The Quantification of the Reduction of Fire Damage due to Fire Protection Measures

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Abstract

This paper presents the current state of a research project, which evaluates the effectiveness of fire protection measures and elaborates a general statistical basis in Germany (*vfdb fire loss statistic*). The statistical proof of effectiveness relates to system technologies (e.g. fire detection and fire alarm systems, fire extinguishing systems, smoke and heat exhaust systems). Up to now, 29 fire services are supporting the project with 5,016 survey sheets on fire alarms (in the context of buildings), using uniform criteria including 1,216 real fire interventions. Effectiveness is analysed by comparing the damage due to fires with and without fire protection measures. Based on this sample, statistical findings on the fire phenomenon and fire service interventions are detailed and useful for risk analysis.

Keywords: fire statistics, fire losses, fire loss statistics, fire protection system technologies, effectiveness, risk analysis

Introduction

The *vfdb fire loss statistic* [1] is a research project by Department 14 of the German Fire Protection Association e. V. (vfdb). This project evaluates the effectiveness of fire protection measures and elaborates a general statistical basis on fire losses in Germany (cf. [2], [3] and [4]). So far, there has been no comprehensive statistical basis about fire interventions and the fire phenomenon in Germany and no evidence of the statistical effectiveness of fire protection systems (cf. [1], [2] and [5]). The proof of effectiveness relates to fire detection and fire alarm systems (cf. [2], [3], [6] and [7]), fire extinguishing systems, smoke and heat exhaust systems and the type of fire services [1].

Method

Currently, 29 fire services are supporting the *vfdb fire loss statistic* with 5,016 survey sheets on fire alarms in the context of buildings, using uniform criteria including 1,216 real fire interventions [1]. The uniform survey sheet contains 20 survey blocks about the fire service intervention conditions, the fire alarm causes, the development and spread of building fires from the initiation of alarms to the losses incurred as well as the initiated fire protection measures. The survey blocks are shown in table 1.

Table 1. Survey blocks in the uniform survey sheet of the *Fire Loss Statistic* project (see also [2]).

1. general	11. assumed location of fire outbreak
2. fire service status	12. assumed object of fire outbreak
3. building type	13. fire size on arrival of the fire service
4. building use	14. fire limited to (spread)
5. emergency call / notification	15. smoke spread
6. real fire / false alarm	16. smoke layering
7. false alarm trigger	17. usability of the escape route
8. triggered fire protection system	18. human lives saved / fatalities
9. assumed reason of fire causes	19. estimated material damage
10. floor where the fire broke out	20. use of fire fighting water

The intervention data obtained from the received filled-in survey sheets are anonymised and saved to a central database [2]. The assessment of the data is classified in A) individual assessments (with an overview on all data), B) cluster assessments, and C) a total assessment [7].

Results

The assessment A and B of the data delivers statistical information on the fire phenomenon. Two examples are given below in order to exemplify these results. These are the evaluations of the *assumed location of fire outbreak* (example 1) and the *consumption of extinguishing water* (example 2).

Evaluation of the assumed location of fire outbreak

In a general sense, the evaluation of the existing database shows that the kitchen poses the highest risk when it comes to the *assumed location of fire outbreak*. The data of phase I with 2,775 recorded building fire alarms incl. 681 fires provides information on 615 cases of fires with details on the *assumed location of fire outbreak*. 26 % of these fires occur in kitchens and are therefore the majority. The data of phase I+II with 5,026 survey sheets incl. 1,216 fires and 1,151 statements on the *assumed location of fire outbreak* provide information on 308 kitchen

fires (27 %). Despite the doubling in size of the database, the proportion remains almost the same at 26 % compared to 27 %. However, this is a conservative observation as all building uses are taken into consideration. The examination of the relation between the *assumed location of fire outbreak* and the *building use* shows that 46 % of all fires occur in the *building use "living space"* (see Fig. 1). In turn, 48 % of all fires in the building use "living space" occur in the *kitchen.*

