Leveraging technology to improve field service

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Keywords *Technology, Service, Service operations, Productivity, Customer satisfaction*

Abstract *The primary objective of this paper is to propose a theoretical framework for assessing the role and influence of technology in creating an effective field service organization. We examine the role of technology in the context of managing relationships among the company, its employees and customers. Using the analogy of a country managing its foreign affairs, we suggest that consistent and concurrent attention to carrying out Diplomacy, Preparedness and Engagement responsibilities with the aid of Technology (DPEAT) would result in superior service outcomes. We illustrate implementing our framework in a field service organization and use a published case study to demonstrate the application of our model.*

Introduction

In recent years, companies are realizing that a customer's product purchase decision is not only influenced by the product's value (i.e. performance relative to cost), but also by the service support available after the sale of the product. As pointed out by Lele and Karmarkar (1983), providing good product support, which encompasses everything that can help maximize the customer's after-sales satisfaction, is a good marketing strategy and can play an important role in achieving competitive advantage. It is also a means of creating sustainable relationships with customers. This realization is leading to a shift in the terms of competition in nearly all industries. Many of the innovations in providing a better after-sales service experience are driven by new developments in technology. In this paper, we address the issue of leveraging technology to improve field service, which is defined as after-sales service of equipment located at a customer's site.

Considerable attention has been given recently to the notion of leveraging technology to create and sustain a competitive advantage. There has been a concerted push to e-everything from training (e-learning) to the entire business (e-business). In the service arena, this has resulted in a whole new suite of products and applications claiming to automate the service function or make it

The authors would like to thank the three reviewers for their careful reviews and valuable suggestions, which improved the paper.

International Journal of Service Industry Management, Vol. 13 No. 1, 2002, pp. 47-68.

DOI 10.1108/09564230210421155

e-service (Berst, 1999; Newell, 2000). However, many of the claims of successes are wildly exaggerated and have failed to produce the returns on investment expected by the senior executives. The common problems have been in the areas of integrating the separate functions such as marketing and logistics, and providing a common framework for all functions to collaborate on the task of providing superior service. Managers may also have chosen to focus on improving one operational area while not considering the implications on other functions, leading to "islands" of technological excellence. We believe that this is due to a lack of a theoretical framework that guides managers in the selection and implementation of appropriate technologies that fit the requirements of the business strategy. Past research has shown that the benefits of information technology (IT) have been accrued to firms whose IT strategy was congruent with their strategic intent (Powell and Dent-Micallef, 1997) indicating that managers, guided by an integrated framework, are likely to make effective strategic choices.

The primary objective of this paper is to propose a theoretical framework for assessing the role and influence of technology in creating an effective field service organization. We examine the role of technology in a field service organization in the context of managing relationships among the company, its employees and customers. In the next section, we first distinguish between facility-based and field-based services and then define field service as a part of field-based service and explain its importance.

Field service and its importance

Service organizations can be divided into two major categories: facility-based and field-based. In a facility-based service, customers access the service facility while in field-based service, it is the responsibility of the service provider to provide service to people and/or their possessions, located at a customer's site. Note that field-based services can provide on-site customer service or remote service through a form of communication such as remote satellite repair and self-help instructions provided on a Web page. Field-based services could further be divided into three categories:

(1) pick-up/delivery services such as packages and mail services, and garbage collection;

(2) emergency services such as police, fire and ambulance; and

(3) after-sales service support of equipment such as installation, maintenance and repair.

After-sales support takes place in three broad markets: capital equipment such as computers, office automation and office products, medical electronics and farm equipment; consumer goods such as appliances and personal computers; and utilities including telephone service, electric/gas service and cable television. In this paper, we refer to after-sales support as field service. Figure 1 categorizes services and shows where field service falls in the spectrum.

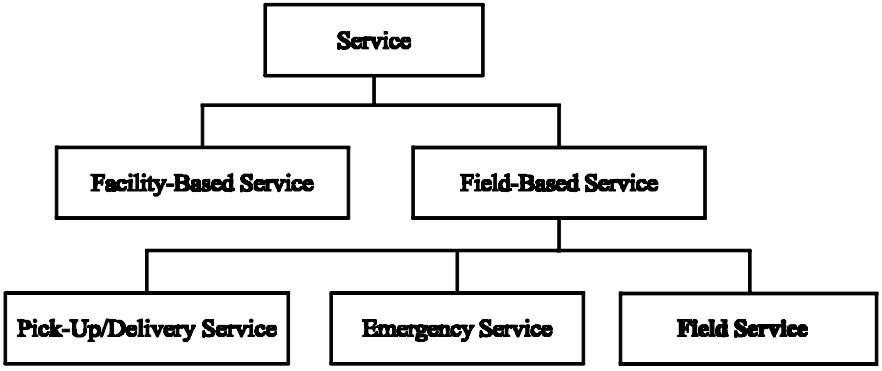

Figure 1.
A categorization of services

The three categories in field-based services were chosen based on the complexity of the decision making involved to manage these services. One of the most important performance measures for field-based services is the down time, defined as the time between the request for service and completion of service. Down time could be further divided into response time and on-site time. Response time is the time between the request for service and the arrival of a technician at the customer location. On-site time is the time spent on-site to provide the service. For pick-up/delivery operations, response time is relatively unimportant since the service is typically scheduled in advance and on-site time is usually insignificant. For emergency service, the response time is critically important and must be carefully managed. For firms engaged in after-sales support activities, hereinafter referred to as field service, it is important that they manage both response time and on-site time. For a detailed discussion of major differences between facility-based and field-based services, important managerial issues in managing facility-based and field-based services, and a review of the current literature in field service, refer to Simmons (2001).

