Supply chain leagility in professional services: how to apply decoupling point concept in healthcare delivery system

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Abstract
Purpose – This paper aims to show how leagility can be applied in professional services, especially hospitals.
Design/methodology/approach – The case study approach was used to consider the concept of leagility in professional services. Therefore, it studies a specialized hospital in Iran as a professional service provider.
Findings – The specific condition of the patients forces the hospital to be highly agile and at the same time it can benefit from lean strategies. By grouping healthcare services into three pipelines, it identifies decoupling points for the supply chain. It also argues that while discussing leagility in a professional service organization, the important role of human resources should be highlighted.
Research limitations/implications – The paper considers leagility in a specialized hospital. There is a need to discuss this concept in generalized hospitals with multiple pipelines. It is also limited because it considers one specialized hospital, thus the results of this research cannot be generalized to other specialized hospitals.
Originality/value – Leagility in professional services is something rarely dealt with in the literature. Thus, this research expands on the concept of leagility in professional service, particularly in hospitals, and the paper fills this gap in the literature which could be further explored.

Keywords Professional services, Health, Iran

Paper type Case study

1. Introduction

Manufacturing companies are continually paying attention in responding to the customer demand for gaining a competitive advantage over their rivals. They have well found out that it is the supply chain that compete not the company solely (Christopher and Towill, 2001).

Leanness and agility are two strategies helping supply chains in different situations. While lean strategy affords markets with predictable demand, low variety and long product life cycle, agility acts best in a volatile environment with high variety and short product life cycle (Agarwal *et al.*, 2006). In the 1980s, lean thinking attracted a great deal of interest in business environment and after that, in the 1990s, agile manufacturing emerged as a new strategy to companies. The former was a reaction to old production strategies which included full of wastes and unsatisfactory quality, while the latter was a response to changing customer demand. Some authors have suggested that agility is the next step after leanness, that is when lean principles are implemented in a system, then agility is the best to be achieved (Mason-Jones *et al.*, 2000b; Hormozi, 2001) and although lean and agile paradigms have different goals, can be successfully combined within a total supply chain (Mason-Jones *et al.*, 2000a). This idea has led to the emergence of the hybrid strategy, "Leagility", which separates these two paradigms in a total supply chain using a strategic stocking point called "decoupling point".

Looking at the past trend in research about leagility, it could be seen that no research is titled by the subject "leagility in services" or the like. Services have been not only ignored in this context but also it is the same situation in other areas of Operations Management (OM) concepts and techniques. According to Bowen and Youngdahl (1998), "manufacturing tends to be the locus of OM's innovations much more than service".

While considering manufacturing-based concepts in service sector, it is important to distinguish between different typologies studied in the service literature (Bowen, 1990; Silvestro *et al.*, 1992; Kellogg and Chase, 1995; Cook *et al.*, 1999). Of the most frequently noticed classifications is that of Silvestro *et al.* (1992). In their article, they classify services to three categories, i.e. mass services, service shops and professional services. The focus of this paper is on professional services, particularly healthcare, supply chains. Accordingly, the next section is allocated to the literature of leanness, agility and leagility. Then, it argues the healthcare supply chain as a professional service provider. In the third part, the case organization is presented. This section follows

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with the findings and discussions of the case and at the final stage, conclusion is provided.

2. Lean, agile and leagile paradigms

The terms "lean production" and "lean thinking" (Womack *et al.*, 1990; Womack and Jones, 2003) were coined to present the state of the art production strategies of Japanese companies versus American and European old systems. The creators of the terms noted that leanness means eliminating seven kinds of muda and totally defining, doing more with less. From that time, too much research is handled by different researchers in this field (Katayama and Bennett, 1996; Cooney, 2002; Comm and Mathaisel, 2005).

In order to serve the customer with short lead time, lean system produces the inventory in advance, similar to mass production, but what distinguishes lean production from mass production lies on the forecast horizon, i.e. if the horizon in mass production is months or years, but in lean system it is two weeks or less (Goldsby *et al.*, 2006). To afford such an accurate forecast, great attention should be focused on the customer.

The reaction of western against Japanese companies and the continually changing needs of the customer, which sought something more than leanness, led to the emergence of agile production. The origin of agile concept goes back to Agility Forum by a group of researches at Iacocca Institute, Lehigh University in 1991 (Ramesh and Devadasan, 2007). Agility is "using market knowledge and a virtual corporation to exploit profitable opportunities in volatile marketplace" (Naylor *et al.*, 1999, p. 108). Agility is a holistic and strategic idea (Power, 2005) and a "business-wide capability" (Christopher and Towill, 2000) shed light on all aspects of a supply chain including internal structure and trade partners, but the most important prerequisite to achieve agility is the culture compatible with agile enterprise, that is the people side of the supply chain (Aitken *et al.*, 2002). The key to be agile is service level, comprising flexibility and responsiveness, which is called the market winner of an agile supply chain against the cost which is the market winner of leanness. On the other hand, the market qualifiers for the former are quality, cost and lead time while quality, lead time and service level are the market qualifiers of the latter (Mason-Jones *et al.*, 2000a).

A new concept arisen in recent years in the area of supply chain management is leagility. Leagility is the combination of leanness and agility within a total supply chain strategy using a decoupling point so as to best suit the need for responding to the downstream volatile demand while providing level scheduling upstream from the market place (Van Hoek *et al.*, 2001). Despite the importance of this concept, it has not been well discussed in different sectors as much as leanness and agility. Although it is the combination of lean and agile paradigms, the most distinguishing point of leagility from the two is the concept of "Decoupling point". The decoupling point (DP) is defined as:

> the point in the product axis to which the customer's order penetrates. It is where order driven and forecast driven activities meet. As a rule, the decoupling point coincides with an important stock point – in control terms a main stock point – from which the customer has to be supplied (Mason-Jones and Towill, 1999, p. 16).

