Information Technology and Training in Emergency Call Centers

Susan Athey, MIT & NBER Scott Stern, MIT & NBER

January, 1999

Introduction

This paper is motivated by the question of whether information technology (IT) increases or decreases the returns to skill and training, particularly in the service sector. To address this question, we examine the empirical patterns of IT and human resource practice adoption in a particular type of telephone customer service organization, the emergency call center.

Emergency call centers, typically accessed in the U.S. by dialing 911, serve as the first point of contact between an emergency victim and the local police, fire, and health infrastructure. For every telephone call received, a telecommunicator determines the nature of the emergency and the location of the caller, and then assists in the dispatch of appropriate emergency services. A number of new technologies have become available in recent years. The 1990s saw widespread adoption of computerized "Enhanced 911" (E911) systems that automatically identify a caller's location. In earlier research, we found that the adoption of E911 increases productivity by decreasing response time to emergencies, and that lower response time leads to lower mortality rates from heart attacks (Athey and Stern, 1998a).

This paper extends the scope of our previous analysis to include human resource practices. We focus on three distinct practices affecting training and skill: hiring and screening requirements, total hours of employer-sponsored training, and the adoption of a specific training system known as Emergency Medical Dispatch (EMD) training. We present empirical evidence about the interaction between 911 technology adoption and the use of these human resource practices. Our results suggest that E911 technology is positively related to total training and EMD training, and unrelated to hiring requirements.

IT and Training in Emergency Call Centers

Emergency call centers usually serve a political entity such as a county or town; this paper focuses on call centers that provide service for an entire county, and we take the geographic area and population served by a given call center as exogenous. The call centers are operated as a public service, usually funded by a some combination of state and local subsidies and telephone system taxes, and they are loosely regulated by state government.

Call centers vary widely in their use of technology. In some communities, local police and fire departments are reached by calling an operator to obtain the 7-digit telephone number, and then contacting the agency directly. In other areas, "Basic 911" technology allows callers to use the universal telephone number, 911. In both cases, once the call is received, the telecommunicator verbally ascertains the address of the caller, as well as any necessary directions. Armed with a map and a pencil, the telecommunicator locates the address, and the service is dispatched. In rural areas or areas with incomplete or unsystematic addressing, this method is error-prone, and crucial minutes may be lost trying to direct emergency services to the scene. Recently, advances in IT have enabled more sophisticated options. E911 systems link digital information about the source of the call with a detailed address database maintained by the call center. The telecommunicator then views the caller's address and location on a computer screen as the call is received. Even more advanced alternatives are available, including computer-aided dispatching and geographic positioning systems. We will refer to this complete system as "High-tech E911."

Call centers also face a variety of human resource alternatives. During the early years of emergency call centers (and even today in smaller centers), call-taking typically was assigned to untrained police officers or firemen, sometimes as alternative duty for injured personnel or as an informal sanction for weak job performance (Pivetta, 1995: 61). Over time, the job has been reassigned to lower-wage, non-uniform personnel. Initially, these workers received little training, and anecdotal evidence suggests that the systems suffered from low productivity and high rates of turnover. In response, some call centers increased their levels of training, and many states have adopted standards for training and certification of telecommunicators.

During the 1990s, there has also been an increase in the adoption of a specific type of training program, EMD. EMD training programs teach call-takers how to gather and use information about medical emergencies. The EMD system utilizes pre-printed cards to guide telecommunicators through the process of providing pre-arrival instructions to callers about a variety of emergency conditions. Further, medical information obtained from the caller can be used to prioritize the demands for limited ambulance and paramedical resources. EMD training typically takes about 40 hours, and it is usually provided by one of several private vendors.

Both advanced technology and human resource practices contribute to the various performance goals of emergency call centers. They have a direct effect by reducing response times to emergencies, which in turn improve outcomes. EMD training may be also have other benefits, including improved allocation of ambulances and a direct effect on health.

An immediate question arises as to whether elements of the human resource environment and E911 technology interact in affecting productivity (whether measured narrowly as response time or more broadly as health outcomes). Clearly, the optimal training and skill requirements for workers are different depending on the level of 911 technology. First, a minimal level of computer-specific training is required just to use an E911 system, and thus we expect to see increases in at least some types of training in response to E911 adoption. Second, two of the primary responsibilities of telecommunicators in the older systems, gathering address information and identifying the caller's precise location, are automated with E911. As a result, E911 may make it possible to eliminate the requirement for training or skill beyond the minimum necessary to operate the computer. On the other hand, E911 frees time and mental resources for both the call-taker and the caller. The telecommunicator can potentially use that time to gather information to be used to decide how to allocate ambulance resources, as well as to provide medical instructions until the ambulance arrives. Consequently, E911 might be a complement to training programs that improve worker decision-making, such as EMD.

