ADMINISTRAÇÃO DE MARKETING

FLEXIBILITY IN FIELD SERVICES: A CONCEPTUAL MODEL

FLEXIBILIDADE NO SETOR DE SERVIÇOS: UM MODELO CONCEITUAL

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RESUMO

A flexibilidade pode ser considerada como a capacidade de uma organização para enfrentar a incerteza. Como o setor de serviços é caracterizado por um elevado grau de incerteza, a flexibilidade pode ser considerada uma importante arma competitiva nesse segmento. A flexibilidade tem sido extensivamente estudada em ambientes de produção, no entanto, não existem trabalhos abordando este tema na literatura de serviços de campo para o nosso conhecimento. Neste trabalho, nós desenvolvemos um modelo conceitual, onde as dimensões mais importantes da flexibilidade no setor de serviços são definidas e as relações entre eles são descritos. Esse modelo pode ajudar os gestores de serviços a compreenderem como a flexibilidade pode ser alcançada e como ela pode auxiliar na competição no campo de serviços.

PALAVRAS CHAVES

Setor de serviços. Flexibilidade. Modelo conceitual.

ABSTRACT

Flexibility can be considered as the capability of an organization to face uncertainty. Since field services are characterized by a high degree of uncertainty, flexibility can be considered an important competitive weapon in field service business. Flexibility has been extensively studied in manufacturing environments, however, to the best of our knowledge, there are no papers addressing this topic in the field service literature. In this paper, we develop a conceptual model where the most important dimensions of field service flexibility are defined and the relationships between them are described. Such a model can help service managers understand how flexibility can be achieved and leveraged to compete in field service business.

KEYWORDS

Field Service. Flexibility. Conceptual model.

INTRODUCTION

Flexibility can be defined as the ability to respond with little penalty in time, effort, cost and performance to the ever-changing and increasing customers' needs (SETHI; SETHI, 1990; UPTON, 1994). Flexibility is important to accommodate changes in the operating environment. Hence, the need for flexibility increases as the uncertainty in the environment increases. The types of flexibility in manufacturing and the methods for measuring them are extensively researched in literature. However, the corresponding literature in service flexibility is very sparse. To the best of our knowledge, flexibility in field service has never been researched before.

Field services, are those services involving server's personnel, vehicle and equipment travelling to the customer location in order to deliver the service (AGNIHOTHRI *et al.* , 2002). This definition of field services is broad enough to include pick-up/delivery services, emergency services and after sales services. In this paper, we will focus only on these latter, as a result, we will consider as field service the installation/ maintenance/repair services provided, at the customer site, after the product sale. In general, the need for Field Service emerges when: (a) the product/asset to serve cannot be easily moved from customer's site because of its physical characteristics in terms of weight, volume and fragility, and/or (b) the unavailability costs related to the product's malfunctioning or downtime prevents moving the product from customer's site to the service facility. When unavailability costs are high, the value created for customers through the field service is high as well. In such a situation the field service can be a very profitable business (OLIVA; KALLEMBERG, 2003; AGNIHOTHRI; MISHRA, 2004; ABERDEENGROUP, 2005a; BLUMBERG, 1991, p. 24; GOFFIN, 2001; RAPACCINI *et al.*, 2005). Managing the field service, however, can be a cumbersome task for OEMs traditionally involved in "product centric" business (OLIVA; KALLEMBERG, 2003; MATHIEU, 2001). As a result, several OEMs outsource the customer support. In this paper we will refer to Field Service Organization (FSO) to identify the unit responsible for the field service management, which can be either an OEM division or an independent service organization to whom the responsibility of managing the field service has been outsourced.

FSOs are exposed to highly uncertain environments. As we will point out later (see Table 1), these uncertainties are associated with both the FSO's resources and the operating conditions. In fact, although some routine activities (such as installation, training and preventive maintenance) can be scheduled in advance, forecasting the demand for field service is, in general, very difficult. In addition, since most of the resources are deployed on-field, a great deal of uncertainties affects, also, the operating condition. The success of FSOs, however, depends upon the responsiveness and the dependability of the support they provide. As a result, FSOs, on the one side, tend to reduce the uncertainty of their operating environment (through preventive maintenance, remote monitoring and support, customer training, etc.) and on the other side, need to be flexible to face the residual uncertainty. In this paper, we develop a conceptual model where the most important dimensions of field service flexibility are defined, and their relationships are described. Such a model can help service managers understand how flexibility can be achieved and leveraged compete in field service business.

The paper is therefore organized as follows: in section 2 we illustrate the concept of flexibility; in section 3 we will review the literature on service flexibility; in section 4 we will describe the conceptual model, and in section 5 we will draw some conclusions, suggesting the directions for future researches.

THE CONCEPT OF FLEXIBILITY

An extensive review on the concept of manufacturing flexibility, mostly referring to manufacturing contexts, can be found in Gupta and Goyal (1989), Sethi and Sethi (1990), DeToni and Tonchia (1998, 2005), Vokurka and O'Leary-Kelly (2000), Koste and Malhotra (1999), Giachetti *et al.* (2003). In these papers, there is a general consensus around the definition of flexibility provided by Upton (1994), as the "ability to change or react with little penalty in time, effort, cost and performance".

