patients, or customers who are simply passive recipients of processing, such as passengers on an airplane or guests at a concert. In those situations the process step is often depicted on one side of the direct interaction region, suggesting that instigation of the process step is not mutual.

It turns out almost all process steps fit into one of these three process regions. The initiator (operator) of the process step is the entity whose process domain the step falls within, or, in the case of direct interaction, jointly falls within. In the process step, the process entity is acting on, or integrating, resources. If the entity is acting on or with the person of another process entity, then the step falls in the domain of direct interaction. If the process entity is acting on the resources (belongings or information) of another process entity without direct interaction, it is surrogate interaction. If we have neither direct nor surrogate interaction, then process step is independent processing – acting only on resources owned/controlled by the process entity.

Some steps may involve a process entity acting upon another entity's person and belonging/information resources at the same time. Although they might be categorized as simultaneously direct and surrogate interaction, the direct-interaction effects are likely to dominate. However, if the step can be split into two sub-steps, one involving direct interaction and the other involving surrogate interaction, then they should be split. The level of detail of analysis should be fine enough to delineate the categorization of each step.

It is easy to recognize that every interactive process step, direct and surrogate, involves acting on customer-provided information. This is because people and belongings are always information laden. For that matter, every resource is information laden (Normann 2001, p. 29), meaning that every process step is at some level an information processing step. Information availability is the universal resource that ties process steps together in dependent relationships.

The functional and managerial distinction of these three elemental process step regions will be discussed in the subsequent sections. In a nutshell, there are major differences in operating characteristics of the three regions, and therefore major differences in knowledge and skill requirements – even for process steps that exist within the same process chain.

Using PCN Diagrams for Service Process Analysis

PCN analysis begins with visualizing the process in question. The following are basic steps for creating a PCN Diagram:

1. Identify a process to analyze. As suggested above, the appropriate unit of analysis is a process or process segment, not a firm (Sampson 2001; Sampson and Froehle 2006). PCN analysis takes place at the process level.
2. Identify the process entities that participate in the given process segment. This usually includes a focal firm and an immediate customer or customer segment. In many cases, especially B2B processes, the PCN Diagram should include the immediate customer's customer, so as to visualize how the focal firm facilitates the immediate customer accomplishing its customer-serving business objectives. The diagram might also include suppliers, partners, and others involved in the value constellation (Normann and Ramírez 1993).
3. Record the steps that mark the start and end of the chosen process segment. Process segments often start with an identified customer need and end with the fulfillment of that need.
4. Fill in intermediate steps, showing which process domain and region each step occurs in, as discussed in the prior section. This may include steps in the process domains of the focal firm, customers of the focal firm, suppliers of the focal firm, and other entities in the process-chain network. As mentioned, the arrows between process steps indicate state dependencies (which may or may not involve product flows).

5. Identify steps where the customer receives benefits (i.e., need-filling value that provides motivation to compensate a focal firm) and where the customer incurs non-monetary costs (such as inconvenience). We tag customer benefits with ☺ and non-monetary costs with ☹. This is to identify the process's value proposition to the customer.
6. Identify steps where the focal firm(s) incurs costs (tagged -$) and/or receives monetary compensation (tagged +$). Cost steps may include labor costs, component costs, facility capacity costs, etc. This gives us an idea of the profit impact of that given process segment as currently configured.
7. Environmental conditions, such as facility resources, can optionally be identified by placing labels next to appropriate steps. For example, in Figure 4 the "wait to be seated" step has the word "décor" next to it, reminding us that waiting room décor provides important physical evidence. This accomplishes the same purpose as a "physical evidence" row that is included in some Service Blueprints (Bitner, *et al.* 2008), except with PCN Diagrams the evidence is noted by the step.

Analyzing a PCN Diagram involves considering the implications of the current process configuration, in anticipation of process improvement and innovation (discussed in the next section). The nature of process steps varies depending on the process region in which a step resides. Independent processing is fundamentally different from interactive processes in design and execution. Table 1 summarizes some of the ways the process regions differ.