Upstream from this point lean strategy can be utilized to gain cost-efficient advantages of predictable demand. Downstream of DP agility can be applied. Related to the concept of decoupling point is postponement. In postponement final customization is delayed until customer orders are received (Van Hoek, 1999). The application of postponement in business dates back to 1920 which was used by companies such as Benetton and Hewlett Packard (Boone *et al.*, 2007). In order to determine which of the paradigms (lean, agile and leagile) can be utilized in a total supply chain, different types of strategies in which the decoupling point is located in different locations of the total supply chain is proposed in literature. These strategies are shown in Figure 1.

In a leagile supply chain, an "assemble to order" is the appropriate strategy (Huang *et al.*, 2002).

2.1 Leanness and agility in services

As noted earlier, considering OM's concepts in services needs more scrutiny. In mass services, at one extreme and professional services, at the other extreme, much difference can be put forth. While mass service operations are product focus and therefore, to some extent similar to manufacturing operations, professional services are process focus. In addition, the high level of discretion and also high intense customer involvement in providing service makes much difference between this kind of services and manufacturing sector.

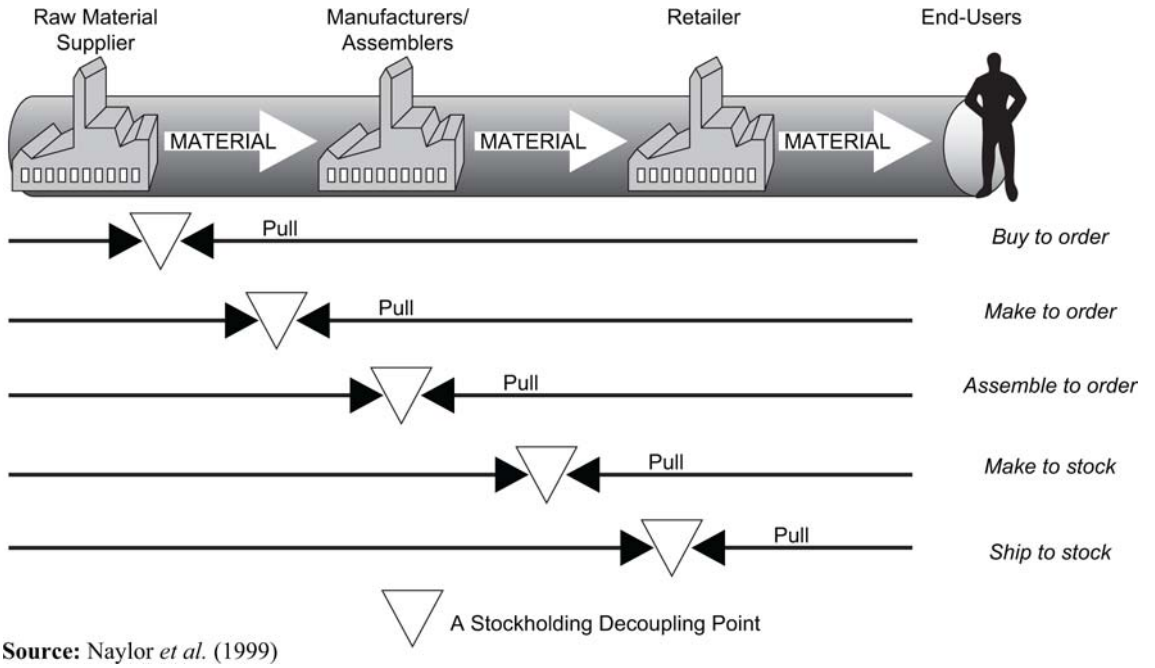
Professional services are a rapidly-growing service industry today. Knowledge both as a resource and as a service sold to clients distinguishes professional service firms as knowledge-intensive, from other kinds of services (Smedlund, 2008). To understand which occupations are perceived as "profession" by the customer helps practitioners effectively manage their services (Thakor and Kumar, 2000).

Leanness has been studied in service sector by different authors (Bowen and Yaungdahl, 1998; Spithoven, 2001; Emiliani, 2004; Piercy and Rich, 2009). For instance, Emiliani (2004) discussed lean practices in higher education and identified outsourcing, technology initiatives and collaboration as the three key methods to reduce cost and improve efficiency in this sector. Bowen and Yaungdahl (1998) consider lean service versus manufacturing and show how leanness has been implemented in a restaurant, airline and hospital.

The application of lean thinking in healthcare sector as a professional service has also been considered in the literature. Womack and Jones (2003) argue that lean thinking can be applied in healthcare systems. They identify time, comfort of the patient, empowered teams and the active involvement of the patient as the key performance measures of the system. Breyfogle and Salveker (2004) examine the application of lean thinking in healthcare sector using the six sigma approach. Kollberg *et al.* (2007) also discuss how a performance measurement system, called "the flow model", is designed to measure changes towards lean thinking in healthcare services. Hence, the model has been introduced as a suitable tool for this purpose. Moreover, they argue that the model needs to be balanced in order to receive a complete picture of lean performance. They suggest some other issues to be considered for the application of lean thinking in healthcare.

Although agility has been the locus of many articles, few researchers have studied this concept in the context of services (Kandampully, 2000; Börjesson and Mathiassen, 2005; Oloruntoba and Gray, 2006). Considering the tourism industry, Kandampully (2000) offers the continuous fluctuation in demand as the challenge for managers.

Figure 1 Different supply chain strategies



Source: Naylor *et al.* (1999)

Börjesson and Mathiassen (2005) study agility in a software development center and conclude that agility principles would help the case organization respond more effectively to events that impact the software process improvement initiatives. Oloruntoba and Gray (2006) investigate the nature of the humanitarian aid supply chain and discuss the extent to which certain business supply chain concepts, particularly supply chain agility, are relevant to humanitarian aid. They also develop a model of an agile supply chain for humanitarian aid. Bowen and Yaungdahl (1998) also argue that responding to customer's demand for variety depends on the abilities of employees.

While leanness and agility have been paid attention in the supply chain literature, it seems that no research has studied the application of leagility in services, especially professional services. As argued, the key challenge in leagile supply chain is to determine the location of DP.

2.2 Research questions

The main objective of this research is to investigate and understand how leagility can be applied and operationalized in professional, especially healthcare, services. The major challenge for an organization is to achieve the advantages of both lean and agile strategies. The literature shows that there are three general positions with respect to lean and agile: those who believe that they are distinct concepts that cannot co-exist, those who believe that they are mutually supportive strategies, and those who believe that leanness must be a precursor to agility.