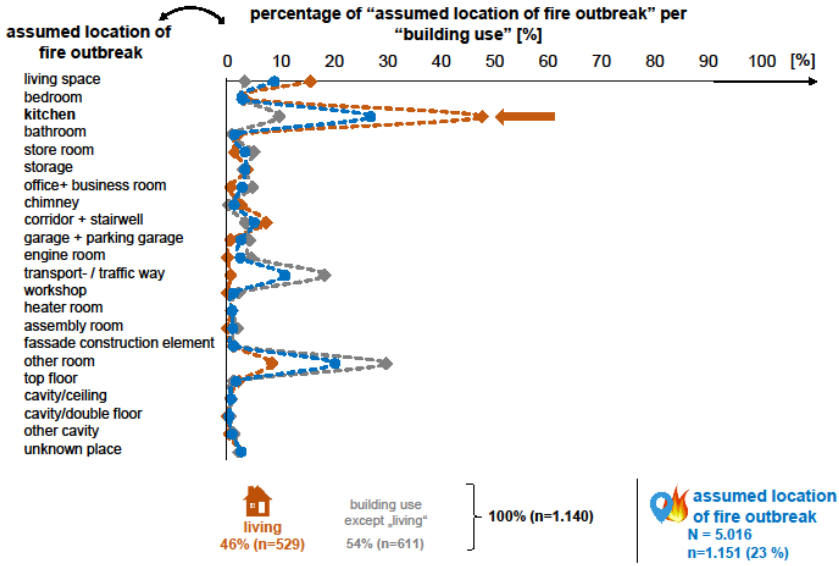

Fig. 1. Percentage of “assumed location of fire outbreak” per “building use” (N = 5,016; n = 1,151) [1].

By the way: 78 % of all fires occurring in the kitchen as the assumed location of fire outbreak are caused by stoves or ovens and the resulting material damage is less than €1,000 in 71 % of the cases.

Evaluation of the consumption of extinguishing water

Ensuring the extinguishing water demand of fire departments is a key issue of the future as, on the one hand, the availability of the public water supply may not be ensured everywhere in the future due to reductions of pipe diameters and, on the other hand, because water is becoming scarce. Information on 1,170 fires is available. No extinguishing water was used in 477 cases (41 %). In 505 cases (43 %), less than 500 l of extinguishing water were used, while more than 500 l and less than 2,500 l were required in 131 cases (11 %); in 57 cases (5 %), more than 2,500 l of extinguishing water were used. This means that more than 500 l of extinguishing water are required in 16 % of all fires.

Therefore, the amounts of extinguishing water carried along by fire departments (600 - 2,500 l) in accordance with the standard are sufficient for 84 % of fires.

As shown in fig. 2, the alarm path influences the consumption of extinguishing water. The amount of extinguishing water used by responding units increases from left to right. It can be recognised that the percentage of alarms by installed Fire Detection & Fire Alarm Systems decreases in this order. With reference to the subject's logic, it can be concluded that the consumption of extinguishing water decreases with installed Fire Detection & Fire Alarm Systems although such systems are used with a concentration of values in buildings. The percentage of alarms via mobile phones or landlines increases with the consumption of extinguishing water.

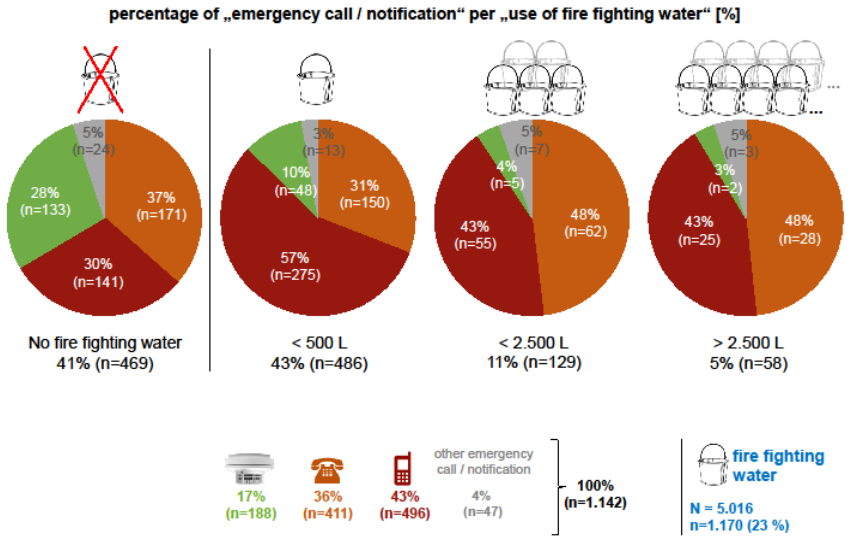

Fig. 2. Percentage of „emergency call/notification“ per „use of extinguishing water“ (N = 5,016; n = 1,170) [1].