Table 1: Design issues related to process regions (see Chase 1978, p. 138)

Design Factor	Independent Processing	Direct Interaction
Facility layout	Organized to enhance process flow.	Accommodate customer needs and expectations.
Worker skills	Focus on efficiency and consistency. Rote training.	Focus on interaction skills and responsiveness.
Job design	Tightly defined with precise steps and cycle time.	Broadly defined.
Sales opportunity	Mass marketing.	Personal selling.
Quality control	Based on formal specifications.	Based on variable standards from customers.
Asset utilization	Schedule assets for maximum utilization (ROI).	Balance asset utilization with customer responsiveness.
Use of technology	Cost/productivity issues dominate.	Customer acceptance issues dominate.
Economies of scale	Key to cost effectiveness.	Limited by variation in customer requirements/resources.

The following are some general principles about PCN process design:

Principle #1: Process inefficiency. In general, interactive processes are less efficient (from the perspective of the provider firm) than independent processing, with directly-interactive processes being the least efficient[4]. As Chase (1978; 1981) taught us, operating efficiency is an inverse function of the degree of customer interaction. This relates to the concept of “customer intensity,” which is defined as “the degree to which variation in customer input components causes variation in the production process” (Sampson 2010a, p. 116; Sampson 2010b, p. 38). Interaction leads to customer intensity, and the resulting variation hinders process efficiency. If efficiency is a goal, effort should be taken to reduce customer intensity by minimizing how much of the process chain operates in the region of direct interaction.

Principle #2: Customization. Customization increases as process steps move closer to the customers’ independent processing region. A firm can provide customization by moving steps from independent processing (e.g., make-to-stock manufacturing) to surrogate or direct interaction (e.g., make-to-order manufacturing). However, firms can increase customization even further by moving steps into the customer’s process domain, allowing the customer to customize their execution of steps and use of resources, as depicted in Figure 6. Indeed, the words “customize” and “customer” share the common root.

Principle #3: Economies of scale. As will be demonstrated in the subsequent section, customers involved in interactive processes usually have the option of performing certain aspects of the process independently – so-called “do it yourself” (Sampson 2001, p. 202). For example, a customer can hire a carpenter to build an addition onto his house or alternatively can purchase tools and attempt the project himself. Even though customers typically have a customization advantage by being their own providers (Principle #2), focused providers typically have a scale advantage. In particular, firms can build superior competencies due to their specialization.

Principle #4: Surrogate positioning. Surrogate interaction is a tremendous tool for balancing the classic tradeoff between process efficiency and customization (Frei 2006). Changing an independent processing step to an interactive step or vise versa can be disruptive; and firms can use the surrogate-process region as a less-disruptive alternative.

These four principles are depicted in Figure 6. Observing the present state of a given process is only part of the benefit of constructing a PCN Diagram. Greater value comes from analyzing process alternatives, and observing how changes in process configuration impact the operation and value proposition. In the next section, we will review considerations for process improvement.

Innovation and Strategic Process Positioning

Innovation has been identified as a perennial challenge in services (Ostrom, *et al.* 2010). Bitner, *et al*, observe that “…innovation in services is less disciplined and less creative than in the manufacturing and technology sectors” (2008, p. 66). This section will demonstrate how our framework provides a systematic approach to service innovation.

