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Urban Fire Situation in Indonesia

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Abstract. The article analyses the fire situation in urban areas. The recent monthly and daily fire incident data in the two largest urban areas in Indonesia, Jakarta and Surabaya, for the last 7 years have been analyzed to understand the characteristics of incidents. It is found that most fire incidents occurred in residential buildings. This is caused mainly by electrical faults. The casualties and direct loss are relatively low, while there is a long emergency response time of fire brigade due to heavy traffic congestion and access difficulties. Discussion is focused on the issue of public behavior, fire service performance, urban strategy and building design. It is suggested that specific works on fire protection should be taken by increasing of public awareness, improving of a unified fire incident reports, empowering building law enforcement to the community, and improving the household's electrical products quality.

Keywords: Fire statistics, Response time, Fire incident reports, Fire services

1. Introduction

In Indonesia, during the last two decades, there has been rapid development in building construction following rapid economic growth. The rapid urban development can be clearly seen in the two cities of Jakarta, the capital, and Surabaya. This rapid expansion causes problems and fire is a major one for both cities. Unlike natural disasters that invite national and international attention, such as the 2004 Aceh tsunami or the Yogyakarta earthquake in 2006, building fires are a common tragedy that goes unnoticed. Fires in buildings are not a natural disaster since their occurrence can be predicted and a scientific method can be applied to reduce the risk. In order to improve public safety, reduce fatalities in society, increase the quality of life and decrease property loss, research is required to understand common failings within the current system with the aim of improving building design, building construction and the use of fire protection technology as a means to reducing fire risk. This paper presents fire incident data has been collected from fire departments in both cities to discuss the current status, how the problems that need to be solved are different from systems used in industrialized countries and how the system can be improved to better inform building requirements.

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2. Fire Research Methods and Data

Two approaches are commonly used to study fire in communities. Firstly deterministic modeling uses engineering calculations in a quantified approach. Typically this involves the study of structural behavior, fire growth and spread, and occupant's evacuation within a building. Secondly statistical data on fire incidents is used to determine uncertainties in cause and effect and risk estimations of likelihood and severity. This latter method is suitable for evaluating fire risk for the whole building and provides knowledge of important fire scenarios that can be developed for study by the deterministic approach. Thus the combination of both methods is found more effective for overall fire assessment of a building [1]. Fire statistics data is used for exploring the potential for fire loss reduction by identifying causes of importance [2], improving the level of information for and reducing uncertainties in a fire engineer's decision of appropriate design [3], improving fire prevention and protection to a given level of performance [4], assessing the fire risk level in buildings [5], evaluating the efficacy of building fire safety provisions, fire codes and government policy [6, 7], and also calculating the future challenges for fire safety and workplace safety [8, 9]. Fire statistics is only valuable in examining the fire incident behavior when it is supported with inclusive and trustworthy incident data.

Obtaining comprehensive fire data is not a trouble-free issue, since it requires the necessary participation from local communities, professionals in private and government institutions as well as the presence of adequate technology within the fire services. Some important attributes in obtaining reliable data are that reporting mechanisms should ensure data is comprehensive, accurate organized with well defined terms to avoid dissimilarity in the way data is reported and interpreted from different sources. UK, USA, Australia and New Zealand are some leading countries that have spent many years in initiating and developing fire data systems. The United Kingdom has created the Incident Recording System (IRS), a model fire data collection system applied to all Fire and Rescue Services (FRS's) together with stakeholders throughout the country [10]. The United States Fire Administration (USFA), a single governmental agency is collecting, analyzing and disseminating fire statistics through the National Fire Incident Report System (NFIRS) at the federal level [11]. This system provides a standard, national reporting system to trace fire incidents reports in more than 20,000 fire services. Australia has the Australasian Incident Reporting System (AIRS), a national data system linked online among fire services [12]. New South Wales Fire Brigade for instance, utilize AIRS for collecting, recording and reporting any incident and emergencies reported and attended by the fire services.

Due to the difficulty in obtaining data from the entire region of Indonesia, it is impracticable to illustrate the current building fire prevention and protection situation at a national scale. This article analyses the characteristics of building fire incidents in the largest cities of Indonesia, Jakarta and Surabaya where fire incident data has been recorded. A total of 3,299 fire incidents in Jakarta and 921 in Surabaya were used to analyze the fire trends in both cities between 2002 and 2008.

3. Methodology

Two data sets have been used in this study. The monthly data set comprises information about the number of fires, their locations, type of object involved in the fire or the main use of property, the ignition factor, the number of casualties, the number of fire vehicles dispatched to the fire, and predicted costs of direct loss. The daily data set shows more detailed information of fire incidents attended by fire service and includes the location, type of damage, specific fire causes, casualties, personnel and equipment used by the fire service at the scene, an estimated direct fire loss, a time record of each fire fighter's operational steps and the source of water used to control the fire (Table 1).

Due to missing data and inaccuracy during the process of collection, not all incidents recorded in the monthly data could be found in more detail in the daily reports. The daily reports only include incidents reported to and responded to by fire services. Some fire incidents remain unrecorded because they are too small or they are extinguished by the others without notifying the fire service. Those incidents which were reported without relevant data were excluded in this study. Checks across both sets were made for consistency and sense before being analysed by the SPSS (Statistical Package for the Sosial Sciences).

