INSIGHT

Developing a global standard for fire reporting

December 2020

RICS®

DEVELOPING A GLOBAL STANDARD FOR FIRE REPORTING

Insight paper

December 2020

Copyright acknowledgment

Figures 4 and 11 are reproduced with permission from Justin Sullivan.

Published by the Royal Institution of Chartered Surveyors (RICS)

Parliament Square

London

SW1P 3AD

www.rics.org

ISBN 978 1 78321 407 5

Typeset using Typefi.

Acknowledgments

Author

Brian J. Meacham PhD PE EUR ING CEng FIFireE FSFPE

Technical reviewers

Marty Ahrens, National Fire Protection Association, USA

Danielle Antonellis, Kindling, USA

Ben Bradford, BB7 Fire Ltd, UK

Dennis Davis, CTIF, UK

Natalia Flores Quiroz, Stellenbosch University, South Africa

Neil Gibbins, Institution of Fire Engineers, UK

Sir Ken Knight, UK

Simon Lay, OFR Fire and Risk Consultants, UK

Birgitte Messerschmidt, National Fire Protection Association, USA

Judith Schulz, Arup Fire Safety Engineering, UK

Graham Smith, Jacobs, UK

Professor Richard Walls, Stellenbosch University, South Africa

Professional group lead

Gary Strong

Project manager

Helvi Cranfield

Editor

Mary McGowan

Contents

Foreword

Every day, unwanted fire causes catastrophic damage around the world, affecting people, the environment and the economy.

The causes of fire are numerous, and its impacts far-reaching. The past decade has seen deadly factory fires in Bangladesh, the Grenfell tower tragedy in the UK and massive wildfires raging across vast regions of California and Australia. It is clear that fire is one of the most pressing global hazards we face.

Less clear, however, is the data behind the danger. An accurate picture of how many people are killed or injured by fire per year does not currently exist. The circumstances in which fire incidents take place are not fully understood, nor are the locations in which they occur or the resources currently in place to tackle them. The data that does exist is patchy and inconsistent, and primarily from high- and middle-income countries.

These gaps in data leave policy makers and governments blind. Without access to consistent information about fire, they cannot fully comprehend the scale of the problem they face, making it impossible to manage the risks of fire effectively.

This insight paper shines a light on this issue and proposes that a global standard for fire reporting would lead to fire-related data that is reliable, consistent and comparable globally. This would enable fire services and professionals across the built and natural environment to develop informed and robust policy and market strategies, resulting in a uniform and comprehensive approach to tackling fire and its impacts. After all, the science of fire knows no geographical or political boundaries.

RICS is committed to improving fire safety. In the aftermath of the Grenfell tower tragedy, we were instrumental in the formation of the International Fire Safety Standards (IFSS) Coalition, backed by the UN. We were also instrumental in the publication of the **IFSS – Common Principles** document, which aims to establish a consistent, overarching approach to fire safety and is now being published as a UN ECE standard, the first ever in fire safety. This insight paper aims to further advance these important discussions.

Gary Strong

Global Building Standards Director, RICS

1 Introduction

Fire is a globally significant problem. It impacts all societies, economies and geographies. The costs to people, property, business and the environment are enormous. However, the ways in which data on fire incidents, fatalities, injuries, impacts and costs are collected, recorded and estimated vary greatly across countries, organisations and sectors. The lack of data – and the inconsistency in reported data and estimates – makes it very difficult to compare factors such as:

- types of ignition events
- number of fires, injuries and fatalities
- demographics, including socioeconomic factors
- use, construction, height and locations of buildings involved
- efficacy of fire mitigation measures in buildings and
- fire brigade capacity and efficacy.

This in turn makes it very difficult to develop effective mitigation strategies at all levels, from government policies and mechanisms, to business or portfolio risk management approaches – including lending and insurance – and occupant or tenant individual risk management decisions on furnishings, appliances, behaviours and more.

Better data on the impacts of fire will enable a better understanding of the types of communities, buildings and infrastructure where fire safety can be significantly improved through application of risk mitigation standards, guidelines and regulations. This will in turn inform and aid the implementation of more effective fire risk management strategies by:

- governments
- non-governmental organisations
- fire and rescue services
- insurers
- regulators
- professional bodies
- banks and
- owners, managers and end users of buildings and infrastructure.

In this paper, an overview of the global fire problem, based on available data, is presented. Challenges in data collection and the comparison of data between countries are discussed. A tiered system of data collection that would address these challenges and provide a way forward for global consistency in how fire-related data are reported is suggested.

1.1 The global fire problem

Unwanted fire can result in significant injury or loss of life, economic impact, property damage or loss and business disruption worldwide. Unfortunately, there are currently no globally consistent methods of reporting, collecting and analysing fire loss data. In addition, some data are proprietary, such as insurance loss data. This creates numerous challenges to implementing data-based measures to prevent, avoid, mitigate or insure against the ravages of fire.

It is difficult to accurately estimate the magnitude of the impact of fire worldwide for a variety of reasons:

- growing wildland and wildland-urban interface (WUI) fires
- concentration of value in commercial property, contents and operations
- increasing growth and densification of urban centres and
- variability and gaps in fire loss data collection and reporting, particularly in low- and middle-income countries (LMICs).

While some of these data are available in many individual countries, they are not published in all. Also, it can take some time to analyse and report the extent of impacts. However, there are some resources that provide insight into the extent of the problem.

Globally, loss due to wildland fire is presently greater than at any time in the past. In 2016, the US National Institute of Standards and Technology (NIST) estimated the total annualised economic burden of wildland fire in the US alone to be between US$71bn and US$347bn.[1] In January 2020, bushfires raged across vast portions of Australia. By the end of the 2019–2020 bushfire season, the estimated impacts were staggering: 18,983,588 hectares were burned, 3,113 houses and 33 lives were lost in 15,344 bushfires and damage from the bushfires is estimated to have had an A$20 billion impact on the economy.[2]

Figure 1: Wildland fire in Zion National Park (Source: US National Park Service)

The cost of fire in terms of impact to business and property is also considerable. Analysis of over 470,000 global insurance claims from 2013 to 2018 by insurers Allianz, for example, reveals that fire and explosion incidents cause the largest claims for insurers and the businesses they cover, resulting in an excess of €14bn worth of losses. Fires were also responsible for more than half (11) of the 20 largest non-natural catastrophe events analysed.[3]

Looking at the US as a whole, the National Fire Protection Association (NFPA) estimated the 2014 annual costs associated with direct property loss caused by fire at US$13.2bn and insurance costs at US$23bn.[4] Considering just these direct costs, US$36.2bn accounts for about a third of the natural disaster five-year loss average of US$106bn (2015–2019).[5] The figure of US$36.2bn in fire losses does not include the costs of fire safety measures through building regulation, fire protection systems and fire safety management, nor the costs associated with the fire service. These measures add to the total cost of fire, but without them, the expected losses would be much higher.

$13.2 bn

annual costs associated with direct property loss caused by fire

$23 bn

annual costs associated with insurance claims related to fire

Figure 2: Firefighters in action (Source: US National Park Service)

In LMICs, the impacts of fire are often even higher. A particular challenge in LMICs is the presence of informal construction and settlements, which are often prone to rapid fire growth and spread and can displace thousands of people, even if casualties are low. Unfortunately, due to the lack of robust and consistent reporting, an accurate estimate is difficult to develop. At the high end, the World Health Organisation (WHO) has estimated that as many as 180,000 deaths per year may result from burns associated with fire, of which 95% occur in LMICs.[6] In addition to those who die, the WHO suggests millions more are left with lifelong disabilities and disfigurements, often resulting in stigma and rejection.

Figure 3: Burn injuries in LMICs

The warehouse fires and collapses in Bangladesh over the last ten years, for example, have seen hundreds of deaths and thousands of injuries. The costs to government, local businesses and their international trading partners, including the resources expended by the Accord on Fire and Building Safety in Bangladesh (Accord) and the Alliance for Bangladesh Worker Safety, have been significant. The cost to local companies for six of the fires alone is estimated at almost US$365m, without consideration of associated losses such as direct and indirect losses through the supply chain, human losses and impacts on infrastructure.[7] Across the ready-made garment sector, the initial cost of remediation estimates alone was US$929m, of which US$372m was associated with electrical and fire issues.[8] This led members of Accord to pledge to invest up to US$500,000 each for remediation of factories.[9]

Figure 4: Informal settlement fire (copyright Justin Sullivan, reprinted with permission)

2 Variability of existing fire loss data

Fire loss data are collected by the fire service in a number of medium-high income countries and high-income countries (HICs), including much of Europe, North America and parts of Asia-Oceania. In some cases, the data are published by a national body (e.g. the Home Office in the UK, the Directorate of Civil Protection in Norway, US Fire Administration and NFPA in the US and the Fire and Disaster Management Agency in Japan). These data can be quite detailed and include information such as:

- number of fire incidents
- extent of fire damage
- numbers of injuries and fatalities
- number of firefighters
- fire stations and
- fire apparatus.