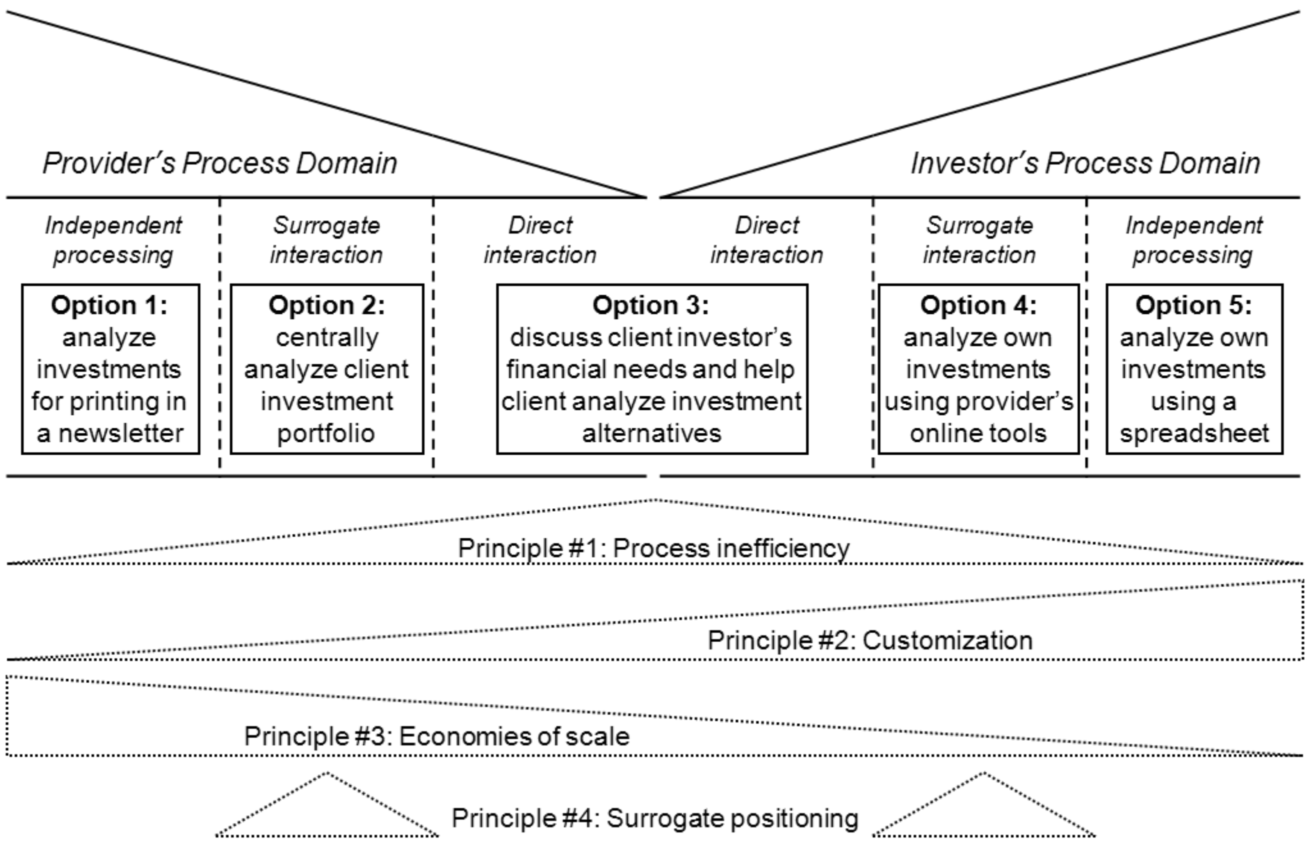
The PCN framework unlocks a powerful approach to service innovation based on exploring process configuration alternatives. Innovation can be introduced into process chains by repositioning steps or sets of steps across the regions of a process domain, or across the entities of a process-chain network. It should be recognized that there are always process alternatives, with some more practical than others in terms of costs and benefits. It should also

[4]Customers engaging in self-service surrogate interaction or do-it-yourself independent processing are usually not paid by the provider firm for their efforts; therefore represent efficiency to the firm.

be recognized that in many cases, service (or interactive processing) is one option, and independent processing is another. Service is a strategic choice!

For example, consider a process chain involving financial investment management. Figure 6 depicts positioning options for a process step to analyze investment alternatives, with the provider being a firm with investment expertise. With option 1 the firm performs the investment analysis independently from any client investor. With option 2 the firm analyzes a client investor's investments portfolio in a back office operation that does not require direct interaction with the client. Option 3 accomplishes the investment analysis through direct interaction. Option 4 switches over to the customer's process domain, meaning that the customer executes the analysis, using the provider's resources. Finally, option 5 represents the customer doing the analysis independently from the firm.

