2

Global Disaggregation of Information-Intensive Services

Uday M. Apte and Richard O. Mason

1. Introduction

Several factors – increasing global competition, opportunities made available by the progress of information technology, and emerging global work force – are forcing corporations to evaluate the performance and cost of their service delivery value chains (Porter 1985, Quinn 1992). As is illustrated by the examples discussed in this paper, both in manufacturing and in services the value chains are being reformulated and geographically dispersed around the world.

Quinn calls this phenomenon the *disaggregation of services*. It occurs when one or more components of a value chain of service activities, that were traditionally carried out within an organization at a single location, are disaggregated (i.e., decomposed or dispersed) in a manner that transcends both the organizational and geographic bounds. Improvement in the cost/performance ratio of information technology has been an important factor that will enable the trend towards disaggregation of services to continue into the foreseeable future. Advances in telecommunications have facilitated the moving of information intensive tasks out of the "office," both domestically or globally. Corporate executives must be aware of this trend towards global disaggregation of services so that they can face the challenges posed by it and take advantage of the opportunities it makes available.

2. Global Disaggregation: Recent Examples

2.1. Disaggregation Options

A value chain entails a number of elemental service activities. In disaggregating service activities, one needs to investigate feasibility, and the costs and benefits of disaggregation. The activities that should be considered for disaggregation may be those that are traditionally labelled as services (e.g., financial, transportation, professional services, etc.) as well as those that constitute the service component of a manufacturing process (e.g., product/process design, inbound-outbound logistics, management information systems, finance, accounting, marketing, etc.).

A taxonomy of service disaggregation is proposed in Figure 1. The alternatives for performing a service activity within an organization (i.e., insourcing),

Source: *Management Science*, 41(7) (1995): 1250–1262.

	Insourcing	Outsourcing
Single Location	AGGREGATED SERVICE A small community college Ford's River Rouge Plant	CO-LOCATION OUTSOURCING Kodak – IBM/DEC/Business Land
Domestic Multi-location	TELECOMMUTING Amex – Travel Related Services Travelers Insurance	DOMESTIC OUTSOURCING Chevron & AT&T, Commodore Business Machines – Federal Express
Global Multi-location	GLOBAL MULTI-LOCATION INSOURCING Texas Instruments, TI – India Met Life – Irish Subsidiary	GLOBAL OUTSOURCING Data Base Companies – Data Entry Vendors GE Appliances – Infosys

Figure 1: A classification framework for disaggregation of services

or through an external entity (i.e., outsourcing) are shown as two columns in the figure. Within in/outsourcing alternatives, there are three geographic choices; an activity may be performed at a single location, or at multiple locations either domestically or globally. Examples of each of the resultant six disaggregation options are also shown in the figure. The main focus of this paper is on global disaggregation, i.e., on the last two options involving creation of a wholly-owned foreign subsidiary or global outsourcing of service activities.

2.2. Recent Experiences with Service Disaggregation

Insourcing options are generally three-fold. *Aggregated service* is the most familiar, and most commonly practiced organizational form, and requires little further discussion. *Telecommuting*, the second insourcing option, represents an interesting and growing trend. Telecommuting, a term coined by Nilles (1974), is broadly defined as the organizational work performed using computer and communications technologies outside the normal confines of space and time. Some examples of telecommuting include travel agents serving customers from home at the Travel Related Services of American Express, and employee benefits administrators working out of home at Travellers Insurance. There are a significant number of telecommuters in the U.S. today, and this number is growing rapidly. Link Resources, a research firm specializing in telecommuting, reported that about 5.3% of workforce telecommuted in the U.S. in 1992. Nilles (1988) used the estimates of information workers (Porat and Rubin 1977) in the U.S., and other technology adoption and

market acceptance considerations, to estimate that under a reasonable "nominal" scenario, about 29.5% of U.S. workers will telecommute by the year 2005.

The case of semiconductor giant, Texas Instruments (TI) and its Indian subsidiary, TI, India, provides an interesting example of *global multilocation insourcing*. TI's Indian subsidiary in Bangalore is entrusted with the design and development of software for computeraided design of integrated circuits (Apte and Mason 1992b). High-skill back-office service activities are also being globally disaggregated through the formation of wholly-owned subsidiaries. For example, New York Life Insurance and Cigna Corporation have medical claims processing operations (Lohr 1988, Wysocki 1991) and Metropolitan Life has both underwriting and claims processing operations in Ireland (O'Reilly 1992). As managers of these facilities explain, low operating costs (about 30% less than the U.S. costs) and financial incentives offered by the Irish governments are only part of the reasons for global disaggregation. Even more important are the availability of well educated staff, the strong work ethic, and the low turnover rates induced by the high unemployment rates in Ireland. In manufacturing companies, service activities such as product design work and logistics management, and in some cases even the R&D activities, are being globally disaggregated (O'Reilly 1992). Examples include, Hewlett-Packard's new portable ink-jet printer business being run from its subsidiary in Singapore which is responsible for design and manufacturing; and AT&T Bell Labs and Motorola conducting selected R&D projects in southeast Asia.

These insourcing options establish outsourcing counterparts. *Colocation outsourcing* is illustrated by Kodak's decision to outsource its entire information system (IS) function to three parties – IBM, DEC, and Business Land. Since this landmark event, outsourcing has been seen as a credible and important alternative by the IS community.