In addition, data on injuries and deaths associated with fire are reported as part of national mortality and morbidity statistics. These data are either reported or estimated for most countries, regardless of economic classification. The data are based on the **International Statistical Classification of Diseases and Related Health Problems, 10th revision** (ICD-10), as developed by the WHO. There are several ICD-10 codes for burn-related deaths and injuries caused by:

- electricity
- fire or flames
- hot gas, liquid or objects
- radiation
- steam and
- other thermal sources.

There are also numerous codes for fire/flames alone, including inside or outside of a building, different fuel sources (e.g. bed or sofa), smoke inhalation and more (see for example the Centre for Disease Prevention and Control's coding for **exposure fire**).

In many countries, fatal fires or otherwise significant fires may be investigated by the fire service, the police or other authorities. Whether or not these data are publicly available depends on the city or country, its legal requirements and the details of such investigations. In suspected criminal cases, for example, the data may be unavailable pending finalisation of legal action.

Fire loss data are also collected by insurance companies. These data may be focused on injury and death, property damage or continuity of business operations. Such data are used by insurers to understand changes in hazards and risks (perils) insured, resource needs for payment on potential claims and setting of premiums. While insurers have considerable data on the fire performance of the buildings, facilities and businesses that they insure, details are typically proprietary and not made public. As above, some data may be restricted for legal reasons as well. In some cases, however, summary data from various sectors are made public.[3]

In some countries, to obtain a comprehensive picture of the fire loss problem, data from several sources need to be consulted. For example, fire incidents might be recorded and reported by the fire service, whereas injuries and fatalities are reported via national mortality and morbidity statistics. In Sweden, for example, it is necessary to look at the database on fatal fires held by the Swedish Civil Contingencies Agency (MSB), the database on forensic examinations held by the National Board of Forensic Medicine and the Cause of Death Register held by the National Board of Health and Welfare to gain a comprehensive picture.[10]

The **International Association of Fire and Rescue Services** (CTIF) Fire Statistics Centre collects, analyses and publishes select fire loss data from a number of countries and cities, an example of which can be seen **here**.[11] The data are obtained from responses to the requests of the Fire Statistics Centre and from published official statistical reports of various countries. Over the past several years, CTIF has collected data from as many as 61 countries. The CTIF 2019 report presents 2017 fire and loss statistics obtained from 34 countries and 35 cities as well as fire and loss data over the period 2013–2017, as obtained from 61 countries that have supplied data for one or more of the five years during the period. Apart from undertaking an annual questionnaire enquiry among national correspondents in participating countries, CTIF also makes use of relevant data published by the WHO in respect of its annual causes of death enquiry, in which many of its member countries take part.

Another source of international fire loss data is those consolidated by the World Fire Statistics Centre, an affiliated organisation of the **Geneva Association**, which in the past published the **World Fire Statistics Bulletin**. The Geneva Association is a leading international thinktank of the insurance industry which has been carrying out research for nearly 50 years. When it was in operation, the main objective of the World Fire Statistics Centre was to persuade governments to adopt strategies aimed at reducing the cost of fire, using fire loss statistics from some 20 countries. The World Fire Statistics Centre is no longer operating, and their last report was issued in 2014.

In some LMICs, in particular low-income countries, there may not be a national fire service or professional paid fire services. If there is a fire service, it may lack the resources to collect and publish detailed national fire loss statistics. In such cases, data from the fire service may sometimes be reported for major cities, but in other cases, only ICD-10 data are reported. ICD-10 data are reported to the WHO, which in turn reports global health estimates (GHE).[12] WHO GHE data are often cited as representing the global situation with deaths and injuries due to fire. The CTIF 2019 report data and the WHO GHE data for 2016 are used in the following sections.

2.1 Fire-related deaths

Obtaining a well-documented and consistent picture of fire-related deaths is challenging given the diversity and gaps in collecting and reporting the data.

2.1.1 WHO and CTIF data

Looking first at the most current WHO dataset, the overall total number of deaths worldwide that may result from burns associated with fire is estimated at about 152,000 in 2016. These data come from ICD-10 codes for burn-related deaths and injuries caused by flames. It is not known how many of these are related to different sources, such as cooking fires, structure fires (formal or informal), vehicle fires or outdoor fires.

Data from the CTIF Fire Statistics Centre from countries that reported over the period 2013–2017 reflect an average annual number of fire deaths at an estimated 41,874. More than 33,000 of these occurred in

LMICs, with 19,797 coming from India alone. Based on these data, more than 75% of fire-related deaths occur in LMICs. In the CTIF dataset, not every country reported in each year, and there are differences in how fire death data are reported across the countries. The 2019 CTIF report cautions the reader to keep in mind that every country has its own rules for reporting fire-related data when comparing statistics and that these rules change from time to time.

While some country estimates are similar between WHO and CTIF data, the differences can be significant. In Figure 5, fire deaths per 100,000 population are presented. The WHO and CTIF data from medium-high income countries and HICs align quite well, whereas in LMICs, the variability is significant. This trend can be seen across all data for countries represented in the CTIF report.

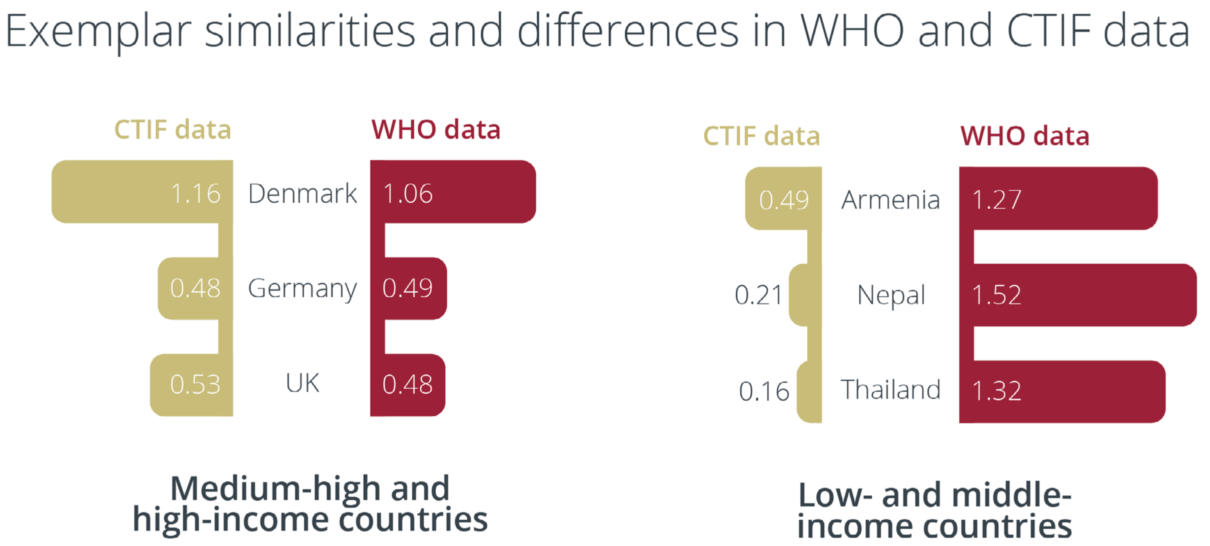

Figure 5: Example similarities and differences in fire deaths per 100,000 population

In the case of LMICs, the difference could have a significant impact on fire safety policies. For example, the data reported to CTIF suggest a much smaller fire problem compared with the WHO estimates, which in turn could result in fewer resources being allocated to the fire problem.

Other LMICs have even higher rates of fire deaths per 100,000 population, as seen in Figure 6 (using WHO data only). These stand in stark contrast to the rates of around 0.5 per 100,000 population for Germany and the UK (Figure 5).