3.1. Uncertainties

The process of data gathering with open-ended forms can create some level of uncertainty and subjectivity in the data due to different interpretations of the questions by the people completing the forms. A validation was carried out to identify and review questionable data. Typical error types though infrequent were found to be:

1. Information about the time of fire discovery is subject to data error due to variation in time given by the witnesses and systematic errors from watch inaccuracies used by the officer receiving the fire call in the office or by the firefighter recording the operational time at the incident site. Such inaccuracies impact on the analysis of fire growth, response time, or lead to an illogical sequence of times. A sequential data order has been used to check the consistency of time data entry.
2. Inaccuracies in the time record are observed more frequently in larger fire outbreaks where fire services attended over several days. In these cases, reports from different fire services and different firefighters on duty may be missing making it difficult to trace incident sequences. Those incidents where inaccuracies were observed were not counted in the analysis. Some adjustment and cross checking from other reports have been made for inconsistent data. There were 3,333 reports for 3,299 fire incidents in Jakarta and 1,288 reports for 921 incidents in Surabaya used in this study.
3. The cause of fire is subject to uncertainty when there are no eyewitnesses. In Indonesia suspicious fires are handled by the police authorities and fire investigators are only called in on request (usually associated with large fires). As a consequence data is often incomplete. Data from different fire stations have

Table 1
Fire Incident Report Data: X Data is Collected

Daily fire incident data	Jakarta	Surabaya	Monthly data	Jakarta	Surabaya
1. Date of incident	X	X	1. Year/month	X	X
2. Location of incident (street, sub-district and village)	X	X	2. Frequency (number of incident)	X	X
3. Reporter and contact number	–	X	3. City’s zone of location (central, west, east, north, south)	X	X
4. Time of receiving call	X	X	4. Fire causes (stove, non-electrical light, electricity equipment/utility, cigarette, others)	X	X
5. Time of ignition (fire discovered)	–	X	5. Fix property fires (residential, public, industrial, vehicle, others)	X	X
6. Time fire truck departed	X	X	6. Number of occupants suffer from the incident (person, family)	X	X
7. Time of fire truck arrival on site	–	X	7. Casualties (death, injury)	X	X
8. Time of extinguishing start	X	X	8. Number of fire truck sent	X	X
9. Time of main fire end	–	X	9. Area of fire incident (m^2)	–	X
10. Time of wetting end	X	X	10. Loss of property (Rp = Rupiah)	X	X
11. Time of arrival back to station	X	X			
12. Object fire and area damage (m^2)	X	X			
13. Cause of fire	X	X			
14. Object/building owner (person/institution)	–	X			
15. Address of building owner (street, district and sub-district)	–	X			
16. Fire losses (death, injury, material/property)	X	X			
17. Name of on duty firefighters	–	X			
18. Water sources and quantity	X	X			
19. Other details (number and type of fire truck)	X	–			

been cross checked with regard to the head office version as data from this office are usually more complete than district or individual fire unit reports. All fire reports from the different districts are first sent to the district command where they are collated and then passed to head office in each province. There can be a number of reports on the same incident.

4. Multi-function rooms combining a lounge room with kitchen, a dining room with kitchen or even a dining room with lounge room commonly found in small residential buildings often creates difficulty in identifying the location of fire origin.
5. Predicting the direct property loss is another area subject to uncertainty. This information is gathered mostly from the occupant's statements, unless the building was insured. In that case, information on losses is found from the adjuster of the insurance company. Since most of the domestic buildings are not covered by insurance the accuracy of data is questionable since there was no professional estimator involved in most of the fire cases. The fire service officers are not qualified to estimate the actual fire losses. In cases where special investigation is required, the fire loss data is commonly found from the police's investigations or authorized accountant of the insurance company. The reported loss is estimated to be about 0.032%GDP (see Section 4.5).

3.2. Report Dataset

Even though there are number of institutions involved during a fire outbreak, such as the police, hospital, electricity and water utilities, fire data are normally collected by the district office after receiving a notification from the community. After receiving a call, the caller is called back to avoid unnecessary callout. The fire brigade or the fire troop is then dispatched once the information is confirmed. Whenever necessary, the district fire station will request fire services nearby to send support. Data recorded before dispatching includes time of first call received, time of fire brigade dispatch, reporter details, number and type of equipment sent to the fire location, and the names of fire personnel on duty. Those are collected by the individual fire station officer while data entered after dispatch are completed by the field commander in charge.

Interestingly, the type of information filled in the report sheet varies from station to station. However, generally they record the basic details of an incident, such as time of occurrence, casualties and injuries, fire objects, fire causes and loss of property. The reports from local stations are collected periodically by the district fire station and head office. Therefore, a more complete data set is generally found from the head office records.

The variation in fire report sheets completed manually creates a potential misunderstanding in the fire incidents, especially, when there is an inadequate verification mechanism to check the reliability of data. Unless there is a request from individuals or organisations for information on certain incidents, the report is documented and stored at the local fire station. The fire data is normally summarized monthly and tabulated annually in the district fire department and head office. For the time being, the data are mostly used as a reference for internal organizational needs. Only a few data elements have been used for fire safety research performed by external institutions or individuals. Since there is no adequate information system available, missing and inaccurate data can occur and are difficult to trace.

4. Fire Incident Analysis

The following discussion of fire incidents in both cities focuses on the frequency of fire incidents, type of fire objects involved, the time of incident, causes, the number of casualties, estimates of direct loss and the emergency response time (RT) from the fire services.

4.1. Fire Frequency and Object Damage

In the 7 years (2002–2008), Surabaya averaged 321 fires per year and Jakarta exceeded 840 fires per year (Table 2). At least 1 unit object was damaged in Surabaya but 6 in Jakarta. An object in this study is defined as one unit of ownership, for instance a building, a vehicle, a room in one house, or kitchen equipment in one house, while a fire incident is defined as one fire occurrence. In some cases, one incident might damage many objects at once. An extreme example might be a building fire involving seven objects where there is a building owner, five different rooms owned by different people and kitchen equipment owned by someone else. Usually it would comprise structures (houses, shops), vehicles and non-structures (wood stocks, industrial stocks, land fill, grass fires) where ownership is different. In most cases the level of damage and percentage of damage were unreported. In addition, Table 2 shows that Surabaya has at least one fire/day with Jakarta having 2 fires/day to 3 fires/day. With an average of 6 to 7 objects damaged in each incident (Table 2), Jakarta has approximately 15 objects damaged/day.