Figure 6: Investment analysis process options and principles



Which is the best process positioning option? That depends on the needs, expectations, interests, and skills of the investor customer segment, in conjunction with the capabilities of the investment firm. The principles from the prior section provide guidance. The interactive options (esp. option 3) are the least efficient, possibly requiring the customer to visit the provider's location and provide information inputs for the investment analysis–with the location and interaction being important parts of the value proposition. If the customer desires extensive customization and control of the analysis process, positioning the step closer to the customer's central region (option 5) has advantages. However, that comes with a cost of economies of scale, and may require that the customer have the type of specialized investment analysis knowledge that one would expect an investment firm to have. Option 1 can have tremendous economies of scale, allowing the provider's expertise to easily be shared with an unlimited number of investors who receive the newsletter, assuming they do not need unique investment advice. The surrogate options (2 and 4) provide balance between these operational factors.

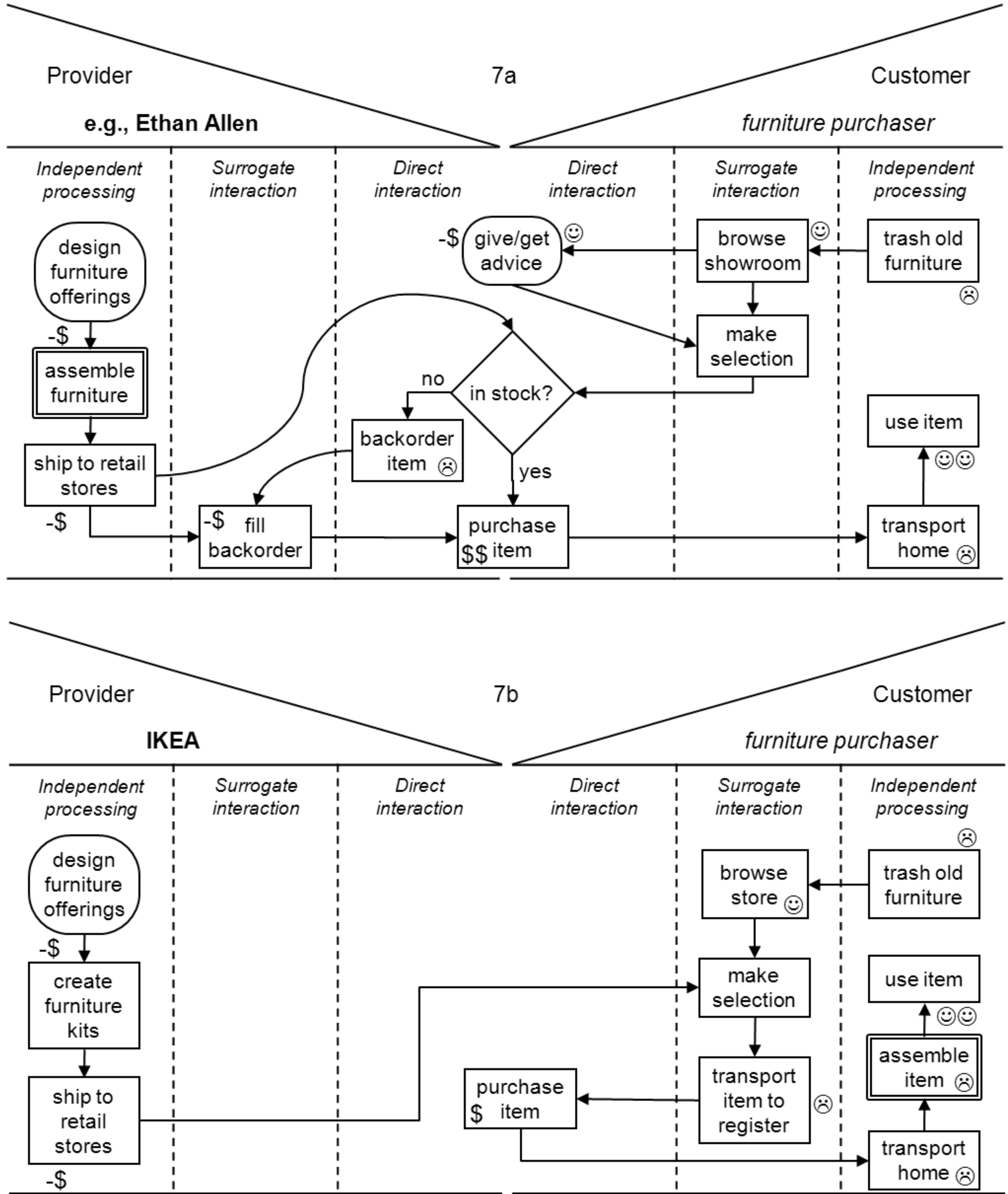
In general, the best process positioning depends on the value proposition of a given process, as depicted by realization of costs and benefits in the process. For example, moving a process step from direct interaction to surrogate interaction will cause a decrease in cost ($), but may also represent some impact on customer value (☺). One reason we mark value and cost steps is to observe where and how changes are likely to impact value and costs. We will now consider two common types of process-configuration changes.