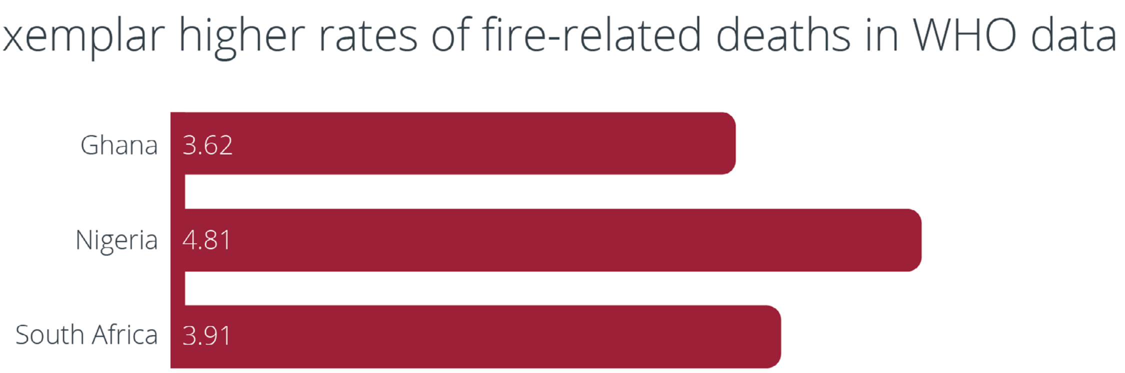

Figure 6: Deaths per 100,000 population in selected African countries

While CTIF estimates in LMICs are far less than the WHO estimates, they are still significant, even though the CTIF data do not consider about two-thirds of the total number of countries. This includes the African continent, China and numerous Asian and South American countries, a large majority of which are LMICs. It should also be considered that the data reported to CTIF primarily include structure or vehicle fires reported by the fire service, while the WHO data come from healthcare reporting, so fire sources may differ.

Likewise, the city data reflected in the CTIF dataset include very few LMIC urban centres. The fire problem in LMIC urban centres is much greater than in HICs, due to challenging factors such as informal settlements and informal construction, lack of robust and appropriate building and fire regulatory systems, lack of fire suppression infrastructure and lack of fire service capacity (see **Building Regulation for Resilience**, a World Bank Group programme that aims to tackle these obstacles by promoting good practice in building regulation. The recently released **Urban Fire Regulatory Assessment and Mitigation Evaluation** diagnostic is focused specifically on fire regulatory systems).

2.1.2 Other existing data in the EU

A 2012 study for the UK Department for Communities and Local Government (DCLG, now known as the Ministry of Housing, Communities and Local Government – MHCLG) that compared European fire statistics noted several types of reporting differences, including:

- Hungary only report deaths if within 72 hours of the fire.
- Swedish fire deaths are collated from Board of Health data rather than from fire services (unlike other states).
- Belgium, Italy, Slovakia and Bulgaria include all deaths at fires, including where a person dies from natural causes prior to the fire, while most other states exclude these.
- It is uncertain which types of deaths are included in Greece and Hungary, such as whether they exclude deaths unrelated to the fire.
- Czech Republic, Holland, Poland, Norway, Denmark, Cyprus and Iceland exclude deaths due to attempting to escape from a fire, such as jumping from a window.[13]

Some countries, such as Spain, do not have a systematic fire reporting system, and only limited data are generally available. Recent research has highlighted how media sources can be used to enhance the data, and how a more systematic approach can yield more useful data.[14] Likewise, comprehensive research in Sweden illustrates the challenges in obtaining data and the benefits that can be gained by exploring a breadth of data sources to characterise the fire problem.[15]

2.1.3 Other existing data in LMICs

Given the variation in a relatively small geographical area (Europe), it should not be a surprise that even more variation exists across global data, in particular for LMICs. Many LMICs do not collect comprehensive fire loss data through the fire service, and mortality data from national statistics do not yield sufficient information upon which to make good decisions.

The situation is exacerbated when there are multiple sources of potential data within a country and if there are limits placed on what data may be reported through which channels. As an example, consider a range of reported fire deaths in India. In India, fire-related deaths are investigated as potential homicides, so the National Crimes Records Bureau (NCRB) of India reports fire fatality data. The NCRB data suggest the number of reported fire-related deaths in 2017 was 13,159.[16] The CTIF data suggest the average annual number of fire deaths in India is about 19,797 (not reported for 2017). These data come from the response to an international survey. By contrast, the WHO data estimate the number of fire-related deaths to be 45,196. The WHO data come from the national sample registration system (SRS), which collects cause of death information for about 50,000 annual deaths using verbal autopsy. Verbal autopsy is a technique in which a trained interviewer uses a questionnaire to collect information about the signs, symptoms and demographic characteristics of a recently deceased person from an individual familiar with the deceased.

However, it has been suggested that the use of the verbal autopsy approach may result in underestimation of fire deaths, in particular with respect to fire injuries and deaths among women, and that the total number of fire deaths among women alone in India may be six times the national estimate for all fire-related deaths – closer to 106,000 per year.[17] Since all fire-related deaths are investigated as potential homicides, it is suggested that verbal autopsy may be inaccurate when interviewees have strong incentives not to disclose information and interviewers have a responsibility to report crimes. This is further complicated by variability in state practices on reporting fire deaths (e.g. medically certified versus estimated or not reported).

Variation in annual fire-related death estimates in India

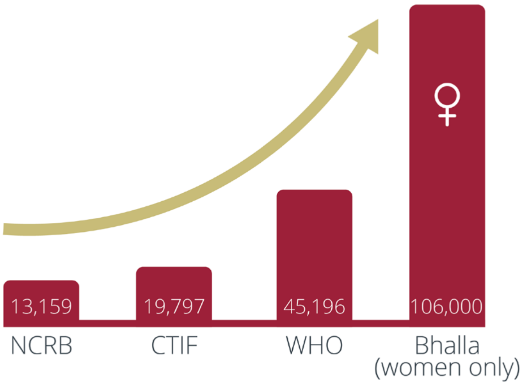

Figure 7: Differences in fire deaths in India by reporting entity (Bhalla estimates are for women only)

India is not alone when it comes to significant differences in reported and estimated fire deaths. There are few data reported from many LMICs in general, and the CTIF data, for example, does not reflect data from the African continent. Where reported data are found, the differences between local and WHO estimates are similar in magnitude to the situation in India. For example, data from the National Bureau of Statistics Nigeria indicate 278 deaths from fire in 2014,[18] whereas the WHO data suggest 8,950. Data from South Africa suggest a range from 529[19] to 2,328[20] and data from Ghana range from 379[21] to 1,021 as reported to the WHO. These data are reflected in Figure 8. While other countries may not have such extremes, these cases point to how significant the variability in reported data can be, and how cultural factors may play a role.

Exemplar differences in data estimates in Africa

Figure 8: Differences in fire deaths in African countries by reporting entity

2.2 Fire-related injuries

2.2.1 WHO and CTIF data

In addition to fatalities, the WHO reports that burns result in more than 7.1m injuries annually, which translates to the loss of almost 18m disability adjusted life years (DALYs). More than 90% of burn injuries occur in LMICs, with the WHO stating the African region bears nearly two-thirds of the total burden.[22] In India alone, over 1m people are moderately or severely burned every year.[23] Looking to the CTIF data on fire injuries, the average reported over the period 2013–2017 is 68,697 for the countries in the dataset. This is far below the WHO data, perhaps a function of the limited number of LMICs in the CTIF dataset, as well as the fact that WHO data reflect injuries and DALYs due to burns, of which not all are fire-related. An overall comparison of deaths and injuries between WHO and CTIF data is illustrated in Figure 9.