A number of large *domestic outsourcing* deals have been announced recently including Chevron's U.S. data networking contract with AT&T (Keller 1992). Examples of non-IS-related service activities that have been domestically outsourced include outsourcing of food service activities by airlines to companies such as Marriott, and Commodore Business Machines' outsourcing of its customer service function to Federal Express (Quinn 1992).

Data entry was one of the earliest information technology-based tasks to be *globally outsourced.* For example, Pacific Data Services has been contracting data entry services to China since 1961 (Noble 1986). Data entry has been one of the easiest service activities to be globally disaggregated, since, it requires only a low level of computer literacy and very little interaction between the customer and the vendor. The customer mails paper-based data forms, or electronically sends scanned images of data forms, to the vendor for data entry. The vendor, in turn, sends the computerized data back via telecommunication lines or by mailing magnetic tapes. In Jamaica, about 3,500 people currently work in office parks linked to the U.S. by satellite dishes. They do data entry, handle calls to toll-free numbers and perform other clerical duties (O'Reilly 1992). With the growing need for information technology applications in all facets of business life, there is also an increasing trend toward global outsourcing of computer programming and program maintenance tasks. For example, GE Appliances has outsourced some of its programming projects to Infosys, a small software house in India (Apte and Mason 1992a).

2.3. Rationale for Disaggregation

Why are services globally disaggregated? Economic factors, such as costs, benefits and the associated risks are undoubtedly the most important considerations. Moreover, as the cases above illustrate, information technology makes global disaggregation feasible. Information, unlike products such as automobiles or televisions, can be transported quickly, reliably and cheaply using modern communications and computer technology. Thus, many information intensive tasks can be moved halfway across the world whenever it is operationally feasible and economically desirable to do so.

Global disaggregation has several advantages and disadvantages. First, the advantages:

- *Substantial cost reduction.* The significant disparity of salary levels of personnel between developed and underdeveloped countries is one of the important reasons behind interest in global disaggregation.
- *Access to a large pool of skilled professionals.* As stated by Richard Gall, managing director of TI, India, the main reason for choosing India was that TI could not hire enough software designers in the U.S. and Europe, whereas India was producing more than it could use (Apte and Mason 1992b, O'Reilly 1992).
- *Faster cycle time for design and development.* Given the size of the human resource pool that a corporation can tap into and deploy, the design and development of products can proceed rapidly. The importance of time as a source of competitive advantage is well established. Consequently, the potential for cycle time reduction has become an important reason for the growing interest in global disaggregation of service activities. An interesting example cited by Quinn (1992) concerns a company obtaining 24-hours of work per day by working in offices around the world. Its American design team begins working on a product and transfers the interim product design to the Japanese team after eight hours of work. The Japanese team in turn transfers the design work to the European team after eight more hours of work. By the next day morning, when the U.S. design team starts its work, the design has progressed by three eight-hour work days in 24 hours. The total cycle time for design is shortened considerably in this manner.
- *Access to a large and growing market.* The markets in developed countries are relatively mature and are expected to have much smaller growth potential compared to some of the developing countries. Hence, for long-term growth, it is strategically important to establish an early presence in the developing countries. Global disaggregation through the formation of a subsidiary or a strategic alliance can provide a suitable foothold in the growing, sizable and lucrative marketplaces of the developing countries.

Thus, there are substantial gains to be made through selective use of global disaggregation. However, with advantages come certain disadvantages:

- *Difficulties in communication and coordination.* The success of global disaggregation of services depends crucially on maintaining proper communication and coordination among organizational entities performing different value chain activities. Poor telecommunications infrastructure, a problem common to the

underdeveloped countries, can be a serious drawback here. A lack of a common language can also be a major stumbling block.

- *Potential for violation of intellectual property rights.* Many third world countries have lax regulations and laws regarding the honoring of intellectual property rights. The option of global outsourcing is particularly vulnerable to the risk of intellectual property rights violations. For strategically important service activities, where a company cannot afford to take such a risk, the option of setting up a fully-owned subsidiary is usually chosen.
- *Lack of control on quality and project timetable.* With inadequate or ever-changing specifications for the performance of a service, the remote organization may find it difficult to meet the quality and cycle time requirements. The physical remoteness also makes it difficult to monitor a project's progress and to take corrective actions.
- *Unclear governmental attitudes toward transborder data flows and trade-in services.* Underdeveloped countries are becoming aware of the potential for increasing their national income by taxing transborder data flows. Although the multilateral negotiations for General Agreement on Trade in Services (GATS) have been recently concluded, its effectiveness at a practical level is far from clear.
- *Difficulty in managing cultural diversity.* Global disaggregation invariably involves dealing with people having different cultures and customs. Managing this cultural diversity is difficult and yet very important to the success of disaggregation (Slocum and Lei 1993).
- *Unstable economic, political, social environment.* Many third world countries are marked by instability of economic, political and social environment. These risks should be properly evaluated before locating the disaggregated service activity in these countries.