Flexibility can be thus considered as the capability to deal with the uncertainty, both in a proactive and reactive way. The dual reactive-proactive nature of flexibility is well explained by Gerwin (1993). The author shows how firms can make use of flexibility, not only to face the changes that may occur in the competitive arena, but also to create uncertainties in the market, that competitors may not be able to face. Uncertainties can be both external, that is, relevant to the operating environment and market (both from the customers and suppliers side), as well as internal, that is, relevant to the firm's infrastructure, operations and processes. Newman *et al.* (1993), provide a comprehensive explanation about how internal and external uncertainties and flexibility are related. They use an analogy of a balance, with uncertainty on one plate and flexibility on the other plate, as a counterbalancing force. They show how the effect of flexibility can be increased by adopting "buffers" such as inventory, overestimated lead time, and overcapacity to move the fulcrum towards the uncertainty's plate. They point out how internal uncertainties are, to some extent, a result of the external ones (e.g. variations in customer requirements in terms of delivery time can cause unexpected changes in the internal planning and control) and how the adoption of buffers (i.e. capacity) to absorb external uncertainties may result in an increased system complexity and therefore internal uncertainties. This, in turn, may increase the need of additional buffers resulting in a vicious circle. While it is easy to recognize that firms need to be flexible to be competitive in a high uncertainty environment, the concept of flexibility, "is complex, multidimensional and hard-to-capture," as stated by Sethi and Sethi (1990). Slack (1983, 1987) states that flexibility is comprised of two elements: "range" and "response". Range flexibility is defined as "the total envelope of capability or Range of states which the [production] system or resource is capable of achieving". Response flexibility is defined as "the ease, in terms of cost, time, or both, with which changes can be made within the capability envelope". Upton (1994) defines the "constituent elements" of flexibility as Range, Mobility and Uniformity. He extends the concept of Range in order to consider, not only the number of different states reachable by a system, but also the extent of differentiation among these states, that is, their heterogeneity. He introduces the term "Mobility" to identify the ability to move from one state to another "in term of transition penalties for moving between the Range". He defines the concept of "Uniformity" as the "capability to perform comparably well within a specified Range". Finally, he states that in order to understand the actual need of flexibility and to devise actions aiming at reaching that level, managers should: (a) asses the flexibility dimensions; (b) consider the time horizon where the need of change/adaptation relevant to these dimensions can occur; and (c) study each dimension, referring to a specific time horizon, according with the constituting elements (Range, Mobility, Uniformity). The concepts adopted by Upton to develop his conceptual model have been widely debated in the literature. The temporal logic to study flexibility was proposed by Merchant (1983) and Zelenovich (1982). They differentiate short, medium and long-term flexibility according with the time horizon when uncertainties arise. Connected with the temporal classification there is a distinction between operational and strategic flexibility. The former is connected with the ability to cope with the uncertainties that arise in the short-medium term, while the latter has a long term orientation and refers to the firm's capability to change its competitive priorities and business (HAYES; PISANO, 1994; STALK, 1992; DE TONI; TONCHIA, 2005). There is a huge body of literature on the dimensions of flexibility, mostly focused on manufacturing environments (SETHI; SETHI, 1990; BROWN *et al*., 1984; GERWIN, 1987; BROWN, 1984; AZZONE; BERTELÈ, 1989; CHEN *et al*, 1992; MANDELBAUM; BUZZACOT, 1990; RAMASESH; JAYAKUMAR, 1991). Koste and Malhotra (1999) provide an exhaustive literature review of these classifications, identify the most often-cited dimensions and (re)define them on the basis of the "constituent elements" introduced by Upton, referred to as Range-Number (RN), Range Heterogeneity (RH), Mobility (M) and Uniformity (U). In addition, they organize the flexibility dimensions in a hierarchical order identifying which of them have to be considered as necessary building blocks for the others, according with the literature.

FLEXIBILITY IN SERVICE.

There are not many papers in the OM literature that explores the concept of flexibility in service. Service flexibility is mentioned several times in literature (KIM, 1991; DIXON, 1990), but the definition provided are usually limited in scope. In fact, these definitions usually refer to "service" as a performance (in terms of delivery time, orders fulfilment, etc.) and not as a business *per se*. Since services are typically labour intensive, there are papers addressing the topic of labor/workforce flexibility (RILEY; LOCKWOOD, 1997; IRAVANI, 2005; NETESSINE, 2002) and cross-training (AGNIHOTHRI *et al*., 2003, AGNIHOTRI; MISHRA, 2004) in service contexts. However, these papers are not aimed at studying the concept of service flexibility. Instead, they develop quantitative models to measure and evaluate the impact of specific dimensions of flexibility on service performance. Due to the heterogeneity of the service businesses, the theoretical papers and empirical researches on service flexibility usually focus on specific service industries. For example, Aranda (2003) use the flexibility dimensions defined by Ramasesh and Jayakumar (1991) to study the role of flexibility as a moderating variable between operations strategy and performance in engineering consulting firms. Heim and Sinha (2002), by means of an extensive survey, identify the major kinds of uncertainty affecting the e-retailing industry and define the six relevant dimensions of flexibility, classifying the e-retailing service processes in a continuum of flexibility. Verdù-Jover and Llorens-Montes (2004) explore the concept of fit between the firm's actual flexibility and that required by the environment, thus proposing a list of items to assess flexibility both in manufacturing and service firms. Harvey and Lefebvre (1997) propose a theoretical framework for studying service flexibility focusing on the banking industry. They show how service firms have to deal with "changes of different kinds that impose on the service delivery process the burden of adapting quickly and frequently." They refer to this as *variability* (instead of uncertainty) and differentiate between internal variability (relevant to the firm and its partners in the value chains) and external variability (relevant to the market). In the same paper, Harvey and Lefebvre state that service firms can reduce variability at the source (e.g. targeting specific market segments and focusing multiple process on different market segments, reengineering the internal processes and improving quality) while facing the residual variability that emerges in different stages of service delivery process. Hence, they define *flexibility* as the capability to face the residual external variability and *robustness* as the capability to face the residual internal variability. In addition, they point out strategies to handle variability in back-office and front-office activities.