In this paper, we limit our attention to field service for several reasons. First, literature on field service management is sparse and limited to operational issues such as scheduling and spare-parts inventory management. In the absence of an integrated theoretical framework guiding choice and deployment of IT in field service operations, we know little about the roles and impact of IT on the effectiveness of field service operations. We believe that the potential for leveraging IT to improve field service operations are significant.

Second, the characteristics of field service make it quite different than other services. Unlike facility-based services such as banks and field-based services such as pick-up/delivery where there is a direct revenue implication, the revenue implications are indirect in field service. In addition, the initial encounter between service personnel and customers could be tense as the customers are likely to be antagonistic towards the company and its representatives when a failure occurs (Henry, 1994). Since the customer does

not visit the service facility, the customer develops company perceptions based solely on the service quality provided by the technician.

The number of companies providing field service is increasing since companies are becoming more customer-centric. Field service is no longer considered as an unwanted additional cost of doing business and is now being viewed as a potential profit center. In 1999, based on Department of Commerce data, firms that were likely to engage in after-sales support accounted for $1.7 trillion in annual total sales. This represented approximately 20 percent of the USA's gross domestic product (GDP). A benchmark study reported in Blumberg (1994a) estimates the profit margin to be 40 percent for field service organizations. There are significant opportunities available to improve productivity, efficiency and quality of field service operations by using the combination of new technology and better practice of service operations (Blumberg, 1994b). The opportunities identified by Blumberg included technology-based improvements in call handling, assignment and dispatch of field personnel, inventory management and problem diagnosis. In the next section, we briefly review the literature on the role of technology in services.

Role of technology in services

Recently, the popular press has been filled with articles on how companies make use of Internet and wireless technology to sell their product and services and to improve business-to-business and business-to-customer services. However, there have been very few attempts to offer a theoretical framework to explain how technology can be used to improve the overall product and service delivery process (Bitner *et al.*, 2000; Parasuraman, 1996). Even though many authors attributed productivity problems in service industries to misuse of information technology (e.g. Roach, 1991), others argued that traditional productivity measurements did not capture the true value of technology. For example, Brynjolfsson (1993) argued that benefits of IT such as improved quality, customer service, speed and responsiveness are poorly accounted for in productivity statistics, thus under reporting the true benefits of IT. The benefits of IT seem to be realized when firms couple their investments in technology with changes in their strategy and organizational processes to leverage the value of IT (Brynjolfsson and Hitt, 1998).

Kotler (1994) proposed the triangle model of services marketing which explicated the links among company, employees and customers. His model suggests that companies have to manage their internal marketing to employees and the interactive marketing between employees and customers in addition to the external marketing to customers. Internal marketing involved preparing and motivating employees to serve their customers well. Interactive marketing focused on all the activities and behaviors necessary to satisfy customers during their encounters with service personnel. Recognizing that technology has a multi-faceted impact on services marketing, Parasuraman (1996, 2000) modified the traditional "services marketing triangle" that includes company,

employees and customers to form a pyramid with technology as a new dimension. The pyramid model of services marketing explicitly considered the impacts of technology on the roles of the company, employees and customers in providing/receiving service. Parasuraman and Grewal (2000) integrated the pyramid model with the quality-value-loyalty model of customer loyalty and identified knowledge gaps requiring additional research. Specifically, very little is known about the impacts of technology linkages on service quality, perceived value and customer loyalty.

Recently Bitner *et al.* (2000) focused on the base of the pyramid model which links customers and employees to study how service encounters can be improved through the effective use of technology. They identify different ways by which technology can be an enabler for employees and customers to achieve customization and flexibility, improve service recovery, and provide spontaneous delight. Their model of technology infusion is limited to service encounters and does not include the impact of technology on employee preparation (internal marketing) or customer expectations (external marketing). Meuter *et al.* (2000) conducted an empirical study to identify sources of satisfaction and dissatisfaction with technology-based service encounters. The self-service technologies examined included ATMs, Internet shopping services, pay-at-the-pump services, automated telephone services, automated package tracking and online brokerage services. While the satisfiers of the service focused on customer benefits (need satisfaction, time and money savings, etc.), the dissatisfiers focused on failure of technology and problems with service design. Their study highlighted the importance of careful service design to leverage investments in self-service technologies. However, their study did not include any self-service encounters involving after-sales support and was primarily limited to facility-based services such as banking and gas stations.

While considerable work has been done to investigate the role of IT on service industries, in general, and services marketing, in particular, very little has been done to provide a framework to guide development of service strategies that leverage the value of IT. Johnson *et al.* (2000) proposed a model to understand and evaluate the new service development process. Their model considers the role of people, technology and organizational systems in conceptualizing, designing and delivering a technology-driven service innovation. While their new service development process model is informative, it does not identify specific ways by which managers can leverage technology to design and implement services that satisfy customers while meeting organizational goals.

In the following section, we discuss our proposed model that extends the work of Parasuraman (1996) and Johnson *et al.* (2000). Our proposed model considers the impact of technology on all three dimensions of the pyramid model (Parasuraman, 2000) offering a service blueprint to assist managers in formulating and implementing their service strategies.