Table 2
Fire Occurrence and Object Damage

	Surabaya			Jakarta		
Year	Fire incidents	No. of objects damaged	Average no. of objects damage/ incident	Fire incidents	No. of objects damaged	Average no. of objects damage/ incident
2002	426	424	1	869	6,956	8.0
2003	295	295	1	888	6,972	7.9
2004	275	275	1	805	3,951	4.9
2005	266	266	1	742	5,628	7.6
2006	344	344	1	902	2,984	3.3
2007	289	289	1	855	7,076	8.3
2008	352	352	1	819	4,346	5.3
Average	321	321	1	840	5,416	6.4

Fire objects are tabulated in Table 3 for the two cities. Structural fires predominate in both cities (93% or 5,023 cases in Jakarta and 54% or 174 of cases in Surabaya).

Non-structural fires are the second most frequent fire type and include yard and grass fires, disposal sites, electrical transmission and outdoor electrical equipment. The large difference between the two cities is in the many grass fires that occur in Surabaya. Fire incidents involving vehicles, such as cars, motorbikes, ships and boats, are the least frequent type of incident that occurs.

Like other cities in the world, the statistical data from Jakarta and Surabaya show that residential buildings are the most frequent category of building involved in fire. The existence of excessive combustible material (e.g. wood, plastics and paper), high density buildings and narrow access are suspected to be common contributing factors to large numbers of residential fires. A recent catastrophic fire which burnt more than a thousand houses at Penjaringan, Jakarta in 2009 is an example [13]. Another reason that may contribute to the frequency of residential fires is the building regulation which gives an exemption to residential fire protection system installment. The regulation requires the installment of such fire protection equipment for public and industrial buildings only. However, by law, every building must be certified for occupancy by the local authorities. The certificate generally complies with the building code rather than specific protection against fire. In reality today, not all buildings are certified. Even when they have a certificate many of them do not meet the building technical requirements [14]. In 2009, the Jakarta Bureau of Building Monitoring and Control sent 12,734 memos of warning, sealed 3,695 buildings and forcedly demolished 2,095 other un-certified buildings [15]. In Surabaya, there were 664 uncertified houses and 229 street kiosks adjacent to the railway track or along the river side which were forcedly bulldozed. There were about 90 luxury houses in Jakarta that were sealed during 2009, because their certificates were not renewed after modification.

Regardless of recent National Building Laws and regulations that have come into force, approximately 90% of industrial and public buildings in Jakarta in 2010 are categorized as having inadequate fire safety standards [16]. Either they are not installed with appropriate fire protection systems or they have outdated fire protection systems. Efforts to control and monitor fire protection systems required within those buildings are ineffective due to limited number of building inspectors available. A total of 419 building inspectors in Jakarta would not be able to oversee all public and industrial buildings continuously. Although no survey of building fire protection systems in Surabaya was found, the implementation of appropriate monitoring systems will ensure all buildings are compliant with fire safety standards in both cities.

4.2. Time of Fire Incidents

Analysis of seven years of fire data shows that August, September and October are the months with the highest fire incidents in both cities, while January to April are the lowest (Figures 1, 2). These correspond to the dry and wet seasons respectively typical of equatorial regions. Even though it is classified as a dry season

Table 3
Fire Object

Year	Surabaya					Jakarta				
	Structures					Structures				
	Residential	Industrial	Public	Vehicle	Non-structure	Residential	Industrial	Public	Vehicle	Non-structure
2002	116	78	26	11	193	5,022	33	1,303	75	523
2003	76	54	13	19	133	3,004	41	3,574	82	271
2004	94	60	0	8	113	3,112	53	531	71	184
2005	88	46	11	9	112	3,673	31	1,698	105	121
2006	103	55	19	14	153	2,309	37	371	60	207
2007	81	65	14	16	113	5,478	31	803	97	667
2008	120	51	46	9	126	3,410	26	624	72	214
Average	97	58	18	12	135	3,715	36	1,272	80	312
Percentage	30	18	6	4	42	69	1	23	1	6

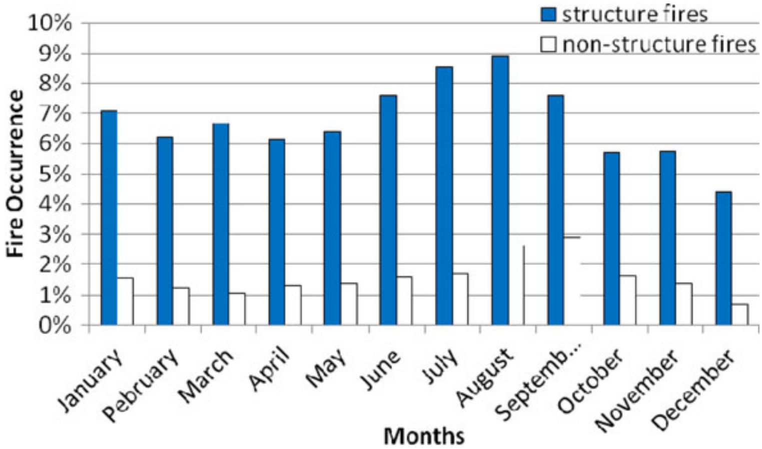

Figure 1. Monthly fire occurrence Jakarta 2002–2008.