Enabling and Relieving Innovations

Normann (2001, p. 73-74) discussed two major categories of process innovations (or what he called "value-space reconfigurations"): *enabling innovations* that enable customers to do things that were previously provided by others, and *relieving innovations* in which a firm takes over activities that previously were done by customers. In the PCN framework enabling innovations are visualized by moving process steps from the provider's process domain to the customer's process domain. Relieving innovations are visualized by moving steps the other direction (toward the provider).

Normann cites the Swedish retailer IKEA as an example of a firm that successfully executed an enabling innovation for strategic advantage (Normann 2001; Normann and Ramírez 1993). A traditional stock furniture retailer such as Ethan Allen assembles furniture (or outsources assembly) and ships assembled items to its retail stores (see Figure 7a). IKEA differentiates by repositioning the "assemble furniture" step from IKEA's process domain to the customers' process domain, as depicted in Figure 7b. (It is often helpful to highlight steps involved in an innovation with double-boarder boxes.) This shift reduces the cost structure of the firm, allowing the sale of higher-quality furniture at a lower monetary price.

Figure 7: PCN Analysis for furniture retail



Another differentiating feature of IKEA is the decreased customer intensity from having less of the process chain in regions of direct interaction (see Figure 7). The interactive firm in 7a provides product advice that is valued by customer (☺) by employing experienced and costly (-$) labor. (The author sometimes places steps requiring employee judgment in rounded boxes.) Avoiding this interaction further helps IKEA's efficiency and cost competitiveness.

Campbell, Maglio, and Davis (2011) describe relieving innovations in what they term *super service*, defined as providers performing tasks previously done by customers. They discuss home-delivery of groceries as a B2C example and vendor managed inventories as a B2B example. Other examples of relieving innovations fall under the heading of *servitization*, which is when manufacturing firms (largely engrossed in independent processing) make a strategic process shift into related services (i.e., interactive processes). Neely (2008) provides some examples. One example is a jet engine manufacturer, Rolls-Royce Aerospace, shifting from selling engines to leasing engines by the hour of use, and in the process relieving customers of engine maintenance and repair processes. Another example is IBM, a firm that previously focused on designing and producing computer hardware that customers would use to meet their computing needs, but now provides managed hosting services, relieving customers of having to manage their own IT. In each of these examples of relieving innovation, process steps shift from the customers' process domains to the providers' process domains.

Discussion and Application

At the beginning we outlined our objective for the PCN framework to help rectify stereotypes and misconceptions about service and SOM. In this final section we discuss how service and SOM can be more clearly conceptualized through the PCN framework, and how the framework can help guide the efforts of professionals from SOM and related disciplines.

How the PCN framework rectifies confusion about SOM

The PCN framework dispels the five confusing stereotypes about SOM that we reviewed previously. First, it emphasizes the process focus of SOM, while also effectively considering organizational entities and resources owned and/or processed by those entities. Second, the PCN framework recognizes that studying service operations can be particularly complex due to having interactive processes that span a network of entities. Third, the framework resolves the confusing goods-versus-services dichotomy by depicting how physical resources (goods) always exist within a region of a process domain, revealing a more useful dichotomy: independent processing of resources (non-service) versus interactive processing of resources (service). Fourth, the PCN framework shows the symmetry between the process domains of customers and providers, simultaneously providing both a customer-focus and a provider-focus. Fifth, the framework provides a concrete definition of "service" as direct- and surrogate-interactive steps that exist between process domains.