FIELD SERVICE FLEXIBILITY

In this section we will develop the model for field service flexibility, following the approach suggested by Upton (1994) and described in the previous sections.

The uncertainties affecting field services can be classified in relation to: (a) the time horizon when they emerge; (b) their internal vs. external nature (see table 1). Considering two different time horizon (short term and medium/long term), we will identify internal and external uncertainties affecting FSOs, and the relevant flexibility dimensions; then, we will describe these dimensions according with the four constituent elements RN, RH, M, U.

Time horizon

We consider two different time horizons: short term and medium/long term. Short term uncertainties are those affecting the delivery process, while long term uncertainties are those connected with both the market opportunity/threat and the design adequacy of the FSO's processes and systems. As a result, in the short term, we will consider: (a) the FSO's resources fixed (except for the on-call workers who can be activated rapidly upon request); (b) the decisions to take operational in nature. The operational decisions are those relevant to the day by day and hour by hour management of the delivery process. Typical operational decisions in field services are the coordination, allocation and control of the service calls; the scheduling, coordination and control of service staff (both in the contact-center and on the field), and the coordination and control of the service parts flows. In the medium/long term we consider the possibility for the FSO's to modify its processes and resources in order to meet future market needs. We will thus consider decisions that are tactical and/or strategic in nature. Strategic decisions are typically those concerned with the modification of the service portfolio. Therefore they pertain the selection of the customers, territories and products to serve and service level to provide to the customers base.

Tactical level decisions are concerned with: (a) the definition of the desired levels of spare parts inventory, (b) the definition of a territory assignment (districting) for Field Engineers (FEs), (c) the definition of the FEs cross-training policy, and finally (d) the design of the delivery process (BLUMBERG, 1991 p. 49). It should be noted that the short term flexibility can be interpreted as an effective performance (in part demonstrated and in part potential) while the long term flexibility, a perspective performance (that is not demonstrated, but only potential).

Dimensions

In services, firms make use of three main inputs, *information, labor* and *materials*, to provide customers with *capability to serve* and *actual service performance* (BLUMBERG, 1991 p.58). In field services, the capability to assure the availability of a given performance generates revenues and determines customer satisfaction, even if no service is actually provided. For example, it is the case of a product not failing within the warranty period. Hence, we define the FSO flexibility by considering both its potential and actual nature.

In order to be flexible, a FSO should be able to cope with both the qualitative and quantitative uncertainties affecting service demand. We will refer to these capabilities as Volume and Mix Flexibility respectively. These dimensions will be placed at the top level (*Firm level*) of our hierarchic model.

Volume and Mix Flexibility, in their turn, can be achieved only if the delivery process is actually flexible. The field service delivery process usually involves three distinct functions that are (BLUMBERG, 1991 p.147): the Call Handling & Technical Assistance, the Logistics & Material Support and the Field Operations functions.

Therefore we will consider the flexibility of these three functions as building blocks of the medium level (*function level*) of our conceptual model. A blueprint of a typical delivery process, with an indication of the activities under the responsibility of the key functions proposed in Table 1.

Table 1

Uncertainties affecting Field Service Organizations

short term	external	Relevant to the customer When will service be required? Where will service be required? How urgently the problem has to be fixed? Does the customer have a preferred “time window” to receive the service? Does the customer have preference regarding the server who has to deliver the service? Does the customer have particular expectations regarding the length of the intervention? Does the customer have preference regarding the service delivery modality? What will be the mood/behaviour of the customer as a consequence of a failure?
		Relevant to the environment What will be the weather, traffic and streets conditions affecting the delivery process?
	internal	Relevant to workforce What skills are required to perform the repair? Which FEs are currently available? Who has the required technical skills to fix the problem? What is the current geographical position of the FEs? Who has the right interpersonal skills to manage the service encounter?
		Relevant to the spare-part What parts are required to perform the repair? Are these parts available in the FE “trunk” or at the customer site? Where does the FE can pick the parts up? Can the parts be delivered to the customer site for the FE to perform the repair?
		Relevant to the information What are the information required to perform the repair? Will these information be available at a convenient time?
long term	external	Relevant to customer How will service requests change as a consequence of the aging of i-base itself? How will the customers’ expectation change? Shall the FSOs expand (or reduce) its service portfolio?
		Relevant to the environment Will regulations affecting the Field Service (e.g. warranty rights, end -of-life products management) change in the future? Will new competitors be able to serve our current i-base?
	internal	Relevant to workforce What will be the workforce required to accommodate the long-run variation in service demand/offer?
		Relevant to the spare-part What will be the future requirements in term of spare-parts inventories and distribution systems?
		Relevant the information What will be the future requirements in term of information and Information Systems?

Flexibility at function level, is enabled by (i) the flexibility of the workforce involved in the relevant processes/activities; (ii) the flexibility of the Information System (IS) used to collect, store, process and communicate (within and between the functions) the information required to perform these processes/activities; and (iii) the flexibility of the Logistics Systems that allow to store (e.g. in depots, warehouses), handle (e.g. material handling system) and transport (e.g. vehicles) the materials/parts required to provide support (and to guarantee the mobility of people). Starting from this latter level (*system level*) we will provide a description for each dimension below. Figure 2 provides a representation of FSO flexibility dimensions and their hierarchic order.