A theoretical framework

As businesses increasingly attempt to integrate all of their functions in a "supply-chain" framework, focus will shift from solving "independent" functional problems to designing and managing an integrated and interdependent enterprise. In the service arena, this will translate to managing the relationships with customers in a manner that promotes both personalized delivery of service as well as lowered costs of delivering that service. Extending the work of Parasuraman (1996, 2000) who proposed a model linking technology with company, employees and customers, we propose in this paper a pyramid model as a theoretical framework guiding technology choice and implementation in service organizations. Lovelock (1992) proposed a service management trinity framework where he suggested that organizations would do well to integrate the marketing, operations and human resource functions to provide a superior service. While there is some overlap between our model and the framework proposed by Lovelock, we believe that there are considerable differences in our central assumptions. In contrast to Lovelock who focused on the three functions and how they should be integrated, we focus on the desired organizational outcomes, and the strategic choices and organizational actions necessary to achieve the outcomes. We believe that our cross-functional and strategy-driven view of organizations is more appropriate to studying the role of technology as it is increasingly clear that advanced information technology applications such as enterprise resource planning (ERP) blur the functional and hierarchical distinctions in organizations.

We call our model for service effectiveness the Diplomacy-Preparedness-Engagement Aided by Technology (DPEAT) model[1], which is presented in Figure 2. At the apex of the DPEAT model is technology and the three vertices of the foundation of a service enterprise are the customers, company and the employees. The three axes define the three primary relationships: customers-company, company-employees and employees-customers. Unlike Parasuraman

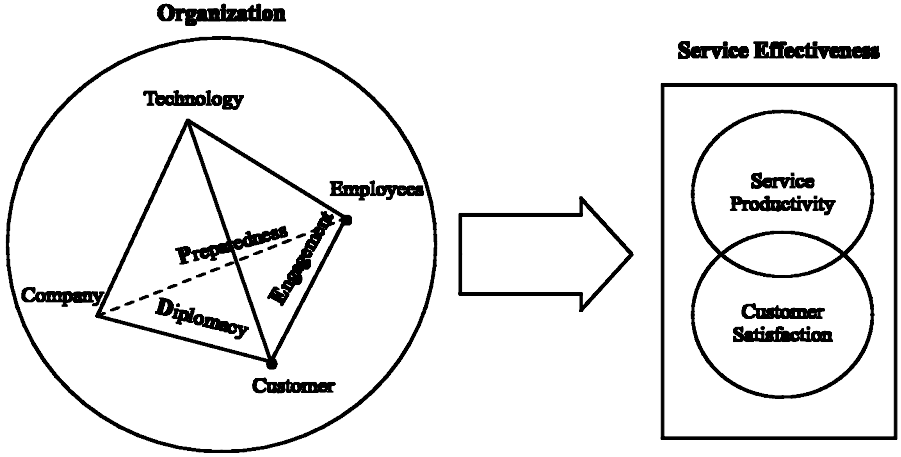

Figure 2.
Diplomacy-Preparedness-Engagement Aided by Technology (DPEAT) model of service effectiveness

(1996) who examined only the connection between technology and the three vertices (company, customers and employees), we examine the influence of technology on the three primary relationships. According to our model, the effectiveness of the service organization is predicated on how well the three primary relationships are managed as part of an integrated customer relationship management (CRM) system. The term, CRM, is used to describe the many different customer-focused approaches companies employ to create loyalty and derive a sustainable competitive advantage. CRM, as the foundation of corporate strategy, is the process of learning to understand the values that are important to individual customers, and using that knowledge to deliver benefits the customers really want and making it easier for customers to do business with the company (Newell, 2000). In contrast, CRM efforts focused only on accessing customer data for cross-selling or up-selling are doomed to fail. Our framework enables the managers to create, manage and satisfy customer expectations effectively.

We use the analogy of a country managing its foreign affairs to describe the three primary relationships. A country's diplomatic efforts are targeted at creating and managing a set of expectations in the target countries. The country's military preparedness complements the diplomatic efforts and might require training in multiple skills to carry out different missions. Finally, engagement is the deployment of personnel in the target country to carry out the mission. We have used this analogy to emphasize the tight coupling required between macro-level strategic planning and micro-level preparation and execution. The company-customer relationship is one of diplomacy while the relationship between the company and its employees is focused on preparedness. Engagement is the third dimension in the model, defined by the contacts between employees and customers. As in the management of a country's foreign affairs, all three relationships are critical to ensure that the organization is effective in the conduct of its business.

The surface area of the plane defines the managerial emphasis on building and managing each of the three relationships. Since the three primary relationships are part of an integrated and interdependent system, we believe that consistent and coherent attention to managing all three relationships would result in a mutually reinforcing and effective service organization resulting in superior customer satisfaction and/or improved service productivity. We also suggest that the overlap between service productivity and customer satisfaction will be influenced by the relative emphasis on the three dimensions as well as how well the technological solutions are implemented. In an ideal customer-centric organization, we would expect the service productivity and customer satisfaction to overlap completely. However, managers make trade-offs due to their strategic positioning and resource constraints, and hence may focus on maximizing one outcome given an acceptable level of the other. In the following paragraphs, we describe the three planes indicated in the figure above and the different technological options

available to manage these relationships. We have also summarized the characteristics of diplomacy, preparedness and engagement in Table I.

Diplomacy

We define diplomacy as the ability of an organization to strategically manage its relationship with its customers by creating and managing their expectations. Heskett *et al.* (1990) identified managing customer expectations as an important characteristic of breakthrough service providers. According to them, innovative service firms attempt to develop their customers by managing and measuring their expectations, and encouraging habitual usage patterns, thus increasing switching costs and customer loyalty (Heskett *et al.*, 1990, p. 42). In the services marketing literature, diplomacy is primarily related to signaling services value and creating customers' service expectations (Bitner, 1995; Kotler, 1994) and hence is seen as the responsibility of the marketing function. Our integrative model differs from that proposed by Parasuraman (1996) and others in that we take a broader view of diplomacy to include all the macro-aspects of the service system which requires cross-functional collaboration for effective performance. Therefore, creating and managing customers' service expectations is as much a responsibility of the field service function as it is of the marketing function. This cross-functional involvement in setting up service promises (Bitner *et al.*, 2000), while reducing the traditional gap between marketing and operations, should enable the service function to design an appropriate service delivery system that delivers the desired outcomes.

