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EARTHQUAKE VULNERABILITY AND EMERGENCY
PREPAREDNESS AMONG BUSINESSES IN
MEMPHIS/SHELBY COUNTY, TENNESSEE

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Introduction

To be effective, earthquake loss reduction policies must be based on an understanding of the range of impacts earthquakes produce. These impacts include not only deaths, injuries, and direct physical damage to the built environment, but also indirect impacts, including losses resulting from the economic disruption earthquakes engender. To anticipate and mitigate negative economic consequences resulting from earthquakes, it is important to understand how earthquakes affect both overall economic activity and different sectors of the economy. One approach to estimating such impacts is to obtain data on how earthquakes are likely to affect business operations.

Despite the obvious economic and social importance of businesses, until recently there has been little systematic research on this topic. Existing studies do document the fact that disasters can seriously damage commercial districts, disrupt consumer shopping patterns, production, and other economic activity, placing severe burdens on entire communities. The downtown business district of Xenia, Ohio, for example, was devastated by a tornado in 1974. Coalinga, California virtually lost its downtown shopping area in the 1983 earthquake; in 1989, the Loma Prieta earthquake seriously damaged the downtown business

districts of Santa Cruz and Watsonville. The potential for negative economic impacts is clear in such cases. When business district damage is extensive, communities are forced to deal with numerous problems during the recovery period, including potential declines in property and sales tax revenues, threats to long-term business district viability, the potential loss of important businesses, concerns that customers will go elsewhere for goods and services, and the need to undertake complex reconstruction and redevelopment projects. Disaster-related business closures can put people out of work and make it difficult for community residents to obtain the goods and services they need.

Experiencing a disaster can also have consequences for individual businesses. Disasters typically cause business interruption, either through direct damage to business properties or through the disruption of lifeline services; being forced to shut down for even a short period of time can generate large losses for some businesses. Businesses that are destroyed or damaged in a disaster must bear the costs associated with reconstruction; those that are forced to relocate may not be as successful in their new locations. The kinds of government grants that are made available to homeowners suffering disaster losses, such as the Federal Emergency Management Agency's Individual and Family Grant Program, are not available to businesses. The principal governmentally-sponsored recovery program for businesses, operated by the Small Business Administration, is a loan program, and

businesses that use the program are forced to take on additional debt.

The small but growing literature on disasters and businesses suggests that disasters have differential effects on different types of businesses; while some may be relatively unaffected or even better off after experiencing a disaster, others may decline. Durkin's work (1984) on businesses that were affected by the 1983 Coalinga earthquake, for example, suggests that businesses that are only marginally profitable, that lease rather than own their business space, that are heavily dependent on foot traffic, and that lose expensive inventories may fare worse than other businesses in the aftermath of a disaster.

Kroll et al. (1991), in their study of the impact of the Loma Prieta earthquake on small businesses in Oakland and Santa Cruz, found that businesses in the trade and service sector were most vulnerable to disruption in that event, and that smaller firms suffered proportionately greater losses than larger ones. Some businesses, such as those involved in construction, reported being better off following the earthquake. Alesch et al. (1993) argue that small businesses suffer disproportionately following disasters, for several reasons. They typically have lower financial reserves to draw upon, and they tend to operate in single locations, so that serious damage can put them completely out of business. Small businesses tend to be less concerned about risk management than larger businesses; they are less likely to be

insured, and they have less money to invest in mitigation and preparedness.

Gordon et al. (1995), who studied the business impacts of the Northridge earthquake, found that 80% of the businesses in their sample experienced some degree of earthquake-related business interruption. They estimated the aggregate business losses incurred in that event to be just under \$6 billion; their analyses indicate that business interruption losses accounted for approximately 23% of the total dollar losses resulting from the earthquake.

Other studies suggest businesses differ in the access they have to certain recovery resources. Dahlhamer (1992), in an analysis of the loan decision-making process for 309 businesses in four Southern California communities that were affected by the Whittier Narrows earthquake, found that proprietor characteristics, business characteristics, and community location were associated with the ability to obtain SBA assistance, as well as with the loan terms offered. Dahlhamer's data indicate that the SBA uses standards similar to those of commercial lenders in making decisions about whether to grant loans and what interest rates to charge, and that certain types of businesses may be at a disadvantage in attempting to obtain SBA funds.