By applying leagility in professional services context, the combined benefits of lean and agile paradigms will help reduce overall lead time and cost of the offering services. In order to examine the aim of this study, the following research questions are established:

RQ1. Is it possible to distinguish between lean and agile parts of the total supply chain in healthcare services?

RQ2. If the answer of the first question is positive, then how can be DP identified to separate these parts of the supply chain?

2.3 Methodology

The method used in this paper to examine the concept of leagility in a hospital as a professional service provider is case study. Case study enables the researcher to gain a holistic view of a certain phenomenon or series of events and can provide a round picture since many sources of evidence were used (Yin, 2003; Mohd Noor, 2008). The case organization was selected because it is a specialized hospital concentrated on a limited number of services. Therefore, it prevents considering too many pipelines serving in a generalized hospital. Additionally, in this way a case organization would be completely studied. In preliminary discussions about the organization's combination of lean and agile, we began to wonder about how these two concepts could co-exist within a specialized healthcare supply chain and whether a decoupling point would be apparent. We formulated the research questions outlined above and initiated an in-depth investigation of the case study organization.

The required information was gathered through in-depth, semi-structured interviews. In semi-structured interview, the questions are non-standardized and the researcher will have a list of themes to be covered. In this method, the questions may vary from one interview to another and some questions may be omitted or added in particular interviews (Saunders *et al.*, 2003; Yin, 2003). In this research, the selected measures for designing the interview questions where derived from the literature, mainly based on the attributes of lean, agile and leagile strategies proposed by Mason-Jones *et al.* (2000a) and Agarwal *et al.* (2006). The measures were selected with the aim of identifying which part of the supply chain should apply lean or agile strategies. Two types of questions were provided. The first type was designed for

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material procurement processes of the supply chain which the administrative personnel were mostly engaged in and the second type was provided for treatment processes of the supply chain. "What" and "how" questions were mostly used for both parts. For the material procurement processes, the interviewees were asked about measures as the demand predictability of the materials, the supply procedure of the materials, the important factors that impact the procurement process and etc. For the treatment processes, the interviewees were asked about two issues. First, the service delivered in the center and if it is possible to separate it to any subservices or pipelines. Moreover, the important factors that totally impact the treatment processes were questioned in order to know whether this part of the supply chain should adopt agile approach. In this regard, some measures such as lead time compression, service life cycle, the predictability and variety of the service, availability and responsiveness and etc. were discussed. Second, the differences between the pipelines were identified based on DWV[3] (Duration of life cycle, time Window, Volume, Variety and Variability). This classification schema developed by Towill and Christopher (2005) was used for pipeline identification and distinguishing between the pipelines in order to separately determine the DP for each pipeline.

It was tried the interviewees to be selected from all the key functions engaged in service providing process. A total of 15 interviews were conducted, each lasting for about 45 minutes. The interviewees involved three nurses, five general practitioners, two specialists and five administrative personnel including the administrative manager, two procurement employees and two employees who were informed from the procurement processes, all with job experiences ranging from five to eleven years. Each interview was tape-recorded and transcribed to allow identification of the common themes and variation in responses.

The information collected from interviews helped create process maps for the case supply chain. Process mapping is a graphical tool depicts the steps that make up a process (Bashford *et al.*, 2002). It is commonly used for process improvement purposes. It simplifies work processes and gives a clear picture of the processes so that the analyzers will be able to readily see problems and improvement alternatives (Ungan, 2006). In this regard, the section below provides a general review of the studied case and then, in the next sections findings will be discussed.

3. The case study

The case study organization is a specialized hospital in public sector located in northeast of Iran. It is a healthcare center providing certain kinds of services (trauma). It is placed in suburb where lots of manufacturing units are located around the region. The injuries occurred in the external routes of the city have also the closest way to the hospital. Generally speaking, the strategic location of the healthcare center makes such a position that contributes both to leanness and agility. On the one hand, it is close to the medical appliances suppliers, which makes constant replenishment of the supplies possible. On the other hand, the injuries from manufacturing units and car accidents can be taken to the center as soon as possible, while time is an important factor in healthcare market.

3.1 The hybrid supply chain in the case healthcare organization

Healthcare services are known as knowledge-intensive services rendered by knowledge workers. However, providing such a service requires using some kinds of goods. In that part of the supply chain where the treatment process starts, the whole process significantly depends on the ability and knowledge of the employees (nurses, specialists and general practitioners) in responding to the uncertain situation of the demand. As the successful treatment process is achieved through utilization of physical components, thus providing these components is an important issue. The demand for these components is to a great extent stable so that the processes of this part can be done in a routine way.

The provision of these components or materials is handled by back-office part of the total healthcare supply chain. In this part, the application of lean practices can lead to cost-efficient flow of the processes. Chase (1996) argues that the back-office part of service operations operates very much like a factory. Therefore, it is where lean practices can be to a great extent adopted the same as manufacturing sector and methods reducing costs can be implemented. For example, irrespective of the kind of problem the patients have encountered, all usually need to be hospitalized on the same beds, consume the same bandage, etc. However, the utilization of these materials in the treatment process should follow lean approach. From the aspect of the material flow, the main concern is how to supply and manage goods (medicine, bandage, etc.) and how to use these goods in a cost-efficient way.

The treatment process in healthcare centers is handled by the front-office employees. Although utilization of lean methods for using the materials in the treatment process is necessary, it is the market qualifier for this part. Because of the special condition of the patients who require quick action in the case supply chain, the ability and flexibility of the personnel is an important issue for the treatment process. In addition, the required lead time for responding to the highly serious and variant needs of the patients is critical. Therefore, the market winners in this part are the lead time and the ability and flexibility of the personnel while encountering different needs of the patients. This requires this part of the supply chain to be highly agile. To do so, frontline employees need to be educated and experienced to respond to the fluctuating needs of the patients. At this part, the more experienced and educated the frontline service provider, the more agile and flexible to the unexpected needs of the patients. It is where the service firm should invest on to ensure the best service level is achieved. In addition, adjusting the capacity with the demand has a significant role on both leanness and agility of the healthcare system so that the quickest response can be delivered at the most efficient way.