The diplomacy dimension focuses on the specific policies and actions of the company that signal a particular value proposition to its customers and create customers' service quality expectations (Parasuraman and Grewal, 2000). This might involve building alliances and partnerships with both customers and other third parties to support the relationship between the customers and the organization. Successful diplomacy minimizes the chance of engagement while being mutually beneficial to both parties engaged in the relationship.

To manage customer expectations, organizations have to make several strategic choices regarding warranties/guarantees, inventory holding and other service level parameters, capacity and infrastructure, and outsourcing of different service functions. For instance, organizations can influence customer expectations by signaling increased product reliability (e.g. Maytag in home appliances), guaranteeing superior service (e.g. Caterpillar in earthmoving equipment) or implementing superior manufacturing, logistics and service system design (e.g. Dell Computers). Infrastructure planning is essentially a macro-level strategic action designed to both signal service system capabilities as well as meet customers' service needs. Organizations also have to decide whether to outsource the service function and who to choose as strategic business partners. While outsourcing of service functions is quite common among US enterprises today, only a few of them have achieved a seamless (and virtual) integration of their outsourced services with other functions. For

Managerial issues	Managerial emphasis Diplomacy	Preparedness	Engagement
Strategic objective	Creating and managing customer expectations	Having the employees combat ready	Win-win, the first time
Strategic decisions	Policy choices governing product functionality and design features Warranties and guarantees Alliances and strategic partnerships Infrastructure planning and design for service delivery (e.g. decision on service capacity, spare parts inventory holding, provision of loaners etc.)	Service organization structure and work design Personnel planning Selecting and training of support personnel Compensation and incentives for support personnel	Decision-making authority given to support personnel Set standards for service delivery (e.g. standards for mean time to respond and mean time to repair
Technological solutions	Self-service Webs/knowledge Webs (1) Self-correcting technologies (2) Call center automation (3) Web-based supply-chain management (4) E-mail/document workflow (5)	Descision support systems/ knowledge Webs (1) Computer-based training and simulation (6) Skill-matching automated call routing (7)	Decision support systems (1) Automated parts ordering (8) Wireless communication for scheduling, and on-site tech-support (9) Field-repair feedback (10)
Assessment	Customer surveys Service ROI Effectiveness of strategic partnerships	Training assessment Attitude surveys	Repair records Computer monitoring Customer satisfaction surveys

Table I.
Characteristics of the three phases of the DPEAT model

example, Dell Computers has outsourced its field service function to a few organizations including Unisys and Wang, and its reverse logistics to UPS, while managing the call center function internally. This allows a customer to call Dell to arrange for service, without being aware of the complex transactions among the various business partners required to execute the service flawlessly.

Several technological options are available to manage this key relationship with the customers. Many organizations have implemented Web-based services that offer product manuals, frequently asked questions (FAQ) and other product literature. Advanced self-service Web sites offer access to knowledge bases, Web-based training, guided diagnostics, automatic product update notices, user groups for tapping and sharing the knowledge among the user community, issuance of service tickets and product returns, and field service scheduling. Some CRM suites, apart from offering all the above features, include synchronous communication technologies like chat rooms and voice-over-IP (voIP), integration with ERP platforms (e.g. SAP) and build customer databases to help in better pricing and marketing of services and related products. For instance, Siebel Systems, the largest CRM vendor, offers a field service system that manages preventive maintenance, service inventory, dispatch and scheduling, return materials authorizations, quotes and orders, and other functions (Albright, 2000). Technologies that integrate e-mail, telephone and document workflow have become critical in managing the relationships and information flow among customers, employees and various strategic partners. Diagnostic and self-correction technologies can also be used to avoid costly repair as well as accurately predicting spare parts requirement prior to a service visit. For instance, the Metropolitan Water Reclamation District of Chicago had a 25 percent reduction in repair/breakdown work orders and a 33 percent reduction in work-hours required for repairs after implementing a maintenance management software system that allows and suggests preventive maintenance (Burnell, 2000). Another advantage of self-correcting technology is that the customer is either unaware that there was a problem or comes to know of the problem later than the service organization. In either case, timely and cost-effective service is delivered to the satisfaction of the customer.

Organizations should continuously assess their performance in this dimension to ensure that they are managing their customers' expectations effectively. Customer satisfaction with the service on-site, as well as on the Web, are a subjective assessment of service effectiveness, while return on service expenditure is an objective assessment of how well the organization has managed the relationship with its customers. Statistics pertaining to self-service Web sites such as total visits, pages viewed and perceived usefulness of knowledge bases to resolve customer issues provide valuable information to improve the content and presentation of these customer contact points. We also suggest that organizations continually assess the performance of their strategic partners. For instance, performance of the vendor responsible for call center

operation could be assessed by call center statistics pertaining to average customer wait time, call volume handled, complaints resolved, calls converted to field service tickets and total cost per service encounter, as well as by using "test" calls.

Preparedness

We define preparedness as having well trained and motivated customer service personnel. Kotler (1994) referred to this as "internal marketing" which involved providing employees with appropriate training, support, motivation and rewards to serve external customers well (Parasuraman and Grewal, 2000). Heskett *et al.* (1994) identified six drivers of an operating strategy and a service delivery system, hypothesizing that an effective service delivery system results in service value leading to customer satisfaction and loyalty. The six drivers are: workplace design, job design, selection and development, rewards and recognition, information and communication, and adequate tools to serve customers. Successful preparation of the service personnel, enabled by these six drivers, enables organizations to effectively satisfy their customers' service needs, be it over the phone, via the Web, or on-site.