Comparison of WHO and CTIF data on fire-related deaths and injuries

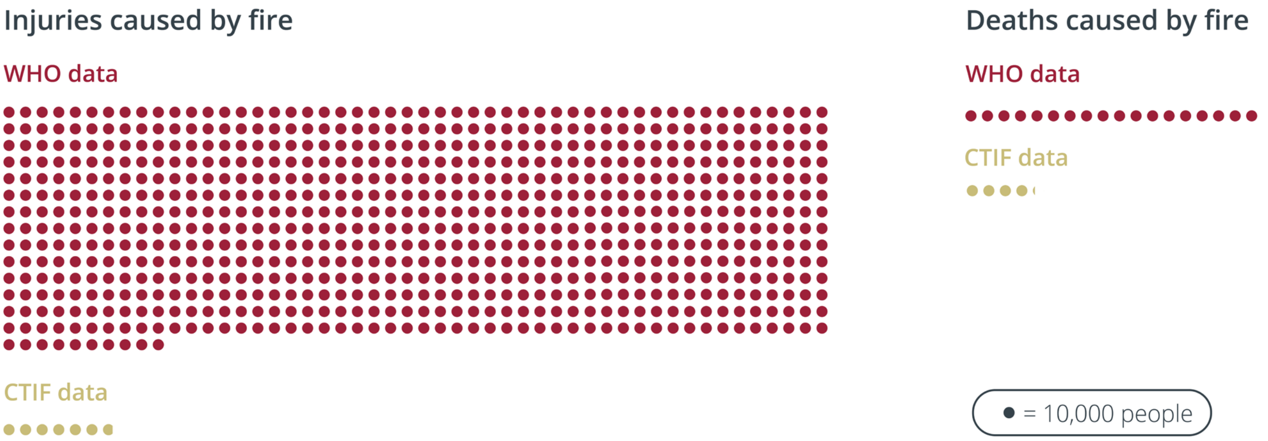

Figure 9: Overall WHO and CTIF fire death and injury comparison

2.2.2 Other existing data

Part of the challenge, as with recording or estimating fire deaths, is the disparity between data reported by first responders (the fire service) and data recorded in hospitals. For example, a report by the US Consumer Products Safety Commission reviewed 2002–2003 fire injury data in the US, noting that an estimated 48,202 fire-related non-arson civilian injuries were treated in hospital emergency departments. Of those, 21,174 injuries were estimated to be from fire department-attended fires and the remaining 27,028 were estimated to be from fires not attended by the fire service.[24] The estimates in this report were much higher than those of NFPA, suggesting that when the injured have left the scene before fire department arrival, or are transported by someone other than the fire service, the injury may not be recorded by the fire service. Here again, research is needed to truly understand the fire-related injury total and risk reduction options.

2.3 Fire incidents

Data regarding fire initiation and spread are less reported than data regarding deaths, injuries and number of fires. As used here, fire initiation data includes sources of potential ignition and first materials burning, while fire spread data reflects the development of the fire beyond the first item burning, sometimes referred to as 'extent of fire spread'.

'Extent of fire spread' may be reported as:

- confined to item(s) of fire origin or first materials burning
- confined to compartment of origin
- confined to floor of origin and
- confined to building of origin.

This level of detail is sometimes captured in national data, such as from the Home Office in the UK, NFPA in the US or FDMA in Japan.

Unlike the WHO data for fatalities and injuries due to burns (many of which result from fire), there is no comparable global dataset on fire incidents to compare with the CTIF data. It is therefore necessary to seek individual country or city data. Furthermore, there is no uniform way in which countries report data, so it is not even clear what breadth of fire incidents the data from countries in the CTIF dataset represent. This also makes comparison difficult. Since the basis is unknown, it can be challenging to apply the data in an appropriate manner. For example, if building fires were being assessed, the focus of concern would be structure fires, and not all reported fire incidents.

2.3.1 CTIF data

The average number of fire incidents per year reported over the period 2013–2017 within the CTIF dataset is 3,535,053. It should be noted that while not every country reports data in the same way, the total is largely based on fires reported to and by the fire service. Overall, this total is dominated by an average annual value of 1,309,000 in the USA. The next highest number is France at 289,155, followed by Italy, Germany and Great Britain in the upper 100,000s and lower 200,000s.

The 2019 CTIF data reflect fires reported in structures, vehicles, forests, grassland, rubbish and 'other' for 23 countries. Just over half of the countries are EU member states (MS), but Russia, Singapore, New Zealand, the US and some other countries are also included. As with fire deaths and injuries, no data are included from the African continent, China or numerous Asian and South American countries, a large majority of which are LMICs.

2.3.2 Other existing data in HICs

A study conducted by the Netherlands Institute for Safety, Nibra – commissioned by the Consumer Council at the Austrian Standards Institute and funded by the Austrian Ministry for Labour, Social Affairs and Consumer Protection – compared some data on domestic fires in various European countries and select other countries.[25] The report presents limited fire initiation (causes) data, such as smoking materials, electrical appliances, heating appliances, etc. for Denmark, the Netherlands, Sweden and the UK, as well as Australia, New Zealand and the US. It is not reported whether the same countries collect extent of fire spread data. Both data types are important, however, in understanding how and to what extent building construction and fire safety features mitigate (or not) the spread of fire and smoke throughout a building.

Since much of the data reflects EU MS, observations from the 2012 UK DGLC comparison of European fire statistics provides insight into data variability. In this report, it was noted that all MS record the number of fires, except for respondents from France, Malta and Slovenia.

However, there are several inconsistencies in the recording and reporting of data, including:

- Some MS exclude certain types of fires such as outdoor fires and fires in derelict buildings.
- Some MS (Holland, Estonia, Spain and Ireland) exclude fires to which the fire service was called but which were extinguished before their arrival.
- Some MS (Luxemburg, Italy, Norway, Sweden, Cyprus, Slovakia, Czech Republic and Hungary) include fires in chimneys as fires in buildings, while others treat these as a separate category.
- Lithuania and Greece also include fires in the garden that do not spread to the building as a fire in a home.
- 16 of the MS (90% of respondents who report fires) stated they subdivide non-residential fires into categories such as school, shop, hotel, etc. However, the subcategories used for building classification vary greatly between the MS.

Additional variation regarding incident reporting across Europe has also recently been noted.[26]

The global variation can be even greater than within Europe alone. The data from the US, for example, reflects all incidents – including structure, vehicle and outside fire. In 2018, structure fires constituted only about 500,000 fires, with over 600,000 being outside fires and about 181,000 being vehicle fires.[27] Furthermore, the NFPA statistics include fire data by 11 types of building classification, including three variants on residential: one- and two-family homes, apartments and other.

2.3.3 Other existing data in LMICs

As noted, some EU MS do not include outdoor fire and vehicle fires, and the classification of buildings varies greatly. The diversity is even greater in LMICs. In Nigeria, for example, only two types of buildings are classified in the fire loss data: domestic/private and factory/industrial. In addition, NFPA estimates do not include fires handled exclusively by federal, state or private fire brigades that were not reported to local fire departments. Further complicating the situation, residential properties with monitored fire detection and alarm systems tend to have numerous calls in response to burned or overheated food. Depending on the responding fire department, some call these false alarms, some call them confined cooking fires, some smoke scares and some overheats. As such, monitored systems can result in an increase in documented minor incidents. Increases can also be expected in LMICs and others where reporting systems become better organised, making it hard to establish whether there are indeed more incidents, or whether it is simply the case that more incidents are being recorded.

It is also worth considering the difference between housing fires that take place in informal constructions and settlements and those that take place in houses constructed according to building regulations. Data from South Africa suggest that the number of reported fires in informal dwellings is on par with fires in formal construction. However, the impact of fire in informal settlements can be far greater, dislodging as many as 10,000 or more people in a single event,[28] as occurred in the **Bangladesh slum fire** in 2019.

Further analysis of the South African fire data found that while informal settlement fires only account for an average of 10.3% of all fires, they result in an average of 50% of the total number of fatalities.[19] The analysis further notes that since 2014, the fire fatality rate has remained relatively constant, fluctuating between 4.02 and 4.63 fatalities per 100 fires, with an average of 4.3. It is interesting to note that during this period, the fire fatality rate in informal dwellings is more than double the fire fatality rate for formal dwellings, which is around 2.0.