From the previous paragraphs, it can be concluded that the case healthcare organization offers two types of services comparable with Fisher's (1997) typology of functional and innovative products (services). As mentioned, the functional products can benefit from lean supply chains, while innovative products can adopt agile strategies. According to this discussion, the provision and usage of the materials of the supply chain can benefit from lean principles. It is also the condition for the services (primary actions) delivered in the same way as the prerequisite for the treatment process which should be delivered cost-efficiently. Similarly, agile strategy is

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necessary for patient's treatment. Indeed, we encounter functional-innovative services in this healthcare organization. Therefore, an alternative supply chain strategy for this sector can be leagility in which the main concern is to position the decoupling point.

3.2 Lean operations in the hospital

The healthcare organization has focused its service delivery on a single procedure (treatment of traumas and injuries) which leads the processes to be done in a cost-efficient way. This feature of specialized hospitals towards leanness has been confirmed by Bowen and Youngdahl (1998).

The materials used in the service providing processes are divided in to two types. The first type includes disposable materials such as stationery, bandage, gloves and dresses and the second type is the medicine. In fact, they are divided into perishables and non-perishables. Because of the special situation of most medicines (perishability), they are replenished every week. Indeed, the procurement of medicines utilizes forced implementation of JIT which also leads to reduced spaces of the warehouse. According to the interviews, most medicines used in the treatment process of patients have an expiry period of about 1-2 week(s). The inventory of these medicines is supplied for about one week. The short distance between the healthcare center and the most famous companies producing medicine has increased the replenishment frequency and consequently decreased the charges paid for frequent transportation of medicines.

Another aspect of JIT which contains services like healthcare is to balance the demand for care with the capacity in terms of the total number of referrals in each period. Thus, JIT requires that demand can be predicted and planned for (Kollberg *et al.*, 2007). In lean approach, the inventory is seen as a kind of waste which should be eliminated. In professional, and particularly healthcare, services the capacity is a supply chain replacement for inventory. Capacity planning in terms of the skilled workforce is related to the assignment of the right number of people at the right place and time in order to perform efficiently the job to be done. As shortage in capacity is the dominated situation in this healthcare center, this is offset through over-time work in order to adjust capacity with demand. In this especial case, the capacity in terms of the total number of referrals can be predictable. The case organization is located near a tourism area. The past trends show that in holidays the accidents are at the extreme because of the heavy traffic in the external routes of the city. This center adjusts its capacity based on these trends. Therefore, JIT is applied for the effective management of capacity in this center. However, in terms of the complication and identification of the required cares it is not possible to predict the demand.

In addition, there are other areas which have adopted lean strategies. Another prominent movement on the route towards leanness is outsourcing of different activities which has led to great cost-savings. The transportation, call center, restaurant, laundry, maintenance and installation are all outsourced.

3.3 The agile characteristics of the supply chain

Because of the special condition of the healthcare operations, agility is extremely important for the treatment process in the healthcare supply chain. The strategic use of capacity facilitates operational agility. In healthcare services, there is less flexibility to deal with uncertain demand due to the inability to inventory demand. Thus, demand management requires this healthcare center to understand its own capacity to absorb additional work through over-time. While lean approach is adopted through synchronizing capacity and demand using over-time work, from the other aspect, the effective management of demand/capacity contributes to agility by decreasing the influence of what are called "obsolescence" and "stock-out" costs.

According to the interviews, medical knowledge and experience of the service providers (nurses, specialists and general practitioners) are also among the most important factors in responding to the various needs of the patients. In this regard, the hospital has intensively invested on the recruitment of the best medical human resources. Workforce recruitment is also important for this small hospital because the long distance between this hospital and the city makes it a non-attractive alternative for skilled workforce. However, offering attractive options by this healthcare center has made this organization a preferable one.

Recruiting the skilled workforce is not the only way to improve agility. According to one of the interviewees, the collaboration between different hospitals is a necessity in the healthcare sector to exchange their newest findings in this field. In this case, this is achieved through continuous meetings hold by different hospitals. In these meetings, medics of different hospitals with different skills and experiences interact with each other. Other ways for improvement are the training courses which are annually held in the case organization. These courses are selected based on the requirements of the workforce.

The structure of the healthcare center for affording the demand helps configure an agile feature. In this case, team working contributes to responding rapidly to serious injuries of the patients as this is an important factor in healthcare centers. Generally, organic structures, in which team working is a significant feature, enable organization to behave flexibly and adapt the organization's response to current environment.

The Hospital Information System (HIS) which supports all the processes of the treatment, from entry to release, has intensely resulted in lead time reduction. For example, the time spent on the transference of the X-ray from one ward to another would be eliminated. This system has also caused flexibility. In this system, the doctor can visit the patient online. This makes the accessibility of the specialty required possible. Through this system which has been recently applied and implemented in few hospitals in the region, patients recover faster and with fewer complications than patients who undergo traditional trauma treatment processes.

3.4 The service processes and the DWV^3 schema

In order to give a clearer picture of supply chain, the service processes of the healthcare center will be explained. This healthcare organization includes cases which are often brought to the center by the ambulance. When the ambulance refers to the accident location, the primary actions are carried out. These primary actions or first aids are limited in nature and either done within a specific framework. For example, resuscitation is needed if the patient is unconscious. Predefined instructions within a specific framework are established for resuscitation in healthcare services. These predefined instructions are called ABC which is the acronym for "Airway, Breathing and Circulation" and

must be controlled for all unconscious patients. Other actions depend on the general condition of the patient. If there are any fractures (whether in case of fracture or serious injuries explained later), the injured limb will be braced, and if there are ruptures (whether in case of rupture or serious injuries), stanching the injured limb(s) is the primary action until the patient is transferred to the healthcare center. As illustrated, although each patient may have various and variable situation, the primary actions are the same simple instructions which are done within a specific framework by non-specialist nurses.

