



Security officers responding to residential fire alarms: Estimating the effect on survival and property damage

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ABSTRACT

Decreasing the response time to residential fires leads to more people being saved, fewer injuries, less property damage and a lesser environmental impact. One way of reducing the response time to fires is to allow the municipal fire and rescue services to cooperate with other actors. This study evaluates a potential agreement between the fire and rescue service of a Swedish municipality (Helsingborg) and a private security officers' firm. A geographic information system (GIS) simulation is used to estimate the reduced response times. The result is combined with a statistically estimated measure of the risk of fatality for marginal changes in the response time to find the effect on survival rates and property damage. The results show that the response time is 52 s on average faster using security officers for residential fires. Combining this gain in response time with the relation to fatalities and adjusting for the fact that security officers are less effective imply a decreased death rate by 0.0105 or 1.3% per year. The project has positive economic effects with the benefits estimated to be 1.4 (saved lives) and respectively 2.3 (saved lives and property damage) times higher than the costs.

1. Introduction

Decreasing the response time to fires leads to more people being saved, fewer injuries, less property damage and a smaller environmental impact. However, once organized, the fire and rescue services' (FRS) response time is often given, since the location of the fire stations and personnel are quite fixed. One way to reduce the response time is to use more flexible organizations. In Sweden this has been tested using smaller units with one or two firemen in their own emergency vehicle and a shorter reaction time. Another way to influence the response time is to use other resources that are 'on the road'. If these resources receive an alarm, they may reach the fire incident site faster. These resources could be public resources such as home health care units or public caretakers. Another possibility is to collaborate with private units on the road, such as security officers or chimney sweepers.

In general the emergency response time can be reduced by using volunteer groups, co-location of response organizations and cooperative use of resources [1]. Besides the reduction in response time, it has been proposed that new collaborations in the emergency response system (ERS) can be motivated as compensation for scarce resources [2]. Only a few evaluations of cooperation have been undertaken in relation to fire services. Weinholt et al. [3] showed that collaborations can be both

socially beneficial (security officers) and not socially beneficial (home care nurses). There are more examples using the fire and rescue services with a faster response time than ambulances and other medical services, for example for cardiac arrests [4–8]. When reviewing the operation research literature on where to locate fire stations and how to dispatch fire crews optimally regarding frequent incidents, we did not find any study taking collaboration into account [cf. 9–11]. Wex et al. [12] presents a decision support model to help coordinating rescue units during natural disasters and finds that the model is superior to the best practice in reducing harm.

The purpose of this study is to evaluate a potential agreement by the FRS of Helsingborg, Sweden, and a private security officers' firm. The agreement implies that the security officers would be alerted to residential fires to make a faster response. To estimate the effect on survival rates and property damage, we use geographic information system (GIS) simulation to estimate the marginal changes in the time to emergency work starting. We combine these results with data on the relation between response time and fatalities as well as the relation between response time and property damage. Finally we summarize the effects in an economic evaluation of the costs and benefits of the intervention. Economic evaluations can help to make rational decisions about the organization of emergency response systems by valuing the benefits and

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costs resulting from an intervention.

There are three motivations behind the study. The first is to show methodologically how the results from a GIS simulation with more people reached can be combined with statistical estimates from a logistic regression on the risk of fatality for marginal changes in the response time. The second is to evaluate the effectiveness of using security officers when it comes to reducing the response time for fires in residential homes. The third is to combine the effect with the costs in an economic cost–benefit analysis.

1.1. Related literature

The majority of the literature regarding the application of GIS in the FRS sector concerns visualization and analyses of various factors regarding specific risks, for example social, economic or structural factors relating to the risk of residential fires [13,14]. The aim of analysing variations in time and space is mainly to support preventive measures, but in some cases the result can also support emergency preparation [15,16]. Rohde et al. [17] found that the risk of residential fires in Australia varies from 2 fires per year to 25 fires per year in different areas, which may have a bearing on both how the FRS (and others) focuses on preventive measures and the emergency handling organization (e.g. the location of fire stations, material and personnel). Parallels to the development of GIS to support the work of the police in combating crime can be drawn [17,18]. Fires as well as crimes have a clear temporal and spatial variation. In a comparison of residential burglaries and residential fires, it was found that the spatial positions for these two events largely overlap, while the timing is different [18,19]. Wuschke et al. [18] claimed that the police has managed to interpret this variation successfully in its preventive work, for example by indicating ‘hot spots’, while the geodata about residential fires is deemed to be largely untapped by FRSs.

Sund [20] combined GIS simulation of driving times with register data on survival rates from out-of-hospital cardiac arrests (OHCA) in the area of Stockholm. In that case the emergency resources comprised an ambulance alone and an ambulance plus fire services. The simulation model predicted a baseline survival rate of 3.9% after an OHCA, and adding the fire services as first responders (dual dispatch) increased the survival rate to 6.2%. The simulation was also validated using empirical data from a ‘real’ project.