The following are three important insights coming from the PCN framework.

1. The diversity of business operations are built upon three fundamental process regions.

Some have suggested that the diversity of service businesses may require "developing separate paradigms for different categories of services" (Lovelock and Gummesson 2004, p. 37). For example, Edvardsson, *et al*, reviewed 57 research articles on defining service and surveyed 11 top service researchers, concluding that, "on lower abstraction levels a general service definition does not exist. It has to be determined at a specific time, in a specific company, for a specific service, from a specific perspective" (2005, p. 119). Conversely, we propose that processes that possess similar sequences of independent, surrogate interactive, and direct interactive steps will have similar operating characteristics, even if they are in seemingly disparate businesses. For example, auto repair involves independent processing to prepare skills and technology, direct interaction to review symptoms, surrogate interaction to diagnose, direct interaction to confirm a treatment plan, surrogate interaction to repair autos, and direct interaction to handle payment. That process chain is surprisingly similar to process chains found in management consulting, kitchen remodeling, healthcare, and estate planning (Sampson, Menor and Bone 2010, p. 30-31). Indeed, the basic structural elements of PCN Diagrams can reveal commonality among seemingly disparate lines of business.

2. Every business has a mix of interactive processes and independent processing.

As mentioned, some researchers have suggested that all businesses are service businesses. That may imply that all process chains ultimately involve value-laden interactions with customers, which may be true, but provides little in the way of strategic direction (Sampson, *et al.* 2010). All businesses also involve essential aspects of independent processing, which does not imply that all businesses are make-to-stock manufacturing (the quintessential non-service process). The PCN framework shows how process chains contain both independent and interactive process elements – and we will not likely find any businesses that *only* involve interactive service processes or *only* involve independent processing.

3. The nature of the process mix makes a difference in how the process should be managed.

Some processes are conducive to interaction, and others are not. Table 1 listed some examples of significant managerial distinctions between independent processing and direct interaction, and others are described in (Sampson 2001) and (Sampson and Froehle 2006). Service interaction requires some degree of integration of processes across multiple entities, and therefore can be more difficult to design and execute than independent processes.

How the PCN framework enlightens SOM and related disciplines

We reassert that SOM is primarily the management of process chains that have steps involving interaction among process entities. From this perspective, a “service system” can be defined as a network of process entities that have one or more process chains in common (e.g., Figure 5), and the emerging field of “Service Science” can be defined as the science of multi-entity interactive processes. The purpose of PCN Diagrams is to help SOM researchers and practitioners in documenting, designing, analyzing, and reconfiguring processes of all types. It is hoped that those outside of SOM can also find value in their use.

Service Marketers can use PCN Diagrams in New Service Development (NSD) to prototype (on paper) potential service offerings and assess opportunities for increased customer value. This may include exploring the implications of increased customer engagement, such as by moving process steps from a firm’s process domain to the customer’s process domain. PCN Diagrams can help communicate new service configurations to potential customers, and, using methodologies such as conjoint analysis, assess customer value resulting from changes in process configuration.

Human Resource Managers can use PCN Diagrams to help employees understand their roles in service delivery processes, and how their roles relate to customer roles. The nature of job design is very much influenced by the process region the job spans, which has implications for employee selection criteria. Also, work measurement and compensation can vary dramatically depending on the process configuration.

Strategic planners can use the PCN framework in considering the implications of various process configuration alternatives. Further, current and proposed processes can be assessed as to whether they are consistent with the process strategy and skill set of the firm.