For the case illustrated, there are three pipelines including rupture, fracture and serious injuries. The word "pipeline" refers to the difference in flow of patients (which corresponds to product flow) in pursuance of all phases of their treatment from referral to full recovery (Towill and Christopher, 2005). The results of pipeline identification in this case are in line with the formal document in the field of medical knowledge regarding the professional standards namely "Triage, first aid and transportation of victim". When the patient is transferred to the center (emergency room), the physician initially takes a general evaluation of the patient's situation in order to identify which pipeline the patient should be treated in. Figures 2 and 3 show the treatment process for each pipeline.

The first pipeline includes patients with ruptures on the body who are conscious and moreover, need not to be hospitalized. Ruptures in which the nerves are not damaged move through this pipeline. The life cycle duration for rupture injuries is short, limited to each patient. In terms of variety and variability, this pipeline locates at a high point. This pipeline also consists of the high volume services. Although the injuries in this pipeline are not as intense as serious injuries, they require quick action (in order to prevent subsequent injuries). The treatment of these patients usually differs from the initial steps based on the depth, intensity and the injured limb itself. When it was determined that the patient should be treated in rupture pipeline, then, the case-sensitive treatment begins. The second pipeline consists of fracture injuries other than those that the nerves are damaged. In this pipeline, the patient is conscious and may need to be hospitalized for a short period of time. Similar to rupture injuries, the life cycle duration in this pipeline is short, limited to each patient. This is because the variety and variability is at a high level. The same as ruptures, fracture injuries constitute high volume of injuries in this center. Although the injuries in this pipeline are not as intense as serious injuries, they must be treated rapidly (in order to prevent subsequent injuries). When the external signs of fracture injury were identified, the patient would go through this pipeline. The first thing to do for a patient with fracture injuries is that he or she would be transferred to radiology ward for more exact diagnosis of the internal injury of the limb. Although, in this pipeline, the injured limb may differ for each patient, the radiology is a stable process for this kind of patients and is performed to a great extent similarly so as to enables the standardization of the process. From this point on, the treatment differs based on each patient's situation. The third pipeline, emergency condition, is the case when the patient is seriously injured, i.e. when the nerves are damaged. It may also include the cases in which both rupture and fracture co-exist. In this case, the first action to be taken is resuscitation, which is needed for serious injuries because the patient is mostly unconscious. This resuscitation differs from that one which was first done at the location of the accident. In this regard, the process consists of ABCD which is the acronym for "Airway, Breathing, Circulation and Drug" and is complementary and more specialized so that must be done under the supervision of the specialists. This resuscitation is not the same for all patients and differs based on the situation of the patient. Again, the life cycle duration for serious injuries is short and limited to each patient. This pipeline consists of the low volume injuries, but both the variety and variability are at a high level. In this pipeline, the action must be taken rapidly because the patient may lose his/her life. After the resuscitation process, the patient goes through the specialized treatment process which differs for each patient and depends on the patient's situation. Following the treatment process for each case of these three pipelines, the convalescence period begins which depends on each case treatment process.

Table I presents the characteristics of each pipeline based on the DWV[3] schema (Towill and Christopher, 2005).

The classification schema was used to know whether it is possible to differentiate between the pipelines in order to