3. Managing Global Disaggregation

Balancing these advantages and disadvantages requires a framework. In dealing with global disaggregation of services, managers are faced with four main issues: (1) selecting the service activities that can and should be globally disaggregated, (2) choosing the appropriate country to locate it to, (3) designing a suitable organizational structure, and (4) managing cultural diversity. This paper primarily addresses the first issue. (Refer to Apte and Mason (1994) for a discussion of the other three issues.)

3.1. Value-adding Components of Service Activities – Analysis of Actions

To assess the feasibility and desirability of disaggregating a service activity, it is essential to answer three basic questions: What types of actions are taken in performing a service activity? How much time is spent in these actions? How value is added by a service activity? The answers to these questions are based on a taxonomy of actions we propose:

1. *Physical* actions that involve manipulation of physical objects. The purpose here is to move, transform, or create physical objects. Cooking, delivering a package, and repairing an automobile are some examples.
2. *Information* actions that involve manipulation of symbols, i.e., collection, processing and dissemination of symbols – data, information and decisions. Actions such as developing a computer program, designing a chemical process, or analyzing an income statement all fall in this category. These actions are the building blocks of today's growing information economy.
3. *Interpersonal* actions that involve dealing with customers and others. The term customer is to be understood here as both the external customers, i.e., the ultimate beneficiaries of services, as well as internal customers, i.e., the next person in the value-added chain who is the recipient of the service. Examples of these actions include giving a haircut, providing therapy, or greeting a visitor to the facility.
4. *Other non-value-adding* actions that do not belong to any of the above categories. Examples of such actions include doing unnecessary paperwork, or taking avoidable long coffee breaks.

Clearly, the above action types are not mutually exclusive. In a given activity, one may be dealing with information while also interacting with a customer. In operationalizing the proposed concept, we suggest that a service activity be studied to understand the type of actions being performed under that activity. The amount of time being spent in different actions should also be measured. This information can be plotted as a Venn diagram shown in Figure 2.

In Figure 2(A), the rectangle represents the total amount of time spent in an activity, while each of the three circles (intersecting in this instance but not necessarily so in general) represents the amount of time spent in each type of action. The area that is within the rectangle but that is not included in any circle represents the time spent in non-value-adding actions.

The relative areas of three circles indicate the relative emphasis that the service activity has on different types of actions. For example, an activity such as data entry will show a very large symbolic manipulation circle with very small circles for customer contact and physical actions. This activity can therefore be characterized by high "information intensity," a very low "customer contact need," and also a very low "physical presence need" (the three terms in quotation marks are more fully defined and discussed below). Potential for the application of information technology is evident, and as discussed earlier, this activity can be located practically anywhere in the world. Thus, data entry shows a very high potential for global disaggregation.

Analyzing a service activity using the above concepts and methodology is useful in answering a number of important questions. An approach for estimating the disaggregation potential is already sketched. But the diagram is also useful for answering broader questions such as *reengineering*, or redesigning, an activity using information technology so that the value it adds to a customer can be increased while simultaneously reducing the associated costs. Consider, for example, the recent trend towards teleradiology, where medical images are transmitted for viewing and evaluation by an expert present at a remote location. Massachusetts General Hospital now uses tele-radiology to access the diagnostic skills of experts (Wallace 1990). In effect, the Massachusetts General Hospital analyzed the original

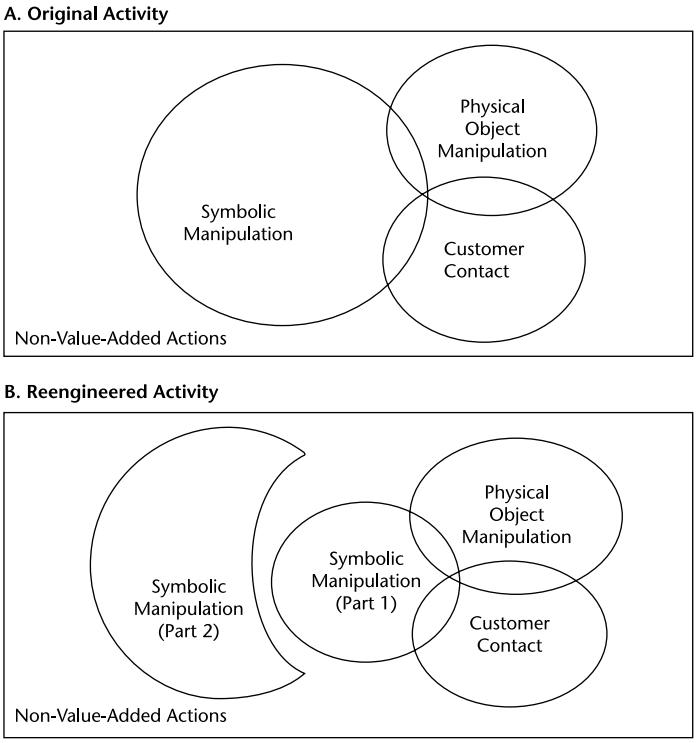


Figure 2: Components of service activities

Note: Areas represent the amount of time spent in different types of actions.

radiology job as represented by Figure 2(A) and reengineered it into two jobs – a in-person job of a radiology technician and a remote, symbolic manipulation job of an expert radiologist – as represented by Figure 2(B). Other most commonly used approaches for reengineering include redesigning the service activity by reconfiguring physical and customer contact components, and seeking ways to reduce the non value-added actions.