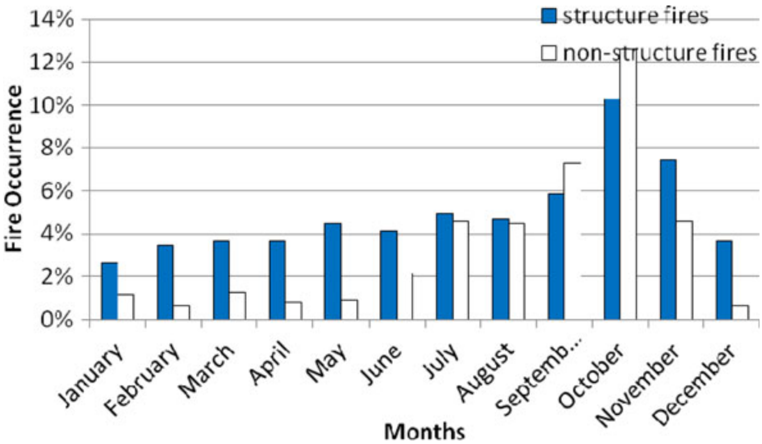

Figure 2. Monthly fire occurrence Surabaya 2002–2008.

because of the absence of rain, the relative humidity remains above 75% with temperatures above 28°C (77°F). The monthly fire occurrence are indirectly influenced by the changes in weather throughout the year, considering that incidents appear more frequent during the driest months. Based on fire experience, it is found that the worst fires occur when many failures take place simultaneously [17]. These failures include human mistakes, electrical or mechanical faults, as well as extreme weather conditions. A study in Queensland, Australia, suggested that higher fire incidents correlate with the impact of high temperatures in locations around [18]. The high number of unstructured fires in Surabaya at the start of the wet season appear to be mainly electrical faults occurring as water seeps into electrical equipment such as transformers.

Table 4
Correlation Between Weather and Fire Incident

	Jakarta		Surabaya	
	Correlation	Sig (1-tailed)	Correlation	Sig (1-tailed)
Temperature	−0.567	0.027	0.687	0.007
Humidity	0.444	0.074	−0.882	0.000
Rainfall	0.501	0.049	−0.581	0.024
Wind speed	0.310	0.163	0.592	0.021

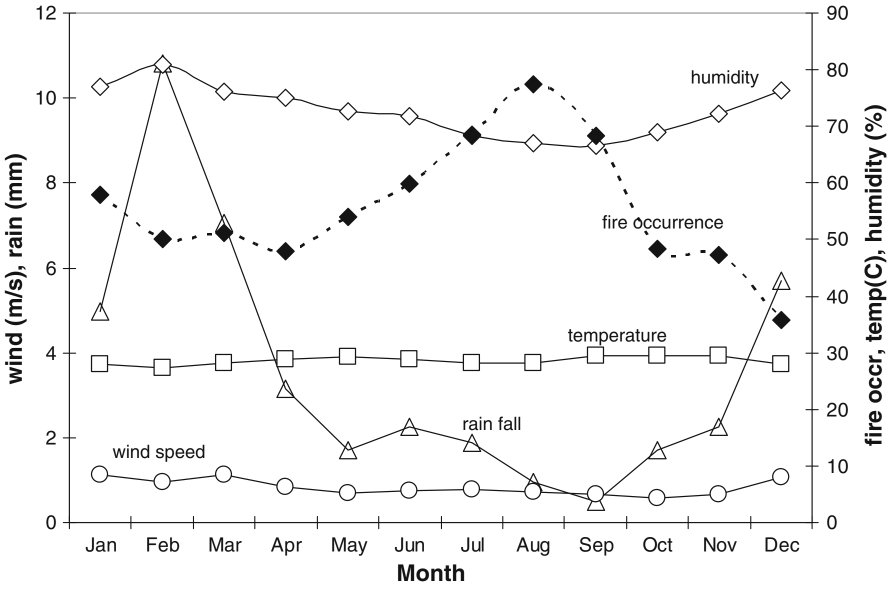

Figure 3. Monthly fire occurrence and weather condition in Jakarta.

A simple evaluation using a descriptive statistics correlation test between the average monthly weather record and average monthly fire incidents in both cities was carried out. It shows that the fire occurrence has significant correlation with the weather condition in Surabaya with significance level less than 0.05 (Table 4). In Jakarta, less correlation was found, especially between fire occurrence and humidity level (sig: 0.074), and between fire occurrence and wind speed (sig: 0.163). The fire occurrence in Surabaya has an inverse correlation to the atmospheric precipitation and the humidity level. When the level of air moisture decreases below 70% and rainfall is less than 6 mm, fire incidents increase (Figures 3, 4). While more research on the correlations between atmospheric weather and building fires is needed, it requires investigation and recording of detailed weather conditions around fire sites at the time that the fire breaks out.

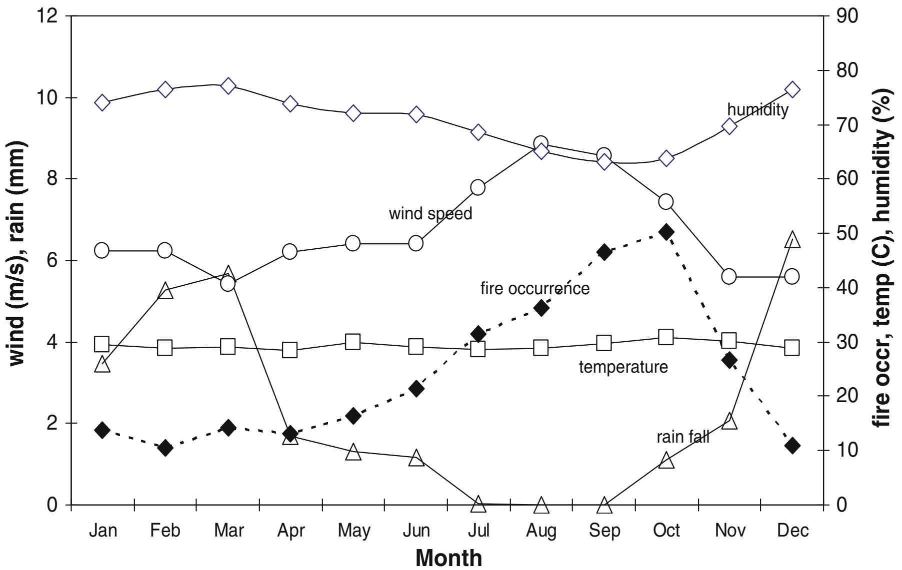

Figure 4. Monthly fire occurrence and weather condition in Surabaya.

