2017 RESILIENCE INDEX **ANNUAL REPORT**

pentland ANALYTICS

FM Global

EXECUTIVE MESSAGE

We are proud to present you with a powerful, strategic decision-making resource to help you gain insight into your business and supply chain risks throughout the world. The 2017 FM Global Resilience Index offers a detailed road map toward maximizing enterprise resilience. We hope these unique analytics will assist you when deciding where to site your operations or with choosing supply chain partners so you can produce without interruption.

Resilience is the ability to withstand disruption and rebound quickly. It becomes vital when your business is dependent upon more than one country as each has its own drivers of resilience, some of which may be unknown in developing countries.

The 2017 FM Global Resilience Index is more robust than ever at ranking 130 countries and territories according to their enterprise resilience to disruptive events. It pulls together authoritative global resources including data not publicly available, such as country-level rollups and supply chain risks. More data points and a more robust methodology have enabled us to enhance our measurement of key drivers of enterprise resilience across these regions. This information can help you better:

- Determine which locales are most resilient to disruptive events
- Site your facilities
- Select suppliers
- Evaluate your established supply chains
- Uncover customers who are vulnerable

You can dive deeper into the new data at www.fmglobal.com/resilienceindex. This online, interactive version of the FM Global Resilience Index is the first data-driven tool and repository of its kind. To ensure the independence of the analysis, we have commissioned Pentland Analytics, an advanced analytics firm focused on risk and shareholder value, to produce the FM Global Resilience Index.

The index can assist a variety of leaders and a wide range of organizations. **C-suite executives**—in particular, the **chief executive officer** (CEO), **chief operating officer** (COO) and the **chief financial officer** (CFO)—can use the index as a planning tool to strategically manage enterprise risk. Operational managers—such as the **risk or insurance manager**, the **supply chain manager**, or the **plant or facilities manager**—can access the index to easily find where vulnerabilities in different countries may lie. For the **insurance industry**, the index highlights geographical areas of potential risk aggregation, offering an additional resource for effective capital and cash flow management. While for **governmental agencies**, the index underlines the need for attention in areas such as **zoning, urban planning** and the revision of **building codes**. Fortifying resilience to disruption is essential for protecting stakeholders against tragedy and loss, and sustaining long-term economic performance.

For more than 180 years, we have been convinced that most loss is preventable, not inevitable. Let the Resilience Index help you reduce risk within your enterprise and make you more resilient.

Because when you're resilient, you're in business.

Regards,

Jonathan W. Hall
Chief Operating Officer
FM Global

EXECUTIVE SUMMARY

The year 2016 was wrought with challenges across the globe. Hurricanes, earthquakes, terror and political upheaval all took a toll. In addition, three emerging drivers of resilience have come to the forefront in recent years that are now included in the index: the rate of urbanization, inherent cyber risk and supply chain visibility. Resilience against events that could disrupt operations is a top priority for business executives seeking to minimize risk and maximize performance across their operations. The ability of businesses to overcome disruptions throughout the world can make all the difference.

The 2017 FM Global Resilience Index is an annual ranking of 130 countries and territories according to their enterprise resilience to disruptive events. Rankings are calculated as an equally weighted composite of 12 core drivers that affect the enterprise resilience of countries significantly and directly. The historical data in this year's index has been updated and calculated on this new basis for each of the last five years to enable valid historic comparison. The key results are summarized below.

2017 KEY RESULTS

Switzerland occupies the top position in the FM Global Resilience Index. This reflects the fact that Switzerland is among the best in the world for its infrastructure and local suppliers, its political stability, control of corruption and economic productivity. **Luxembourg** has risen gradually from eighth in 2013 to second in 2017, owing partly to its reduced reliance on oil for economic productivity. This reflects the continued growth in the importance of its services sector. Luxembourg enjoys a strong reputation for its financial sector, its network of service providers, and its responsive, business-friendly regulations. The country is well-placed to benefit from financial institutions that may be seeking a new home, post-Brexit, following the United Kingdom's departure from the European Union.

The lowest-ranking country in the index is **Haiti**, which is among the poorest countries in the world. Ranked second to last, **Venezuela** is hampered by exposure to wind and earthquake, perception of extensive corruption, poor infrastructure and ill-perceived local supplier quality.

Inherent cyber risk can have a tremendous influence on enterprise resilience and is a driver added to the 2017 index. It combines equally a country's vulnerability to cyber attack with the country's ability to recover from such an attack. In general, countries ranking high in internet penetration and low in civil liberties rank lowest for cyber risk. Middle Eastern countries have a particularly high exposure to cyber risk. In fact, the four countries ranking lowest in the index for inherent cyber risk are **Saudi Arabia** (ranked 56), **Bahrain** (ranked 44), **United Arab Emirates** (ranked 32) and **Qatar** (ranked 13).*

The 2011 floods in Thailand brought the flooding problem prominently to global attention, but the disruption it causes to business operations is a continuing occurrence. The six Asian countries in the FM Global Resilience Index that have the largest area devoted to economic activities exposed to riverine flood are **Pakistan** (ranked 125), **Laos** (ranked 113), **Bangladesh** (ranked 111), **Thailand** (ranked 97), **Vietnam** (ranked 95) and **China** (ranked 68, 72, 66)[1].

*Rankings shown are the composite of all 12 drivers.
[1]China is subdivided into three ranked regions because its geographical spread encompasses disparate exposures to natural hazards.

Urbanization rate is related often to the toll taken by natural hazards and is a driver of resilience newly added to this year's index. Countries in the index with significant flood exposure and high urbanization rates include **Bangladesh** (ranked 111), **Thailand** (ranked 97), **Vietnam** (ranked 95), **China** (ranked 68, 72, 66)[1] and **India** (ranked 60). These major global manufacturing hubs are susceptible to flooding, so the potential for severe disruption across business operations and global supply chains is considerable.

Supply chain visibility, another new driver within the index, is the ability to track and trace consignments across a country's supply chain. **Vietnam** (ranked 95), with its thriving manufacturing sector increasingly important to the global supply chain, dropped eight places in the index since last year, owing primarily to poorer supply chain visibility.

Now, with years of data based on the FM Global Resilience Index algorithm, a noticeable level of consistency can be seen in terms of country rankings around the world. Countries at the top or bottom of the index tend to retain their status. However, new risks that affect a country may emerge and FM Global will monitor these continually to provide the most accurate assessments of enterprise resilience for its clients and organizations around the world.

ENHANCED RESILIENCE WITH THIS NEW, IMPROVED INDEX

A good index should evolve as better data and analytics become available. A significant enhancement to the index this year is the inclusion of three new drivers of resilience: urbanization rate, inherent cyber risk and supply chain visibility. Each is highly topical and central to enterprise resilience. These are examined in the subsequent section of this report, "New Drivers Included," on page 6.

For companies with international operations, enterprise risk can be significant and complex. Any disruption to timely or actual delivery of product has a direct impact on a company's reputation, market share and financial performance. Sudden disruption to a company's operations can be triggered by a natural disaster or a corporate crisis, by fire or explosion, by a terrorist or cyber attack, by an oil price shock or civil war. The sources of interruption are many and the timing often unexpected. The relative prominence of each peril varies each year, but the overall threat to enterprise resilience remains intense.

The ability of companies to respond effectively to a sudden and unexpected rupture within their global operations is critical to the maintenance of reputation and value. The FM Global Resilience Index ranks countries by their enterprise resilience to disruptive events. Enterprise resilience combines the vulnerability to operational disruption with the ability to recover from such disruption.

The FM Global Resilience Index continues to rely on well-known, reliable and credible data sources, including the International Monetary Fund (IMF), the World Bank, the World Economic Forum (WEF) and the U.S. Energy Information Administration (EIA). This year, the index also includes data from the United Nations and Freedom House. These combine with FM Global's proprietary data, generated by the insurer's 1,800 property risk engineers who evaluate more than 100,000 locations annually around the world. The availability of better data and technology has enabled refined measurement within the index for exposure to natural hazards, natural hazard risk quality and fire risk quality. These refinements are described in a future section.

The structure of the 2017 FM Global Resilience Index is illustrated in Figure 1.