Considerable research evidence has been accumulated indicating human resource management's positive effects on the organization's bottom line (Huselid, 1995). Specifically, prior research has found a positive impact of effective management of customer-contact employees on service quality and customer satisfaction (Hartline and Ferrell, 1996; Hutchinson *et al.*, 2000; Schneider *et al.*, 1998). Team-based work systems, employee self-efficacy, role clarity and job satisfaction, and a service-oriented work climate, were all found to be related to superior service quality and customer retention. Paying attention to person-job fit when selecting service personnel, and supporting them with strategic leadership can ensure a service-oriented work climate. Organizations can affect employee self-efficacy through continuous training and support. Team-based work systems have been found to be positively related to service quality and productivity (Batt, 1999). Organizations can reduce role ambiguity by communicating their expectations and the importance of each employee's role in the service organization. A challenging work environment, personal development opportunities, well-understood role and compensation tied to performance, are all likely to contribute to job satisfaction.

Technological advances have made it possible for organizations to affect employee preparedness in a cost-effective manner. A well-designed call center can be programmed to route customer calls automatically by matching skills on the basis of customer responses to the screening questions. Coupled with advanced decision support systems that track user and machine repair history, and knowledge webs that capture field learning and best practices, customer contact employees can be prepared to respond to customer queries quickly and accurately. This increases employee self-efficacy. Computer-based or Web-based any-where, any-time training and simulations can also be used to

provide employees with up-to-date information and training to respond to customer complaints. For example, IBM saved $1.5 billion by handling customer queries electronically and another $350 million by using the Internet for internal training in the fiscal year 2000 (Kemp, 2001). Johnson Controls is consolidating data from 195 databases into a single Oracle database and is integrating legacy systems with its field service automation software (Gilhooly, 2000). This would allow the firm and its over 2,200 field service employees to provide better service to its 30,000 customers. Emerging wireless technologies and applications promise field service personnel immediate access to technical and customer information improving their readiness to perform the on-site service. MediaOne, a Colorado-based broadband services company, became so efficient in the field using a wireless workforce management system, that it was able to free up 25 percent of its employees to take over the workload generated by a new product offering (Albright, 2000).

We suggest that organizations continually assess their performance in this dimension to ensure that their service personnel have high levels of preparedness to engage in the service encounter. On-going training assessments provide information for individual development while employee attitude surveys provide summary information on the level of preparedness of different service employee groups such as call center employees and service technicians.

Engagement

We define engagement as the actual encounter between a customer and an employee which could occur on the Web, over the telephone or on-site. Service engagements (more generally referred to as service encounters in the literature) are "critical moments of truth in which customers often develop indelible impressions of a firm" (Bitner *et al.*, 2000). Each employee encounter with a customer, whether face-to-face, over the phone or via the Web, is an opportunity for the firm to reinforce or change customer perceptions of the firm's offerings. In a field service setting, the primary objective of engagement is to successfully resolve the customer complaint at the very first encounter. However, this does not mean that customer contact employees are encouraged to dismiss the complaint or recommend a short-term solution. We believe that the strategic objective of each engagement should be to resolve the issue so that the resolution minimizes the chances of a repeat complaint on the same or similar issue. As the final and critical phase in managing the service relationship with the customer, engagement has significant impact on service costs, quality, customer satisfaction, intentions to repurchase and loyalty (Bitner *et al.*, 2000). Research on the negative consequences of poor service suggests that a dissatisfied customer is likely to tell ten to 20 people about the poor service while customers whose problems are resolved are likely to inform only about five people (Fitzsimmons and Fitzsimmons, 2001). A well-prepared employee might be able to successfully resolve customer problems the very first time or recover quickly from service problems, mitigating the negative consequences of an unresolved problem. On the other hand, a poorly prepared

employee may not be able to resolve the problems or find ways to recover from service errors, compounding the initial problem.

Organizations will have to consider several strategic issues related to increasing their chances of succeeding in each service encounter. A well-prepared and empowered work force, when given appropriate organizational support, can ensure that customer complaints are resolved speedily and to customers' delight. Organizations can create the performance expectations by setting the service standards to respond to and resolve complaints. When clearly communicated to the well-trained employees, these performance expectations will become the "goals to beat."

Several technological options exist to successfully carry out this phase. Decision support systems/expert systems can help service personnel in problem diagnostics and resolution. Technological capabilities for spare-parts identification for each service request and automatic ordering of parts as-required help minimize costs of inventory carrying as well as non-productive on-site visits due to missing spare parts. Dynamic scheduling of field service visits, improved wireless communication technologies and global positioning systems can be utilized for more effective allocation and utilization of service technicians' skills and time. Advances in wireless and hand-held technologies enable service technicians to communicate with their peers for both technology support and locating spare parts. Web-based field-repair ticket/feedback from service technicians can be used to update customer information, develop the knowledge base as well as design future products and services. For example, service personnel at MidAmerican Energy Co. of Iowa use a geographic information system (GIS) to obtain and update mapping information and mobile data terminals (MDTs) to execute work orders and verify field data (Koch, 2000). Lemon Busters, which provides mobile vehicle inspection services, uses a mobile workforce management system that performs street-level routing and optimization scheduling activities (Albright, 2001).

There are several methods available to assess the performance of the service personnel in this dimension. Unlike the other two dimensions, the focus of assessment is the individual employee or the service team rather than the entire service organization. Repair records reveal achievement of performance standards in terms of mean time to respond to and resolve complaints. Computer-aided monitoring can be used to track the performance of call center employees. Finally, customer satisfaction surveys can be used to track the perceptions of the customers.