The Disaster Research Center has recently begun carrying out studies that are designed to shed light on business vulnerability to disasters, how disaster-related damage and disruption affect business operations, and business mitigation and preparedness

practices. Following the devastating floods that struck the Midwest in 1993, DRC studied the ways in which flooding and flood-induced lifeline service interruptions affected the operations of businesses in Des Moines and Polk County, which were hard-hit by the flooding. That study found that approximately 40% of the businesses surveyed were forced to close down for at least some time during the flooding. Rates of business closure were highest for large manufacturing and construction firms and large companies offering business and professional services. Only about 20% of the businesses that closed did so because of actual physical flooding of the property. More frequently, they couldn't do business because of loss of water, electricity, sewer and waste water services, and because customers and employees lost access to the business. Compared with flood damage, the loss of critical lifeline services was a much more important cause of business closure, affecting a significantly larger number of businesses.

The floods appear to have had slight but discernable impacts, both positive and negative, on businesses in Des Moines. Approximately one year after the floods, 70% of the businesses had recovered to pre-disaster levels, 18% were better off, and 12% were worse off than just prior to the flooding. (For more detailed discussions of the Des Moines survey, see Tierney, Nigg, and Dahlhamer, forthcoming, and Tierney, 1995).

A similar DRC study on businesses in Los Angeles and Santa Monica, California after the 1994 Northridge earthquake found that physical damage and lifeline service loss were widespread in the

impact area. Just over half (56%) of businesses in the two study communities were directly damaged by the earthquake, 61% lost electricity, and 54% lost phone service for some period of time, although lifeline service interruption following the earthquake was less extensive and lengthy than lifeline disruption in the Midwest floods. Of the businesses surveyed, 56% closed for some period of time as a result of the earthquake. In general, small businesses were more likely to close than larger ones. The most common reasons why businesses closed were the need to clean up damage, loss of electricity, the inability of employees to come to work, loss of phone service, and damage at owners' homes that took precedence over damage at the business.

At the time the survey was conducted, approximately 18 months after the earthquake, about half of the businesses surveyed rated their well-being as comparable to what it had been before the earthquake. One-fourth of the businesses reported being better off; both small and large firms in the manufacturing and construction sector were particularly likely to report that business had improved. A comparable proportion of businesses had fared worse since the earthquake; businesses in the wholesale and retail trade and service sectors, small businesses in general, and businesses that had been physically damaged in the earthquake appear to be more likely to report being worse off (for additional data from the Northridge survey, see Tierney, 1995).

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The Memphis/Shelby County Business Survey

In 1993, as part of NCEER's coordinated Memphis/Shelby County risk assessment project, DRC conducted a study on earthquake hazard awareness, perceived vulnerability to earthquake-induced lifeline service interruption, and disaster preparedness among proprietors of a representative sample of businesses in Memphis and Shelby County, Tennessee. In the first stage of the sampling design, the 27,197 businesses in Shelby County were aggregated by Standard Industrial Codes (SIC) into five business sectors: wholesale and retail sales; manufacturing, construction, and contracting; business and professional services; finance, insurance, and real estate (F.I.R.E.); and other businesses (agriculture, forestry, and fishing; mining; transportation, communication, and public utilities). In the second stage of the design, small (those with less than twenty employees) and large (those with twenty employees or more) businesses were randomly selected within each of the five sectors.

The survey instrument developed for the study was an 11-page mail questionnaire containing items on business characteristics; owners' perceptions of the short- and longer-term risk of earthquakes in the Memphis area; ratings on the extent to which businesses rely on various lifeline services, along with assessments of the length of time businesses could operate without those services; and questions on the extent to which businesses had undertaken mitigation and preparedness measures to contain and manage disaster-related damage and disruption.