Figure 1: The index structure

I. INDEX	THE FM GLOBAL RESILIENCE INDEX		
II. FACTORS	ECONOMIC	RISK QUALITY	SUPPLY CHAIN
III. DRIVERS	Productivity	Exposure to Natural Hazards	Control of Corruption
	Political Risk	Natural Hazard Risk Quality	Quality of Infrastructure
	Oil Intensity	Fire Risk Quality	Local Supplier Quality
	Urbanization Rate	Inherent Cyber Risk	Supply Chain Visibility

Indicates newly added drivers for 2017
Indicates enriched data for 2017

NEW DRIVERS INCLUDED

The FM Global Resilience Index keeps pace with a changing risk landscape by reviewing the composition of the index each year. New perils emerge while others escalate. However, not all will be supported by sufficient data availability and quality to enable inclusion in the index.

EACH NEW DRIVER CAPTURES AN ESCALATING RISK THAT IS CENTRAL TO ENTERPRISE RESILIENCE.

The underpinnings of the 2017 FM Global Resilience Index include three new drivers that meet the necessary criteria. Each of these drivers is directly related to enterprise resilience, each is highly topical and growing in importance for effective enterprise risk management (ERM), and each meets the requisite data quality standards for inclusion. The new index drivers are described on the following pages.

Terror

Germany (ranked 5) experienced a week of terror in July 2016 that left the country stunned and fearful. In separate gun, bomb, axe and machete attacks, 10 were killed and dozens more injured. In a further act of terrorism, 12 people were killed and 49 injured on December 19 when a lorry smashed its way through the popular Christmas market at Breitscheidplatz in Berlin.

Politics

The world of politics seems generally more uncertain, as growing numbers of citizens voted successfully for 'Brexit' in the **United Kingdom** (ranked 16), a Trump presidency in the **United States** (ranked 10, 18, 9)[2], and rejected constitutional reforms in **Italy** (ranked 33), forcing the resignation of Prime Minister Renzi. Presidential and federal elections are forthcoming in **France** (ranked 11) and **Germany** (ranked 5) in 2017. The decline in commodity prices (oil, in particular) appears to have stabilized, but economic growth prospects are uncertain amid popular discontent and a widespread backlash against globalization and free trade.

[2]The United States is subdivided into three ranked regions because its geographical spread encompasses disparate exposures to natural hazards.

URBANIZATION RATE

Urbanization can bring many economic and social benefits to a country, and tends to be associated with economic opportunity and growth. When urbanization is rapid and unplanned, however, it poses acute risks to a country's critical infrastructure and social stability, induces competition for basic resources and exacerbates the spread of disease. For those seeking the smooth running of their business operations, a country with a high urbanization rate is a warning sign requiring active management. The urbanization rate is defined as the average annual rate of change in the extent to which a country's population is living in an urban area.

When combined with a significant exposure to natural hazards and poor building code quality or enforcement, the fragility in the country's enterprise resilience is compounded. Cities are expanding faster than core infrastructure, utilities and drainage systems can be planned, executed and managed. Flood events are becoming more severe, while extensive urbanization has significantly increased flood runoffs.

Urbanization Rate and Flooding in Eastern Hemisphere

Countries in the 2017 FM Global Resilience Index with significant flood exposure and a high urbanization rate include **Bangladesh** (ranked 111), **Thailand** (ranked 97), **Vietnam** (ranked 95), **China** (ranked 68, 72, 66) and **India** (ranked 60). All are major global manufacturing hubs: **Bangladesh** (ranked 111) for apparel and textiles; **Thailand** (ranked 97) for equipment, electronics and automotive components; **Vietnam** (ranked 95) for equipment and electronics; **China** (ranked 68, 72, 66) for raw materials, electronics and equipment; and **India** (ranked 60) for automotive and equipment. The potential for severe disruption across business operations and global supply chains is considerable.

INHERENT CYBER RISK

Cyber resilience must now be recognized as a core component of effective enterprise risk management (ERM) and reputation management. The rapid pace of technological change, with its attendant cyber risks, continues to exceed the pace of cyber security. The risk of a costly data security breach is conspicuous for many businesses. Increased connectivity, global interdependence, the growth of data and digitization, and the threat of cyber crime all prey on the unprepared. While discussion is plentiful, data remain scarce.

The 2017 FM Global Resilience Index includes a measure of inherent cyber risk that combines equally a country's vulnerability to cyber attack with the country's ability to recover from such an attack. The former is captured by a measure of internet penetration, on the basis that greater access to the internet provides greater opportunities both to hack and be hacked. To reflect a country's ability to help businesses heal and recover from a cyber attack, a measure of civil liberties is used. This applies the idea that a more open society fosters a thriving industry for prevention and recovery. On this combined measure[3], less developed countries can score well, as access to the internet is not yet widespread and there are minimal resources attractive to hackers.

The **United Kingdom**'s position (ranked 16) in the index is hampered by its inherent cyber risk, due to 92 percent of the country's population having access to the internet. The U.K. government is cognizant of the threat and announced in November 2016 that Bletchley Park, home to World War II codebreakers, would become the site of the U.K.'s first National College of Cyber Security. Due to open in 2018, the college will be a training academy dedicated to defense against cyber attack. The position in the index of **France** (ranked 11), where 85 percent of the population has access to the internet, is also held back by its exposure to cyber risk.

INHERENT CYBER RISK COMBINES A COUNTRY'S VULNERABILITY TO A CYBER ATTACK WITH THE ABILITY TO RECOVER FROM AN ATTACK.

Middle Eastern countries have a particularly high exposure to cyber risk: the four countries ranking lowest in the index for inherent cyber risk are **Saudi Arabia** (ranked 56), **Bahrain** (ranked 44), **UAE** (ranked 32) and **Qatar** (ranked 13). The **Middle East** owns the largest share of the world's oil reserves and is also one of the fastest growing regions for personal internet use and mobile telephony. Centers of population are widely spread and wireless communications dominate. Yet companies in the region can appear skeptical and ill-equipped to deal with the cyber threat. Thus far, no meaningful local industry has developed to address cyber security and recovery. Promoting greater awareness is key, and some companies are reporting a renewed willingness to recognize cyber risk as a key business threat and invest in cyber security.

[3]See Appendix 3 for further detail.

Recent Cyber Attacks

At a minimum, a cyber attack can result in loss of sales, market share, reputation and shareholder value. In 2016, prominent cyber attacks on companies included a distributed denial of service (DDoS) attack on **U.S.** (ranked 10, 18, 9) internet performance management company Dyn, a data breach at **U.K.** software company Sage, the online disclosure of records hacked from **U.S.** social networking site MySpace, and fraudulent transactions taking place at **U.K.** grocer/retailer Tesco.

SUPPLY CHAIN VISIBILITY

With manufacturing supply chains becoming ever more international, complex and multitiered, supply chain visibility has never been more critical an issue. It is cited regularly as one of the highest priorities for improvement by supply chain managers, and one that is vital for achieving controlled access and transparency in transactions across the supply chain. The goals of supply chain visibility are to reduce enterprise and supply chain risk; improve agility, lead times and performance; and identify shortage and quality issues along the supply chain. At a corporate level, managers seldom have complete visibility beyond the simplest of operations and value chains.

In recognition of the growing importance of supply chain visibility to manufacturing agility and responsiveness, the 2017 FM Global Resilience Index now includes a measure of visibility at a country level. Using data sourced from the World Bank, visibility is defined as the ability to track and trace consignments across a country's supply chain.

Enhancing visibility is essential to improving enterprise resilience and maximizing value in supply chain performance. Visibility is about awareness: how aware a company is of the location, operations and vulnerabilities of its suppliers. While it is important for domestic companies with multitiered supply chains, the imperative is amplified for those working with global supply networks.

ENRICHED DATA FOR RISK QUALITY DRIVERS

This year's index uses improved data for the natural hazard risk quality, fire risk quality and exposure to natural hazard drivers. Natural hazard risk quality includes a measure of the quality and enforcement of a country's building codes with respect to natural hazard-resistant design. Likewise, fire risk quality measures the quality of a country's management of fire risk by combining a measure of the quality and enforcement of a country's building codes with respect to fire-based design, along with a measure of the fire risk quality of actual facilities visited by FM Global's property risk engineers. Exposure to natural hazards is based on wind, flood and earthquake maps. Populated areas are defined by satellite-based night lights and additional information acquired by FM Global engineers.