Figure 2 The primary actions previous to the main treatment processes

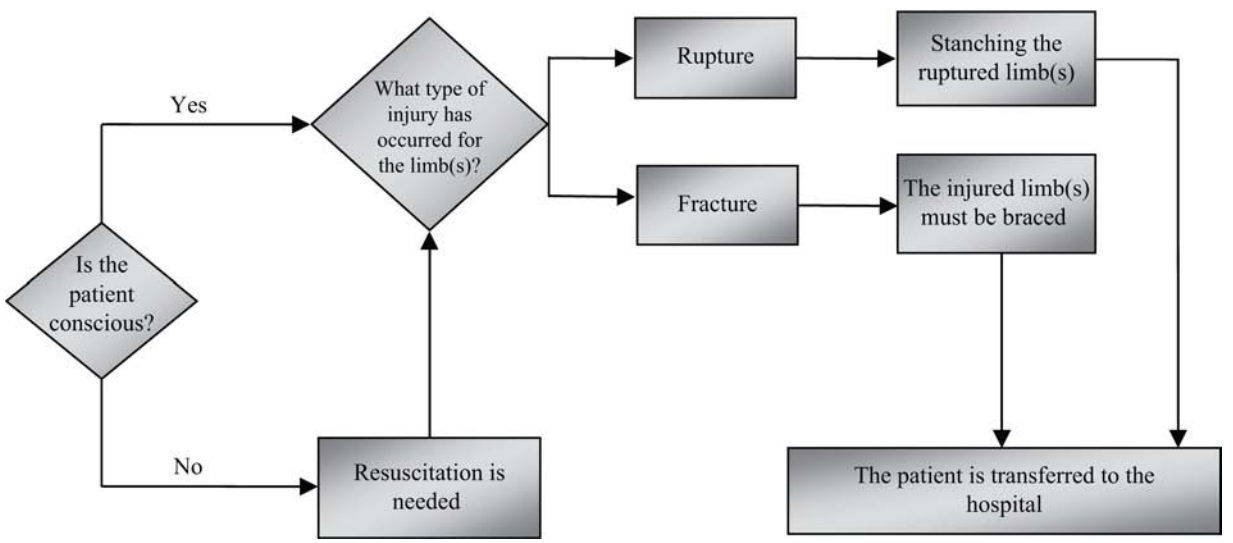


Figure 3 The main treatment processes for each pipeline

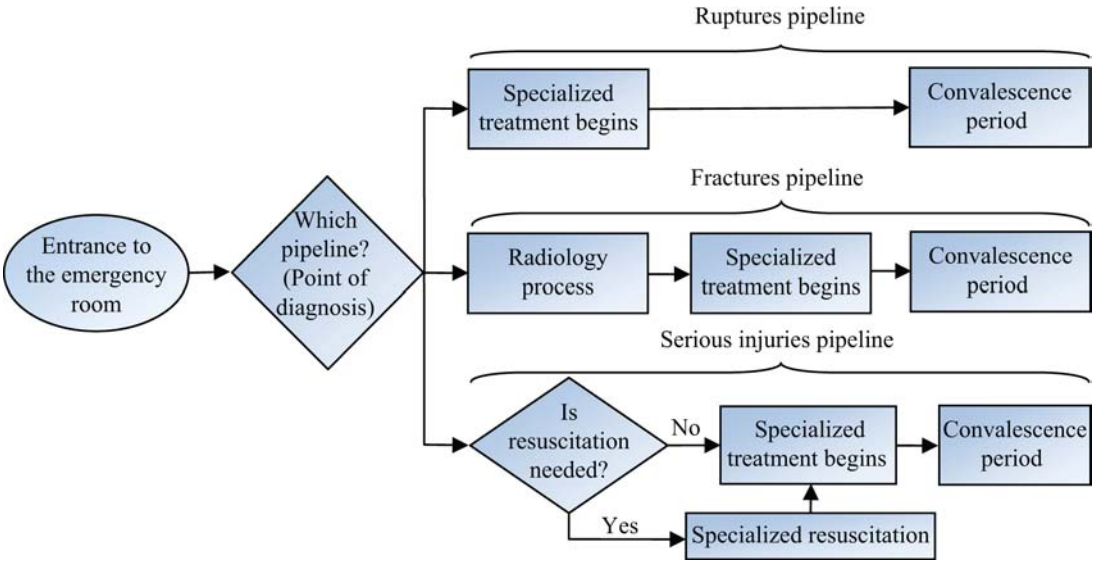


Table I The characteristics of each pipeline based on the DWV3 schema

Pipelines	Rupture	Fracture	Serious injuries
Variables			
Life-cycle duration	Short	Short	Short
Time window for delivery	Narrow	Narrow	Narrow
Volume	High	High	Low
Variety	High	High	High
Variability	High	High	High

adopt different supply chains strategies and to determine the DPs. Because the case is a specialized service provider, it is less possible to classify the products (services) to different types, as have been done by other studies (Childerhouse *et al.*, 2002; Towill and Christopher, 2005). The characteristics of the three pipelines show that the best option for this part of the total supply chain (the three pipelines in treatment process) is an agile approach. Only one variable (volume) represents difference in these three pipelines. But it seems that the status of the other variables justifies the application of agility. Thus, agility is suggested as the suitable strategy for the treatment process. While it is not the aim of this article to discuss the DWV[3] classification schema, readers are referred to Childerhouse *et al.* (2002) and Towill and Christopher (2005) for more details.

4. Findings and discussion

The findings show that since the medical appliances are usually the same for all patients, the variety and variability in terms of the patients' injuries is high. According to the interviews, about 80 percent of the medical appliances are used for most of the patients and the demand for them is predictable, thus supplying these appliances can follow lean principles. Moreover, the services (primary actions) delivered as the prerequisite for the treatment process make no difference because no major treatment process starts at this part. Delivering these services requires no skilled workforce while they are done within a specific framework with few options to choose.

The low predictability and high service variety and variability make the treatment process uncertain necessitating agile strategy. The effective management of demand/capacity helps shorten the treatment process by delivering the required services quickly. Moreover, another important factor in the treatment process is the ability of the service providers to respond quickly to different needs of the patients making the organization to invest on this aspect by employing the most skillful staff and holding training courses.

As discussed, the healthcare organization offers two types of services comparable with Fisher's (1997) typology of functional and innovative products (services). Thus, it can be claimed that lean and agile strategies can be applied by delivering these services, respectively, based on the characteristics shown and summarized in Table II.

In order to realize leagility in the healthcare supply chain, it is needed to match some of the terminologies in manufacturing sector to services. These concepts include "assembly" and "sub-assembly". Contrary to manufacturing, in services, subassemblies cannot be stocked as a buffer; instead, the possible alternative would be the effective management of the capacity. In services, the capacity plays the role of inventory. While this is the case, the conundrum is that how the subassemblies are defined. As the physical components and expertise of the workforce are seen as raw materials in the healthcare supply chain, some combinations of them constitute the subassemblies. For example, the predefined combinations of some resources such as the required specialists, the facilities for radiology process (X-ray), medicines and medical components constitute the subassembly for fracture pipeline. However, the combinations of the subassembly may differ for each especial case of each single pipeline. These combinations are related to the concept of demand/capacity management in that how the capacity of these subassemblies supplies the demand for each pipeline in this healthcare system. To deliver the right service package for each especial patient quickly and efficiently, the effective management of the capacity, in terms

Table II A comparison between the attributes of the two types of the healthcare products/services

Types of services	Innovative products/services	Functional products/services
Distinguishing measures		
Product/service variety	High	Low
Predictability of demand	Low	High
Life cycle duration	Short	Long
Customer drivers	Flexibility and lead time	Cost
Dominant costs	Synchronizing capacity with demand	Synchronizing capacity with demand
	The costs of improving workforce ability	Physical and service costs
Lead time compression	Essential	Essential

of the required number of workforce and the physical components, is the essential issue for this center.

In the healthcare system, the patient is a potential source of capacity. It causes the subassemblies to differ for the three pipelines in terms of the total number of resources (persons). For example, in the rupture and fracture pipelines, where the patient is conscious, he or she affects the provision of capacity, especially at peak times, by participating in the treatment process. Thus, lead time will be reduced and totally, more patients will be treated in a certain period of time. It has also an impact upon costs. In the third pipeline (serious injuries), when the patient is mostly unconscious, more capacity and effort should be invested to treat each patient.

Lastly, the final assembly, which is the combination of the subassemblies and the patient's needs, is postponed until the patient refers to the center. Since the major terminologies were clarified, the next step is to determine the location of DP.

4.1 The healthcare supply chain decoupling point

For healthcare supply chains it is possible to identify DPs whose specific purpose is to avoid interference between various patient flows (Towill and Christopher, 2005). It helps identify which patient to be treated first.

In this hospital supply chain, the DP is located on the diagnosis of the injury which distinguishes between these three pipelines. This diagnosis is achieved through the medical knowledge of the medics and shows within which pipeline the service should be provided. The location of DP at this stage also helps medics and practitioners know for which injuries the actions should be taken first. It means to know which patient needs more agile response. This can be also a kind of sequencing approach based on the seriousness of the injury.