3.1.1. *Information Intensity.* Porter and Millar (1985) propose assessing *information intensity* for identifying opportunities for the competitive use of information technology. Porter and Miller consider information intensity at the level of a complete value chain for an organization, and view it as a function of the information content of the product/service, and the information processing need of the value chain activities. Most products and services are considered in this framework to have both physical and information components. The authors, however, do not treat customer contact as a separate component. The relative importance of information versus physical components is captured in the "information content of product/service" and the "information processing need in value chain activities" dimensions.

Information intensity is an intuitively appealing and powerful concept. Operationalizing this concept, however, is more challenging. In measuring the relative importance of information versus physical components, one should ideally estimate the ratio of value added by each component; a difficult measurement task indeed.

As alluded earlier in the example of data entry, *the information intensity of an activity is defined here as the ratio of time spent in dealing with information in an activity to the total time spent in that activity.* The proposed measure rests on an assumption that the fraction of time spent is a good surrogate of fraction of value added by the information component. The validity of this assumption is arguable, but we believe that this is a reasonable assumption that allows us to measure information intensity in an easy and accurate manner in many situations. Moreover, the measurement scheme is simple enough for implementation and use. This measure also relates directly to Chase's (1981) measure of customer contact.

In the context of the proposed information intensity measure, it can be seen that the higher the information intensity of a service activity, the easier it is to use information technology for performing that activity at a time and location that is more efficient and results in higher quality. Thus, the higher the information intensity of a service activity, the easier it is to disaggregate it and perform it at a remote location.

3.1.2. *Customer Contact Need.* Chase (1981) proposed a theory of the customer contact approach to services. *The degree of customer contact is defined here as the ratio of time during which a customer is in direct contact with the service facility to the total time required for the creation of the service.* The focus of attention in this theory is mainly on external customers, but there is no reason to think why the same ideas could not be applied to internal customers. The customer contact theory holds that services that entail a high degree of customer contact have inherently smaller potential for efficiency due to the variability and uncertainty that customers introduce in the creation of services.

We propose that customer contact be conceptualized as consisting of two components. One involving *an in-person contact* between a customer and a service provider, that is required for service creation, acquisition or consumption, and another involving *a symbolic contact* where the main purpose of a customer's presence is to exchange the information necessary in service creation and consumption. Customer contact, in general, will be composed of both components. This distinction between the symbolic and in-person components is useful in developing additional criteria that aid disaggregation. In general, the lower the need for customer contact, especially the in-person contact, the easier it is to disaggregate the service activity and perform it at a remote location.

Recognizing that the main purpose of symbolic contact is information exchange, it can be argued that information technology has a natural role to play in carrying out the symbolic component. This has obvious implications for the use of information technology in reengineering a service activity. As information technology is used for substituting in-person contact with symbolic contact, a manager of a service process acquires a greater degree of freedom for reengineering of service processes where a service activity can be performed at a place and time that provides "best in class" performance. This is so because with the use of information technology, cost can be reduced and a remote labor market can be accessed for acquiring a special skill or knowledge.

3.1.3. *Physical Presence Need.* The physical presence need arises primarily from the requirement to perform the physical object manipulation, i.e., the movement, transformation or creation of physical objects. The essential characteristic of physical object manipulation is that it must take place within the confines of specific time and space constraints. Moreover, as it involves dealing with inanimate

objects, the issue of measurement becomes somewhat easier here as compared to that in information or interpersonal actions. The subject of physical object manipulation has been studied extensively by industrial and manufacturing engineering disciplines where the time and motion studies are used as the primary means of analysis for finding improvements in physical object manipulation process. Following this lead we define *physical presence need as the ratio of time spent in physical actions to the total time spent in a service activity.*

3.2. Select Candidate Activities for Global Disaggregation – Fundamental Criteria

Based on the analysis of actions for a job, service activities that are good candidates for global disaggregation generally satisfy the following criteria:

Necessary Conditions. 1. The activity is information intensive. The need for physical presence of an employee, to perform the physical object manipulation, is low. The customer contact need is also low. Moreover, within customer contact time, the ratio of symbolic contact time to in-person contact time is high.

2. The symbolic manipulation component of the activity is separable. It can be isolated and disembodied from the customer contact component and the physical object manipulation component of the activity. (See Figure 2(B).) More specifically, (1) the relevant string of symbols can be "packaged" in a movable medium, (2) a receiver can open the package, interpret the symbols and supply meaning and understanding to them, (3) the receiver has an incentive to do so, and (4) there are no technological, legal or political barriers that inhibit the movement of the packages. (See Badaracco 1991.)

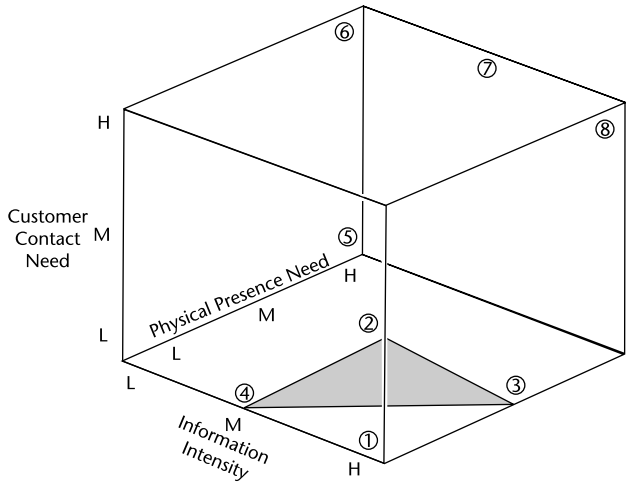
Feasibility Conditions. 3. The information technology solution for manipulating symbols (i.e., collecting, processing and disseminating symbols) exists and is cost effective. The more well-structured and specific the activity, the more easily the criteria is satisfied.