Supply Chain Visibility

Many of the **African nations** appear toward the end of the ranking by this measure while the top performers tend be the more developed countries: **Sweden** (ranked 3), **Austria** (ranked 4), **Germany** (ranked 5), **Belgium** (ranked 14) and the **United States** (ranked 10, 18, 9) form the top five. Diverging fortunes emerged this year with respect to visibility for **India** (ranked 60) and **Vietnam** (ranked 95). **India** rose 13 places in the index since last year, due primarily to improvements in supply chain visibility, infrastructure and natural hazard risk quality. In contrast, **Vietnam**—with its thriving manufacturing sector increasingly important to the global supply chain—dropped eight places since last year owing to poorer supply chain visibility.

NATURAL HAZARDS AROUND THE WORLD

While some risks are emerging, others are old as time. According to the United Nations[4], floods are the most frequently occurring natural disaster globally—the hazard escalating to disaster when human lives are lost and livelihoods damaged or destroyed. This is despite the fact that much of the impact from flooding is both predictable and preventable.

THE IMPACT FROM FLOODING IS BOTH PREDICTABLE AND PREVENTABLE.

Advanced flood mapping provides tremendous improvements in the detection of flood exposure. Solutions for flood protection include dams and dykes, afforestation and reforestation, better early warning systems, floodplain zoning and the restoration of wetlands. At a company level, flood mitigation solutions include the erection of flood barriers, sealing walls and floors, and providing flood pumps and other mitigation equipment. In recent years, the nature of disastrous floods has changed, with flash floods, and acute riverine and coastal flooding increasingly frequent. Severe weather contingency plans are essential when managing enterprise risk.

NATURAL DISASTERS HEADLINED 2016

Following Storm Jonas, a record blizzard that left 48 dead in the northeast of the **United States** (ranked 10, 18, 9), came the **Taiwan** (ranked 36) earthquake in Tainan in February, which left 116 dead. August brought ferocious wildfires to California, USA, flooding once again to Louisiana, USA, and major earthquakes to both **Italy** (ranked 33) and **Myanmar** (ranked 121), the former of which left in its wake an estimated death toll of 240. Hurricane Matthew arrived in October, bringing flooding, destruction and death to the southeast of the **United States** (ranked 10, 18, 9) and the Caribbean; 1,000 are estimated to have died in **Haiti** (ranked 130) alone. The following month, the Kaikoura earthquake struck **New Zealand**'s (ranked 22) South Island, forcing thousands to evacuate and, in early December, the Aceh earthquake struck Sumatra Island in **Indonesia** (ranked 94), killing more than 100 people and leaving 84,000 people homeless.

Flooding in China

In July 2016, severe flooding in the Yangtze River Basin in **China** (ranked 68, 72, 66) left 764 people dead or missing, according to China's Ministry of Civil Affairs (MCA), and a total economic cost estimated at US$33 billion, just 2 percent of which is thought to be covered by insurance. This highlights acutely the need for active resilience strategies, especially in countries yet to fully embrace higher standards of corporate risk management. While the inherent natural hazard risk in a country cannot be altered, there is plenty that businesses can do to prevent or mitigate subsequent damage. In addition, constructive dialogue through sharing of experience and information, supporting in their efforts for risk improvement, and raising awareness of the weaknesses in the global supply chain, all help to strengthen enterprise resilience for the benefit of all stakeholders. Diverting water from property, optimizing drainage and protecting water supplies are all measures companies can take to mitigate flood damage.

[4]The Human Cost of Weather Related Disasters (1995-2015), The Centre for Research on the Epidemiology of Disasters (CRED) and The UN Office for Disaster Risk Reduction (UNISDR), 2015

COUNTRY BUILDING CODE RATINGS

The most influential determinant of risk quality for a country's commercial and industrial properties is the prevailing building code and its enforcement. Until now, the absence of quantitative data on building codes meant that it was not possible to incorporate code quality into the index. Addressing this data inadequacy, this year FM Global has generated a proprietary measure of building code quality by country.[5] The measure incorporates both the quality of codes and their enforcement.

Building codes and regulations are developed to protect public health, safety and the welfare of people in the construction and occupation of buildings and structure. They define the minimum acceptable criteria for these areas, and are developed and delivered by a variety of institutions: industry, trade associations and government agencies. The various institutions do not share the same desired objectives and this leads to differences in approach. Individual countries may develop their own codes, or adapt others' codes to suit their own needs and desired outcomes. The codes then can be enacted into law by an appropriate authority to help ensure that the requirements are met. This leads to the other key aspect of codes and regulations: enforcement.

The codes and regulations as written may set out minimum requirements but a scheme is required to ensure that practices on the ground are delivering to that standard. Skills and technical education are required also to ensure that the right level of execution is achieved by the practitioners and those who are enforcing the requirements. There are different approaches to enforcement across the world. But it is clear that whether or not a code is enforced has a significant influence on whether the desired outcome is delivered.

There is no universal building code or regulation globally. Therefore, the outcomes that codes are designed to achieve vary, despite addressing similar themes. At the same time, practice on the ground and the level of effort to enforce their requirements can determine the delivered outcome. A business operating globally will be familiar with these elements. Consequently, there can be large variations in enterprise resilience to fire and natural hazard events, beyond meeting the applicable building code and regulations.

The poorer nations in the FM Global Resilience Index tend to have lower standards of building code for both natural hazard and fire risk, whereas the more developed countries tend to have higher construction standards with regularly updated codes. Countries with a maximum code rating are those with a comprehensive building code that is enforced consistently.

In countries with low construction standards, it becomes patently more important for companies to go beyond that which is required, and invest in best practice risk management with respect to natural hazards and fire. It is only through such measures that business executives and other stakeholders can be confident in their enterprise resilience.

Effect of Building Codes

INDIA

In March 2016, a tragic explosion of fire crackers left 110 dead and 400 severely injured in the crowded precincts of the Puttingal Devi Temple at Paravur, south of Kollam, Kerala, **India** (ranked 60). In October 2016, 24 people were killed and more than 100 injured when fire broke out at the dialysis unit at a hospital in Bhuabneswar. Fire risk is ranked as the eighth biggest risk facing Indian industry, up from 12th two years ago.[6] The National Building Code of India (Fire and Life Safety) was first formed in 1970, and subsequently revised in 1983 and 2005 to create a comprehensive building code. In regulatory support to new building construction, the 2016 update, launched in March 2017, includes a greater requirement for automatic fire sprinklers in commercial and industrial buildings. Such governmental endorsement is welcome. The key challenge for India will be to ensure widespread enforcement of its updated code, which would improve its fire risk quality and natural hazard risk quality.

UNITED ARAB EMIRATES (UAE)

Following several fire incidents in high-rise tower blocks in the **United Arab Emirates (UAE)** (ranked 32), the country has undertaken an extensive review of its national fire building code. The revised Fire and Life Safety Code, released in January 2017, tightens safety requirements (particularly as regards to the use of combustible materials) and includes tougher enforcement measures.

[5]See Appendix 4 for further detail.

[6]India Risk Survey 2016, Federation of Indian Chambers of Commerce and Industry (FICCI)

CONCLUSION

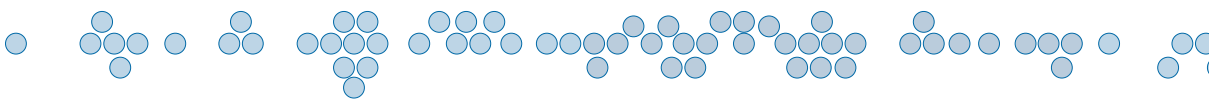
Sources of enterprise risk abound, but with pertinent information and thoughtful planning, many of these risks can be identified and their adverse impacts mitigated. The 2017 FM Global Resilience Index combines the core drivers of enterprise resilience to disruptive events across countries in a single index.