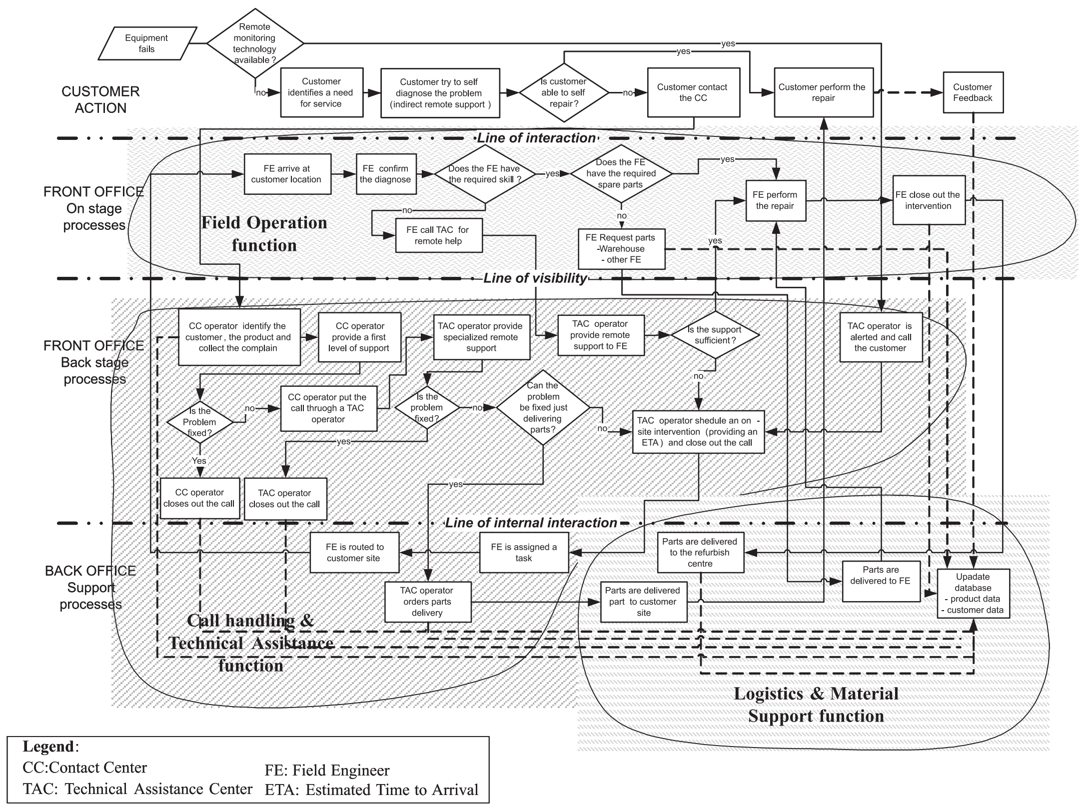

FIGURE 1 - A typical Field Service Delivery Process

Workforce System flexibility

Workforce flexibility refers to the capacity of a workforce system to adapt/change effectively to variations in the supply and demand of labour. Atkinson (1984) identifies the different practices followed by organizations to achieve this goal (the so called flexible working practices) and defines three types of flexibilities; functional, numerical, and financial.

Functional flexibility is defined as the capability of redeploying employees "quickly and smoothly across activities and tasks". The functional flexibility that a firm can achieve, depends upon the number of workers, how much they are cross trained across tasks and how they are chained (MOLLEMAN; SLOMP, 1999; SLOMP; MOLLEMAN, 2002; RAPACCINI; VISINTIN, 2007; VISINTIN; RAPACCINI, 2008). The need for cross training can be reduced by chaining workers appropriately. A "chain" can be formed as a consequence of an assignment decision by connecting a group of tasks with servers to form a connected graph (JORDAN; GRAVES, 1995). It implies that each task can be performed, at least, by two servers so that one server can backup another in case of absenteeism or overload. Chained servers, moderately cross trained, usually allow a sufficient level of coverage without incurring in prohibitive costs (BRUSCO; JONES, 1998; AGNIHOTHRI; MISHRA, 2004).

Numerical flexibility is defined as the capability of increasing or decreasing the total number of employees and the number of the hours worked according with the actual need of labour. Numerical flexibility, in general, can be achieved through the use of overtime and temporary workers (PINKER; LARSON 2003; MILNER; PINKER 2001).

Financial (wage) flexibility is defined as the capability to align wages with employees' and company performance. Financial flexibility can be achieved by adopting performance related remuneration systems where servers' salary depends on the skills they master, the actual hours they work, their personal performance and the overall performance of the FSO.