4. Customers (and senior company managers) are psychologically willing to accept the disaggregation alternative, and that disaggregation is culturally and legally feasible.

Desirability Conditions. 5. The relative strategic importance of the activity is low. It is generally not a core competency that requires corporate protection.

6. The relative efficiency (encompassing costs, benefits and risks) with which the service activity can be carried out within the organization is low. That is, some other organization potentially has a performance advantage.

3.2.1. *Potential for Global Disaggregation – Applying the Framework.* A three-dimensional model for estimating global disaggregation potential of a given service activity using the first criterion is shown in Figure 3. Also plotted in Figure 3 are a few selected service occupations. In Figure 3, the disaggregation potential is assumed to be high when information intensity, customer contact need, and physical presence need are respectively high, low and low. The disaggregation potential is assumed to be medium when the values of these three characteristics are either high (H), medium (M) and low (L), or (H, L, M), or (M, L, L). The medium potential is shown as a shaded plane in Figure 3. All other combinations of values are assumed to lead to a low potential for global disaggregation.



Legend	Occupation	Information Intensity	Customer Contact Need	Physical Presence Need	Disaggregation Potential
①	Actuary	H	L	L	H
②	Marketing Manager	H	M	L	M
③	Civil Engineer	H	L	M	M
④	Comm. Eqpt. Operator	M	L	L	M
⑤	Cleaning	L	L	H	L
⑥	Food Service Manager	L	H	H	L
⑦	Secretary	M	H	H	L
⑧	Registered Nurse	H	H	H	L

Figure 3: Disaggregation potential of selected service occupations

Our studies reveal that about 9 million jobs in the U.S. meet the conditions necessary for global disaggregation. This accounts for over 10% of the 88 million service jobs, or about 7% of the 123 million total jobs, in the country as reported in 1990. This estimate is based on the analysis presented in Appendix A that uses the rationale of Figure 3 to rate the global disaggregation potential of over 140 occupations listed by the U.S. Department of Labor.

As Bell (1979) noted in "The Coming of Post-Industrial Society," (and for which authors like Machlup (1980), and Porat and Rubin (1977) have provided evidence), the number and importance of information intensive jobs is increasing throughout the global economy. The number of jobs vulnerable to global disaggregation are therefore expected to grow further in the future.

3.2.2. *Global Disaggregation – Bringing Additional Considerations to Bear.* Global disaggregation enables improvements in performance and quality in delivering services to customers. As the value chain activities are disaggregated, the ability to manage communications and coordination requirement across various activities assumes added importance. The simplest way to ensure good communications is to disaggregate only those activities that are well structured and specified. Thus, as experience confirms, global disaggregation of data entry or computer programming activities have a good chance of being successful, while the disaggregation of strategic planning, a poorly structured and specified activity, may meet with

greater difficulties. We hypothesize, therefore, that well structured and specified activities are easier to disaggregate than abstract activities.

In addition to the criteria discussed earlier, we must also consider aspects such as the legal and cultural feasibility, and the psychological willingness of corporate managers and customers to accept global disaggregation as a valid option. Considering the past experience with acceptance and slow growth of managerial innovations such as Just-in-Time Systems or Total Quality Management, we believe that global disaggregation of services will also gradually evolve and grow up to its full potential over a time-frame spanning perhaps a couple of decades.

Global disaggregation can be implemented in two alternate forms: insourcing, or outsourcing. At a conceptual level, this choice can be analyzed systematically using the Transaction Cost theory (Williamson 1985), which compares the total of production plus transaction costs (i.e., the costs of negotiating, monitoring, and enforcing an agreement or contract) under each alternative to recommend the preferable governance structure. As discussed more fully in Apte (1991), the outsourcing option generally has smaller production costs and higher transaction costs as compared to the insourcing option.

At a more practical level, the choice between insourcing and outsourcing should be guided by two main considerations: the strategic importance of a service activity to the company, and the relative efficiency with which the company can perform that service activity (Walker 1988). In general, the higher the strategic importance of a service activity, and the higher the relative efficiency of performing that service activity internally, the more desirable it is to insource that activity. Conversely, a service activity that scores low on both the dimensions should, in general, be outsourced. The actions preferable under different combinations of two underlying factors are given in Figure 4 (adapted from Walker 1988).