For c-suite executives—in particular, the chief executive officer (CEO), chief operating officer (COO) and the chief financial officer (CFO)—managing enterprise risk is a strategic issue. Serious disruption to the smooth running of a company's operations can result in a permanent loss of customers, market share, reputation and shareholder value. For the corporate c-suite, the FM Global Resilience Index offers a planning tool that provides a unique perspective on where a company may wish to invest in new facilities or divest ageing facilities, source key suppliers or customers, or assess the risk profiles of potential acquisitions. For operational management—such as the risk or insurance manager, the supply chain manager, or the plant or facilities manager—the index highlights where the vulnerabilities in different countries may lie and provides a macro context for determining priorities for investment in risk improvement.

As business continues to globalize, new risks emerge and interdependencies deepen. Beyond the direct exposure to physical damage, the loss in business income from a disruption to operations can be significant. The insurance industry has responded with various business interruption policy solutions whereby an element of the financial exposure is transferred, for a premium, to the insurer. Active monitoring of these exposures, many of which are prone to aggregation, is of central importance to insurers and reinsurers, as they seek to manage their capital requirements and cash flow. The implications for credit rating agencies are plain. Accompanying the financial risk transfer market, are those industries focused on loss prevention, risk management and security. Detail of the risk profiles of different countries provides these industries with data by which investments and marketing may be prioritized.

The advent of megacities, combined with climate change and extreme weather, produces a fierce mix of risk. For national governments, the onus of responsibility is upon them to respond. There are tremendous opportunities in zoning, for example, to embrace the challenge and prevent both tragedy and economic destruction, through effective city design and urban planning. Building codes in many countries would benefit from review and upgrading to include more comprehensive requirements for fire protection and enforcement. And prudent investment in infrastructure would help minimize competition and dependency on energy, transport and telephony when disaster strikes.

Enterprise resilience is about minimizing vulnerability to disaster and boosting the ability to recover from it. Strengthening resilience to disruptive events brings economic and social benefits to citizens, corporations, industries and governments around the world. FM Global hopes that the 2017 FM Global Resilience Index may even go so far as to help address the United Nation's concern that, "there is little evidence that the risk information produced is really informing development or disaster risk reduction"[7]. For those willing to embrace its numerous implications, the index serves as a public resource to highlight strengths and vulnerabilities in enterprise resilience across the world, and facilitate informed decision-making in strategic risk management.



[7]Global Assessment Report on Disaster Risk Reduction, United Nations (2015)

THE 2017 FM GLOBAL RESILIENCE INDEX

Presented next is the 2017 FM Global Resilience Index. Complete rankings are provided for the overall composite index and for each of its component factors: economic, risk quality and supply chain. Adjacent to each rank is presented a score, bounded on a scale of 0 to 100. A score of 100 does not imply a perfect score, but rather, that the territory ranks highest in that particular dimension. The scores, therefore, are a relative measure of resilience across countries, rather than an absolute measure.

The index is produced for 130 countries and territories: 124 countries and three regions each for China and the United States. China and the United States are subdivided into regions because their geographical spread encompasses such disparate exposures to natural hazards: wind, flood and earthquake. Regions in the United States are based on states, and regions in China are based on provinces, municipalities and autonomous regions. The composition of each region is provided in Appendix 5.

COUNTRY/REGION	FACTORS							
	Composite		Economic		Risk quality		Supply chain	
	Rank	Score	Rank	Score	Rank	Score	Rank	Score
SWITZERLAND	1	100.0	3	78.8	20	78.9	1	100.0
LUXEMBOURG	2	95.9	2	85.0	22	78.8	11	87.6
SWEDEN	3	94.7	8	67.8	14	87.2	4	93.7
AUSTRIA	4	94.6	6	69.1	16	84.2	2	94.2
GERMANY	5	94.4	13	63.0	6	95.1	6	92.5
NORWAY	6	93.3	4	75.2	8	94.0	20	81.9
DENMARK	7	91.1	10	65.9	13	87.5	10	88.1
FINLAND	8	91.1	16	61.3	15	86.7	7	91.9
UNITED STATES 3	9	90.6	22	58.1	1	100.0	12	86.3
UNITED STATES 1	10	89.2	22	58.1	7	95.1	12	86.3
FRANCE	11	88.1	26	55.9	5	95.6	16	85.4
NETHERLANDS	12	87.5	30	53.9	17	81.7	5	93.0
QATAR	13	85.5	1	100.0	41	57.6	30	68.0
BELGIUM	14	85.2	42	49.0	9	93.6	15	86.0
AUSTRALIA	15	85.1	18	60.9	10	89.6	22	79.2
UNITED KINGDOM	16	84.4	19	60.0	19	79.2	18	83.9
CANADA	17	84.1	35	51.9	11	88.8	17	84.3
UNITED STATES 2	18	83.7	22	58.1	25	75.1	12	86.3
HONG KONG SAR	19	82.9	7	68.6	47	48.6	8	90.9
IRELAND	20	82.8	5	74.4	34	67.1	24	76.7
CZECH REPUBLIC	21	82.2	11	64.0	3	97.4	34	67.3
NEW ZEALAND	22	80.4	14	63.0	31	68.3	21	79.9
ICELAND	23	79.7	12	63.3	32	67.6	23	78.8
SPAIN	24	79.0	38	51.0	4	96.9	27	71.1
JAPAN	25	78.3	27	55.4	58	44.3	3	94.1
POLAND	26	77.4	17	61.2	2	100.0	39	58.7
SINGAPORE	27	74.4	47	46.9	45	49.6	9	90.1
PORTUGAL	28	73.7	48	44.7	12	88.2	28	70.2

COUNTRY/REGION	FACTORS							
	Composite		Economic		Risk quality		Supply chain	
	Rank	Score	Rank	Score	Rank	Score	Rank	Score
ESTONIA	29	72.6	28	55.1	28	70.1	29	69.9
LITHUANIA	30	71.3	25	57.5	35	66.6	33	67.4
SLOVAK REPUBLIC	31	70.4	9	66.8	23	76.8	43	53.5
UNITED ARAB EMIRATES	32	69.9	15	62.0	93	27.4	19	82.1
ITALY	33	68.2	29	55.1	30	68.6	36	62.3
ISRAEL	34	63.3	63	36.4	33	67.1	31	67.6
LATVIA	35	62.7	34	53.2	39	60.0	41	57.6
TAIWAN PROVINCE OF CHINA	36	61.1	32	53.6	95	27.1	25	71.5
BOTSWANA	37	60.5	33	53.3	18	80.2	65	42.8
MALAYSIA	38	59.4	61	38.1	43	50.9	32	67.4
SLOVENIA	39	59.3	21	58.6	81	33.1	37	61.4
HUNGARY	40	59.1	37	51.4	36	62.1	51	51.1
SOUTH AFRICA	41	57.9	79	28.5	26	73.8	38	59.6
CROATIA	42	56.1	50	43.1	37	62.0	49	51.5
KOREA, REPUBLIC OF	43	55.7	54	40.0	94	27.3	26	71.2
BAHRAIN	44	55.2	49	44.2	55	45.1	40	57.9
CHILE	45	54.4	43	47.7	98	26.0	35	63.9
ROMANIA	46	53.6	41	49.3	29	69.3	71	38.3
MALTA	47	52.9	95	22.7	24	75.5	44	53.2
URUGUAY	48	51.9	36	51.5	50	46.9	59	45.3
BULGARIA	49	49.9	52	41.9	38	61.6	69	40.8
OMAN	50	49.0	40	49.3	86	31.6	53	49.4
GREECE	51	47.8	68	33.9	51	46.9	52	50.5
CYPRUS	52	47.8	66	34.7	44	49.9	56	48.2
NAMIBIA	53	47.2	98	21.5	21	78.9	67	41.6
TURKEY	54	46.9	81	28.0	60	43.7	42	54.8
MAURITIUS	55	45.9	31	53.8	99	23.7	60	44.3
SAUDI ARABIA	56	45.5	78	29.0	65	40.6	45	52.9
RUSSIAN FEDERATION	57	45.0	74	29.9	27	73.6	83	33.9
PANAMA	58	44.1	76	29.4	59	44.0	57	48.2
COSTA RICA	59	42.9	58	38.8	73	36.4	64	42.9
INDIA	60	41.7	100	20.1	54	46.1	54	49.4
TRINIDAD AND TOBAGO	61	40.9	20	59.3	109	19.3	87	33.0
KAZAKHSTAN	62	40.7	39	49.3	89	30.7	82	34.1
MEXICO	63	40.6	80	28.0	72	36.7	58	46.4
KUWAIT	64	40.5	46	46.9	113	15.1	63	43.6
SERBIA	65	40.0	51	41.9	63	41.0	90	32.6
CHINA 3	66	39.8	107	17.3	71	37.0	46	52.6
BRAZIL	67	39.3	73	30.5	46	48.6	76	35.8
CHINA 1	68	38.7	107	17.3	83	32.9	46	52.6