When the time of the fire incident is grouped by 6 hourly periods during the day, most fires occurred during the afternoon between noon to 6:00 pm (Figures 5, 6). This fact is counter intuitive. Most people believe the critical time of fire is the time when most people start using the electrical power in houses, after 6:00 pm which is reasonable in the view that the daily electricity peak load goes from 6:00 pm to 10:00 pm. The data show that fire incidents are not significantly related to the level of electricity consumption, even though electrical shorts are the main cause of ignition.

4.3. Fire Causes

Causes of fire in domestic buildings vary from human error to failure of electrical equipment. In United States, cooking accidents are the main cause of residential fires [19], while in Australia, mechanical failure of heaters and malfunction in electrical distribution are the leading causes of fire [20]. The failure of electrical devices is the main cause of fire outbreak in Jakarta (Table 5). These include overheating fans and air conditioners; heat from overloaded electrical wires and short circuits in old and brittle wiring as well as improper installation. The low quality of electrical plugs contribute to ignition in residential areas, even though there has been a product quality standard applied in Indonesia [21]. Poor quality cheap electrical plugs and outlets are readily found in the electrical stores and bought mostly for their low-cost by householders and small home industry.

In Surabaya, unlike Jakarta, cooking activities are the major cause of building fires (Table 5). Unfortunately there is not enough information in the database to

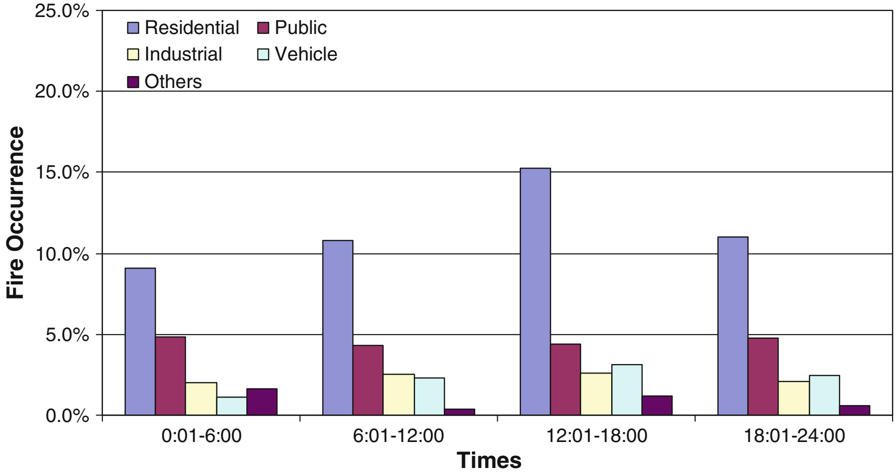

Figure 5. Fire incidents by time of day (in 6-h intervals)—Jakarta.

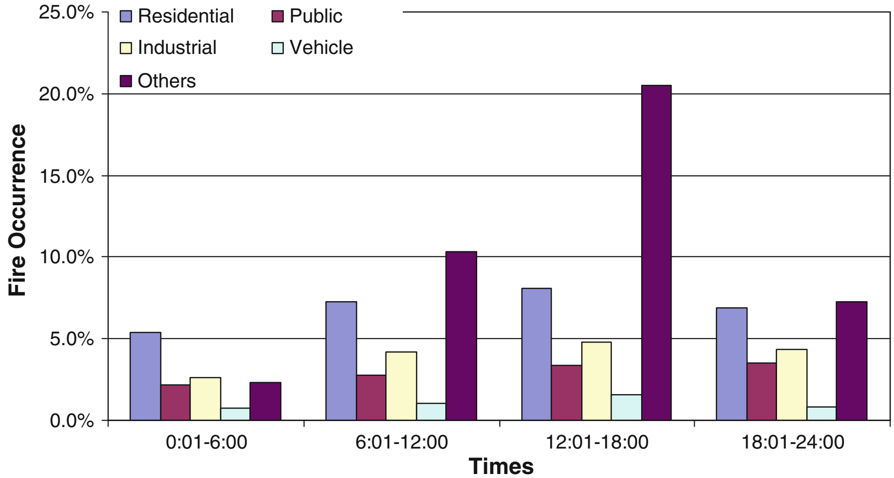

Figure 6. Fire incidents by time of day (in 6-h intervals)—Surabaya.

distinguish the proportion of LPG to kerosene stoves used for cooking that contribute to residential fires during 2002 to 2008. The trend in stove explosions has increased since the central government advocated the National Energy Conversion Program in 2006; a substitution program to use Liquid Petroleum Gas (LPG) instead of kerosene offered to all householders. LPG explosions in Jakarta were 80 from 693 fires (11.5%) in 2010 [22]. Changing cooking style from using kerosene stove to LPG for the majority of dwellers increases fire risk, especially when there is poor operational guidance. The component of LPG installations (LPG tank, pipe, flexible hoses, regulators and appliances) which cause gas leaks has

Table 5
Causes of Fire Per 100,000 Population

	Surabaya					Jakarta				
Year	Stove	Light	Electricity	Smoking	Others	Stove	Light	Electricity	Smoking	Others
2002	3.06	0.34	2.00	0.26	6.51	1.05	0.08	4.67	0.93	3.49
2003	0.74	0.43	1.34	0.03	5.89	0.96	0.05	5.45	0.99	3.00
2004	1.71	0.11	1.11	0.37	4.54	0.98	0.09	5.36	0.52	2.52
2005	1.63	0.29	1.17	0.17	4.37	0.80	0.15	5.39	0.49	1.89
2006	5.03	0.66	2.54	0.00	1.60	1.08	0.07	6.11	0.68	2.67
2007	2.91	0.23	1.77	0.03	3.31	1.11	0.33	5.52	0.52	2.59
2008	5.34	0.17	2.63	0.03	1.89	0.98	0.24	5.59	0.58	2.27

been source of public concern [23]. Despite of modern cooking and other household's appliances that are known to be safer, neater and more environmental friendly [6], changing a society's culture and habits requires a long-term strategy for change.