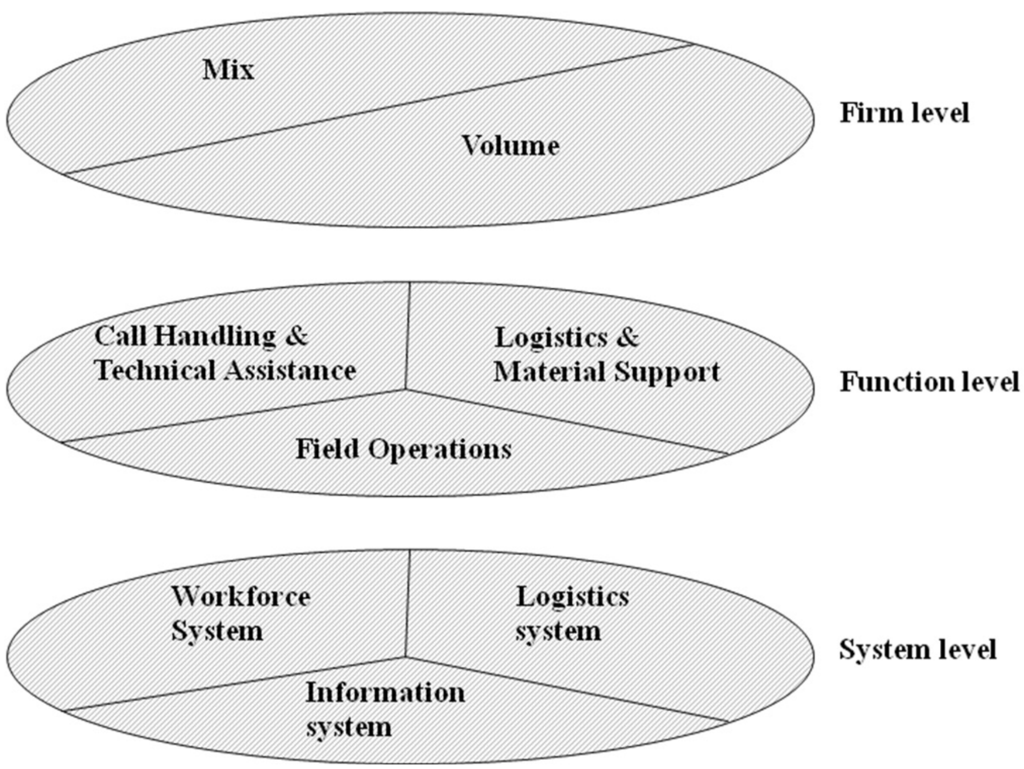

FIGURE 2 - Flexibility dimensions and hierarchy

For the workforce flexibility, we now define RN, RH, M, and U respectively.

In the short term we consider the range number (RN) of the workforce flexibility as the number of different resource-task assignments that is possible to make. Obviously the more the server are cross-trained the more server-job matching options are suitable to fulfil the demand. The range heterogeneity (RH) is represented by the differences among these options, having the lowest value when the desired coverage is obtained making use of only dedicated server. The mobility (M) can be seen as the easiness with which the task coverage can be changed and (or) adapted, as a consequence of demand peak or absenteeism, making use of on-call workers and overtime, if necessary. Finally, the uniformity (U) can be thought as the capability of achieving a uniform overall performance as a consequence of different server-job assignments. In the long run, the range elements (RN, RH) of workforce flexibility are given by the distribution of task coverage achievable by hiring or firing and trainings new servers. Accordingly the mobility (M) will be represented by the time/cost needed to hire (fire) and train the servers or outsourcing some activities. The uniformity (U) is measured by the capability to maintain a satisfactory performance as a consequence of the hiring (firing) of new servers.

Information System flexibility

For a FSO to be flexible, a flexible Information Systems (IS) is required. A very useful definition of IS flexibility is the one proposed by Gebauer and Schober (2006). They distinguish between the so called "flexibility to use" an IS, defined as "the Range of possibilities that is provided by an IS until a major change is required" and "Flexibility to change an IS" defined as "the effort required to change a given IS after its initial implementation". They state that the former depends upon the features supported by the IS, the scope of database, the different user-interface options, and the overall processing capacity; while the latter is determined by both technical design choices (e.g. platforms and networking architectures, objectorientation paradigm adoption, etc.) and availability of valuable IT staff skills. In our model we will take up these definitions, considering the "flexibility to use" as short term flexibility while the "flexibility to change" as long term flexibility. In addition, we will extend that definition to include all four constituent elements. As a result, the flexibility Range for IS flexibility can be thought as to the number (RN) and heterogeneity (RH) of the general features (*application layer*) and Graphical Users Interfaces (GUIs, *presentation layer*) that allows to collect, process and communicate the information, and the scope of the database (*data layer*) that allows to store them. The mobility (M) will be represented by the easiness with which service related data (warranties, contract entitlements, inventory status, spare part availability, technical issues, etc.) can be accessed and shared in real-time (or near real time) by all the stakeholders (e.g. Executives, Contact Center and TAC operators, FEs, etc.). The uniformity (U) is given by the capability to maintain a satisfactory processing capacity regardless the amplitude of the range. As a consequence, in the long run, the IS flexibility range number (RN) will be represented by the number and heterogeneity (RH) of possible changes, expansions, and upgrades the systems allow after their initial installation. The mobility (M) will be given by the easiness with which changes, expansions and upgrades can be performed, while the uniformity (U) will be related to the capability of performing equally well as a consequence of the modifications. This capability is usually referred to as "scalability" (GIMARC; SPELLMANN, 2002).