COUNTRY/REGION	FACTORS							
	Composite		Economic		Risk quality		Supply chain	
	Rank	Score	Rank	Score	Rank	Score	Rank	Score
BOSNIA AND HERZEGOVINA	69	37.6	82	27.8	40	58.7	99	29.2
ARGENTINA	70	37.0	55	39.3	74	36.0	91	31.5
CÔTE D'IVOIRE	71	36.8	96	22.4	52	46.6	72	38.2
CHINA 2	72	36.8	107	17.3	97	26.0	46	52.6
SRI LANKA	73	36.3	53	40.9	127	7.4	61	44.2
PHILIPPINES	74	36.1	57	38.8	87	30.8	89	32.8
MACEDONIA, FYR	75	35.3	56	39.2	112	15.4	70	39.1
JORDAN	76	34.8	112	14.3	88	30.7	55	48.7
GEORGIA	77	33.9	65	35.0	102	21.8	75	36.1
ARMENIA	78	33.7	45	47.3	114	14.6	94	30.6
MOROCCO	79	33.3	102	19.7	67	38.5	73	37.7
GHANA	80	33.2	87	26.3	61	43.2	96	30.1
TUNISIA	81	32.9	75	29.5	91	28.8	81	34.7
PERU	82	32.8	64	35.4	101	23.5	86	33.0
AZERBAIJAN	83	32.7	70	32.5	100	23.6	80	34.9
COLOMBIA	84	32.0	71	32.1	103	20.7	78	35.4
PARAGUAY	85	31.7	60	38.2	62	43.1	117	18.5
MONGOLIA	86	31.4	62	37.4	77	35.8	112	22.4
GABON	87	31.4	44	47.5	84	32.9	122	16.4
TANZANIA	88	31.0	110	15.6	42	51.7	98	29.4
ZAMBIA	89	30.9	67	34.2	70	37.9	111	22.7
UKRAINE	90	30.8	111	15.1	56	45.0	88	32.9
EGYPT	91	30.7	92	24.4	78	35.0	93	31.1
KENYA	92	30.5	127	5.9	76	35.8	62	43.9
SENEGAL	93	30.2	101	20.1	57	45.0	102	28.1
INDONESIA	94	30.2	97	21.9	110	17.9	68	40.9
VIETNAM	95	29.9	114	13.9	53	46.2	92	31.4
DOMINICAN REPUBLIC	96	29.4	69	33.0	108	19.9	95	30.3
THAILAND	97	27.9	130	0.0	69	38.1	66	42.1
MOLDOVA	98	27.7	83	27.7	80	33.9	108	23.4
ZIMBABWE	99	27.4	59	38.3	66	39.8	125	12.1
EL SALVADOR	100	27.4	77	29.2	115	11.8	84	33.5
RWANDA	101	27.4	123	6.5	121	9.4	50	51.3
CAMBODIA	102	26.9	86	27.1	82	33.0	109	22.9
UGANDA	103	26.2	119	10.3	49	47.8	104	26.2
GUATEMALA	104	25.9	89	25.8	123	8.1	79	35.0
ALGERIA	105	25.7	93	23.6	90	29.4	107	25.0
BENIN	106	24.2	116	12.6	48	48.2	113	20.4
ECUADOR	107	24.1	99	21.0	128	6.6	77	35.8
ALBANIA	108	23.6	91	25.1	120	10.1	97	30.1

COUNTRY/REGION	FACTORS							
	Composite		Economic		Risk quality		Supply chain	
	Rank	Score	Rank	Score	Rank	Score	Rank	Score
MOZAMBIQUE	109	23.2	94	23.4	75	35.9	121	17.0
NICARAGUA	110	21.9	84	27.5	106	20.3	115	19.7
BANGLADESH	111	21.3	120	10.1	85	31.7	105	25.5
TAJIKISTAN	112	21.2	85	27.2	129	2.8	103	27.8
LAO PDR	113	20.4	88	26.0	104	20.4	118	17.9
HONDURAS	114	19.9	117	11.4	119	10.2	85	33.1
CAMEROON	115	19.6	103	19.6	68	38.3	126	11.7
GUINEA	116	19.0	106	18.6	64	40.8	127	10.0
JAMAICA	117	19.0	124	6.4	125	8.0	74	36.2
IRAN, ISLAMIC REP.	118	18.7	113	14.1	117	10.7	101	28.5
BOLIVIA	119	18.1	90	25.6	122	9.1	114	19.8
MALI	120	17.3	121	8.9	79	33.9	120	17.6
MYANMAR	121	16.9	104	19.4	96	26.5	124	12.9
MADAGASCAR	122	16.5	105	18.8	105	20.3	123	15.9
NIGERIA	123	15.1	126	5.9	92	27.7	116	18.8
LEBANON	124	15.0	122	8.4	116	11.4	106	25.2
PAKISTAN	125	13.1	128	1.6	126	7.4	100	28.9
CHAD	126	12.9	72	31.1	107	20.2	130	0.0
ETHIOPIA	127	12.7	129	1.1	111	17.9	110	22.9
NEPAL	128	11.6	118	10.6	118	10.3	119	17.8
VENEZUELA	129	5.6	115	13.0	130	0.0	128	10.0
HAITI	130	0.0	125	6.4	124	8.0	129	0.0

APPENDIX 1

THE FACTORS OF RESILIENCE

The risk of disruption to a company's operations is a complex exposure, subject to many different influences. The process of identifying for an index a set of core drivers with significant impact on enterprise resilience to disruptive events is partly heuristic, partly statistical and partly practical.

Research into the causes of operational disruption and the drivers of recovery highlights some common themes. Conflict and political unrest, terrorism, corruption, vulnerability to oil shortages and price shocks, natural disasters, extreme weather, rapid urbanization, maturity and investment in risk management, infrastructure, and the quality of local suppliers all appear regularly. Increasingly, cyber risk and supply chain visibility also loom large.

To meet statistical criteria, the drivers of the index must demonstrably have an impact on resilience; represent faithfully the intended property; have sufficient sensitivity to detect changes in resilience, but not so much volatility as to disrupt the index; exhibit minimal correlation across drivers; and be calculated consistently (over a period of time to allow back-testing).

Practical considerations require that the data are available, quantitative (or quantifiable), global, annual and from credible sources.

Twelve core drivers of resilience have been selected for inclusion in the FM Global Resilience Index. These drivers are categorized as pertaining to economic, risk quality or supply chain factors, and are summarized below.

1. **Economic** – This factor represents political and macroeconomic influences on resilience. Combining to form this factor are four drivers: productivity, political risk, oil intensity and urbanization rate. Terrorism was found to be highly correlated with political instability, so these two variables are combined into a single driver: political risk.
2. **Risk quality** – A unique attribute of the FM Global Resilience Index is its ability to draw upon the wealth of experience and data gathered over many years by FM Global's team of property risk engineers who visit and assess more than 100,000 locations annually across the world. The metrics have the advantage of being applied consistently across all industry sectors and regions. This factor comprises three drivers sourced from FM Global: exposure to natural hazards, natural hazard risk quality and fire risk quality. An additional fourth driver is included to capture the inherent cyber risk of a country.
3. **Supply chain** – This factor relates to the supply chain itself and comprises four drivers: control of corruption, quality of infrastructure, local supplier quality and supply chain visibility.