A total of 1,840 businesses were randomly selected to participate in the study. Following a modified version of Dillman's (1978) "total design method," an initial mailing was sent to those businesses in early June, 1993. Survey participants who did not respond within three weeks were sent a reminder postcard, which was followed one month later by a second mailing of the questionnaire to non-respondents. Follow-up phone calls, timed to coincide with the second mailing, were made to businesses that had not yet replied to the survey. A total of 737 questionnaires were received, for a 40% response rate, which was adequate for undertaking the necessary statistical analyses.

Table 1 contains general information on the businesses in the Memphis/Shelby County sample. At the time of the survey, the median age of the businesses was 14 years. Slightly over two-thirds were individual firms, and 63% leased, rather than owned, the business property. The study methodology was designed to target large as well as small firms, and the mean number of employees for businesses in the sample was 60. However, the median business size was six employees, indicating that the small businesses in the sample were generally very small.

This chapter discusses survey findings on business vulnerability to earthquake-induced disruption and on business mitigation and preparedness activity. To begin addressing questions of differential business vulnerability, sectoral and size differences are emphasized in the discussion.

Business Vulnerability

The survey attempted to assess business vulnerability to earthquake-related damage and disruption in several ways. First, to gain a general idea of business vulnerability to physical damage, we obtained information on the types of buildings in which businesses of different types are located. Second, we asked a series of questions designed to assess business dependency on major lifeline services and the ways in which lifeline service loss would affect business operations. Third, we obtained estimates from business owners on how long they could afford to be shut down without incurring financial losses. Finally, we asked business owners to provide their subjective ratings of the likelihood of future earthquakes and their probable consequences.

Building Type and Business Location. The relationship between the degree of structural damage a building sustains and post-earthquake business functionality is not linear. Obviously, if a building collapses completely or even partially in an earthquake, the businesses it houses are also likely to incur very severe damage and loss of functionality. However, the obverse is not the case: even if a building survives an earthquake with minor or no structural damage, businesses can still suffer severe losses due to nonstructural damage, damage to contents and inventory, lifeline service interruption, or other causes. As the Des Moines case discussed above indicates, lifeline loss alone is sufficient to render businesses inoperable, even without physical damage. Thus care should be taken in attempting to make inferences about business impacts on the basis of data on building types.

Nevertheless, it is safe to assume that other things being equal, businesses that are located in hazardous types of buildings, such as unreinforced masonry buildings, generally face higher risks because of the danger of building collapse and serious structural damage. This assumption seems particularly valid for Memphis, since the community has adopted no provisions for retrofitting these types of structures.

Survey respondents were asked to provide information on the type of building housing their businesses. The building types listed in the survey included wood frame or wood and stucco, brick, concrete and steel, and concrete block. Respondents were given the opportunity to specify the type of building in which their businesses were located if none of the above categories were applicable, and several owners did list alternatives to those provided in the survey. In order to assess the extent to which different types of businesses were housed in more-hazardous structures (Table 2), building type was recoded into "brick" and "other."

In all, 24% of the businesses in the sample reported being located in brick buildings. Small service firms (33%) were the most likely to be housed in brick structures, followed by small businesses in the F.I.R.E. (31%) and manufacturing and construction sectors (30%). While 21% of the small wholesale and retail trade businesses were housed in brick buildings, only 5% of the large businesses in this sector were located in those types of structures.

A t-test was performed to determine the relationship between business size and location in brick structures. Results indicated that small businesses are significantly more likely to be housed in those structures than their larger counterparts. In contrast, no significant relationships were found between economic sector and the building types in which businesses were located. It thus appears that small businesses, regardless of business type, are disproportionately located in buildings that have a higher probability of collapsing or sustaining severe structural damage in an earthquake.¹

Lifeline Dependency. Survey respondents were asked to rate the importance of five lifeline services--electricity, water, natural gas, sewers and wastewater treatment, and telephone services--to their ability to do business. A four-point scale, ranging from "Very important" to "Not important at all" was used.

Table 3 summarizes those importance assessments. A large majority of business respondents rated electrical and telephone services as very important to their operations (82% and 78%, respectively), and only a very small number rated these lifelines as unimportant. Water, wastewater treatment, and natural gas were also seen as important by Memphis businesses, but by a much less substantial margin.