Logistics Systems Flexibility

The logistics system flexibility should be associated to both the firm's "logistics systems" and to the firm's "logistics products". This is consistent with the definitions provided by Kress (2000) and Barad and Sapir (2003). The "logistics systems" are the material handling, the transportation systems and depots/warehouses that are used to handle and store a variety of "logistics products". In the context of field service the "logistics products" are the material/spare parts necessary to perform an intervention. Note that the spare parts' versatility, defined as the capability of a given spare parts to be used for different products/purposes, has been continuously increasing. This is due to the growing adoption of modularity and other design techniques aimed at simplifying the inventory management and reducing service costs (LELE, 1997; GOFFIN; NEW, 2001). However, unlike the OEMs, the FSOs are not directly responsible for the product/part design. Hence, we won't consider this aspect in our model. Consequently, in the short term, the logistics system Range element of flexibility is represented by the number (RN) and heterogeneity (RH) of different picking/transport/delivery missions the system is able to perform. For example, a hybrid vehicle fuelled with electric power as well as gas that allow the FEs to travel in protected areas such as historical city center is more flexible than a vehicle fuelled with only gasoline. Accordingly, the mobility (M) of the logistics resource can be measured by the set up time and/or cost to sustain in order to re-configure the system for the mission to be accomplished. Mobility can be thus represented by the time/cost needed to adapt the systems to handle/store different packages (as a consequence of different local regulation for packaging recycling), pallets (due to different overall weight or size of spare parts), to reconfigure vehicles etc. Finally, the uniformity (U) can be seen as the capability to maintain a satisfactory performance as a consequence of the modifications. In the long run, the range elements of flexibility of the logistics system can be thought as the number (RN) and heterogeneity (RH) of different parts the systems could be able to handle/store and thus the number of different missions they potentially could perform. The mobility (M) will thus be related with the capability to make changes needed to allow the new missions to be accomplished. The uniformity (U) is related with the capability of achieving satisfactory performance as a consequence of the change.

Call Handling and Technical Assistance function flexibility

The call handling function involves servers whose tasks are (i) to take customers' call (or to get their complaints through other channels) and identify the customer and the products; (ii) to provide a remote support aiming at fixing the problem remotely (the so-called call avoidance process); (iii) to dispatch one or more FE to perform the on-site intervention if the problem is not fixable remotely; and (iv) to close out the call. For very small FSOs these tasks are all performed by the same people. For bigger FSOs, the call handling activities are performed by contact center operators, while the technical assistance and dispatching are performed by trained operators (usually experienced FE) working in well equipped Technical Assistance Center, to whom the calls are put through. The decoupling of these two activities is usually recommended because of the fact that the call handling activities don't require particular skills and are quite easy to perform. However, an effective remote support can be performed only by an operator with a strong product knowledge and the ability to accurately identify the problem and hence dispatch an FE with right skills. The TACs operators also provide remote support to the FEs working on customer's site.

The flexibility of the Call Handling and Technical Assistance function can be defined as the capability of providing the customer with a high number (RN) of heterogeneous (RH) channels to interact with the FSO according with her/his preference. These channels can be subdivided in synchronous (telephone, text-chat, web collaboration) and asynchronous (e-mail, voice mail, fax, SMS). The mobility (M) can be considered as the capability of switching, if required, from one channel to another, even in progress (for example providing support by phone if the customer has problem interacting via text chat etc.), while uniformity (U) can be considered as the capability of achieving a uniform performance in terms of call avoidance/customer satisfaction regardless the channel(s) adopted.

The Call Handling and Technical Assistance function's flexibility is enabled by IS such as CRM solution for the IP-network multi-channels contact center, ACD applications for the skill-based routing of calls from the contact center operator to the TAC operators, and shared knowledge base system (KBS) where all the operators can easily retrieve technical information, lessons learned, etc. to provide a consistent support even if the requests are handled by different operators. The task coverage among the operators (especially in the TAC) is very important as well. A flexible team of TAC operators, coupled with flexible IS supporting the aforementioned functionality, allows the contact center to be very efficient in dealing with the uncertainties affecting the incoming service requests even with few operators. For example, Griffin (2004) reports how the pharmaceutical giant GlaxoSmithKline answers 10,000 customer queries per month, primarily by phone and email with little more than a dozen agents.

In the long run the Call Handling and Technical Assistance function flexibility can be seen as the capability of introducing, without remarkable efforts (M), a wide (RN) and heterogeneous (RH) number of solutions to support the communication between the customers and the FSO (and between the FEs and the TAC). Finally, the uniformity (U) can be seen as the capability to achieve a satisfactory performance as a consequence of the introduction. The long run flexibility is obviously connected with the scalability of the IS as well as the long run flexibility of the workforce. For example, Griffin (2004) reports that FSO are facing remarkable difficulties training off-shore contact center operators to interact with customers in written language, as a consequence of the introduction of the e-mail as a support channel.

Logistics and Material Support function flexibility

As stated by Blumberg (1994), 60 to 75 percent of all service requests require parts to be filled in addition to some technical skills. An optimal service logistics "pipeline" should comprise the manufacturer (or vendor) of the parts, national warehouse, district depots, field-level depots (located both at customer site and in server's vehicles) and refurbishment centers. All of these elements should form a closed loop with parts and material flowing both from and to customer's site with flows of parts occurring also at same echelon (see Figure 3)