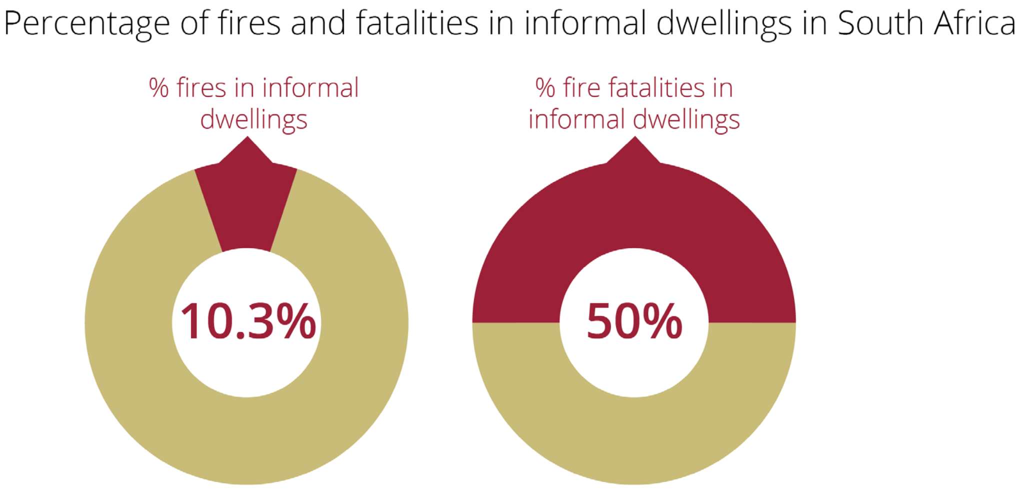

Figure 10: Percentage of fires and fatalities in informal dwellings in South Africa, created using statistics presented in research by Flores Quiroz, N. et al[19]

The way in which the data report the cause of fire, and perhaps other factors, may also be unclear. For example, reporting fields for fire cause might include 'open flames' and 'cooking appliances', among others. In many LMICs, particularly in informal settlements, both cooking and heating may be carried out over open flames. So, while summary statistics imply that the leading cause of ignition is open flames, accounting for 27.1% of all ignition sources, given that open flames are used for cooking, heating or lighting purposes, the information presented does not provide enough detail to develop preventive measures and to make an accurate classification.

It is also important to consider the additional challenge of how fire investigation and reporting is influenced by the education, training, experience and biases of investigators. In LMICs, social pressures on individuals (as in the case in India noted in section 2.1.3) and in communities to not report the actual cause of fires (in informal settlements, for example), as well as the lack of resources for fire investigations and reporting, can have an impact. Furthermore, the extent of property loss can be significant, both for individuals and communities, as fires can wipe out major portions of informal settlements, resulting in individual and social losses.

Figure 11: Aftermath of fire in informal settlement (photo by Bradyn Hopkin © Justin Sullivan, reprinted with permission)

2.4 Fire service resource limitations

2.4.1 CTIF data

CTIF collects and reports fire service statistics as well as fire loss data. This includes fire service deaths and injuries, but also the number of fire stations, fire engines, fire ladder trucks and firefighters, whether they are full-time or part-time firefighters or volunteers. These data can be helpful when assessing the overall fire safety problem in a country, as they can provide an indication of whether the fire service has suitable capacity to carry out rescue and suppression activities. As with the data on number of fires, deaths and injuries noted previously, the CTIF dataset is limited, and does not include data from the African continent, China and numerous Asian and South American countries, a large majority of which are LMICs.

2.4.2 Other existing data in LMICs

In many LMICs, one of the many fire safety challenges is the lack of fire service resources. For example, consider the city of Lagos, Nigeria, which has a population of about 14m inhabitants. In 2011, research was carried out to determine the extent of fire service resources. It was discovered that there were only 29 fire stations (state-supported and private sector) and a total of 1,154 firefighters.[29] Both totals are quite low.

The extent of the problem in Nigeria is summarised by Fidelis Ogbogoh, the former number one fire officer in Nigeria, in an opinion piece to the Guardian in 2015, in which he writes:

> 'At present, Nigeria has a total of 252 ill-equipped and poorly-manned fire stations, covering a geographic area of 909,890 square kilometers in 774 Local Government Areas. In effect, one fire station takes care of three Local Governments, with an average population of over 450,000 living in a space area of approximately 2,637 square kilometres.' [30]

Another example is the gap in fire service resources in India, which has deficits of:

- 65.1% in the number of fire stations needed
- 90.8% in the number of fire personnel needed
- 79.5% in the number of firefighting appliances and
- 94.2% in specialised firefighting equipment.[31]

By comparison, CTIF data indicates that the city of Chicago, US, which has a population of about 5m, has 100 fire stations and 4,500 firefighters covering an area of approximately 766 sq km and that Paris, France, which has a population of about 6.7m, has 76 fire stations and 7,800 firefighters, covering about 760 sq km.[11]

3 Developing a global standard for fire reporting

Achieving global consistency in fire reporting is a significant challenge that can only be accomplished through the implementation of three key steps. First, the political will and necessary resources for collecting, analysing and reporting data at national levels worldwide need to be raised. The value proposition for investing in such systems and the access to resources are essential factors. Second, a broad consensus on what data should be collected and how they should be reported needs to be reached. The requirements are likely to vary between countries because of differences in language, socioeconomic conditions, fire service culture and political systems. Third, clear feedback mechanisms should be implemented that provide input into fire risk mitigation efforts through regulation, better risk communication with the public, appropriate resourcing of the fire service and investment in fire protection measures. The focus in this section is on the first step: obtaining the resources required to implement a global standard for fire reporting.

3.1 Data collection needs in medium-high income countries and HICs

Many medium-high income countries and HICs already have detailed methodologies for fire data collection, such as the **National Fire Incident Reporting System (NFIRS)** in the US or the Home Office's online **Incident Recording System (IRS)** in the UK. These are well-documented systems that have the capacity to capture a large amount of data, which can be used for risk mitigation policy and investment decisions.

However, these systems and the data collected are not without fault. One problem is the variation in what data are collected and how they are presented. This problem is widely recognised, and some efforts are underway to rectify it. In addition, there are also challenges regarding the data quality.[32, 33] This can result from a number of factors, including training, experience and commitment to complete reporting, which can be challenging after a fire call in the middle of the night. Furthermore, just having the data is not enough. In the US, while national data are reported through NFIRS, which operates under the US Fire Administration, these data are complemented by further data and analysis conducted by NFPA, a non-governmental organisation.

In 2014, ISO published the technical report **ISO/TR 17755:2014 Fire safety — Overview of national ire statistics practices**. This report, developed under ISO Technical Committee (TC) 92, Working Group (WG) 13, assembled data on the national fire statistics practices of ten countries: Australia, Canada, China, France, Japan, Kenya, Korea (Republic of), Russia, United Kingdom and the US. The report is organised into four sections:

- basic aspects of data collection and analysis
- general characteristics of fires
- characteristics related to cause of ignition and
- characteristics related to mitigation of fire severity.

Within this ISO report, the survey instrument is included as Annex A, and the details of the coding system used by FDMA in Japan are provided as Annex B.

In total, there are 25 sections in the ISO report, which include responses from the 10 participating countries presented in tabular format. The topics include:

- methods of estimation (e.g. simple count or with statistical treatment)
- fire deaths subject to reporting
- victim characteristics
- occupancy classification
- type of construction
- fire protection features present and
- source of ignition.

While ISO/TR 17755:2014 does not provide guidance for the collection of data, because it presents the survey questions and outcomes of the survey, the contents provide a potential roadmap regarding what might be considered within a standard approach for data collection. The report also further confirms variation in definitions, types of data collected and level of detail reported between countries. Discussions are underway within ISO TC92 regarding development of guidance on fire data collection.

In addition to the work in ISO, a new project by the European Commission (EC) hopes to harmonise fire data reporting in Europe. The new project aims to:

> 'map EU countries' terminology and data collection regarding fire events to propose a common terminology and data collection method across all EU countries [...] to obtain meaningful datasets (based on standardised terms and definitions). At EU level, this will allow knowledge-based decisions on fire safety regarding building fires (i.e. fires in houses, apartment blocks, office buildings, commercial buildings, hospitals, schools and kindergartens, etc.).'[34]

It is feasible that ISO/TR 17755:2014 might be one of the documents used as a starting place for the EC-supported effort as well as for a global standard for fire reporting.

Some private sector entities have also begun to develop means for consistent reporting of fire-related data. In South Africa, for example, the firm SYW has developed **FireWeb**, a mature, web-based information, incident and communications tool that has been tailor-made for fire and rescue services and has been successfully utilised in national, provincial, district and local government throughout South Africa. It is important to note that insurance companies also collect fire data, which can help paint a broader picture of the fire loss situation. However, these data are often proprietary and are not always available to researchers and policymakers.