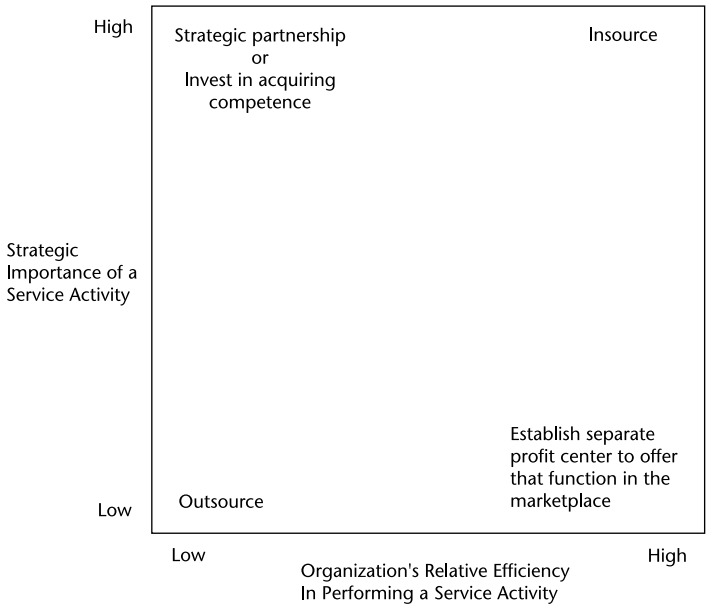


Figure 4: Insourcing versus outsourcing

In choosing the country where the disaggregated service activity is to be located, the technological, economic, political and cultural environment of the country should be thoroughly analyzed. In arriving at a suitable organizational arrangement, a manager should consider two important factors: the degree of control that is desired for performing the activity, and the need to protect the intellectual property rights. To ensure both, the approach of creating an owned subsidiary is generally preferable.

4. Summary and Conclusions

The trend towards global disaggregation of services offers enormous challenges and opportunities for managers in today's increasingly global economy. To help managers deal with this growing phenomenon, we develop in this paper six criteria for selecting and organizing those service activities that can and should be globally disaggregated. The first step is to analyze the following characteristics of each service activity: information intensity, customer contact need, and the physical presence need. The activity that rates high, low and low respectively on these three characteristics has a high potential for global disaggregation. To further evaluate the feasibility and desirability of globally disaggregating a service activity, three additional factors should be considered: separability of its symbolic manipulation component, its structuredness and specificity, and the legal and cultural feasibility of globally disaggregating the activity. Finally, the choice between insourcing or outsourcing an activity is governed by its strategic importance, the relative efficiency with which the company can perform that activity.

References

Apte, U. M., "Global Outsourcing of Information Systems and Processing Services," *The Information Society*, 7, 4 (1991) 287–303.

Apte, U. M. and R. O. Mason, "Global Outsourcing of Information Processing Services," *Working Paper of the Cox School of Business*, Southern Methodist University, Dallas, TX, 1992a.

———, "Texas Instruments (India) Private Limited," a case available as a *Working Paper of the Cox School of Business*, Southern Methodist University, Dallas, TX, 1992b.

———, "Global Disaggregation of Information-Intensive Services," *Working Paper of the Cox School of Business*, Southern Methodist University, Dallas, TX, 1994.

Badaracco, J., *The Knowledge Link*, Harvard Business School Press, Cambridge, MA, 1991, 34.

Bell, D., *The Coming of Post-Industrial Society: A Venture in Social Forecasting*, Basic Books, New York, 1979.

Chase, R., "The Customer Contact Approach to Services: Theoretical Bases and Practical Extensions," *Operations Research*, 21, 4 (1981), 698–705.

Keller, J. J., "More Firms Outsource Data Networks," *The Wall Street Journal*, Wednesday, March 11, (1992).

Lohr, S., "The Growth of the Global Office," *The New York Times*, October 18, (1988).

Machlup, F., *Knowledge; Its Creation, Distribution and Economic Significance, Volume* 1: *Knowledge and Knowledge Production*, Princeton University Press, Princeton, NJ, 1980.

Nilles, J., *Telecommunications Substitutes for Urban Transportation*, Center for Futures Research, Graduate School of Business Administration, University of Southern California, Los Angeles, CA, 1974.

Nilles, J., "Traffic Reductions by Telecommuting: A Status Review," *Transportation Research*, 22, 4 (1988), 301–317.
Noble, K., "America's Service Economy Begins to Blossom – Overseas," *The New York Times*, December 14, (1986).
O'Reilly, B., "Your New Global Workforce," *Fortune*, December 14, (1992).
Porat, M. V. and M. R. Rubin, *The Information Economy*, 9 Volumes, U.S. Department of Commerce, Office of Telecommunications Special Publication 77–121(1) through 77–12(9), U.S. Government Printing Office, Washington, D.C., 1977.
Porter, M. E., *Competitive Advantage*, The Free Press, A Division of MacMillan, Inc., New York, (1985).
Porter, M. and V. Millar, "How Information Gives You Competitive Advantage," *Harvard Business Review*, July–August (1985).
Quinn, J. B., *Intelligent Enterprise: A Knowledge and Service Based Paradigm for Industry*, The Free Press, a Division of McMillan, Inc., 1992.
Slocum J. and D. Lei, "Designing Global Strategic Alliance: Integrating Cultural and Economic Factors," in G. P. Huber and W. H. Glick (Eds.), *Organization Change and Redesign*, Oxford University Press, 1993, 295–322.
Sobol, M. G. and U. M. Apte, "Domestic and Global Outsourcing Practices of America's Most Efficient IS Users," *Working Paper, Cox School of Business*, Southern Methodist University, Dallas, TX, 1995.
Wallace, S., "Rx for Faster Image Transmission," *Datamation*, 36, 18, September 15 (1990), 95–98.
Walker, G., "Strategic Sourcing, Vertical Integration and Transaction Costs," *Interfaces*, 18, 3, May–June (1988).
Williamson, O. E., *The Economic Institutions of Capitalism*, The Free Press, New York, 1985.
Wysocki, B., "Overseas Calling," *The Wall Street Journal*, August 14, 1991.