Fire incidents in residential building caused by non-electrical lighting such as candles and kerosene lights are found in both cities. Most cases have occurred when the residents need lighting during electricity blackouts. Fallen or knocked candles and kerosene lights that touch combustibles nearby can occur when the lights are not attended or when residents fall asleep while the lights are still burning.

Smoking behavior contributes to the global fire toll [24] and it causes fatal fires in residential buildings [25]. Fire incidents started by smoking materials in Jakarta are relatively common and ranked third as a fire cause (Table 5). The daily fire reports show that fire incidents are caused by smoldering cigarettes igniting combustibles in waste bins or igniting dry leaves in the workplace and from falling onto the bed in residential premises. There is a need to improve habits surrounding smoking behavior in society by providing better and more available information to society that remind people of the risks associated from careless smoking behaviors. Banning smoking in society appears ineffective, even when it is prohibited in public facilities. Indonesian is one of the top five tobacco consuming countries in the world, and about 30% of Indonesians are smokers [26].

The "others" fire causes in Table 5 consist of burn-off of grass, rubbish fires, welding torch fires, fireworks, children playing with matches, in-appropriate vehicle fuel filling methods and other unidentified open fires that are significant in both cities.

4.4. Casualties

The number of fire casualties is an important fire statistic collected from every fire incident in the world. Casualties are classified into fatal and non-fatal casualties (injuries). A fatal casualty is classified if death occurs within 30 days of the fire. The number of fatalities is subject to change as it requires documentation from the local authorities. Even though there is a system of recording deaths and

Table 6
Fire Casualties per 100,000 of Population

	Surabaya				Jakarta			
Year	Death	Injury	Death/ 100,000 population	Injury/ 100,000 population	Death	Injury	Death/ 100,000 population	Injury/ 100,000 population
2002	5	5	0.14	0.14	23	34	0.27	0.40
2003	5	2	0.14	0.06	39	245	0.46	2.88
2004	5	73	0.14	2.09	29	83	0.34	0.98
2005	1	0	0.03	0.00	37	35	0.44	0.41
2006	0	0	–	0.00	17	85	0.20	1.00
2007	0	0	–	0.00	15	63	0.18	0.74
2008	0	0	–	0.00	15	59	0.18	0.69

investigating suspicious fire deaths, for some reason, some incidents are not reported by the relatives. The figure for fire death is generally measured as a rate per 100,000 of population. In residential fires, the form of ignition, the form of material ignited and personal factors contribute most to occupant fatalities [27]. It is well known that carbon monoxide, toxic organic chemicals in smoke, oxygen reduction and excessive heat are found as major causes of fire death [28]. Unfortunately data related to those factors in Indonesia is currently unavailable. Non-fatal injuries include persons who receive first aid at the scene and/or need further medical treatment or are advised to see a doctor.

Table 6 shows that fire deaths in both cities is low, compared with the number of annual incidents. Surabaya fire death rate ranges from 1 to 5 people and Jakarta from 15 to 39. 2003 was the year with highest number of casualties in Jakarta with a death toll of 39 people and 245 injuries. Comparing the data for the cities, the fire death rate per 100,000 of population in Surabaya is 0.14 and Jakarta ranges from 0.16 to 0.4. Currently data related to the causes of death from hospitals is unavailable. These death rates for Jakarta and Surabaya are much lower than other large cities in the world as estimated by the Geneva Association Organization in the World Fire Statistics [29].

Reports from the National Disaster Education and Coalition, USA and the Australasian Fire and Emergency Service Authorities Council—AFAC (2005) Australia showed that the majority of fatal fires occur when people are likely to be less alert during sleeping hours. Although there are no studies related into the low mortality of fire incident in Indonesia, the residential patterns and social values of society could be behind the low death rate in both cities. The close building distance in residential areas makes it easier to notify neighbors. The number of social activities and 24 h security patrols undertaken in residential environments will possibly detect fire quicker. In addition, strong family values where an old parent is living and looked after by one son's family is believed to reduce the number of fire deaths for the elderly in the community.

4.5. Direct Fire Losses

Direct fire losses in this article are defined as property losses due to building damage. Reports on fire loss are basically based on information given by the owner. Currently, the fire departments in Jakarta and Surabaya do not have an officer specialized in appraising the building value as well as there being few building fire consultants available. Insurance companies do have building appraisers, but residential buildings covered by insurance are relatively low. Compared to Surabaya, Jakarta has more consistent data. The following table (Table 7) shows the direct fire loss in Jakarta that has increased to US$ 23,262,307 (Rp. 214.013.220.000) in 2008 equivalent to US$ 28,403 per fire incident.

Comparison of fire loss with the national GDP of Indonesia is not an easy task due to the unavailability of fire loss data on a national scale. However, a simple prediction can be made on assumption that Jakarta is representative of the country. The GDP of regional Jakarta in 2008 [30] is US$ 73,635,352,065, with an average fire loss of US$ 23,262,307, the ratio of fire loss to GDP will be 0.032% this is lower than other countries listed in the World Fire Statistics [29]. Yet, the fire loss figures do not adequately represent the loss to the victims that are mostly from the middle to low income earners. Compared with the rich, their economic recovery will take longer and involve more hardship.

The fire growth is generally found to double in size for each minute (NFPA 1710) of delay in response. RT is a crucial matter; however, few studies have focused on the quick response of fire services. A recent statistical study by Challands [31] show a clear correlation between RT and the damage to buildings. Furthermore, they found that for every 1 min increment of RT, the fire will grow by 2.3%.