The concept of service specialization also justifies the location of DP at this point. It is at this point that the "capacity management" concept reveals its importance. Here, the resources play an important role in terms of both the number and the expertise and skill of the workforce assigned. In terms of the assigned number of workforce, the center tries to overlap the team members using the same nurses and general practitioners in different teams so that the minimum number of workforce would be required. In addition, the experience and expertise of the workforce have a positive influence on the capacity in that the high experience of the nurses and general practitioners makes them to be able to engage in variant working teams. The high experience and skill of the workforce also help the treatment process be rapidly ended so that more patients will be treated in a shorter period of time. From the aspect of the number of specialists, it is important to know which specialty of the pipelines and in which number should be assigned so that the system could be able to respond quickly and efficiently to the different needs of different patients.

At this point, the service is specialized and customized for each patient based on the required treatment process. Therefore, the service package differs based on the fact that in which pipeline the treatment should be done. Accordingly, the predefined subassemblies covering medical teams and physical components will be assigned to the specific treatment process. Before this point, the processes are done through a lean approach. After the DP, each treatment process drives its way so that agility is required. Figure 4 shows the location of DP in the total supply chain of the healthcare center.

While the main DP in the total supply chain is located on the point of diagnosis and the sequence of treatment is based on the seriousness of the injury, another DP can be determined for the second pipeline (fractures). As noted, the radiology process is done for all patients in this pipeline. Therefore, it can be done by the radiologist as the medical team is delivering services to, for example, seriously injured patients. This makes both the costs and lead times reduced. Moreover, it makes the specialist's time free enough to cure more patients. Thus, the DP in the second pipeline moves one step forward to locate on the radiology process. Figure 5 presents this situation for the fracture injuries.

In this paper, the pipelines were identified so that the patients will be treated in a way that totally the most agile response will be adopted in the treatment process.

The application of leagility in the healthcare delivery system has some implications. Since the DP, as the separator of lean and agile, is related to the concept of capacity management, it cannot be identified too categorically. This is because both leanness and agility can be achieved through capacity management while trying to specify the capacity and no exact point can be determined as the separator of lean and agile. Moreover, the capacity management may sometimes move towards leanness and sometimes towards agility. This is due to the nonphysical aspect of inventory in services which has led to variations in adjusting capacity with demand. To further elaborate, in cases where there are enough capacity to respond to all the patients' needs at the same time, the shortened time of treatment process leads to agility, but in cases where the capacity cannot respond to the needs of patients at the same time, the patients' needs are sequenced based on the required quick action. Totally, the system should adjust the capacity so that both leanness and agility can be achieved at the same time.

Figure 4 Healthcare delivery pipelines and the location of the main DP

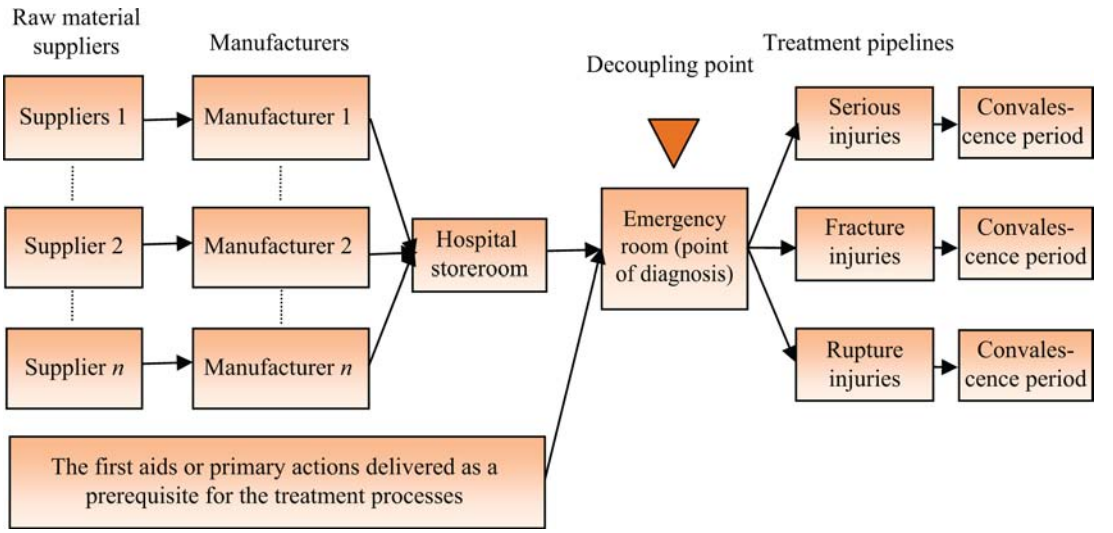
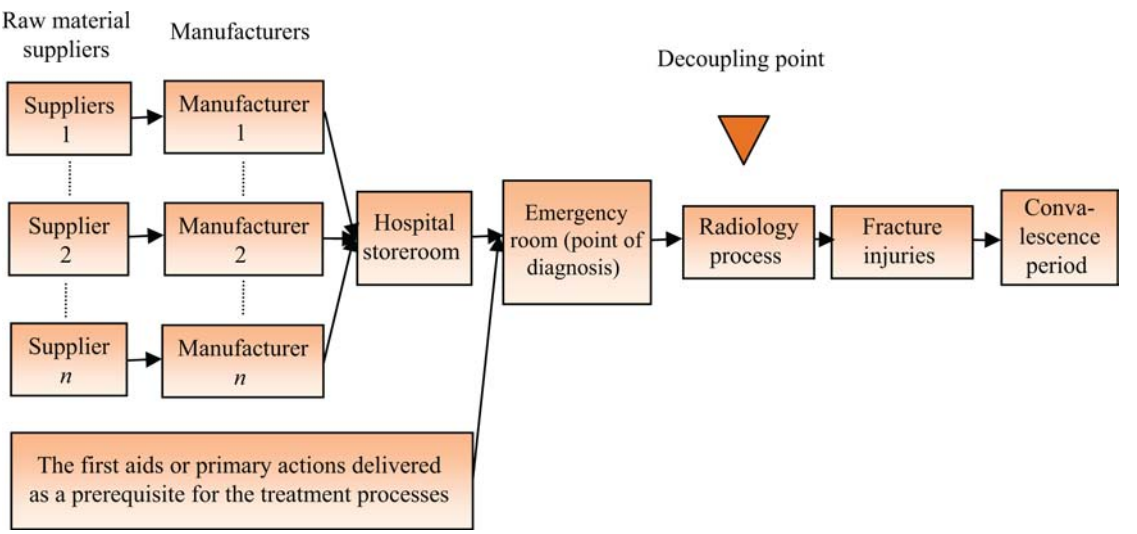