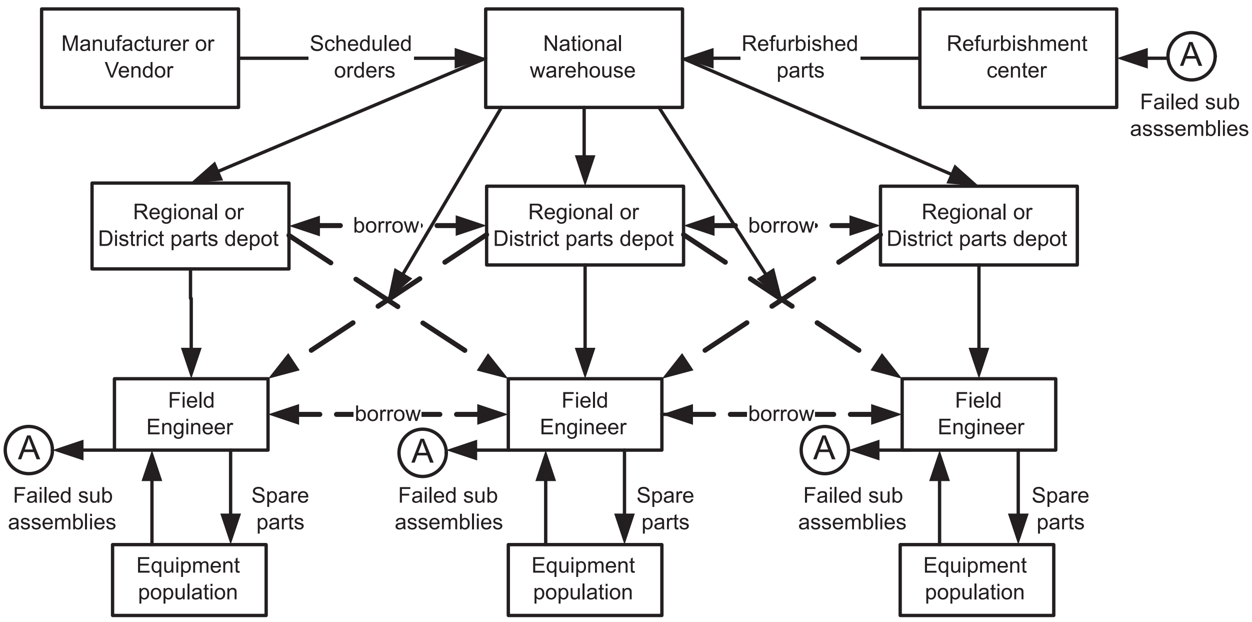

FIGURE 3 - FSO's Logistics System pipeline (Source: adapted from Blumberg, 1994)

Blumberg (1994) estimates that normally, nearly 50 percent of the inventory can be found at field level, approximately 80 percent in value of the inventory flows back to be refurbished and 30 to 35 percent of the return loop flows is made of good units. This data shed light on the importance of managing parts efficiently along the pipeline. However, in field service, request for parts can vary a great deal over the time and are very difficult to forecast. These uncertainties require the Logistics Function and Material Support to be very flexible.

In the short term, we consider the flexibility of this function given by the number (RN) and heterogeneity (RH) of different possible options to re-supply in the field. This depends on the number of sources that potentially can supply the FEs (e.g., regional depots, national warehouses, other FEs etc.), the number of different means of transportation that can be used to deliver parts (e.g., own vehicle, same day courier, next day courier etc).

Correspondingly the mobility (M) is given by the easiness (time/costs) with which stock transfers between depots/warehouse (at the same or different echelons in the pipeline) can be dynamically performed on the basis of the real time information coming from the field. The capability to quickly transfer parts between locations (referred to as trans-routing flexibility by Barad and Sapir, 2003) allows to reach a desired overall service level (in terms of fill rate) reducing the need of inventory buffer. An extremely flexible way to re-supply is to use "roving vans" (Blumberg 1991 p. 168). These vans store spare parts and operate in important metropolitan areas and are dispatched to customer site to deliver parts to the FEs. Using this approach the need for parts is identified during the call handling process, and if the required items are not conveniently available for the FE (in his vehicle or in local stock) they are directly delivered to the customer site to be used by the FE. Mobility is enabled by IS (in particular ERP/SCM) for the material and inventory management, which allows to have a full visibility of the stock level in the entire pipeline and are able to trigger the transhipment process whenever a shortage occurs. Finally, the Uniformity (U) can be related to the capability of the logistics system to perform well (in terms of fill rate, costs, etc) regardless of how the parts are delivered, In the long term, the Logistics Function and Material Support flexibility can be thought as the capability to accommodate major improvements of the logistics pipeline. These improvements pertain to structural changes aiming at accommodating (or stimulating) new business opportunities. The Range elements of logistics flexibility can be thus seen as the number (RN) and heterogeneity (RH) of these improvements (modifications on the warehouses number, improvements in the vehicle fleet, adoption of roving vans, outsourcing of the logistics operations to 3PL, 4PL in certain territories etc..). The mobility (M) can be represented by the cost/time required to realize them (that can be reduced using specific application for the demand forecasting and resources capacity planning). The uniformity (U) can be related with the capacity to maintain a satisfactory performance as a consequence of these improvements.

Field operations flexibility

The field operations are carried out by a team of Field Engineers (FEs) performing a set of different tasks, at customer's site, on the basis of a schedule they are assigned usually by a TAC operator. For industry with a huge i-base (such as the utilities one) and a high number of FEs, the job prioritisation and the dispatching and routing activities are automatically performed by specific software applications. The most sophisticated applications for the scheduling optimization available in commerce are able to take in to account a wide set of different variables/constraints. These variables can be the customer location, the customer SLA, the magnitude of the customer problem, the FEs skills required to perform the intervention, the FEs daily workload, the parts availability, the customer preference about the time window to receive support and the customer preference about the modality to provide support. The on-site support, in fact, can be provided in several ways including (a) the dispatching of a FE with the required skills/part at customer site; (b) the delivering or storing of parts directly at customer site for the FE (or customer with TAC remote support) to perform the repair when a failure occurs, and (c) the coordinated dispatching of FEs and parts to customer site. In the short term the Field Operations flexibility range can be thus defined as the number (RN) and heterogeneity (RH) of the options available to provide on-site support to the customer (in terms of time window, responsiveness, server and modality). The mobility (M) can be thought as the capability to switch from one option to the other, even in progress, as a consequence of unanticipated change in the environmental condition (the temporary unavailability or delay of a FE, a traffic jam, the need of another FE to complete the job on time etc) or the occurrence of a new and more urgent task (that may require a FE already dispatched for another job). A high Mobility is enabled by the so-called field service mobile technology (PDA/smart-phone with GPS systems etc., see section 5) that allows a full visibility of the FSO resource in real time. Finally uniformity (U) can be seen as the capability of obtaining a satisfactory performance regardless the way followed to provide support. In the long run the Field Operations flexibility could be associated with the capability of modifying the range number (RN) and heterogeneity (RH) of options available to serve the customers without incurring in prohibitive costs (M) and maintaining a satisfying performance (U).