Weinholt et al. [3] analysed the effects of using security officers for fire response in a small municipality in Sweden (Söderköping). They found that, out of 60 alarms, the security officers turned up first in 34 cases. In 7 of these, the security officers were able to suppress the fire on their own. For 2 of these fires, there was a risk of the fire spreading and causing damage. Comparing the estimated benefit from the collaboration with the costs, the economic evaluation indicated that the action was socially beneficial.

The effect of the time factor for fire and rescue services was studied by Jaldell [21,22]. Jaldell [21] estimated the importance of the time factor for FRSs in Sweden, measured in monetary units. He studied and aggregated all types of responses: fires in building, fires not in buildings, traffic accidents, drowning accidents, storms, flooding and so on. The importance of the time factor is calculated by adding the value saved when the rescue services arrive earlier or the value lost through later arrival at the scene of the incident. The resulting value includes both personal injury (death, severe injury and mild injury) and damage to property (property and the environment). On average, for all types of responses, a decreased response time by 5 min saves SEK 59,000 for every alarm. The time factor is the most important for drowning accidents, fires in buildings and traffic accidents. Jaldell's [21] paper updated the study by Mattsson and Juås [23].

Jaldell [22] estimated the importance of the time factor for FRSs for saving lives in residential homes. Using a logistic regression analysis, he found that the risk of fatality is a non-linear function of the response time. For a given change in the response time, the increase in the risk of fatality is larger for a short response time, then it decreases and eventually

approaches zero. If it was possible to decrease the median response time by 1 min, 0.00035 lives could be saved for every alarm on average. For all alarms in residential homes, that means that about 2 lives, or 3%, could be saved per year. The response time is the most important for blocks of flats, nursing homes and semi-detached/terraced houses. It is more important for fires due to smoking or children playing or fires that are started intentionally.

Jaldell [21] also discussed the effect of using smaller mobile units with so-called first responders instead of the ordinary five-to ten-man crew for fire and rescue units. The advantage is that the first person to arrive at the scene is faster than the normal rescue unit. However, the first person obviously is not able to perform all the actions that an ordinary device does. Jaldell observed four effects. First, since the first person arrives before the rest, it might be possible to perform an orientation and assessment of the situation. If the first person is a fire officer, he or she can directly make decisions and give orders on this basis. For large items up to 5 min' attack time can be saved, but for small ones perhaps only seconds. Second, the first person is able to check that the address is correct and therefore show the main force the right path. This could shorten the response time by perhaps a minute. Third, the first person can directly make his or her own effort. The fourth advantage is that the crew can be sent home earlier if it is not needed. Lång [24] analysed 1150 incident reports for fire and rescue services, in which the first-responder firefighter estimated the proportion of the contribution made by this single unit. The average share of the 1150 incidents was 0.444, while the share for fires in buildings was 0.343. Lång's conclusion was that the economic benefits of using first responders exceeded the economic costs.

2. Method and data

In this section we first describe the characteristics of the municipality of Helsingborg as well as providing some general statistics about residential fires in the region. Section 2.2 presents the model that we use to calculate the level of damage resulting from these fires and the method of estimating the marginal effect of changes in the emergency response system (ERS). The methods and data for the estimation of the effect of security officers responding to residential fires are introduced. Our second model, cost–benefit analysis, is presented in section 2.3 along with the data for the economic evaluation.

2.1. Municipality of Helsingborg

The municipalities are fully responsible for organizing the FRSs in Sweden, either on their own or in collaboration with others. There are 290 municipalities and about 150 FRSs. The FRS studied here is a collaboration between the municipalities of Helsingborg, Ängelholm and Örkelljunga, called Rådningstjänsten Skåne Nordväst. However, this study only considers the geographical area of the municipality of Helsingborg.

Helsingborg is located in the south of Sweden and is the eighth-largest municipality by number of inhabitants (137,909 on 1 January 2016), but in terms of area it is in place 219 of the 290 municipalities (344 sq. km) (data from Statistics Sweden). The FRS in Helsingborg has three full-time and two part-time stations in Helsingborg.¹ In 2015 the FRS was alerted 89 times to residential fires within the municipality [25].² The average number of residential fires over the 10-year period 2006–2015 was 84 alarms, with the highest incidence rate in 2010 of 101 alarms and the lowest rate in 2006 of 65 alarms. This means that there were 0.65 alarms per thousand inhabitants in Helsingborg over the 10-year period. As a

¹ Full-time firefighters are in preparedness at the station all the time, ready to turn out in 90 s. They are full-time staff hired by the fire and rescue service. Part-time firefighters should be prepared to turn out in 5 min. They work or live close to the fire station.

² Excluding holiday cottages.

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