Impact on service effectiveness

We hypothesize that consistent and coherent attention to managing customers' service expectations, preparing employees and conducting service engagements will result in improved service productivity and customer satisfaction. Service productivity and customer satisfaction have different foci in that service productivity is about improving the efficiency of internal

operations while customer satisfaction is an indicator of the impact of a firm's actions and strategies on the customer. Managers, faced with limited resources, may have to engage in a trade-off between service productivity and customer satisfaction to make their strategic decisions. For instance, at a large manufacturer of electronic machinery, executives are so focused on account servicing and retention that they have field engineers posted exclusively at clients' sites and do not seem to track any metric related to service productivity. They believe that such obsession with customer service is critical for their survival as they compete with global firms for business.

Figure 3 presents the service productivity-customer satisfaction relationship where the solid curved edge represents the limits of what is possible with current technologies and service design. The line indicates the highest customer satisfaction that can be achieved for a given level of service productivity or the best productivity possible for targeted customer satisfaction. Ineffective organizations are likely to be positioned inside the curved edge (the frontier), not able to maximize their position on one dimension given their level on the other dimension.

Organizations that place considerable emphasis on diplomacy may enjoy higher levels of customer satisfaction but not necessarily service productivity. This is due to their emphasis on "delighting" their customer, which might require creating a sufficient buffer in the service system. Similarly, organizations interested in improving their service productivity may place too much emphasis on minimizing the costs of preparedness and engagement so as to control the overall costs associated with providing the field service.

To move beyond the frontier is simply not feasible given the current status of the service organization and would require adoption of new service strategies that leverage the potential of IT. We represent these potential

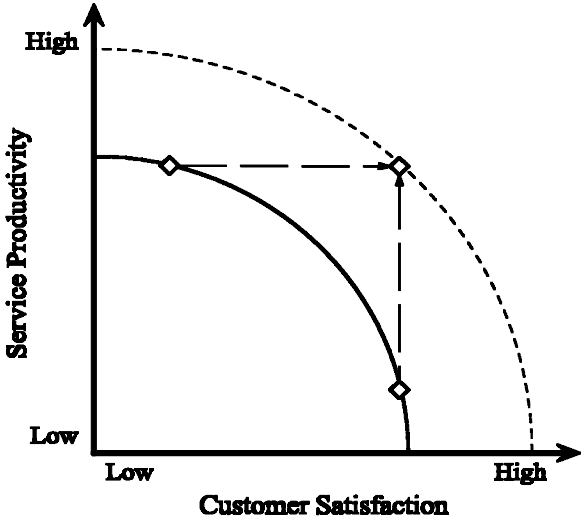

Figure 3.
Service productivity-customer satisfaction frontier

breakthrough improvements by the dotted curved line identifying the new productivity-customer satisfaction frontier. The proposed DPEAT model assists in identifying new opportunities to restructure the service system to move the firm to the new efficiency-effectiveness frontier. By designing and deploying a technology-infused service system, a service organization can move from low service productivity to high service productivity for the same level of customer satisfaction. Conversely, the organization can improve its customer satisfaction while maintaining high levels of service productivity. In the examples cited above, we noted how several firms have leveraged the potential of IT to reduce service delivery costs, improve employee training and provide improved service to the customer. In the next section, we demonstrate the utility of our framework using a generic field service blueprint. The Appendix [2] illustrates, using a published case, how our framework can be applied to change service strategy and improve service operations.

Application to field service

The actual value of any conceptual model is dependent on the ease with which it can be applied in a real-world setting. In Figure 4, we present a service blueprint for a typical field service organization. The line of visibility separates the customer's perspective of the service process (front office) from the numerous unseen operations that must be performed by the firm to deliver the service (back office). A service blueprint such as this is often used to locate possible fail points in the process. However, the purpose here is to improve the service delivery process by identifying potential applications of technology based on the DPEAT model.

The arrows in Figure 4 represent transitions in the service process and have been labeled with a D, P or E as appropriate, based on the nature of the receiving block. In this way we can relate the strategic decisions and technological solutions provided in Table I to an actual process. It can be seen that above the line of visibility the labels are mostly D and E, which implies relationships with the customer. Below the line the only actual engagement is through the call center. Also below the line there are some policy-setting diplomacy issues and most of the preparedness activities.

The information presented in Table I can be easily identified on the service blueprint. Note that in Table I the technological solutions have been identified with numbers. Most of the arrows in Figure 4 list some of these numbers in addition to D, P or E in order to identify potential applications of technology based on the DPEAT model. For example, the flow along the top of the blueprint shows that it is possible a customer might not have to contact the firm directly for service. Strategically, this represents policy choices concerning customer involvement in the repair process and possibly product design. Possible technical solutions would be for the customer to access a self-service Web site or for the product to have been designed with self-correcting technology (1, 2).