¹ Since building type information was obtained from survey respondents, it may not be entirely accurate. Ideally, this information should be checked against less-biased sources, such as tax assessors' records. Such analyses were beyond the scope of the project discussed here.

Next, we looked for size and sectoral variations in the need for electricity and telephones, the two most critical lifeline services (see Table 4). Large businesses in the F.I.R.E. sector assigned the highest importance ratings to electricity; in fact, there were no businesses in this group that did not consider electricity very important. In general, large businesses were more likely than small businesses to consider electricity very important for their operations; small service-oriented businesses, 89% of which considered electricity very important, are an exception to this pattern.

Just over three-quarters of the businesses in the sample considered telephone service to be very important to their business activities. This lifeline was rated as highest in importance by large businesses in the "other" category; small businesses in that category and in the F.I.R.E. sector also tended to see phones as crucial for their ability to do business (Table 5).

A related question in the survey asked how long businesses could stay in operation if they lost any of the five lifeline services. Again, electricity was considered by respondents to be most critical for their ability to do business, with 59% reporting that loss of electrical power would cause them to shut down immediately. Telephone services were also seen as crucial for staying in business; the median length of time business owners said they could operate without phones was four hours. Business owners believed they could stay open longer (about two days) without water

or wastewater services and reported being least dependent on natural gas (see Table 6).

In a related analysis, Nigg (1995a, 1995b) tested for size and sectoral differences in lifeline dependence. Her findings indicate that business size and sector are unrelated to reliance on electrical power; businesses universally consider this service critical. Some variation was found in the criticality of phone service, with small businesses in the wholesale and retail trade sector indicating they could stay open longer than other businesses if phone service were lost. Small businesses considered themselves significantly less dependent on water service than their larger counterparts, and service-oriented businesses reported greater reliance on sewer and wastewater treatment services.

These data provide a basis for ranking lifeline services in terms of their importance for continued business activity. By both criteria discussed above--assessed importance and the estimated impact of service loss--electrical power and telephone service are viewed as most crucial by business owners. A large proportion of business owners could not envision remaining open for any appreciable period of time without those services. An earthquake that caused extensive damage to electrical and telephone transmission or distribution systems serving the Memphis area would thus have an immediate and substantial negative impact on economic activity.

The survey results also show that businesses generally cannot tolerate loss of water or wastewater treatment service lasting

longer than about two days; after that time, businesses would begin being forced to close. Since restoration times for these lifelines could be lengthy following a major earthquake in the New Madrid area, their loss could also have major negative economic effects.

Perceptions of the Earthquake Threat. To assess the extent to which earthquakes were perceived as a problem, respondents were asked to rate the probability of a damaging earthquake striking the Memphis/Shelby County area within the next year, the next ten years, and the next thirty years, using a four-point scale. As Table 7 indicates, owners generally did not believe a damaging earthquake to be likely within the coming year; although about one-fifth of the sample viewed such an event as likely or very likely, the overwhelming majority rated such an event as not very likely or not likely at all. However, perceptions of the risk began to shift as longer time-frames were considered. The sample was about evenly split between respondents who thought a damaging earthquake was likely or very likely in the next ten years and those who didn't think an earthquake was probable. The proportion of those considering an earthquake likely or very likely rose further, to about 70%, for the thirty-year time window. Based on these data, it appears that business proprietors were moderately concerned about the earthquake hazard in the Memphis area. While they didn't consider the threat immanent--i.e., something that could occur within the next year--they did assess the probability of a damaging earthquake in the next one to three decades as relatively high. Subsequent analyses indicated that these risk perceptions were not

related either to business size or business type.