Evaluation of the reduction of fire damage due to fire protection measures

In the total assessment (C), the survey sheets of all fire services involved are consolidated in an overall data set which is then used to examine the effectiveness of fire protection measures. The effectiveness is analysed by comparing the damage due to fires with and without selected fire protection measures. The damage difference allows to make a statement on the effectiveness of the fire protection measures initiated (see table 2).

In summary, it can be seen that, based on all criteria, installed fire detection and fire alarm systems resulted in lower fire damage. In the context of fires in buildings with fire extinguishing systems only 128 cases were investigated, whereby detailed information on the damage criteria is only available for a maximum of 12 real fires. These data does not provide reliable statistical information but a first trend. In summary, fire extinguishing systems have a positive effect on limiting the spread of fire and on supporting the effective fire-fighting operations in the investigated cases.

In 38 cases out of 5,016 registered building fire interventions, information on smoke and heat exhaust systems with differentiated information on the damage criteria is available. Reliable statistical information are not given but already more than a trend. Based on the criteria, data shows that a positive influence of smoke and heat exhaust systems on the fire development can be observed.

There are differences with respect to the effectiveness of professional fire services (FSprof.), volunteer fire services (FSvol.) and private fire services (FSpriv.) due to different conditions (see table 2).

Overall, depending on the type of fire service, the distribution of damage in the case of the private fire services differs from that of the professional and volunteer fire services, whereas the distribution between the professional and volunteer fire services is similar. Differences result from the structural range of interventions. The volume of fire protection systems is high in the area of private fire services, which means that early alerting by fire detection and fire alarm systems as well as an early initiation of fire extinguishing systems are to be assumed. There are more rapid intervention of a private fire service, too.

Table 2. Fire damage criteria without activating fire protection systems and when activating installed fire detection and fire alarm systems, fire extinguishing systems, smoke and heat exhaust systems; Fire damage criteria depending on the fire service status: Professional fire services (FSprof.), volunteer (FSvol.) and private fire services (FSpriv.) (N=5,016; nFire=1,216) [1].

CRITERION		no fire protection system	fire detection and fire alarms systems	fire extin-guishing systems	smoke & heat exhaust system	$FS_{prof.}$	$FS_{vol.}$	$FS_{priv.}$
		[no]	[no]	[no]	[no]	[no]	[no]	[no]
estimated material damage [EUR]	D < 1,000	452	128	3	18	383	125	220
	D < 10,000	132	22	2	10	125	57	6
	D < 100,000	59	5	3	8	69	16	4
	D < 500,000	10	0	0	0	11	1	0
	D < 1,000,000	1	0	0	0	1	1	0
	D > 1,000,000	1	0	0	0	0	2	0
	no data available	76	23	3	2	98	5	12
	sum	**731**	**178**	**11**	**38**	**687**	**207**	**242**
fire limited to (fire spread)	object	534	166	8	24	485	156	238
	room	133	20	1	9	163	35	5
	several rooms	22	5	2	1	23	9	3
	flat	9	0	0	0	14	1	0
	floor	14	2	1	0	11	4	1
	several floors	7	0	0	0	7	4	0
	fire compartment	8	0	0	1	7	3	0
	sev. fire compartments	2	0	0	0	1	2	0
	stairwell	3	2	1	1	3	2	1
	whole building	13	0	0	0	14	3	0
	other buildings	2	0	0	0	1	1	0
	sum	**747**	**195**	**13**	**36**	**729**	**220**	**248**
spread of smoke	not noteworthy	374	92	4	4	228	86	222
	room, shaft	117	56	3	9	160	56	12
	Flat	119	23	3	14	192	39	1
	floor	54	8	1	5	57	16	1
	stairwell	48	7	1	14	72	15	2
	corridor	25	7	0	6	31	12	4
	several floors	37	5	0	2	41	12	2
	sum	**774**	**198**	**12**	**54**	**781**	**236**	**244**
	smoke layering	158	20	3	12	107	114	5
	escape route usable? yes	446	156	7	25	460	165	164
extin-guishing water	no extinguishing water used	216	127	5	17	326	85	66
	< 500 L	375	45	4	14	270	72	163
	< 2,500 L	105	7	0	5	85	39	7
	> 2,500 L	45	4	2	2	39	14	4
	sum	**741**	**183**	**11**	**38**	**720**	**210**	**240**

Conclusion

The elaborated statistical findings on the fire phenomenon and fire service interventions are detailed and useful for risk analysis. They gave information about focus of risks and fire interventions. They are valuable to derive the effectiveness from the measures examined. All investigated measures show that the damage – measured by several different parameters – turn out to be less if fire protection measures are taken, compared to fires without these measures.

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