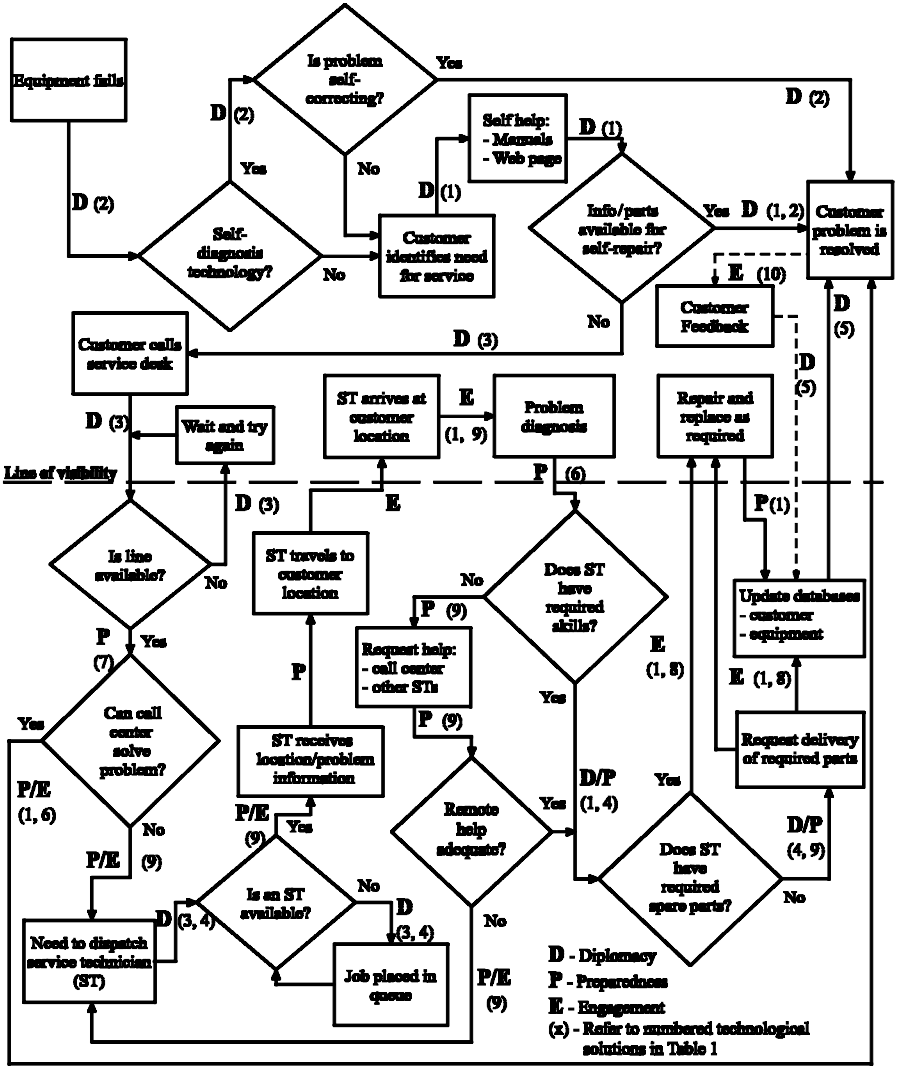

Figure 4.
Service blueprint for field service operation

An example of preparedness involves the question block asking: "Does service technician (ST) have required skills?" The strategic issue is the selection and training of support personnel. A technological solution is the use of computer-based training and simulation (6). If the response to the question block is "no," the solution could be to contact the call center or another service technician with wireless communication (9). A "yes" response leads to the diplomacy/preparedness issue of managing spare parts (4).

A very important engagement action is for the ST on site to diagnose the problem. This involves the strategy of giving decision-making authority to the on-site personnel. The technological support for this can come from decision support systems and wireless communication (1, 9).

Conclusion

In this paper, we proposed a framework to guide the selection and implementation of technological solutions to improve field service effectiveness. We suggest that managers pay consistent and concurrent attention to carrying out their DPEAT. By effectively managing customer expectations, having a well-trained work force and successfully engaging each service encounter, organizations can achieve superior service productivity and customer satisfaction. We believe that organizations can move to a new service productivity-customer satisfaction frontier by focusing on creating new service strategies that leverage the value of IT.

Our framework has considerable implications for research as well. The service management literature has lacked a theoretical framework to examine the influence of technology on field service effectiveness. Our DPEAT model of service effectiveness provides one such framework to empirically examine the impact of managing the three relationships on service effectiveness.

Considerable work remains to be done on expanding our model to explain the inter-connections among the three relationships. For instance, we need to further theorize the impact of strategic partnerships on employee preparedness, or the influence of employee training on warranties and guarantees offered. Also more work needs to be done on identifying factors that determine the relative importance of the three relationships and the possibility of employee preparedness influencing company policies. We can only speculate about the influence of product design and company policies on employee preparedness and engagement at this time. Future research addressing these issues can help advance the field of service management.

Notes

1. At a conceptual level, we make a distinction between the three dimensions but we recognize that certain organizational actions may touch upon or impact two or more dimensions.
2. Case prepared by A.V. Hill and appeared in Schroeder (2000).

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Appendix. Case: the field service division of DMI

Case summary

Diversified Manufacturing, Inc. (DMI), a multibillion-dollar company headquartered in Denver, Colorado, manufactures and distributes a wide variety of electronic, photographic and reprographic equipment used in many engineering and medical system applications. Although field service was becoming more important in new machine purchase decisions, field service was not viewed as a critical part of DMI's corporate strategy.

DMI's Field Service Division employed 550 technicians who serviced an installed base of over 240,000 machines in North America. Warranties or service contracts covered about 80 percent of the emergency maintenance service calls. The other 20 percent were billed to the customer based on "time and material cost." Typical service contracts promised an average response time of four hours or less. DMI's National Service center had 40 call-takers who handled about 3,500 calls per day. Currently, call-takers help the customers fix the problem themselves in about 10 percent of the cases. The call-takers provided the expected response time for the remaining calls. Call-takers entered the service call information into the system and the information was sent electronically to one of the five regional dispatch centers assigned to that customer location. Dispatcher assigned the call to a tech, given the machine location, tech's location and training profile. After completing a service call, techs call the dispatchers and receive a new call and then call the customer to give an expected time of arrival. Techs repaired the machine if parts were available in the van. If parts were not available, the part was express mailed to the customer and the repair was done the next day. Techs reported inventory usage when they cleared a service call. Parts center used a one-for-one policy to replenish tech inventory via a two-day delivery service. The primary measure of performance was "the percent of service calls that make the target response time." About 20 percent of all service calls did not make the target response time. Getting into third party service was under serious consideration.