4.6. Fire Service Response Time

The RT is highly variable as it is affected by such factors as distance of the incident to the nearest fire service, street quality, traffic density, accessibility to the fire

Table 7
Direct Fire Loss

	Surabaya			Jakarta		
Year	Direct fire loss (Rupiah)	Direct fire loss (US$)	Average loss/incident (US$)	Direct fire loss (Rupiah)	Direct fire loss (US$)	Average loss/ incident (US$)
2002	61,832,195,000	6,720,891	15,777	130,947,140,000	14,233,385	16,379
2003	60,109,334,500	6,533,623	22,148	109,838,835,000	11,939,004	13,445
2004	3,372,000,000	366,522	1,333	119,767,710,080	13,018,229	16,172
2005	48,259,730,000	5,245,623	19,720	144,683,575,000	15,726,476	21,195
2006	119,906,000,000	13,033,261	37,887	142,992,500,000	15,542,663	17,231
2007	24,569,500,000	2,670,598	9,241	168,675,120,000	18,334,252	21,444
2008	2,697,500,000	293,207	833	214,013,220,000	23,262,307	28,403

Note: US$ 1 = Rp. 9.200

Table 8
Fire Response Time of Some Countries

Country	Inner city attendance	Isolated area attendance	
Hong Kong	6 min	9 min 23 s	
US	5 min (50% attend)	11 min (90% attend)	
UK (Scotland)	5 min high risk area	8–10 min moderate area	20 min low risk area
Japan	4–6 min		
Australia (NSW)	6 min 49 s (50% attend)	10 min 41 s (90% attend)	
Indonesia Surabaya	14 min		
Indonesia Jakarta	7 min		

scene, the fire department management system, size and dispersion of population, and application of advance technology system in the fire services (e.g. Computerized Mobilizing System, Telephone System, Geographic Information System, and Wireless Digital Network System). The NFPA standardizes RT performance as 6 min allowing 1 min for call processing, 1 min for the turnout time and 4 min for the journey time in 80% of fire service attendances. In fact the US Fire Administration [32] found that the RT was less than 5 min for 50% attendance regardless of the region, season or time of day. Hong Kong, US, Canada, UK, Japan and New South Wales have recorded 4 min to 6 min for RT in the city areas and more than 8 min for the isolated/moderate to low risk areas (Table 8).

When many countries are moving towards a short RT, Jakarta and Surabaya remain above the NFPA 6 min standard. From 4,680 car dispatches in Jakarta, the average RT is 6.57 min, comprising a 1.25 min dispatch time and a 5.32 min trip time, this was taken under the assumption that fire Jakarta's fire fighters require 1.31 min to then apply first water similar to the time in Surabya. In Surabaya, from 859 dispatched fire trucks, the average RT is recorded as 13.21 min (Figure 7) comprising of a 2.54 min dispatch time and a 10.27 min trip time. The average RT, however, covers only cases where it is less than 1 h. The difference of RT between two cities could possibly due to the difference of fire station coverage area. With 81 stations, one station on average in Jakarta covers 8 km^2 (3.08 sq mi) area compared with more than 46 km^2 (17.7 sq mi) in Surabaya.

The more complete time recording in Surabaya's can be used to indicate the occupant's response time after discovering the ignition. By using the time of first call received and the time when fire was discovered as reported by the witnesses, it was found that there was a delay of 22 min in reporting fire. This gap will significantly affect the ability to successful control the fire on brigade arrival. There could be number of possible reasons for the delay. Firstly, the occupants attempt to put out the fire, even when this cannot be done effectively. Secondly, they remove their belongings from the house before calling the fire service. Thirdly, they are not aware of the direct emergency number. This is similar to the study by Holborn in the UK [33] which questioned the reasons for such delays in calling the fire brigade. In Indonesia it seems that the occupants panicked when discovering the fire and they behaved irrationally in trying to terminate the fire. There

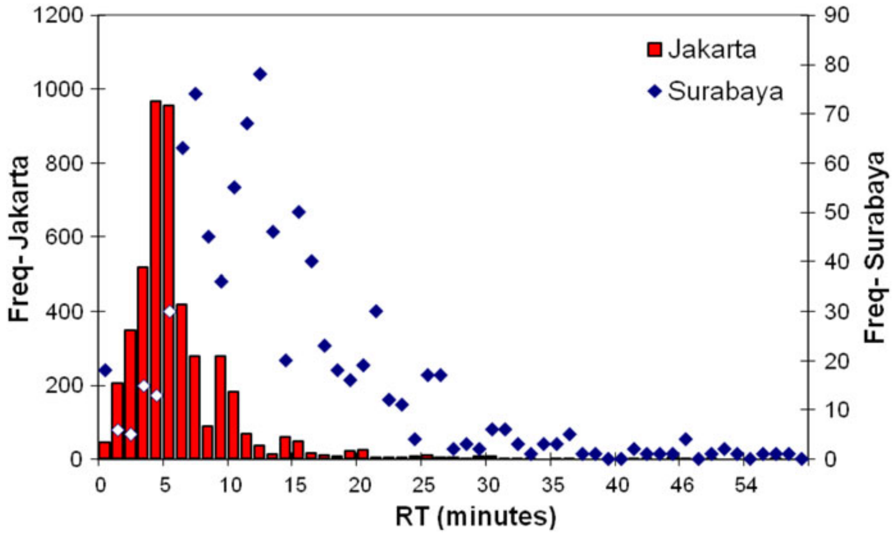

Figure 7. Fire response time.

were some cases where they used water to flush a fire from a kerosene spill in the kitchen which caused the fire to spread to the whole room.

5. Discussion

Fire in buildings frequently involves several factors; the occupant behavior, urban design, fire service performance, building code enforcement and the quality of home electrical products. Occupant behavior is the main contributing cause in building fire loss, as there is a presumption in the community that the fire is more an accident that happens rather than a risk that should be avoided. This presumption only creates a less prepared society. Furthermore, a lack of knowledge of life safety combined with an unawareness of fire behavior results in low public awareness about fire safety. Careless smoking, lack of maintenance of electrical installations, unattended domestic burning of waste and careless cooking are some of the behaviors frequently observed in the community. In addition, a society highly dependent upon the fire services only creates public opinion that the fire service is the only institution responsible for fire safety and that it is not every ones responsibility. This ignores a simple principle that fire prevention is always better than fire extinction.