Appendix 1

Disaggregation potential of service jobs in the USA (1990)

Occupation	*No. of jobs (000)*	*Info. intensity*	*Customer contact need*	*Physical presence need*	*Dissag. potential*
Exec., administrative, and managerial					
Managerial and administrative					
Admin services manager	221	M	H	M	L
Communic., transp. & utilities manager	143	H	M	L	M
Construction managers	183	M	H	H	L
Education administrators	348	H	H	H	L
Eng., math, & natural sciences managers	315	H	L	L	H
Financial managers	710	H	L	L	H
Food services & lodging managers	595	L	H	H	L
Funeral directors & morticians	35	L	H	H	L
General managers & top executives	3086	H	M	L	M
Government chief executives & legislators	71	H	H	H	L
Industrial Production Managers	210	H	M	L	M
Mktg. advert, & public relations mgrs.	427	H	M	L	M
Personnel, training, and labor rel. mgrs.	178	M	H	H	L
Property & real estate mgrs.	225	H	M	L	M
Purchasing mgrs.	248	H	L	L	H
All other manager and administrators	1850	M	M	M	L

(*Continued*)

(*Continued*)

Occupation	*No. of jobs (000)*	*Info. intensity*	*Customer contact need*	*Physical presence need*	*Dissag. potential*
Management Support					
Accountants & auditors	985	H	L	L	H
Budget analysts	64	H	L	L	H
Claims examiners, property & casuality	30	H	M	M	L
Construction & building inspectors	60	M	H	H	L
Cost Estimators	173	H	M	L	M
Credit analysts	36	H	L	L	H
Employment interviewers (pvt. or public)	83	L	H	M	L
Inspectors & compliance officers	156	M	L	H	L
Loan officers & counselors	172	M	H	M	L
Management analysts	151	H	M	L	M
Personnel, training, and labor rel specialists	278	M	H	H	L
Purchasing agents	218	H	L	L	H
Tax examiners, collectors, & revenue agents	62	H	M	L	M
Underwriters	105	H	L	L	H
Wholesale & retail buyers	194	H	L	L	H
All other management support workers	846	M	M	M	L
Professional specialty occupations					
Engineers Aeronautical	73	H	L	L	H
Chemical	48	H	L	L	H
Civil	198	H	L	M	M
Electrical	426	H	L	L	H
Industrial	135	H	H	M	L
Mechanical	233	H	L	M	M
Metallurgists & materials	18	H	L	L	H
Mining	4	H	L	M	M
Nuclear	18	H	L	L	H
Petroleum	17	H	M	L	M
All other engineers	347	M	M	M	L
Architects and Surveyers					
Architects, except landscape & marine	108	H	L	L	H
Landscape architects	20	M	L	H	L
Surveyors	108	M	L	H	L
Life scientists					
Agricultural and Food Scientists	25	H	L	M	M
Biological scientists	62	H	L	L	H
Foresters and conservation scientists	29	H	L	H	L
Medical scientists	19	H	L	L	H
All other scientists	39	H	M	M	L
Computer, mathematical, & OR analysts					
Actuaries	13	H	L	L	H
Systems analysis & computer scientists	463	H	L	L	H
Statisticians	16	H	L	L	H
Mathematicians	22	H	L	L	H
Operations research analysts	57	H	M	L	M
Physical scientists	200	H	L	L	H
Social scientists Economists	37	H	L	L	H
Psychologists	125	H	H	L	L
Regional Planners	23	H	L	L	H
Other life scientists	38	H	M	L	M
Social, recreational, & religious workers	1049	M	H	H	L

(*Continued*)

(*Continued*)