Which leaves us with the question of the role of SOM professionals in the broader contexts of business. Perhaps as much as anything SOM professionals are (or should be) service system integrators, or what Normann referred to as "Prime Movers" (2001, pp. 26-36). This means they need to have a broad understanding of the firm's interactive and independent processes, and also the related processes along the process chains with which the firm is involved. This requires understanding traditional operations, understanding customer interfaces, and understanding supply chains that extend outside of the firm. This can mean understanding the processes of suppliers, suppliers of suppliers, and so forth. Integration requires identifying what information needs to be shared across the process chain, and how the integration should best be implemented, measured, and controlled.

Using the PCN framework to advance SOM Research

We have provided a relatively limited overview of the PCN framework and methods for PCN Analysis. Although the methodology has been applied in numerous practical settings, there is a need to apply it in increasingly complex service systems, looking at increasingly complex SOM issues. This will precipitate expanding and testing the usefulness of the PCN framework by applying it to various areas of SOM research.

SOM research is somewhat eclectic, sitting on the border between production-oriented OM research and consumer-oriented marketing research. This has been the source of some difficulty for SOM researchers who try to apply traditional OM research paradigms to service contexts. Roth and Menor observer how, "Many service management problems are fuzzy and unstructured; are multidimensional and complex; and are less conducive to normative, analytical modeling" (2003, p. 146). Nie and Kellog assert that, "service OM must be studied in different ways, using different theories, skills, competencies, and language" than traditional manufacturing-oriented OM research (1999, p. 352).

Much of the research involving service management has come from the marketing discipline (Lovelock and Gummesson 2004, p. 22; Rust 2004). As outlined in the background section, marketing scholars have even taken the lead in addressing traditional OM topics (quality management, facility layout, process focus) in service contexts. Meanwhile, SOM researchers have marched into traditional marketing topics such as target marketing and customer satisfaction. While there is value in cross-functional research, SOM researchers should not neglect the traditional OM perspective. The PCN framework can help SOM researchers do what Johnston terms "returning to the roots" of the core OM discipline (2005).

The PCN framework accommodates the tradition of structured manufacturing processes that occur within regions of independent processing. A fundamental research question for SOM is: How do operational phenomena that occur in regions of independent processing (e.g., in the factory) manifest themselves differently when they occur in regions of surrogate or direct interaction? In other words, what happens when we take an OM methodology out of the factory and apply it in a customer-intensive process? The following are examples of how the PCN framework can be leveraged in future SOM research.

1. **Inventory management** considers methods for identifying optimal inventory policies to guide the location and replenishment of inventories. With interactive processes the customers are often waiting in inventory (Sampson and Froehle 2006, p. 335). We suggest that there are

differences between customer waiting inside a system (direct interaction), waiting vicariously (surrogate interaction), or waiting independently, as depicted in a PCN Diagram. An SOM research question is how to design processes to optimally position waiting across the three process regions.

2. **Production scheduling** includes methodologies for configuring assembly lines to balance production flows, reduce the impact of bottlenecks, and thus improve station utilization. We suggest that production scheduling will differ dramatically across the three process regions of a PCN Diagram. Production scheduling in regions of direct interaction is confounded by the stochastic nature of processing caused by customer involvement. Surrogate interaction allows increased efficiency by buffering customers from the system. An SOM research question is how to optimally schedule production in processes that span process regions.

3. **Lean production** focuses on eliminating waste in production systems. Waste in an independent processing region is easily identified as overproduction, rework, and so forth. In interactive processing, waste is manifest differently: overproduction may mean interacting more than necessary, providing direct interaction when surrogate interaction is more effective, or providing interactive capacity that is hardly ever utilized. A lean production research question for SOM researchers is how to design service systems to provide the optimal level and type of interaction (e.g., see Froehle and Roth 2004).

Conclusion

The PCN framework helps us visualize service operations, including phenomena that otherwise might be difficult to conceptualize. Service systems have been characterized as complex, which can be attributed to the intertwining processes that span networks of entities with bidirectional interactions. The PCN framework facilitates the analysis of interactive service processes as they exist within multi-entity systems. PCN Diagrams allow us to depict complex processes, identify value propositions and cost drivers, and consider strategic process alternatives. Practitioners and researchers can use PCN Analysis to visualize, analyze, and solve SOM problems.

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