There are two natural approaches available for empirically analyzing the interaction between technology and human resource practices. One approach hinges on the insight that if technology and training are complementary in production, then call centers adopting higher levels of technology will find more it more attractive to use more training. Thus, complementarity provides support for a positive correlation between the adoption of technology and the adoption of specific human resource practices. Of course, a finding of positive correlation can typically also be attributed to positive correlation in the unobserved costs or benefits of adoption; thus, it is particularly useful to identify exogenous variables, such as state regulations, that directly affect the adoption of one choice but not the other.

A second approach is to examine productivity directly. In Athey and Stern (1998a), we take an initial step in this direction, focused on the impact of technology. In that work, we examined the impact of more advanced level of 911 on response time using a unique, detailed, dataset composed of cardiac emergencies requiring ambulance services in the state of Pennsylvania in

1995. After carefully controlling for patient severity and other factors, we found that counties with advanced levels of 911 arrive at the scene of the incident 8-10% faster. Further, in the four counties that increased their 911 level over the course of the year, the response time reductions were even more pronounced. Extending such an analysis to evaluate the interaction between human resource elements and technology poses a variety of challenges, both for consistent estimation (Athey and Stern, 1998b) and for measurement (training data has not yet been collected for this sample, and further we expect that it may be difficult to discern the subtle effects of EMD on health outcomes). Leaving a full productivity analysis of the interaction between training and technology to future work, we now turn to evidence regarding adoption.

Adoption of 911 Technology and Training: Evidence from a National Cross-Section

This section explores the patterns of adoption of E911 and training in a cross-section of U.S. counties in 1995. The primary source of data is a national survey about IT and training undertaken by the National Emergency Number Association (NENA) in 1995. We focus on the subset of 803 call centers that responded fully to the survey and reported serving as the primary call center for a county-wide geographic area. We then link this data to county-level demographic variables from the City and County Data Book. A final information source is a survey of state training regulations undertaken by NENA in 1996. This survey identified ten states that, beginning at the latest in 1995, required that all telecommunicators undergo state-certified training; one state mandated EMD training for certification. Further, ten states had minimum skill standards, such as high school diplomas, for telecommunicator certification. Table 1 summarizes our results about training and technology adoption.

TABLE 1: Training and 911 Technology Adoption in U.S. Counties in 1995			
Procedure	OLS	Ordered Probit	Instrumental Variables
DEPENDENT VARIABLE	Ln(Hours of Initial Training)	Level of 911 Technology (0=No 911, 1=Basic 911, 2=Low-tech E911, 3=High-tech E911)	High-tech 911 (D) (0=No 911, Basic 911, or Low-tech E911, 1=High-tech E911)
Basic 911 (D)	.272 (.186)		
"Low-tech" E911 (D)	.315 (.180)		
"High-tech" E911 (D)	.469 (.179)		
Ln(Initial Training)		.121 (.041)	.146 (.097)
Min. Skill Required (D)	.027 (.096)	–.009 (.104)	.009 (.039)
St. Train Cert. Required (D)	–.302 (.088)		
EMD Required (D)	.674 (.319)		
Ln(Call Volume)	.102 (.028)	.178 (.032)	.055 (.017)
Ln(Population Density)	–.006 (.039)	.206 (.043)	.050 (.017)
Ln(Per-Capita Income)	.546 (.214)	.134 (.250)	.123 (.116)
Ln(Police & Fire Expend.)	.068 (.042)	–.043 (.048)	–.005 (.020)
% Fire Expenditure	.632 (.326)	–.376 (.375)	–.119 (.157)
Regression statistics (N=802)	R^2=.23	Pseudo R^2=.12	

Notes: (D) indicates a dummy variable. Instruments in column 3 are state training regulations, including certification requirements and EMD requirements.

The first column of Table 1 confirms that systems with higher levels of 911 are associated with higher levels of training, as would be consistent with complementarity between training and technology. Further, training hours are higher in the single state that mandated EMD training for all telecommunicators. State skill requirements do not affect training. It is more difficult to interpret the finding that training is lower in states which mandate state-certified training. While open to interpretation, this result may reflect a greater efficiency in formal, centralized training programs; it may also represent some sort of selection effect (for example, training standards may have been instituted in laggard states).

The first column of Table 1 also highlights a variety of additional factors that affect the choice about how much initial training to provide. As some fixed costs are required to set up and implement a training program, we expect some economies of scale; Table 1 shows that training is increasing in call volume. Higher levels of income and overall police and fire expenditures also increase the level of training. Finally, we find that when a higher fraction of the (combined) police and fire budget is allocated to fire, training increases. Interviews with industry participants suggest that police departments often object to high levels of specialized training, since this may imply a loss of control for the department as well as a loss of employment for injured or disabled police officers.

The second column of Table 1 presents an ordered probit regression of the level of technology. Again, the level of technology is positively related to hours of initial training. It is unrelated to minimum skill requirements for state certification. As with training, technology is strongly related to call volume, indicating a scale economy.