3.2 Data collection needs in LMICs

Obtaining accurate fire-related data in LMICs is increasingly important given the rapid growth in population and rapid urbanisation. Citing UN data, it has been noted that in Africa:

> '...the current population of 1.2 billion is expected to grow to around 2.5 billion by 2050, whilst at the same time the proportion of people living in urban areas is expected to increase from 40% to 56%. This means that the urban population will grow by around 920 million

people in the next 30–35 years. It is inevitable that there will be insufficient housing, leading to larger numbers of people living in informal settlements where fire safety is very poor.'[35]

More broadly, it has been noted that:

'Over 90% of urban growth is occurring in the developing world and an estimated 70 million new residents are added to urban areas of developing countries each year. Over the next two decades, the urban population of the world's two poorest regions — South Asia and Sub-Saharan Africa — is expected to double, suggesting that the absolute numbers of informal settlement and slum dwellers in these regions will dramatically grow.'[36]

Developing good fire loss data is essential to creating policies and strategies for facilitating fire-resilient communities and to measure their success during this future population and urban expansion. This can be supported by the establishment of fire data systems and more appropriate regulatory systems so anticipated development occurs in a safer and more resilient way.

While the ISO international benchmarking exercises are helpful and the EC project for European fire data collection will be good for European harmonisation, it is worth considering that the development, implementation and proper use of a rather detail-oriented system (i.e. hundreds of data points) may prove problematic for LMICs, particularly where fire service resources are significantly limited.

If there is not currently a fire incident reporting system in a country or city, then the resources needed to develop, implement and effectively use a fire incident reporting system could be considerable. In addition to the development of the instrument itself – which would require the development of questions and information management systems – there would need to be adequate resources to collect and input the data, which in turn would require training and support. Resources for data analytics, long-term maintenance of the system and related factors would also need to be addressed. Private-sector tools such as FireWeb may be part of the solution, but may still not deliver all of the desired features.

Data collection in LMICs also needs to focus on the challenges and needs specific to LMICs. Recent efforts in this space include:

- the World Bank's **Building Regulation for Resilience** program, in particular the **Urban Fire Regulatory Assessment and Mitigation Evaluation** (Urban FRAME) diagnostic
- the **Improving the Resilience of Informal Settlements to Fire** (IRIS-Fire) collaboration between the University of Edinburgh, UK and Stellenbosch University, South Africa and others
- the **framework for fire safety for informal settlements** developed by Arup through interdisciplinary research and close collaboration with those affected by fires in informal settlements
- the **framework for fire investigation in informal settlements**
- the **guidelines for fire safety engineering guidelines for informal settlements**.

These are examples of the types of cooperative and integrated approaches needed to create a common language and structure, which is robust yet flexible enough to accommodate cultural differences.

3.3 Global leadership

At present, there is no organisation with a clear leadership role in the fire incident reporting space. Wide variations exist between countries, and many LMICs lack the capacity to move forward on their own. While some work has been conducted within ISO, and a new EC-focused project is underway in this area for Europe, there is not yet global participation.

To move forward in the development of a global set of standards for fire incident reporting that incorporate the views and are cognisant of the resource limitations in LMICs, global leadership, inclusivity and resourcing is required. There needs to be a champion, adequate funding and widespread engagement from countries around the world.

An obvious champion is the **International Fire Safety Standards (IFSS) Coalition**. An aim of the IFSS Coalition is to provide global consistency in understanding, classifying, defining, measuring, analysing and presenting a holistic understanding of fire safety on different scales, i.e. building, project, regional, state, national or international level. The first product developed by the IFSS was the **International Fire Safety Standards: Common Principles**, which defines fire safety expectations for buildings and infrastructure. The aim is that countries and markets can adopt these fundamental principles to achieve minimum levels of fire-safe design.

Moving forwards, the IFSS Coalition could take on the task of developing a globally consistent set of standards for fire incident reporting, drawing on the concepts and work products outlined in this paper. With its range of highly respected members, the IFSS Coalition has the capability to produce a quality product, and if it could be connected with the EC effort, the result could be even greater. The IFSS Coalition could take advantage of its connections with the UN and the World Bank to reach a broad sample of countries, in particular LMICs, which arguably have the most to gain from such an effort.

Another potential champion for this cause could be ISO. ISO TC92 WG 13 could initiate a project with the aim to develop an ISO standard for fire incident reporting. Since this group has already published survey results on this topic and has members who represent entities that publish fire loss statistics, such as NFPA, it could be a suitable leader. A potential downside, however, is that this ISO working group only has active members from a small number of countries. If input and development is limited to a small group of ISO members, it may miss important contributions and considerations, especially from LMICs. Also, a group that is already a recognised leader in fire data analysis, such as NFPA or CTIF, could be a potential champion.

3.4 Resource requirements

The resources required to adequately advance robust fire incident reporting on a global basis are considerable. Support is needed to reach out to all countries, benchmark the current situation and assess what is needed to facilitate a common fire incident reporting system globally. Ultimately, resources will also be needed for implementation, use and maintenance globally, in particular in LMICs. This type of effort has been successful before, such as the **100 Resilient Cities** scheme, which was operated through the Rockefeller Foundation and partner organisations.

Plans for resourcing would fit well within the IFSS Coalition's global plan for the 'Decade of Action for Fire Safety' ('the Decade'). The plan is intended as a guiding document that will facilitate coordinated and concerted action towards the achievement of the goal and objectives of the Decade. It provides a context that explains the background and reasons behind the aim of a declaration of a Decade by the UN Economic Commission for Europe (ECE) and serves as a tool to support the development of national and local plans of action, while simultaneously providing a framework to allow coordinated activities at the global level. It is directed at a broad audience that includes representatives of national and local governments, civil society, professional bodies and private companies willing to align their activities over the next decade with the global framework.

A UN-supported Decade would provide a timeframe for action to encourage political and resource commitments to fire safety both globally and nationally. Partners could use the Decade as a stimulus to integrate fire safety into their assistance programmes. LMICs could use it to accelerate the adoption of effective and cost-effective fire safety programmes and standards, while HICs could use it to make progress in improving their fire safety performance as well as to share their experiences and knowledge with others. The partnerships between HICs and LMICs, along with NGOs, industry and others, could result in exciting learning opportunities in all directions.

Development and implementation of globally consistent and robust fire incident reporting systems, and the local capacity to support them, would require significant investment, but would also fit well with programmes such as the **World Bank Building Regulation for Resilience**, **Disaster Risk Management**, **Resilient Cities** and more. It would also align with the **United Nations Sustainable Development Goals** and the **United Nations Office for Disaster Risk Reduction**. The participation and support from these organisations – and many more – would be critical to the effort.

3.5 Other needs

Instituting data collection systems and collecting the data is only the start of what is needed to engage in the development of good policies on fire risk management. It is also important to:

- explore how geographic information systems (GIS) and other satellite system databases, drones, smartphone photos and video and social media posting and other current and emerging technologies can be used, along with data analytics, to enhance data collection. Use of ubiquitous technology, simple recording schemes, artificial intelligence and other innovations should be explored and may be necessary to facilitate better and broader data collection and storage
- institute good quality assurance systems in the data collection systems. Developing a data quality assessment scheme, along with a data gathering quality assessment scheme, will be helpful in identifying and maintaining both the quality and appropriateness of data for policy decisions
- develop better data analysis tools, which can be used to help evaluate better critical fire factors and efficacy of mitigation measures, and which perhaps can assist in correlating between mortality data (e.g. WHO data), insurance data and fire fatality data. Use of 'big data' and data analytics may be helpful in collection, quality control and appropriate use of the data
- fully understand the risk-cost-benefit relationships associated with investments in fire safety – at all levels – in the context of benefits to be realised within a country.[37] These relationships are likely to vary significantly from LMICs to HICs due to the differences in type, magnitude and impact of daily risks and impacts of risk mitigation investments. Tools such as the life quality index (LQI) approach and others may be useful in guiding such discussions[38, 39]
- consider new methods to calculate the losses from fire that improve inclusion of societal impacts. For example, if financial losses are too heavily weighted in an urban fire assessment, losses in informal settlements may not appear to be a problem. The displacement and relocation costs could be significant
- look across the whole of the building and fire safety system – regulations, fire service capacity, industry, materials, practitioners, technology and the society served – to develop a holistic and integrated approach.[40] As a sociotechnical system, it is necessary to take into account all aspects of institutions, technology and society to help ensure societal targets are being met, and if not, how unintended consequences might occur[41]

- develop strategies for implementing the systems that are developed. Identifying what data should be collected and why is important, but it is also necessary to develop and facilitate implementation strategies for such programs to be successful
- develop policies regarding data ownership and data sharing, including the protection of intellectual property/personal information, who should have access to the different levels of data and how the data may be used.