Volume flexibility

We consider volume flexibility as the capability of the FSO to cope with uncertainty in the volume of service requests. In the short term, uncertainties arise as a consequence of the difficulties to forecast the distribution of the calls arrival within the day. In the long term, uncertainties arise as a consequence of the variation in the aggregate level of demand that occurs because of expansions or the aging of the i-base. These uncertainties make the servers and parts requirements planning very difficult. Capacity buffers (more servers) and inventory buffers (more parts) could help although their utilization is often problematic. The high cost of labour and the time needed to train servers, make capacity buffer an expensive options and the obsolescence risks associated with certain kinds of spare parts (especially in high-tech sector like the computer industry) make inventory buffers costly as well. Volume flexibility is therefore strongly needed. Adapting the Koste and Malhotra's (1999) definition, volume flexibility can be defined, both in the short term and long term, considering the range number (RN) as the range of variation on the aggregate number of service requests that the FSO can accommodate (within the day and in the long run, respectively) and the range heterogeneity (RH) as the extent to which the demand vary uniformly for all service requests. A high heterogeneity originate when an increase in service requests comes only from some specific products (for example as a consequence of a defective component) or territories (for example as a consequence of an environmental disaster) making the resource planning even more complicated. The mobility (M) can be thought as the easiness with which change in the service requests volume can be accommodated (a flexible workforce in this case is strongly needed due to the necessity to add servers for the specific task to be performed). The uniformity (U) can be thought as the capability of performing equally well regardless the changes in the service requests' volume.

Mix flexibility

In order to define the FSO's service mix flexibility, it is necessary to define what should be considered as service mix or "service portfolio". For a FSO the service portfolio should be defined on a multi-dimensional basis (BLUMBERG, 1991 p. 122). It is necessary to consider (a) the "service products", that is, the different services a FSO is able to provide (maintenance, training etc..); (b) the delivery time and coverage, that are the days of the week and the hours of the day when the FSO is able to provide a certain service; (c) the response time, that is the time required to deliver a certain service as a consequence of a customer call; and (d) the different equipments and territories the FSO is able to serve. A conceptual model for classifying a generic field service portfolio is proposed in Figure 4.

equipment/territory			Delivery time coverage				Response time			
			5 days		7 days		4h	8h	day	…
			8 h	24 h	8h	24h				
Service products	Basic services	Installation								
		Warranty								
		Maintenance								
		Repair								
		Update/upgrade								
	Support services	Training								
		Documentation								
		Parts and supplies								
		Other								

FIGURE 4 - Service portfolio for Field Service Organization (Adapted from Blumberg (1991)

In the short term, service mix flexibility can be defined considering the range number (RN) and heterogeneity (RH) elements represented by the amplitude of the service portfolio. The mobility (M) can be considered as the capability of effectively schedule the interventions and deploy the resources necessary to accommodate the day by day changes in the actual mix of services to provide. Mobility is very complex to achieve, since it requires coordinating a high number of resources spread on wide geographic area to provide daily a variable set of routine and emergency services, under strict internal and external constraints. Finally, the Uniformity can be seen as the capability of maintaining a satisfactory performance in terms of customer satisfaction and SLA compliance, regardless of the daily changes in the service mix.

In the long term, as FSOs increase their expertise in managing complex service portfolio, they usually try to get new revenue streams and profits expanding their offer. Typical expansions are (a) the provision of new "services products" on the current customer base; (ii) the provision of the same "services products" but on the basis of new SLAs (that is the offer of a broad delivery time coverage and/or a faster response time); (b) the provision of field service as third party maintenance vendor to new customers; (c) the expansion on new territories; or (d) a combination of these. The Range element of flexibility can thus be considered the number (RN) and heterogeneity (RH) of the aforementioned possible expansions the FSO could achieve (and thus by the amplitude of the resulting service portfolio). Accordingly, the mobility (M) represents the easiness with which the expansions can be accommodate and the uniformity (U) the capability of delivering the new services mix as well as the pre-existing ones. We can notice that, mix flexibility and volume flexibility, jointly define, in the short term, the operational flexibility of the firm and in the long term its strategic flexibility.

CONCLUSIONS

In this paper, we propose a conceptual model for studying field service flexibility, defining and ordering hierarchically the most relevant flexibility dimensions. The model can help managers to make investments and develop business practices targeted at improving the field service flexibility.

Our model has important implications for research as well. Service literature, in facts, lacks in model for studying flexibility.

The future research could be extended in two directions. First, it is strongly needed an empirical validation of the conceptual model, targeted at verifying the relevance of the dimensions proposed and their hierarchic relationship. Second, once the relevance of the proposed dimensions is proved, a measure for quantitatively evaluating the relevant flexibility should be developed. A robust metric to measure flexibility, in fact, would be helpful to assess the trade-off between the cost and benefits of flexibility and to assess when and how much flexibility is actually needed.

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