Management was giving serious consideration to three technologies to improve field service operations: an expert system for problem diagnosis to be used by techs in the field; an expert system for assigning and scheduling techs; and a geographic positioning system that could be used to track tech locations at all times.

Application of the DPEAT framework

We have summarized the major issues identified in the case in Table AI. As can be seen from the table, these issues span the three dimensions. Clearly, not meeting promised response time

Table AI.
Issues and evalution of DMI's improvement plan and our recommendations

	Diplomacy	Preparedness	Engagement
Issues	Promised response time of four hours not always met Customers unaware of status of their complaint Service policies not related to service goals Capacity planning and design (in terms of dispatch center locations and number of techs and parts inventory management) 80 percent of calls for service under warranties, enquiring about complaint status 10 percent calls solved by customer with guidance from call center employee Reverse-logistics system ineffective	Lack of trust and motivation Lack of training (increase in number and complexity of models) Rewards tied to meeting "target response time" and not other relevant measures Difficult to find qualified technicians Lack of communication between service managers and technicians Lack of a systematic method to capture knowledge (technician training, nature of call, resolution, best practices, etc.) and match technician skills to service call requirements	No standards for mean time to repair; standards only for mean time to respond Technicians have to make short interval calls (within 24 hours) because of lack of parts Technicians cannot call dispatch center due to busy phone system No system to check on parts availability or contacting knowledge sources to resolve customer complaint Call center employees resolve 10 percent of the complaints and answer many calls related to complaint status Technicians idle 50 percent of the time
Evaluation of technologies considered by DMI management	Do not address the service gaps between expectations and delivery Do not address improving system performance Addresses scheduling issues related to dispatch center performance	GPS will help manage time to respond Expert system for assigning and scheduling techs will improve utilization as well as response time Do not address training, motivation and reward issues	Expert systems for diagnostics and tech assignment will improve repair time Do not address return calls necessitated by parts inventory or inability to complete telephone calls to dispatch center Do not address performance of call center employees

(continued)

	Diplomacy	Preparedness	Engagement
Our recommendations	Self-service Webs – for diagnosis/resolution of common problems, reporting service issues, scheduling site visits, participation in user communities Centralized database on machine inventory, customers' service usage/repair history, parts requirement, etc. Real-time segmentation based on customers' service needs and preferences – personalization of service delivery facilitated by IT Reverse logistics linked to service calls	Knowledge Webs that build a culture of collaboration among field technicians; system to capture, codify and retrieve problem resolution and best practices in field Computer-based, anytime, anywhere (on-demand) training on all products Rewards linked to system performance – customer satisfaction, service productivity, contribution to knowledge Webs, etc.	Wireless applications to improve communication between technicians and call center; minimize the need for telephone calls (e.g. reporting service completion via mobile Web-application Web-based scheduling to minimize transit time (from Call Center to Dispatch Center to Field technician) – facilitated by GPS/wireless application Computerized tracking for parts retrieved from customer site and centralized drop-off points for parts recovery

Table AI.

and customers remaining unaware of the status of their service requests are diplomacy issues as the promises create customers' service expectations. We also see evidence in the case about the lack of trust in field technicians and their lack of motivation to provide exemplary service. Similarly, technicians and call center personnel are not (always) successful in their encounters with customers. Technicians may have to make short-interval calls due to lack of parts or knowledge about the machine requiring service. Similarly, call center employees are unable to provide customers with accurate status on their service request. Based on the information provided in the case, we believe that DMI is positioned inside the service productivity-customer satisfaction frontier as shown in Figure A1. To improve their position, management has considered three technological options, which we have evaluated against meeting the requirements of each of the three dimensions (Table AI). The technologies considered do not address the diplomacy issues and only partially address the preparedness and engagement issues.

We have proposed a set of solutions and have shown how they might address the needs of the company. Specifically, well-designed self-service Webs can redirect many of the calls received by the call center and also enable the customers to seek service solutions that fit their needs and preferences. Similarly, wireless applications can improve communications between call/dispatch centers and field technicians while keeping information on the system updated. This would improve the quality of information provided to the customers as well as improve scheduling and field performance of technicians.

The net effect of the proposed changes is improved customer satisfaction and service productivity. At the same time, our recommendations can create new revenue streams for the company by providing new opportunities for real-time service segmentation based on customers' service needs and preferences.

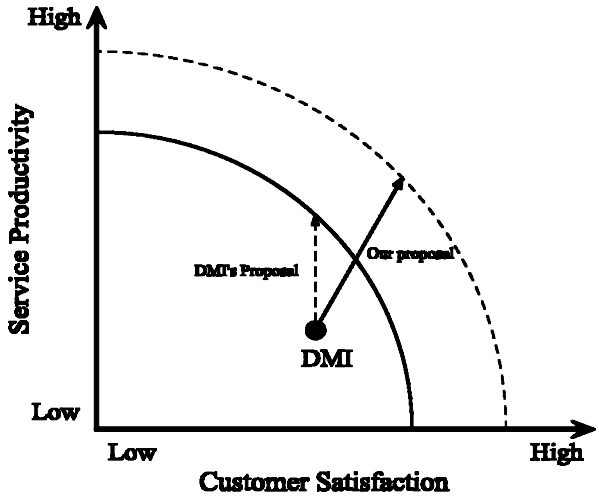

Figure A1.
Position of DMI in service productivity-customer satisfaction frontier