4 A tiered approach to data collection

This section deals with the second step outlined at the start of section 3: determining what data should be collected. From a practical perspective, the development and implementation of a globally consistent and robust fire incident reporting system may need to be developed in such a way that it can be implemented first at a low level that uses 'on the ground' resources, input and maintenance. As more local resources become available, more features of the system could be applied. Therefore, a 'tiered' approach might be a useful way of providing global consistency with due attention to local capacity. In other words, the tool could be designed to facilitate collection, analysis and reporting of the breadth of desired data, but implemented in a way that even resource-limited cities and countries can collect and report basic data.

It should be noted that the exemplar tiers presented in this paper may not be applicable for all situations, and further aspects may be needed, particularly to address informal settlements in LMICs. In informal settlements, there may be additional problems of significant loss of housing and displacement of very large numbers of people. Here, the data collection and reporting needs may be different. When open flame is used for cooking, heating and lighting, the risks may be higher, and the way in which data are collected on the cause of fire may need more care. Even the specification of a 'dwelling' may have significant variation, both in construction materials and the fact that multiple families may live under the same roof. There may be similar challenges in collecting appropriate wildland and WUI fire data.

It is also important to note that, ultimately, the data that are needed to inform local (national) policy decisions may not fit nicely into the exemplar tiers. While the focus may be on a particular tier, data from another tier may be required due to the circumstances of the particular country. It may also be the case that different data are needed. These challenges are recognised; the exemplar tiers are presented here to help facilitate discussion around what data are needed, for which decisions and how best that data may be obtained.

Finally, consideration will need to be given to the quality of the data that can be collected, and therefore how well it reflects the fire problem and the extent to which it can reliably inform policy decisions. This can vary by country and by situation. For example, in order to capture reliable and robust data on the cause of a fire, care is needed to minimise potentially overlapping classifications such as 'open flame' and 'cooking', especially if the prevalent approach to cooking is by open flame.

4.1 Tier 1: fundamental data

As a starting point, an adaptation of the main data areas reflected in ISO/TR 17755:2014 might be considered, including areas such as:

- method of estimation
- fires subject to reporting (i.e. what is reported and what is omitted)
- fire deaths subject to reporting
- fire injuries subject to reporting

- ignition source (to identify trends and develop an action plan for improvements)
- cause and origin (e.g. interior, exterior, accidental, deliberate or natural. In basic systems, causation could be recorded as either accidental or deliberate; in refined systems, it may be possible to draw information that would help target resources for prevention campaigns)
- building construction basics (e.g. material, height, area, etc.)
- location of the fire (physical address)
- area of fire involvement (e.g. building, settlement, wildland and WUI areas)
- number, location and coverage of fire stations (in CTIF data, not in ISO data) and
- number of firefighters (in CTIF data, not in ISO data).

Such a dataset is largely consistent with the 2012 report developed for the UK DCLG. The cost of fire is not included in tier 1, since there are no uniform approaches to defining or estimating cost of fire at the moment. This is a critical aspect that needs to be developed to understand the economic impact of fire in component parts such as the property, occupants, fire service, insurance and environment, and aggregated at different scales, e.g. the building, city or country. Basic information on fire service capacity, such as that given in the CTIF survey, provides a good starting point.

4.2 Tier 2: additional details

The next tier would provide data at a much more detailed level. While all of these data would be helpful from the outset, it is recognised that significant resources may be required to collect, log and report data at this level. If appropriate tools are available to local fire services (e.g. apps, data analytics, remote sensing and reporting mechanisms, etc.), the implementation of this tier could occur more quickly. The data collected would include:

- victim characteristics (e.g. age, gender, cause of injury or death, etc.)
- property damage subject to reporting (e.g. extent of fire damage, such as contained to object of origin, enclosure of origin, fire compartment of origin or room of origin)
- other losses subject to reporting (e.g. contents)
- building construction details (e.g. envelope construction, roof construction, interior, etc.)
- heat sources present
- equipment involved in ignition
- first materials burning
- fire detection and alarm equipment present (and condition)
- fire extinguishers present (and condition)
- sprinklers and other suppression equipment present (and condition)
- smoke control/management equipment present (and condition)
- fire/smoke rated compartmentation present (and condition)
- fire/smoke doors present (and condition)
- fire apparatus by station location
- fire service training requirements
- fire service training facilities

- firefighting water infrastructure and reliability and
- nominal fire service response times.

4.3 Tier 3: cost data

The final component would include items related to financial loss, both direct and indirect. This would help to establish a baseline of the financial impacts of fire on the local economy. Types of data that would be helpful include:

- estimated human costs (e.g. health, healthcare, burn care,[42] relocation, etc.)
- estimated cost of fire damage to structure (per event)
- estimated cost of fire damage to contents (per event)
- estimated costs to building/business operations (downtime, recovery)
- estimated community costs (e.g. local school)
- estimated societal costs (e.g. population relocation, loss of cultural resource)
- estimated cultural impact costs
- estimated cost of environmental impacts
- cost of fire service (personnel, facilities, equipment)
- cost of firefighting infrastructure needs (e.g. water supplies)
- insurance costs
- uninsured costs and
- repair, renovation and replacement costs.

At present, although estimates of the total cost of fire within individual countries have been calculated and published, no comprehensive and globally consistent approach to developing and comparing the component and total cost of fire exists. This makes it extremely difficult to assess both the existing impacts and costs, but also cost-benefit ratios for fire mitigation policies and strategies. This is an issue that affects countries of all economic levels.

4.4 Other helpful data

In addition to a globally consistent fire incident reporting system, a more in-depth study of the WHO data could be undertaken to separate fire-related deaths and injuries from other burn-related deaths and injuries (e.g. from scalding, hot surfaces, etc.). This would result in a more consistent and complete set of fire loss data.

5 Conclusion

This paper has presented the challenges involved with the collection and comparison of fire-related data between countries. The lack of uniformity and consistency in what data are reported and how the data are estimated makes it very difficult to find consistent, comparable data, even across medium-high income countries and HICs. Many LMICs do not report fire incident, injury or fatality data at all because of challenging factors such as a lack of resources, lack of formal building regulations, significant areas of informal construction, inadequate fire suppression infrastructure and little to no incident reporting. In cases such as these, it is extremely difficult to adequately characterise the problem, develop effective mitigation strategies and understand the costs and benefits of implementing risk reduction measures.

To address the deficiencies in reporting, and to make real progress on mitigating the unwanted impacts of fire, governments, non-governmental organisations and industry need to take the collection of fire safety data seriously. Efforts are needed to develop consistent language and collecting and reporting structures. Systems need to be implemented to capture the necessary data where none exists. Financial support is needed to support LMICs that lack the resources to do this today. Policy makers need to understand how the data can be used for efficient and effective fire risk mitigation measures. It will then be easier to direct appropriate resources to the avoidance, prevention, control and suppression of fire and to the fire service who fulfil an important public safety function.

Engagement by the fire community in global conversations on sustainability and resilience will help to demonstrate how resilience to fire can help communities and cities to achieve their wider goals of sustainable development and will help to secure buy-in and mobilise resources from global and local stakeholders. Likewise, partnership with national or subnational stakeholders who understand the local challenges and opportunities with fire risk and fire data in their countries and cities – and who can influence changes in their respective current systems where needed – is essential.

This paper has proposed a tiered approach to data collection, which encompasses a broad range of data types. If all countries were able to obtain the data outlined in all tiers, a global standard for fire reporting would be achieved. However, the advantage of this approach is that it can be implemented in stages. This means that countries facing resource limitations could still achieve a base level of global consistency. The tiered approach facilitates global agreement on data needs by providing a stepwise path that can be followed to achieve full implementation.

The aim of this paper was to start a discussion around the benefits of having a globally consistent method of reporting fire loss data, to identify challenges that need to be overcome and to present a possible pathway to achieve a global standard for fire loss reporting. It is hoped that the concepts outlined in this paper will be useful to the EC project on fire reporting, the ISO activities on fire reporting and countries looking to establish the infrastructure to collect and report fire data. If embodied within a framework such as the UN Decade, that could serve as a catalyst for facilitating funding for and widespread adoption of a standard, particularly in LMICs. Ultimately, implementation of such a global standard will be of immense help to governments and the private sector in understanding the global fire problem and informing appropriate risk mitigation strategies across all sectors and for all people.

References

1 Thomas, D. S. et al, **The Costs and Losses of Wildfires**, Special Publication (NIST SP) – 1215, National Institute of Standards and Technology, November 2017 (accessed 27 November 2020).