The fire services actually face significant barriers, such as a limited operational budget, weak coordination between government agencies and poor human resource development. These barriers often make it impractical for the fire services to provide appropriate service to the community. Limited operational budgets not only restrict updating equipment and developing competent personnel whilst the difference in organizational structures in each province and city impede better coordination among services. As the recruitment system is dependent on the government in each city or province, there is considerable variation in the number and quality of officers retained. Of 3,000 fire personnel in Jakarta, 65% are aged over 45 years and 30% are over 50 years. A study by Cortez [34] shows that fire service staffing in an important issue since their professionalism is expected and demanded by the community. Apparently, top level officers who are inexperienced in fire safety are frequently appointed from other government agencies to fire departments. As an important component in ensuring life and building safety, fire departments in Indonesia need to be reviewed, adjusted and synchronized in a way that each department has the same opportunity to develop. One independent organization in every city which is responsible directly to the central government could be one possible solution.

Poor city infrastructure such as narrow streets, lack of water resources and heavy traffic significantly reduce the effectiveness of the fire service. The number of fire stations in both urban areas is less than required to achieve international standards of response. Assuming one station to serve a population of 50,000, Jakarta needs 170 more stations, whilst Surabaya requires another 64. With the fast development of cities, any master planning of the city needs incorporate future locations of fire station covering the service area within 6 min travel time. The number and quality of water hydrants is a significant urban infrastructures problem. On the assumption that an adequate ratio is one fire hydrant per 5,000 population, Jakarta needs a total of 1,600 fire hydrants. In fact, only 1,000 units are available, and 40% need maintenance. In Surabaya, of the 268 fire wells available, only a half can be operated. The local water supply company should ensure all wells are ready to use and should add a further 290 fire wells to bring it to international standards.

Heavy traffic in both cities is found as a major barrier for the fire brigade to reach the site within 6 min. There are about 4 million vehicles running on 5,621 km (3,492 mi) of roads in Jakarta leaving no space left for quick response maneuvers of fire trucks [35]. With a total 9,993,867 vehicles (June 2009), vehicle growth at 11%/year, and road extensions of only 1%/year, traffic is predicted to be at a standstill by 2014 [36]. The policy of developing new public facilities (e.g. offices, apartments, shopping malls) in the city center in the last few years has only increased the traffic load in the urban area. With the average traffic speed of 12 km/h (7.5 mph) during working hours, it is difficult for fire brigade to decrease the RT. The urban development strategy in Jakarta should be reviewed with the aim of reducing traffic congestion. This may include removal of slum residents into low-cost flats and implementing a more convenient mass transit system.

The long RT is not only caused by heavy traffic congestion, but also the surrounding residential areas, accessibility and the occupant's behavior. A number of residents are living in kampong areas which typically consist of densely spaced buildings with long pedestrian access from the main road and where fire service access is difficult. Fire outbreaks in this area will spread rapidly and will be difficult to extinguish. Using ordinary fire equipment is impracticable; there is a need for small mobile portable fire units in the future.

The occupant's behavior during fire outbreaks interfere with the firemen's performance in extinguishing the fire. When fire occurs in a dense residential area, the fire fighter's access is often blocked by householder's goods that have been moved from the building on fire. Crowds of residents flock to see the incident often interrupt the fire engines maneuver. Disputes between firemen and residents frequently happen in choosing which buildings should be sprayed first: some occupants in certain areas of Surabaya have forcibly taken over the fire hose from firemen to spray their own properties. This selfish behavior only hinders the performance of fire fighters. These situations require the presence of police officers to secure fire brigade operation delaying the attack on the fire. Simple guidelines could be widely circulated in society dealing with things that should and should not be done during fire incidents.

Standardization of electrical products and cooking appliances is another issue in building fire safety. In this case, the private companies should participate to control the quality of products. It is believed that there is no barrier between countries on the use of science and technology [37]. Consequently Indonesia should adopt fire safe household appliance technology that has been implemented internationally. The residential LPG stove blast incident that occurred recently is an opportunity for the central government to review the product standards and enforce existing regulation in the industrial community.

About 102 of 583 high rise buildings have inappropriate fire extinguishers [38] and only 28.6% of 1,033 public buildings exist without emergency fire stairs [39]. A comprehensive evaluation of building permit procedures and a more consistent and strict full building permit regime needs to be implemented if fire safety is to be improved. Fire protection equipment installed in buildings is often too expensive for building owners. Consequently building permits should prioritize on the use of passive fire protection and appropriate fire management. The type of ceiling materials, the electricity connection on the ceilings, electrical wires installed within partition walls and kitchen appliances should be carefully controlled by building designers and reviewers in the building planning process. Finally, the government should guarantee the stability of electrical supply to minimize fire incidents during electricity black out.

6. Recommendations

By analyzing fire site incident reports from fire department, the fire situation can analyzed which may contribute to the fire research development. Several recommendations can be drawn from this study:

1. Special attention should be given to the development of a unified fire reporting system. The report should cover basic information about the fire and consist of time records, detailed location of the incident, source and room of ignition, type and forms of materials ignited, properties loss, casualty and injuries, equipment and personnel involved.
2. A standard fire reporting management system within the fire authorities should be developed to reduce missing data and inaccuracies. This would require an adequate level of human resources and an implementation of simple information

technology system connected between one fire station and the central fire station. Furthermore, the fire incident report should be used not only for internal fire authority's purposes but also for guiding the community to a safer behavior.
3. Since household electricity equipment faults and short circuit connection are found as a major cause of building fire, improvement in the retailing of standardized electrical products and the associated guidance given to people should be a priority as well as the implementation of better quality and reliable electricity connection to buildings.
4. The implementation of building regulation need to be improved and supported with strict law enforcement, while better mechanism of building planning procedure should be implemented using modern fire risk assessment techniques.

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