Business Preparedness

Adoption of Preparedness Measures. One of the main objectives of the survey was to assess the extent to which businesses were engaging in activities designed to reduce losses and enhance emergency response capability in the event of an earthquake. Respondents were asked to fill out a mitigation and preparedness checklist containing both general emergency preparedness and earthquake-specific items; included in the list were activities such as having the building structurally assessed, providing emergency training for employees, bracing shelves and other equipment, stockpiling first aid kits and emergency supplies, having backup power, and having a business recovery plan. Table 8 summarizes business owners' reports on the extent to which they had implemented these measures at their businesses. The more frequently-adopted measures were those geared toward general preparedness, rather than those that are earthquake-specific. For example, over half the businesses in the sample had obtained first aid kits or extra medical supplies (60%) and had learned first aid (51%). A moderate proportion of the businesses surveyed had stored extra office supplies (30%) and fuel or batteries (22%) for use in the event of an earthquake. A comparable percentage had purchased business interruption insurance (30%). Activities undertaken by only a small fraction of the businesses in the sample include holding earthquake training programs for employees (11%), having the business property assessed for structural safety (11%),

conducting earthquake drills or exercises (9%), and making arrangements to move the business to an alternative location in the event of a damaging earthquake (9%).

Interestingly, a sizeable percentage of businesses in the sample had purchased earthquake insurance (41%) and attended meetings or received written information on earthquake preparedness (40%). These relatively high levels of information-gathering and insurance coverage can probably be explained in part by increases in awareness of the earthquake threat in the Central U. S. resulting from the 1990 Iben Browning earthquake prediction. During the late summer and fall of that year, the entire New Madrid region was bombarded with earthquake-related information; numerous organizations, including the Central U. S. Earthquake Consortium (CUSEC), the Red Cross, and the Federal Emergency Management Agency, conducted preparedness campaigns in Memphis and other Central U. S. communities. A DRC survey conducted in Memphis and Shelby County in the fall of 1990, just prior to the December 3 "prediction" date, revealed that community residents had been extensively involved in seeking and sharing information about earthquakes (Tierney, 1994). This concern evidently carried over into their business-related activities.

While the number of businesses that engaged in a few of the preparedness measures listed was relatively large, overall the business community in Memphis/Shelby County is not well-prepared for earthquakes. Only two of the seventeen activities on the checklist--obtaining a first aid kit and learning first aid--had

been carried out by more than half of the firms in the sample; the mean number of preparedness activities undertaken by businesses was four, and the median was three. Fifteen percent of the sample had not engaged in even one of the preparedness activities listed, and an additional 10% had engaged in only one. These data suggest that while business owners in the Memphis/Shelby County area clearly know about the earthquake hazard and consider earthquakes a problem, they are actually doing little to prepare for a future damaging earthquake.

Explaining Business Preparedness. To identify factors associated with business willingness to prepare for earthquakes and other disasters, we tested several models; the one discussed here expands a model developed and analyzed earlier by Dahlhamer and D'Souza (forthcoming). Included in the model are: (1) business characteristics, specifically the age of the business, whether the business is an individual firm or a franchise or part of a chain, whether the business property is owned or leased, business size (i.e., the number of full-time employees), the financial condition of the business, as assessed by the business owner, and business sector; (2) owners' perceptions of the likelihood of a future damaging earthquake; (3) an index of owners' assessments of the importance of four lifeline services (electricity, telephones, water, and sewer and wastewater) for business operations²; and (4) previous disaster experience. The dependent variable in the

²Assessments of the importance of natural gas were not included in the index since only one-third of the businesses in the sample reported using this lifeline service.

analysis, business preparedness, consisted of an index of the 17 preparedness items listed in Table 8.

A regression analysis was employed to determine the extent to which the model predicted business disaster preparedness. As shown in Table 9, the overall model was a significant predictor of preparedness ($F=11.4901$). The adjusted R^2 is .1931, indicating that approximately 19% of the variance in business disaster preparedness was explained by the model.

Four of the model variables were significantly related to business disaster preparedness. Business size was by far the strongest predictor of preparedness levels; larger businesses were significantly more likely to engage in preparedness activities than their smaller counterparts. This is consistent with previous research on business disaster preparedness (Drabek, 1991, 1994a, 1994b; Quarantelli et al., 1979). Size may be indicative of overall business prosperity³, or may make it more likely that a firm will have resources to support preparedness activity. Conversely, smaller firms may simply lack the resources or staff to devote to preparedness activities. Mileti and associates (1993), for example, have highlighted the importance of having staff members with preparedness activities as part of their jobs.