2 Filkov, A. I. et al, '**Impact of Australia's catastrophic 2019/20 bushfire season on communities and environment. Retrospective analysis and current trends**'. Article in *Journal of Safety Science and Resilience*, Vol. 1, no. 1, pgs. 44–56, September 2020 (accessed 27 November 2020).

3 '**Fires and explosions cause largest losses for business: Allianz global claims analysis**', *Allianz*, December 2018 (accessed 27 November 2020).

4 Zhuang, J. et al, **Total Cost of Fire in the United States**, Fire Protection Research Association, October 2017 (accessed 27 November 2020).

5 Smith, A. B., '**2010–2019: A landmark decade of US billion-dollar weather and climate disasters**', *NOAA Climate.gov*, January 2020 (accessed 27 November 2020).

6 '**Violence and Injury Prevention**', *World Health Organization* (accessed 27 November 2020).

7 Mizanuzzaman, M. 'Loss and Damage Assessment in the Context of Fire Hazards: A Study on Selected Garment Factories in Bangladesh'. Article in *International Journal of Finance and Banking Research*, Vol. 2, no. 2, pgs. 24–39, 2016.

8 **Remediation Financing in Bangladesh's Ready Made Garment Sector: An Overview**, Prepared by Emerging Markets Consulting for the International Labour Organization and the International Finance Corporation, June 2016 (accessed 27 November 2020).

9 Evans, B. A., '**Accord on Fire and Building Safety in Bangladesh: An International Response to Bangladesh Labor Conditions**'. Article in *North Carolina Journal of International Law and Commercial Regulation*, Vol. 40, no. 2, pgs. 597–627, Winter 2015 (accessed 27 November 2020).

10 Jonsson, A. et al, '**The state of the residential fire fatality problem in Sweden: Epidemiology, risk factors, and event typologies**'. Article in *Journal of Safety Research*, Vol. 62, pgs. 89–100, September 2017 (accessed 27 November 2020).

11 Brushlinksy, N. N. et al, **World Fire Statistics**, no. 24, 2019, CTIF (accessed 27 November 2020).

12 **Global Health Estimates**, 2016 dataset, World Health Organization (accessed 27 November 2020).

13 **Comparison of European Fire Statistics: Final report for the Department for Communities and Local Government**, Department for Communities and Local Government, 2012 (accessed 27 November 2020).

14 Férnandez-Vigil, M. et al, '**Elderly at Home: A Case for the Systematic Collection and Analysis of Fire Statistics in Spain**'. Article in *Fire technology*, Vol. 55, pgs. 2215–2244, April 2019 (accessed 27 November 2020).

15 Runefors, M., **Fatal Residential Fires: Prevention and Response**, Lund University, Department of Fire Safety Engineering, 2020 (accessed 27 November 2020).

16 **Accidental Deaths & Suicides in India**, National Crime Records Bureau, 2017 (accessed 27 November 2020).

17 Bhalla, K. et al, '**Fire-related deaths among women in India are underestimated**' in *The Lancet*, Correspondence, Vol. 395, no. 10226, pgs. 779–780, March 2020 (accessed 27 November 2020).

18 **National Fire Statistics of Nigeria**, *Nigeria Data Portal*, February 2016 (accessed 27 November 2020).

19 Flores Quiroz, N. et al, '**Developing a framework for fire investigations in informal settlements**'. Article in *Fire Safety Journal*, May 2020 (accessed 27 November 2020).

20 **Mortality and causes of death in South Africa, 2016: Findings from death notification**, Statistics South Africa (accessed 27 November 2020).

21 Addai, E. K. et al, '**Trend of Fire Outbreaks in Ghana and Ways to Prevent These Incidents**'. Article in *Safety and Health at Work*, Vol. 7, no. 4, pgs. 284–292, December 2016 (accessed 27 November 2020).

22 Rybarczyk, M. et al, '**A systematic review of burn injuries in low- and middle-income countries: Epidemiology in the WHO-defined African Region**'. Article in *African Journal of Emergency Medicine*, January 2017 (accessed 27 November 2020).

23 '**Burns**', *World Health Organization, March 2018* (accessed 27 November 2020).

24 Miller, D., **Estimates of Fire Injuries Treated in Hospital Emergency Departments: July 2002–June 2003**, Consumer Product Safety Commission, Washington (accessed 27 November 2020).

25 **Consumer fire safety: European statistics and potential fire safety measures**, Netherlands Institute for Safety (Nibra), January 2009 (accessed 27 November 2020).

26 Ruiter, M. et al, **Fatal residential fires in Europe**, Fire Service Academy, 2018 (accessed 27 November 2020).

27 Ahrens, M, et al, **Fire Loss in the United States During 2019**, NFPA, September 2020 (accessed 27 November 2020).

28 Kahanji, C. et al, 'Fire spread analysis for the 2017 Imizamo Yethu informal settlement conflagration in South Africa'. Article in *International Journal of Disaster Risk Reduction*, Vol. 30, October 2019.

29 Cobin, J. M., '**The Enterprise of Fire Safety Services in Lagos, Nigeria**'. Article in *The Independent Review*, Vol. 17, no. 3, pgs. 379–414, Winter 2013 (accessed 27 November 2020).

30 Ogbogoh, F., '**Memo to Buhari on fire disasters**'. Article in *The Guardian*, May 2015 (accessed 27 November 2020).

31 **Gap in fire services**, Ministry of Home Affairs Government of India, 2012 (accessed 27 November 2020).

32 **Conquering the "Unknowns": Research and Recommendations on the Chronic Problem of Undetermined and Missing Data in the Causal Factors Sections of the National Fire Incident Reporting System**, National Association of State Fire Marshals Fire Research and Education Foundation, 2014 (accessed 27 November 2020).

33 Kinsey, K. et al, **NFIRS Incident Types: Why aren't they telling a clearer story?**, NFPA, January 2016 (accessed 27 November 2020).

34 '**Closing data gaps and paving the way for Pan-European fire safety efforts**', European Commission, November 2019 (accessed 27 November 2020).

35 Walls, R. et al, 'Africa: The next frontier for fire safety engineering?'. Conference paper for *15th International Conference and Exhibition on Fire Science and Engineering*, London, July 2019.

36 **Informal Settlements**, Habitat III Issue Papers, United Nations Conference on Housing and Sustainable Urban Development, May 2015 (accessed 27 November 2020).

37 Ashe, B. et al, '**Total cost of fire in Australia**'. Article in *Journal of Risk Research*, Vol. 12, no. 2, February 2009 (accessed 27 November 2020).

38 Pandey, M. D. et al, '**The derivation and calibration of the life-quality index (LQI) from economic principles**'. Article in *Structural Safety*, Vol. 28, no. 4, pgs. 341–360, September 2006 (accessed 27 November 2020).

39 Fischer, K., **Societal decision-making for optimal fire safety**, 2014 (accessed 27 November 2020).

40 Meacham, B. J. et al, '**A socio-technical system framework for risk-informed performance-based building regulation**'. Article in *Building Research & Information*, Vol. 46, no. 4, pgs. 444–462, March 2017 (accessed 27 November 2020).

41 Meacham, B. J. et al, '**A holistic framework for development and assessment of risk-informed performance-based building regulation**'. Article in *Fire and Materials*, pgs. 1–15, November 2020 (accessed 27 November 2020).

42 Hop, M. et al, 'Costs of burn care: A systematic review'. Article in *Wound Repair and Regeneration*, Vol. 22, no. 4, pgs. 436–450, July–August 2014.

Delivering confidence

We are RICS. Everything we do is designed to effect positive change in the built and natural environments. Through our respected global standards, leading professional progression and our trusted data and insight, we promote and enforce the highest professional standards in the development and management of land, real estate, construction and infrastructure. Our work with others provides a foundation for confident markets, pioneers better places to live and work and is a force for positive social impact.

Americas

Latin America
ricsamericalatina@rics.org

North America
ricsamericas@rics.org

Asia Pacific

Australasia
australasia@rics.org

Greater China (Hong Kong)
ricshk@rics.org

Greater China (Shanghai)
ricschina@rics.org

Japan
ricsjapan@rics.org

South Asia
ricsindia@rics.org

Southeast Asia
sea@rics.org

EMEA

Africa
ricsafrica@rics.org

Europe
ricseurope@rics.org

Ireland
ricsireland@rics.org

Middle East
ricsmiddleeast@rics.org

United Kingdom RICS HQ
contactrics@rics.org

RICS®

rics.org