Provided in Appendix 2 is an overview of the FM Global Resilience Index structure and methodology. Full technical data definitions are provided in Appendix 3.

APPENDIX 2

THE INDEX STRUCTURE

Described in this appendix are the structure and construction of the FM Global Resilience Index. There are three levels to the index:

1. Level I provides a country ranking of enterprise resilience to disruptive events. Level I is an equally weighted composite measure of the three factors in Level II.
2. Level II comprises three factors, the core elements of resilience: economic, risk quality and supply chain. Each factor in Level II is an equally weighted composite of its respective drivers in Level III.
3. Level III includes a set of 12 drivers that determine the enterprise resilience to disruptive events for a country. Each driver measures a different aspect of resilience.

Figure 2: The index structure

I. INDEX	THE FM GLOBAL RESILIENCE INDEX		
II. FACTORS	ECONOMIC	RISK QUALITY	SUPPLY CHAIN
III. DRIVERS	Productivity	Exposure to Natural Hazards	Control of Corruption
	Political Risk	Natural Hazard Risk Quality	Quality of Infrastructure
	Oil Intensity	Fire Risk Quality	Local Supplier Quality
	Urbanization Rate	Inherent Cyber Risk	Supply Chain Visibility

Indicates newly added drivers for 2017
Indicates enriched data for 2017

The index combines equally the 12 core drivers of resilience and provides ranked scores for 130 countries and territories around the world. Selected for inclusion are the largest countries (by gross domestic product in 2016) with the most complete set of data across the last five years. To enable valid historic comparison, the index has been calculated on the new basis across this time period.

The structure of the index enables business executives to identify the sources of strength and vulnerability in a country's resilience, both broadly across factors (economic, risk quality or supply chain), and more precisely across the 12 drivers. Such analysis offers opportunities to managers seeking to improve their company's resilience to disruptive events.

INDEX METHODOLOGY

Described below are the key procedures applied to construct the FM Global Resilience Index from the underpinning data.

1. Annual data, for the most recent five years, are collected for the maximum number of countries and territories for each of the 12 drivers.
2. A common set of countries and territories with complete data availability across the 12 drivers is identified and aligned into a consistent data set.
3. Each data series is standardized through the calculation of z-scores to enable comparison and combination of drivers with different units. Where necessary, z-scores are inverted for consistency across variables.
4. The z-scores are converted into scores on a scale of 0 – 100 for presentation purposes.
5. The scores of the 12 drivers are then combined with equal weighting to form the index.
6. The index comprises the rankings for the top 130 countries and territories for which data are available. Three regions are provided for each of China and the United States because their geographical spread includes disparate exposures to natural hazards, such as wind, flood and earthquake.

Based on data availability, new entrants to and exits from the index may emerge. In order to maintain consistency in the interpretation of results, the index is restricted to the top 130 countries and territories in any given year.

Many simulations were carried out to determine the most appropriate weighting scheme. There emerged very little difference in ultimate rankings from the adoption of various weighting schemes, so rather than impose a subjective system of aggregation without good reason to do so, it is appropriate to remain with equal weights across the 12 core drivers of resilience.

The overall composite index is, by design, a simplified, summary measure of resilience. The FM Global Resilience Index provides an indication of countries' relative enterprise resilience to disruptive events. In combination with additional information, this provides business executives with a source of guidance on enterprise risk when making decisions about risk improvement priorities, sourcing suppliers or the destination of physical investments.

APPENDIX 3

SOURCES AND DEFINITIONS

Provided in this appendix is the technical definition of each index driver and its data source.

TABLE 1. Definitions and data sources

ECONOMIC		
PRODUCTIVITY	Gross domestic product (GDP) based on purchasing power parity, divided by total population	International Monetary Fund (IMF)
POLITICAL RISK	The perceived likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically motivated violence and terrorism	World Bank
OIL INTENSITY	Vulnerability to an oil shock (shortage, disruption, price hike); oil consumption divided by GDP; measures dependency on oil for productivity	U.S. Energy Information Administration
URBANIZATION RATE	The average annual rate of change in the extent to which a country's population is living in an urban area	United Nations (UN)
RISK QUALITY		
EXPOSURE TO NATURAL HAZARDS	The percentage of a country's area devoted to economic activities that is exposed to at least one natural hazard: wind, flood or earthquake	FM Global
NATURAL HAZARD RISK QUALITY	The quality and enforcement of a country's building code with respect to natural hazard resistant design (80%), combined with the level of natural hazard risk improvement achieved, given the inherent natural hazard risks in a country (20%)	FM Global
FIRE RISK QUALITY	The quality and enforcement of a country's building code with respect to fire-based design (80%), combined with the level of fire risk improvement achieved, given the inherent fire risks in a country (20%)	FM Global
INHERENT CYBER RISK	Vulnerability to a cyber attack combined equally with the country's ability to recover; captured by internet penetration (the percentage of individuals in a country who have access to the internet) and civil liberties	UN and Freedom House, respectively
SUPPLY CHAIN		
CONTROL OF CORRUPTION	The perceived extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as capture of the state by elites and private interests	World Bank
QUALITY OF INFRASTRUCTURE	The perceived quality of general infrastructure: transport, telephony and energy	World Economic Forum (WEF)
LOCAL SUPPLIER QUALITY	The perceived quality of local suppliers	WEF
SUPPLY CHAIN VISIBILITY	The ability to track and trace consignments across a country's supply chain	World Bank

Data on Political Risk (political stability and absence of violence or terrorism) and Control of Corruption are obtained from the Worldwide Governance Indicators (WGI) data set from the World Bank. The WGI comprise information from 31 existing data sources that report the views and experiences of citizens, entrepreneurs and experts in the public, private and non-governmental organization (NGO) sectors from around the world, on the quality of various aspects of governance. Data on Supply Chain Visibility also are sourced from the World Bank, specifically from its Logistics Performance Index (LPI). The data are obtained by a survey of global freight forwarders and express carriers who provide feedback on the logistics attractiveness of the countries in which they operate, and with which they trade.

Data on Infrastructure and Local Supplier Quality are obtained from the Global Competitiveness Report produced annually by the World Economic Forum (WEF). The data are based on the WEF's annual Executive Opinion Survey which garnered more than 14,500 responses in its latest edition (2016 – 2017).

The data for three of the risk quality drivers are provided by FM Global, one of the world's largest commercial and industrial property insurers. Further detail on their compilation is provided below.

1. **Exposure to natural hazard** – FM Global property risk engineers determine whether any natural hazard exposures are present at the locations they visit. The determination is based on wind, flood and earthquake maps, populated areas defined by satellite-based night lights, and additional information acquired by engineers. The percentage of the country's area devoted to economic activities that is exposed to at least one natural hazard peril (earthquake, wind, or coastal or riverine flood) is summarized for each country.

   Exposed areas are determined based on potential losses from 100-year wind gusts greater than 100 mph (161 kph), water flowing from rivers in 100-year flood zones, or more frequent than 500-year earthquake motions that can cause damage to weak systems.

   China and the United States are each divided into three regions to accommodate for a significantly different dominant natural hazard exposure within these countries. Regions in the United States are based on states, and regions in China are based on provinces, municipalities and autonomous regions. The composition of each region is provided in Appendix 5.

2. **Natural hazard risk quality** – To capture the quality of a country's management of natural hazard risks, two components are combined. Dominant (and weighted 80 percent) is a measure of the quality and enforcement of a country's building code with respect to natural hazard-resistant design. A full exposition of the building code rating methodology is provided in Appendix 4. The remaining component (weighted 20 percent) reflects the risk quality of actual facilities and is obtained from FM Global's proprietary Risk*Mark*® database available to FM Global clients.

RiskMark is a benchmarking algorithm that calculates the risk quality of FM Global's insured locations. It uses a 100-point scale (100 representing the best managed, highest-quality risk), and the scale comprises the following four components:

i. Fire Hazards and Equipment Hazards: 36 points
ii. Natural Hazards: 30 points
iii. Human Element and Other Factors: 19 points
iv. Inherent Occupancy Hazards: 15 points

The RiskMark score of a location includes a measure of both inherent risks and risks where there are recommendations for improvement. The potential RiskMark score represents the highest possible score achievable by that location, given those inherent risks. The percentage potential RiskMark score provides a way to measure risk improvement opportunities given the inherent risks. It is calculated by dividing the RiskMark score by the potential RiskMark score.