A second business characteristic that was strongly related to disaster preparedness was whether the business property was owned

³ Prosperity alone is not sufficient to stimulate preparedness, however; in the current model, business financial condition was found to be unrelated to preparedness levels.

or leased. Property owners were significantly more likely than lessees to engage in preparedness activities. The finding that property owners are more committed to preparedness than renters is consistent with research on household preparedness (Turner, Nigg, and Paz, 1986). In comparison to renters, owners of buildings may see themselves as having more to lose in the event of a disaster. Owners may also have access to more financial resources than renters for undertaking preparedness activities. Finally, owners of property have access to a wider range of preparedness activities; for example, they can have an engineer structurally assess the building housing the business, while renters would be highly unlikely to do so.

Business type is the final business characteristic that was significantly related to preparedness. Businesses in the F.I.R.E. sector were significantly more likely to engage in preparedness activities than other businesses. Although our survey can't directly shed light on why is the case, the higher levels of preparedness among F.I.R.E. businesses may be related to specific outreach efforts that have targeted this sector. For example, the Central United States Earthquake Consortium (CUSEC), which is located in Memphis, has played a significant role in emphasizing the importance of disaster preparedness among businesses and has paid considerable attention to potential impacts on the F.I.R.E. sector. The finding that business type is an important predictor of preparedness is consistent with earlier research on business disaster preparedness (Drabek, 1991, 1995; Mileti et al., 1993).

Finally, risk perception, that is, proprietors' beliefs about the likelihood of a future damaging earthquake, was also significantly related to preparedness. Owners who perceived the likelihood of a future damaging earthquake to be high were significantly more likely to engage in preparedness activities than owners/managers who were less concerned about the earthquake problem.

The variables in the model that were found to be unrelated to business preparedness were the age of the business, owners' ratings of the importance of utilities for business operations, the company's status as an individual firm or a franchise, owners' assessments of the financial condition of the business, and previous disaster experience. The finding regarding disaster experience is surprising, since other studies (e.g., Drabek 1994a, 1994b; Miletic, et al., 1993) have found that businesses that have gone through one or more disasters are more likely to prepare.

Concluding Comments

Memphis businesses are clearly vulnerable to earthquake-induced disruption; this vulnerability stems in part from the types of buildings in which they are housed and from their dependence on lifeline services that are susceptible to earthquake damage. Nearly one-fourth of the businesses surveyed are located in masonry buildings; this pattern alone suggests high levels of exposure to potential earthquake damage. Business operations are critically dependent on electrical power; more than half the businesses in the survey indicated that they would be forced to shut down immediately

if they were to lose electricity. Telephone service is also viewed as extremely important by Memphis firms; the loss of this service would also be felt immediately by business operators. Although services such as water and wastewater treatment are considered somewhat less important, the loss of those services would have a detrimental impact within a relatively short period of time--approximately 48 hours. A major New Madrid earthquake has the potential for causing extensive lifeline service disruption in the Memphis area. Our data indicate that such disruption would almost immediately result in significant business losses. This type of information on business vulnerability should prove useful for the more comprehensive vulnerability assessments that are being undertaken by NCEER's Loss Estimation of Memphis Buildings (LAMB) Project.

Business owners in the Memphis area are aware of the earthquake problem, and while they do not see the threat of a damaging earthquake as immanent, they do consider the potential for such an event over the next three decades to be significant. This moderately high level of concern is probably attributable in part to the heightened public curiosity and large-scale public awareness and education campaigns that resulted from the 1990 Iben Browning New Madrid prediction scare. The data also show that awareness of the earthquake problem is important for explaining actions taken with respect to the hazard. Consistent with the disaster literature, hazard awareness alone wasn't sufficient to explain preparedness. However, the data do indicate that the belief in the

probability of a future damaging earthquake is high among those who are willing to engage in preparedness activities.

Despite moderately high risk perceptions, Memphis businesses generally have not been enthusiastic about adopting hazard mitigation and preparedness measures. While some businesses show a slight inclination to prepare by taking one or two minimal steps, such as keeping first aid supplies on hand or having employees learn first aid, they are highly unlikely to engage in more comprehensive preparedness efforts.