Our evidence in the first two columns of Table 1 is suggestive of complementarity between technology and training, and we believe that the controls included in the first regression capture some of the most important factors driving adoption. However, we still cannot rule out the possibility that an unobserved factor might affect both choices. For example, industry participants report that because the process of adopting advanced technologies and training requires significant (and often unrewarded) effort on the part of government employees, the motivation and skills of the call center director may increase the level of training as well as the level of technology. In order to account for this problem, the third column of Table 1 presents an instrumental variables (IV) regression. We focus on the relationship between training and High-tech E911, the strongest technology-training relationship, both theoretically and as pairwise correlates in this sample. We use a variety of state training regulations as instruments for the level of training; thus, we are assuming that state regulation of training is uncorrelated with the unexplained component of technology adoption. We find that training and the adoption of High-tech E911 are positively correlated, although the relationship is significant only at just below the 10% level. By way of comparison, an OLS regression with the same specification yields a coefficient on initial training of .039 with a standard error of .015.

Taken together, the evidence suggests that there is a positive relationship between training and the use of IT in emergency call centers. Although we interpret our findings as preliminary, they do appear to refute the hypothesis that the automation brought about by E911 adoption has had economically significant “de-skilling” effects in emergency call centers.

The Adoption of 911 Technology and EMD Training: Evidence from North Carolina

A limitation of our empirical analysis of U.S. counties is that we cannot distinguish between different types of training, which may be important since (as discussed above) different types of training may have different relationships with 911 technology. In particular, it is interesting to discover whether all of the increase in training concerns the use of computers, or whether qualitatively new skills are required. Thus, we now turn to a dataset which allows us to link technology adoption to EMD training. We take advantage of a survey administered by the North Carolina Office of Emergency Medical Services in both 1992 and 1995. The survey includes county-level information about 911 technology and whether the county has adopted an EMD system. The response rate was fairly high: information is available about 93 counties in 1992 and 99 counties in 1995, out of 103 counties. The survey is linked to demographic information from publicly available datasets, including the City and County Data Book and the Census of Governments.

For each year, we divide the sample according to the level of technology provided by the county and whether the county has adopted EMD training. Table 2 reports the means of several variables conditional on this division.

Table 2: Demographic Conditional Means for North Carolina Data – By Year

1992				
EMD Training		911 Level		
		None (26%)	Basic (34%)	Enhanced (40%)
NO (87%)	Number of Counties	23	30	28
	Population (000s)	40.6	43.0	102.2
	Fire & Police Exp. ($ mils)	2.2	2.5	7.9
YES (13%)	Number of Counties	1	2	9
	Population (000s)	56.1	62.2	146.5
	Fire & Police Exp. ($ mils)	3.4	3.2	12.7

1995				
EMD Training		911 Level		
		None (6%)	Basic (35%)	Enhanced (59%)
NO (78%)	Number of Counties	6	29	41
	Population (000s)	19.8	39.4	69.1
	Fire & Police Exp. ($ mils)	0.8	2.3	4.5
YES (22%)	Number of Counties	0	5	16
	Population (000s)		64.0	140.9
	Fire & Police Exp. ($ mils)		4.1	12.6

Table 2 highlights three main findings. First, higher levels of technology and EMD training are observed in 1995 than 1992, consistent with the fact that both technology and training options diffused nationwide during the 1990s. Second, counties with E911 are more likely to also have implemented an EMD program. For example, while overall only 13% of counties had EMD in 1992, 24% of the counties with E911 had EMD. The positive relationship is weaker in 1995, but still present. Moreover, out of 8 counties that switched from no 911 to E911, 3 adopted EMD at the same time; only 8 of the remaining 83 counties adopted EMD during this time period. This suggests that implementation of new technology (and in particular, drastic increases in technology) may induce investment in the training program, or vice versa. Third, some of the positive covariation seems to be explained by common driving forces, such as population and overall fire and police expenditures. We explored the relationship further using multivariate regressions, controlling for the same demographic variables considered in the last section (these regressions are not reported). We find that a significant positive correlation remains between technology adoption and training in 1992, while the correlation stays positive but becomes insignificant in the 1995 cross-section. Taken together, these results are consistent with the hypothesis that E911 technology increases the returns to skill and training. Of course, an instrumental variables analysis using a larger dataset might be more definitive.

Conclusion

Emergency call centers (and telephone customer service centers more generally) provide a rich empirical setting in which to gain additional insight into both the determinants of adoption of human resource practices and technology, and the effects of adoption on service sector productivity. Our results about adoption suggest that advances in IT have coincided with increases in training, in particular in the use of cognitively demanding training programs such as EMD. However, direct measurement of the effects of these practices on productivity awaits future research.

References

Athey, Susan and Scott Stern. 1998a. “The Adoption and Impact of Advanced Emergency Response Services.” NBER Working Paper Number 6595.

Athey, Susan and Scott Stern. 1998b. “An Empirical Framework for Testing Theories About Complementarity in Organizational Design.” NBER Working Paper Number 6600.

Pivetta, Sue. 1995. *The 911 Puzzle: Putting All of the Pieces Together*. Cleveland, OH: National Emergency Number Association.