For the risk quality driver, natural hazard risk quality, the weighted average (by total insured value) percentage potential RiskMark score for the natural hazard component is provided for each country or region where there is a statistically sufficient number of locations. Those countries with few locations are rated solely by the quality and enforcement of the country's building code with respect to natural hazard-resistant design.

3. **Fire risk quality** – For this risk quality driver, fire risk quality, the same logic as natural hazard applies. The quality of a country's management of fire risk combines two components: a measure of the quality and enforcement of a country's building code with respect to fire-based design (weighted 80 percent), and a measure of the fire risk quality of actual facilities visited by FM Global's property risk engineers.

   For this metric, the weighted average (by total insured value) percentage potential RiskMark score for the fire subcomponent of the fire and equipment hazards component is provided for each country or region where there is a statistically sufficient number of locations. Again, those countries with few locations are rated solely by the quality and enforcement of the country's building code with respect to fire-based design.

The fourth risk quality driver, inherent cyber risk, combines equally a country's vulnerability to cyber attack with the country's ability to recover from such an attack. The former is captured by a measure of internet penetration, using data sourced from the International Telecommunications Union (ITU), a division of the UN. To reflect a country's ability to help businesses heal and recover from a cyber attack, a measure of civil liberties is used, combining freedoms of expression, assembly, association, education and religion, and an established and fair legal system that ensures the rule of law, allows free economic activity, and strives for equal opportunities for all. The data are sourced from Freedom House, a nonprofit watchdog organization.

APPENDIX 4

Described in this appendix is the method by which FM Global's engineers estimated the quality of building codes around the world with respect to natural hazard and fire risks. Evaluation of the outcome of building codes and regulations entails a method that is based not only on the requirements of the code but also on the level of its enforcement. The approach adopted combines an understanding of the requirements with actual observations by FM Global's engineers from the field.

BUILDING CODE RATING METHODOLOGY

1. National building codes and their implementation were reviewed first in order to define the key questions for a survey that would yield the most, and most relevant, responses.

2. Based on this review, and following a pilot study, the following filter questions were established to address natural hazard and fire risk, respectively:
   a. Is there a regularly used and updated building code that includes mandatory requirements for natural hazard resistant designs published in the country?
   b. Is there a regularly used and updated building code that includes mandatory requirements for fire-based design published in the country?

3. To ensure that requirements are fully understood, they need to be adopted fully and within the mainstream of building practice in a country. A revised code or draft code would not meet these criteria. A code quality score of 2 was assigned for observed full code covering natural hazard/fire elements, 1 for limited code covering these elements, and 0 where these elements are absent.
   a. In the case of natural hazards, matching design requirements for seismic, wind, snow, etc., were considered.
   b. In the case of fire risk, requirements covering fire-rated compartmentation, fire protection, combustibility requirements for materials, etc., were considered.

4. As noted, the presence of strong enforcement will ensure that the outcome of a code is delivered. For each natural hazard and fire risk, therefore, the following contingency question was asked: Are these requirements regularly enforced?

5. The focus is placed on what is observed in a country rather than what is intended, and responses to the question of enforcement concentrate on the skill, education and training available to implement the requirements regularly. A code enforcement score of 2 was assigned for observed strong and consistent enforcement, 1 for limited enforcement, and 0 for negligible or poor enforcement. The code enforcement score is applied as a multiplier to the code quality score, reflecting the practical power of effective code enforcement.

6. A final modifier was added to the resultant score (quality x enforcement) to introduce the observed availability of flood maps into the natural hazard elements and the requirements for automatic sprinkler protection into the fire elements.
   a. There are limited elements within building codes with respect to flood hazard. Usually, it is considered in the wider elements of building laws relating to development and land use that determine where a building can be sited. However, this requires a scheme of flood maps to assess the risk. A score of 1 is added if nationally recognized flood maps are present and available in the country.
   b. FM Global's experience shows that a key driver in minimizing fire damage is the presence of automatic sprinkler protection. In the industrial arena, the typical target occupancies are offices, warehouses and factories, in particular, buildings of moderate size at 5,000 square meters. Such buildings represent a reasonable scale of investment where fire protection makes economic sense based on value alone in most territories. A score of 1 is added if there is a requirement for the installation of automatic sprinklers within this size of building in any of the specified occupancies.

TABLE 2. Survey structure

NATURAL HAZARD ELEMENTS	SCORE
Is there a regularly used and updated building code that includes mandatory requirements for natural hazard resistant designs published?	0, 1, 2
Are these requirements regularly enforced?	0, 1
Are there current, nationally recognized flood maps available?	0, 1
FIRE ELEMENTS	**SCORE**
Is there a regularly used and updated building code that includes mandatory requirements for fire-based design published in the country?	0, 1, 2
Are these requirements regularly enforced?	0, 1, 2
Based on a 5,000-m^2 build, would the code require automatic sprinklers to be installed in any of office/warehouse/factory buildings?	0, 1

7. The questions were distributed to FM Global's field engineers who were surveyed and interviewed for their expert assessment of building code quality and enforcement, based on their actual observations in the field.
8. For those countries where limited observations were available, secondary research in the form of a literature review of the available code was used to supplement the primary field research.
9. Finally, the ratings were reviewed iteratively by the engineering and standards community to ensure consistency in grading, and to reach consensus on the relative ratings.

The FM Global engineering team operates across the world, visiting industrial and commercial clients to undertake property risk evaluations. The engineers apply their training and assess the current conditions to the applicable FM Global standards in order to determine if there are opportunities to enhance the protection of a facility against natural hazard and fire risks. Through this work, FM Global engineers enjoy unique access to observe the practice and application of building codes and regulations across different countries.

APPENDIX 5

COUNTRY REGIONS BY DOMINANT NATURAL HAZARD

CHINA 1	CHINA 2	CHINA 3	UNITED STATES 1	UNITED STATES 2	UNITED STATES 3
Wind	**Earthquake**	**Miscellaneous**	**Wind**	**Earthquake**	**Miscellaneous**
Fujian	Hebei	Anhui	Alabama	Alaska	Arizona
Guangdong	Jiangsu	Beijing	Connecticut	California	Arkansas
Hainan	Neimenggu	Chongqing	Delaware	Hawaii	Colorado
Jilin	Ningxia	Gansu	Florida	Nevada	District of Columbia
Liaoning	Sichuan	Guangxi	Georgia	Oregon	Idaho
Shandong	Tianjin	Guizhou	Louisiana	Puerto Rico	Illinois
Shanghai	Yunnan	Heilongjiang	Maine	Utah	Indiana
Zhejiang		Henan	Maryland	Washington	Iowa
		Hubei	Massachusetts		Kansas
		Hunan	Mississippi		Kentucky
		Jiangxi	New Hampshire		Michigan
		Qinghai	New Jersey		Minnesota
		Shaanxi (Shanxi)	New York		Missouri
		Xinjiang	North Carolina		Montana
			Rhode Island		Nebraska
			South Carolina		New Mexico
			Texas		North Dakota
			Virgin Islands		Ohio
			Virginia		Oklahoma
					Pennsylvania
					South Dakota
					Tennessee
					Vermont
					West Virginia
					Wisconsin
					Wyoming