The survey data also point to factors that are associated both with earthquake vulnerability and with levels of preparedness among Memphis businesses. Business size is one such factor. Small businesses, for example, are more likely than their larger counterparts to be located in masonry buildings, the kinds of structures that are particularly vulnerable to major earthquake damage. At the same time, small businesses are less likely than large ones to undertake preparedness activities. Our findings regarding the importance of size are consistent with other studies in the literature, as well as with preliminary findings from DRC's recent study on the Northridge earthquake (Tierney, 1995), which suggest that small businesses were especially vulnerable to disaster-related losses and disruption in that event. Sector also turned out to be important for preparedness in Memphis, where we found that firms in the F.I.R.E. sector were most likely to have taken steps to prepare for earthquakes and other disasters. Owners of business properties were more likely to adopt preparedness

measures than renters, indicating that building ownership creates additional incentives for loss reduction.

The Memphis data suggest that the current approach to encouraging earthquake and general disaster preparedness among businesses, which emphasizes public awareness and education, is achieving little. Our survey respondents were aware of the earthquake problem, but for most business owners that awareness did not translate into action. If more widespread adoption of loss reduction measures is the desired goal, it will be necessary to develop a new strategy that makes undertaking such measures attractive to and affordable for the business community.

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TABLE 1
BUSINESS CHARACTERISTICS

Median Length of Time in Business	14 Years
Individual Firm	69%
Franchise/Chain	31%
Own Space	37%
Lease Space	63%
Number of Employees	
Mean	60
Median	6

TABLE 2

**PERCENT OF BUSINESSES IN BRICK VERSUS "OTHER"
BUILDINGS BY TYPE AND SIZE OF BUSINESS**

TYPE AND SIZE OF BUSINESS	BRICK	OTHER
<u>Wholesale and Retail Trade:</u>		
Small (N=141)	20.6%	79.4
Large (N=38)	5.3	94.7
<u>Manufacturing and Construction:</u>		
Small (N=67)	29.9	70.1
Large (N=30)	16.7	83.3
<u>Business and Professional Services:</u>		
Small (N=153)	33.3	66.7
Large (N=55)	21.8	78.2
<u>Finance, Insurance, and Real Estate:</u>		
Small (N=75)	30.7	69.3
Large (N=22)	13.6	86.4
<u>Other:</u>		
Small (N=69)	26.1	73.9
Large (N=34)	8.8	91.2
<u>All Businesses (N=696)</u>	24.3	75.7

TABLE 3
IMPORTANCE OF UTILITIES TO BUSINESS OPERATIONS

UTILITY	VERY IMP.	IMP.	NOT VERY IMP.	NOT IMP. AT ALL
Electricity	82.1%	14.3	3.3	0.3
Water	27.1	33.4	31.3	8.2
Natural Gas*	18.4	28.7	39.5	13.4
Wastewater Treatment	22.6	31.6	32.6	13.3
Telephone	77.8	17.5	3.2	1.5

* Asked only of businesses using natural gas.

TABLE 4

IMPORTANCE OF ELECTRICITY BY TYPE AND SIZE OF BUSINESS

TYPE AND SIZE OF BUSINESS	VERY IMP.	IMP.	NOT VERY IMP.	NOT IMP. AT ALL
<u>Wholesale and Retail Trade:</u>				
Small (N=148)	79.7%	15.5	4.7	0.0
Large (N=41)	87.8	12.2	0.0	0.0
<u>Manufacturing and Construction:</u>				
Small (N=71)	73.2	19.7	4.2	2.8
Large (N=29)	86.2	13.8	0.0	0.0
<u>Business and Professional Services:</u>				
Small (N=152)	88.8	8.6	2.6	0.0
Large (N=56)	83.9	16.1	0.0	0.0
<u>Finance, Insurance, and Real Estate:</u>				
Small (N=79)	82.3	13.9	3.8	0.0
Large (N=24)	100.0	0.0	0.0	0.0
<u>Other:</u>				
Small (N=70)	67.1	25.7	7.1	0.0
Large (N=30)	76.7	16.7	6.7	0.0
<u>All Businesses (N=722):</u>	82.1	14.3	3.3	0.3