Occupation	*No. of jobs (000)*	*Info. intensity*	*Customer contact need*	*Physical presence need*	*Dissag. potential*
Lawyers & judicial workers	633	H	M	H	L
Teachers, librarians, & counselors	5687	H	H	H	L
Health diagnosing occup. (dentists, etc.)					
Optometrists	37	H	L	L	M
Radiologists	43	H	M	L	H
Other health occupations (physicians, etc.)	775	H	H	M	L
Health assessment and treating occupations					
Dieticians & nutritionists	45	H	M	L	M
Pharmacists	169	H	L	L	H
Physician assistants	53	H	H	H	L
Registered Nurses	1727	H	H	H	L
Therapists	311	M	H	H	L
Writers, artists, & entertainers					
Artists and commercial artists	230	H	L	L	H
Entertainers	1013	M	H	M	L
Writers	299	H	M	L	M
All other professional workers	808	M	M	M	L
Technicians & related occupations					
Health technicians & technologist	1833	H	H	H	L
Engineering & science technicians	1327	H	M	L	M
Technicians, except health & engineering					
Aircraft pilots & flight engineers	90	H	L	L	H
Air traffic controllers	32	H	L	H	L
Broadcast technicians	33	H	M	H	L
Computer programmers	565	H	L	L	H
Legal assist. & technicians except clerical	220	H	M	L	M
Programmers, numerical & proc control	8	H	L	M	M
Technical assistants, library	65	M	M	H	L
All other technicians	33	M	M	M	L
Marketing & sales occupations					
Marketing & sales (except travel agents)	13956	M	H	M	L
Travel agents	132	H	L	L	H
Administrative support occupations					
Adjusters, investigators, & collectors					
Adjustment clerks	320	H	L	L	H
Bill & account collectors	183	H	M	M	L
Ins adjusters, examiners, & investigators	147	H	M	M	L
Ins claims clerks	104	H	L	L	H
Ins policy processing clerks	172	H	L	L	H
Welfare eligibility workers & interviewers	93	M	H	M	L
All other adjusters & interviewers	38	M	M	M	L
Communications equipment operators					
Central office operators	53	M	L	L	M
Directory assistance operators	26	H	L	L	H
Switchboard operators	246	H	L	L	H
All other communications equip operator	20	M	L	L	M
Computer & peripheral equip operators	320	M	L	M	L
Financial records processing occupations					
Billing, cost, & rate clerks	318	H	L	L	H
Billing & posting machine operators	95	H	L	L	H

(*Continued*)

(*Continued*)

Occupation	*No. of jobs (000)*	*Info. intensity*	*Customer contact need*	*Physical presence need*	*Dissag. potential*
Bookkeeping, accounting, & auditing clerks	2276	H	L	L	H
Payroll & timekeeping clerks	171	H	L	L	H
Information clerks					
Reservation/ticket agents and travel clerks	150	H	L	L	H
Other information clerks (receptionist, etc.)	1268	H	H	H	L
Mail clerks & messengers	280	L	L	H	L
Postal clerks & mail carriers	439	L	L	H	L
Mater, recording, sched, dispatch, & distribution	2513	M	M	M	L
Records processing, except financial	949	M	L	L	M
Secretaries	3576	M	H	H	L
Stenographers	132	M	H	H	L
Typists and word processors	972	M	L	L	M
Other clerical & administ. support workers					
Bank tellers	517	M	H	H	L
Clerical supervisors & managers	1218	M	H	H	L
Court clerks	47	M	M	M	L
Credit authorizers	21	H	L	L	H
Credit checkers	48	H	L	L	H
Loan & credit clerks	151	M	M	L	L
Loan interviewers	20	M	H	M	L
Customer service representatives	109	M	M	M	L
Data entry keyers, except composing	456	H	L	L	H
Data entry keyers, composing	19	H	L	L	H
Duplicating, mail, & other	169	L	L	M	L
General office clerks	2737	L	L	M	L
Municipal clerks	22	M	M	M	L
Proofreaders & copy markers	29	H	L	L	H
Real estate clerks	29	M	L	L	M
Statistical clerks	85	H	L	L	H
Teacher aides & educational assistants	808	H	H	H	L
All other clerical & administrative support	604	M	M	M	L
Service occupations					
Cleaning & bldg. serv., except priv household	3435	L	L	H	L
Food preparation & beverage service					
Chefs, cooks and other kitchen workers	3069	L	L	H	L
Food and beverage service workers	4400	L	H	H	L
All other food prep. and serv. workers	236	L	M	H	L
Health service aides/assistants (nurse aides)	1972	L	H	H	L
Personal service (barbers, child care, etc.)	2192	L	H	H	L
Priv. household workers (cleaners, cooks)	782	L	M	H	L
Protective service (police, firefighters)	2266	L	H	H	L
All other service workers	852	L	M	H	L

Summary

Major occupational category	*Total jobs (000)*	*Number of jobs (000) according to potential for disaggregation*		
		High	*Medium*	*Low*
Managerial and administrative occupations	12449	2866	4477	5106
Prof., technical and related occupations	20006	2643	2508	14855
Marketing and sales occupations	14088	132	0	13956

(*Continued*)

(*Continued*)

Major occupational category	*Total jobs (000)*	*Number of jobs (000) according to potential for disaggregation*		
		High	*Medium*	*Low*
Administrative support occupations	21950	4536	2023	15391
Service occupations	19204	0	0	19204
Subtotal service jobs	87697	10177	9008	68512
% Disaggregation Potential (3)		40%	15%	5%
Jobs with disaggregation potential	8848	4071	1351	3426

Source: Occupational Projections and Training data, Bulletin 2401, May 1992, Department of Statistics, Bureau of Labor.

Notes:

1. Information intensity, customer contact need, and physical presence need of each occupation are graded as follows: High (H), Medium (M), Low (L).
2. Based on the theory developed earlier, the disaggregation potential is assumed to be high when information intensity, customer contact need and physical presence need are (H, L, L) respectively. The disaggregation potential is assumed to be medium when the values of these three characteristics are (H, M, L) or (H, L, M) or (M, L, L). Otherwise the disaggregation potential is assumed to be low.
3. Disaggregation potential percentages are based on the approach followed in Nilles (1988) and on the results of a recently conducted survey of information systems outsourcing by Sobol and Apte (1995). The feasibility and desirability conditions specified in the paper are also considered in arriving at these assumptions.