APPENDIX 6

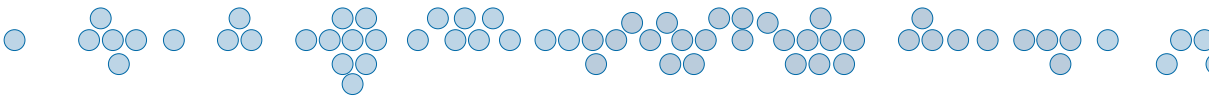
ALPHABETIC RANKINGS 2017 AND 2016

COUNTRY/REGION	FACTORS							
	Composite		Economic		Risk quality		Supply chain	
	2017	2016	2017	2016	2017	2016	2017	2016
ALBANIA	108	107	91	85	120	121	97	94
ALGERIA	105	109	93	95	90	88	107	116
ARGENTINA	70	72	55	53	74	73	91	97
ARMENIA	78	77	45	45	114	114	94	87
AUSTRALIA	15	16	18	17	10	10	22	22
AUSTRIA	4	4	6	6	16	16	2	5
AZERBAIJAN	83	86	70	69	100	100	80	96
BAHRAIN	44	40	49	48	55	55	40	39
BANGLADESH	111	117	120	117	85	89	105	117
BELGIUM	14	14	42	37	9	9	15	9
BENIN	106	108	116	118	48	49	113	118
BOLIVIA	119	116	90	92	122	119	114	107
BOSNIA AND HERZE-GOVINA	69	68	82	74	40	40	99	104
BOTSWANA	37	42	33	33	18	18	65	89
BRAZIL	67	64	73	66	46	47	76	85
BULGARIA	49	51	52	52	38	36	69	71
CAMBODIA	102	100	86	83	82	81	109	110
CAMEROON	115	105	103	101	68	67	126	115
CANADA	17	18	35	40	11	11	17	15
CHAD	126	121	72	89	107	108	130	125
CHILE	45	45	43	41	98	94	35	34
CHINA 1	68	71	107	106	83	84	46	51
CHINA 2	72	76	107	106	97	96	46	51
CHINA 3	66	67	107	106	71	74	46	51
COLOMBIA	84	88	71	75	103	103	78	86
COSTA RICA	59	59	58	59	73	71	64	63
CÔTE D'IVOIRE	71	66	96	100	52	50	72	62
CROATIA	42	41	50	51	37	37	49	49
CYPRUS	52	48	66	68	44	45	56	43
CZECH REPUBLIC	21	21	11	13	3	3	34	32
DENMARK	7	9	10	10	13	13	10	14
DOMINICAN REPUBLIC	96	91	69	73	108	109	95	88
ECUADOR	107	104	99	94	128	127	77	81
EGYPT	91	94	92	96	78	77	93	92
EL SALVADOR	100	90	77	82	115	116	84	69
ESTONIA	29	29	28	28	28	28	29	31

COUNTRY/REGION	FACTORS							
	Composite		Economic		Risk quality		Supply chain	
	2017	2016	2017	2016	2017	2016	2017	2016
ETHIOPIA	127	127	129	128	111	110	110	108
FINLAND	8	11	16	12	15	14	7	16
FRANCE	11	13	26	27	5	5	16	18
GABON	87	93	44	44	84	82	122	124
GEORGIA	77	75	65	64	102	102	75	75
GERMANY	5	2	13	11	6	6	6	3
GHANA	80	82	87	91	61	59	96	95
GREECE	51	56	68	63	51	54	52	59
GUATEMALA	104	97	89	86	123	123	79	70
GUINEA	116	124	106	113	64	65	127	129
HAITI	130	130	125	123	124	126	129	130
HONDURAS	114	113	117	119	119	115	85	83
HONG KONG SAR	19	20	7	7	47	46	8	6
HUNGARY	40	36	37	35	36	38	51	38
ICELAND	23	23	12	14	32	34	23	23
INDIA	60	73	100	104	54	53	54	68
INDONESIA	94	96	97	93	110	111	68	73
IRAN, ISLAMIC REP.	118	119	113	115	117	117	101	103
IRELAND	20	15	5	5	34	33	24	19
ISRAEL	34	39	63	61	33	32	31	42
ITALY	33	32	29	22	30	30	36	35
JAMAICA	117	118	124	124	125	124	74	77
JAPAN	25	24	27	29	58	60	3	2
JORDAN	76	84	112	112	88	87	55	61
KAZAKHSTAN	62	60	39	36	89	86	82	80
KENYA	92	98	127	127	76	75	62	72
KOREA, REPUBLIC OF	43	43	54	54	94	99	26	29
KUWAIT	64	62	46	42	113	112	63	67
LAO PDR	113	111	88	87	104	104	118	112
LATVIA	35	34	34	30	39	39	41	36
LEBANON	124	122	122	121	116	118	106	100
LITHUANIA	30	33	25	21	35	35	33	37
LUXEMBOURG	2	3	2	2	22	22	11	17
MACEDONIA, FYR	75	74	56	50	112	113	70	74
MADAGASCAR	122	123	105	109	105	107	123	122
MALAYSIA	38	37	61	58	43	43	32	28
MALI	120	115	121	122	79	80	120	106
MALTA	47	49	95	97	24	24	44	44
MAURITIUS	55	57	31	39	99	98	60	60
MEXICO	63	63	80	79	72	68	58	58

COUNTRY/REGION	FACTORS							
	Composite		Economic		Risk quality		Supply chain	
	2017	2016	2017	2016	2017	2016	2017	2016
MOLDOVA	98	99	83	77	80	79	108	114
MONGOLIA	86	89	62	56	77	78	112	120
MOROCCO	79	78	102	105	67	70	73	65
MOZAMBIQUE	109	112	94	88	75	66	121	127
MYANMAR	121	125	104	99	96	97	124	128
NAMIBIA	53	53	98	98	21	19	67	66
NEPAL	128	126	118	114	118	122	119	113
NETHERLANDS	12	12	30	31	17	17	5	4
NEW ZEALAND	22	22	14	15	31	29	21	24
NICARAGUA	110	114	84	84	106	105	115	119
NIGERIA	123	120	126	126	92	93	116	111
NORWAY	6	5	4	4	8	8	20	21
OMAN	50	52	40	43	86	85	53	56
PAKISTAN	125	128	128	129	126	125	100	101
PANAMA	58	58	76	90	59	58	57	48
PARAGUAY	85	80	60	65	62	61	117	109
PERU	82	85	64	70	101	101	86	91
PHILIPPINES	74	69	57	57	87	91	89	79
POLAND	26	26	17	18	2	2	39	40
PORTUGAL	28	27	48	49	12	12	28	27
QATAR	13	8	1	1	41	41	30	26
ROMANIA	46	44	41	46	29	31	71	64
RUSSIAN FEDERATION	57	55	74	71	27	27	83	82
RWANDA	101	101	123	125	121	120	50	54
SAUDI ARABIA	56	54	78	72	65	63	45	46
SENEGAL	93	79	101	103	57	56	102	76
SERBIA	65	65	51	55	63	64	90	93
SINGAPORE	27	28	47	47	45	44	9	7
SLOVAK REPUBLIC	31	30	9	8	23	23	43	47
SLOVENIA	39	38	21	26	81	83	37	33
SOUTH AFRICA	41	46	79	78	26	26	38	45
SPAIN	24	25	38	38	4	4	27	30
SRI LANKA	73	70	53	60	127	128	61	50
SWEDEN	3	6	8	9	14	15	4	8
SWITZERLAND	1	1	3	3	20	20	1	1
TAIWAN PROVINCE OF CHINA	36	35	32	32	95	90	25	25
TAJIKISTAN	112	110	85	80	129	129	103	99
TANZANIA	88	106	110	111	42	42	98	121
THAILAND	97	92	130	130	69	69	66	57
TRINIDAD AND TOBAGO	61	61	20	19	109	106	87	90

COUNTRY/REGION	FACTORS							
	Composite		Economic		Risk quality		Supply chain	
	2017	2016	2017	2016	2017	2016	2017	2016
TUNISIA	81	95	75	81	91	92	81	98
TURKEY	54	50	81	76	60	62	42	41
UGANDA	103	102	119	120	49	48	104	102
UKRAINE	90	83	111	110	56	57	88	78
UNITED ARAB EMIRATES	32	31	15	16	93	95	19	20
UNITED KINGDOM	16	17	19	20	19	21	18	13
UNITED STATES 1	10	10	22	23	7	7	12	10
UNITED STATES 2	18	19	22	23	25	25	12	10
UNITED STATES 3	9	7	22	23	1	1	12	10
URUGUAY	48	47	36	34	50	51	59	55
VENEZUELA	129	129	115	102	130	130	128	123
VIETNAM	95	87	114	116	53	52	92	84
ZAMBIA	89	81	67	67	70	72	111	105
ZIMBABWE	99	103	59	62	66	76	125	126



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