TABLE 5

IMPORTANCE OF TELEPHONES BY TYPE AND SIZE OF BUSINESS

TYPE AND SIZE OF BUSINESS	VERY IMP.	IMP.	NOT VERY IMP.	NOT IMP. AT ALL
<u>Wholesale and Retail Trade:</u>				
Small (N=148)	77.0%	16.2	4.1	2.7
Large (N=41)	75.6	14.6	7.3	2.4
<u>Manufacturing and Construction:</u>				
Small (N=70)	75.7	20.0	1.4	2.9
Large (N=29)	75.9	20.7	0.0	3.4
<u>Business and Professional Services:</u>				
Small (N=152)	78.3	16.4	4.6	.7
Large (N=56)	71.4	23.2	3.6	1.8
<u>Finance, Insurance, and Real Estate:</u>				
Small (N=79)	83.5	16.5	0.0	0.0
Large (N=21)	75.0	20.8	4.2	0.0
<u>Other:</u>				
Small (N=70)	80.0	18.6	1.4	0.0
Large (N=30)	90.0	10.0	0.0	0.0
<u>All Businesses (N=721):</u>	77.8	17.5	3.2	1.5

TABLE 6

**MEDIAN NUMBER OF HOURS BUSINESSES COULD
OPERATE WITH LIFELINE LOSS**

LIFELINE SERVICE	MEDIAN NUMBER OF HOURS
Electricity	0
Water	48
Natural Gas	120
Wastewater Treatment	48
Telephones	4

TABLE 7
PERCEIVED EARTHQUAKE PROBABILITIES

	VERY LIKELY	LIKELY	NOT VERY LIKELY	NOT LIKELY AT ALL
30 Years	25.7%	44.4	26.3	3.6
10 Years	9.5	42.7	41.3	6.4
1 Year	1.7	18.6	54.3	25.5

TABLE 8
BUSINESS PREPAREDNESS ACTIVITIES

PREPAREDNESS ACTIVITY	HAVE DONE
Obtained a First Aid Kit	60%
Learned First Aid	51
Purchased Earthquake Insurance	41
Attended Meetings or Received Written Information	40
Stored Office Supplies	34
Talked With Employees About What to Do in Earthquake	30
Purchased Business Interruption Insurance	30
Stored Fuel or Batteries	22
Developed a Business Emergency Plan	22
Braced Shelves and Equipment	17
Obtained an Emergency Generator	15
Stored Food or Water	14
Developed a Business Recovery Plan	13
Held Earthquake Training Programs for Employees	11
Had Engineer Assess Structural Safety of Building	11
Made Arrangements to Relocate Business in Case of an Earthquake	9
Conducted Earthquake Drills or Exercises with Employees	9

TABLE 9
REGRESSION COEFFICIENTS AND STANDARD ERRORS FOR
INDEPENDENT VARIABLES ON BUSINESS PREPAREDNESS

INDEPENDENT VARIABLES	STANDARD ERRORS	UNSTANDARDIZED COEFFICIENTS	STANDARDIZED COEFFICIENTS
<u>Business Characteristics:</u>			
Age of Business	.0768	.0901	.0504
Individual Firm or Franchise	.3202	-.3716	-.0486
Own or Lease	.3059	1.0763	.1486***
Number of Full- Time Employees	.1106	.5400	.2265***
Financial Condition	.1826	.1898	.0433
Wholesale/Retail	.4274	-.4129	-.0537
Manufacturing/ Construction	.5167	-.2121	-.0206
Business/ Professional Services	.4355	.3309	.0432
Finance/Insurance/ Real Estate	.5377	1.6370	.1508**
<u>Risk Perception:</u>			
Likelihood of Earthquake	.3421	1.5364	.1803***
<u>Utility Importance:</u>			
Utility Importance	.0762	.1472	.0816
<u>Disaster Experience:</u>			
Previous Disaster Experience	.4465	.7721	.0701
R ²			.2115
Adjusted R ²			.1931
F-Value			11.4901***

* $p \leq .05$

** $p \leq .01$

*** $p \leq .001$