Figure 5 The location of DP at the second pipeline



The application of leagility in healthcare system has also some other implications. While in manufacturing sector the physical goods is the core problem, in the healthcare as a professional service, the ability of the employees (nurses, specialists and general practitioners) plays an important role. This feature brings the potential for the service provider to be highly responsive and flexible to the highly variant and variable needs of each particular patient as it is an important factor in our case organization. The strategic location of the healthcare center, team working and utilization of technological initiatives such as HIS can also contribute to organizational agility by reducing the lead time. It was also discussed that although utilization of lean methods in the treatment process is necessary, it is the market qualifier of this part. However, there are some parts of the healthcare supply chain that can utilize lean strategies. As discussed, the provision of materials or physical components which supports the treatment process can greatly benefit from lean thinking. Compared to manufacturing, there are processes other than the material flow which can adopt lean strategies in healthcare services. These are the primary actions which are delivered as a prerequisite for the treatment process of each patient. Concepts such as outsourcing and application of JIT can also contribute to leanness in this part.

It was also argued that although it is not possible to store services for future use, some parts of the service processes such as the first aids delivered while transferring the injured person to the hospital by the ambulance or the radiology process in the fracture pipeline are delivered in a similar way so as to enable the supply chain to put the main DP on the diagnosis. Such placement of DP enables supply chains to cushion upstream from the fluctuating customer demand thus minimizing some of the defeating dynamics (Mason-Jones and Towill, 1999).

To date, most researches have considered the application of leanness in healthcare sector, but little attention has been paid to agility. In this case, too much emphasis is put forth on agility (rather than leanness) for the treatment process due to

the emergency condition of the patient in this particular healthcare organization while it provides services for trauma injuries. Other healthcare service providers may not require emphasizing agility as we did for this case. In addition, attention is also paid to the concept of "capacity management" as a major distinguishing feature for the application of leagility in professional services.

5. Conclusion

The concept of leagility has been examined in manufacturing context by different authors (Van Der Vorst *et al.*, 2001; Aitken *et al.*, 2005; Mistry, 2005; Sanderson and Cox, 2008), but it has rarely been studied in service sector, especially professional services. In this paper, the concept of leagility is considered in the context of professional services. For this purpose, a specialized hospital in public sector is selected, as a professional service provider. It was discussed that the geographically strategic location of this healthcare center contributes to both leanness and agility. As the interviewees noted education and job experiences as important factors for agility in healthcare services, the center has invested on this aspect. This is consistent with Bowen and Youngdahl (1998) view that in service organizations, responding to customers' demand for variety depends on the ability of employees. Another achievement toward agility is HIS which has led to reduced lead time and flexibility in the case organization.

Based on the literature, it is clear that leagility best suits in supply chains where ultimate customer demand is highly volatile and unpredictable, but end users are also price sensitive. This combination suggests that while supply chain flexibility and responsiveness are the market winners, the low cost and efficiency are important market qualifiers (Sanderson and Cox, 2008). These mixed characteristics of the end customer demand (in this case, patient demand) are clearly revealed in the case organization.

While DP is the main concern in leagility, the authors discussed the location of DP in this healthcare supply chain. Therefore, the healthcare services were first divided into three pipelines. To streamline the healthcare delivery pipelines into a limited number of effective channels prevents the current interactions causing excessive time delays to dominate healthcare delivery processes (Towill and Christopher, 2005). It was, then, argued that the main DP is located on the point of diagnosis in which, from this point on, the treatment process is customized for each patient. Another DP was further identified for the second pipeline, because one activity (radiology) was necessarily done for all the patients with fracture injuries. In this way, the lead times and costs would be reduced so that the specialist's time would be free enough to take care of more patients.

Related to the application of leagility in healthcare system is the concept of capacity management. This concept has an impact on service agility and leanness. Since the capacity works as the substitute for inventory, it plays an important role at the DP. Here, the resources have a significant impact in terms of both the number and the expertise and skill of the workforce assigned. At this point, the service is specialized and customized for each patient based on the required treatment process. It was also discussed that DP cannot be identified too categorically, because no exact point can be determined as the separator of leanness and agility.

Considering leagility in healthcare organizations (such as the case discussed) that have especial characteristics helps practitioners apply lean and agile strategies when needed in the healthcare supply chain. In the literature, the application of lean thinking in healthcare has been widely studied (Bowen and Yaungdahl, 1998; Womack and Jones, 2003; Breyfogle and Salveker, 2004; Kollberg *et al.*, 2007), but in view of the authors, because of the especial condition of the discussed healthcare organization, the application of agility is a very important issue in some parts of the supply chain since the patients usually need emergency treatment. The DP concept also helps practitioners know where order driven and forecast driven activities meet.

Examining leagility in healthcare organizations also has some lessons for academicians. To date, the application of leagility beyond the manufacturing environment has received relatively little academic attention. This study has empirically demonstrated the validity of leagility approach in a professional service environment. For the academic community this provides useful evidence for the continuing extension of the leagility approach in the professional services, especially healthcare organizations where previous researches have focused on the application of lean strategies in this sector.

The research is limited in that it studies a specialized healthcare center with limited pipelines. To further study, it is important to consider a generalized hospital. It is also limited in that one single specialized hospital is studied. The consideration of other kinds of specialized healthcare centers with different pipelines can be of value. To make the findings of this research more robust, other areas of professional services such as consultancy firms, accountancy/auditing firms and legal and financial service providers can also be studied.

Acronyms

Decoupling Point (DP)
Operations Management (OM)
Hospital Information System (HIS)

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