Expert insights

Fire Safety, Risk Assessment and Bowties

Predict fire scenarios accurately and mitigate their severity

Enablon Bowtie Suite

by Wolters Kluwer

Summary

Fire risk assessments are essential for ensuring the safety of buildings and their occupants by identifying potential fire hazards, evaluating associated risks, and implementing mitigation measures. However, the construction industry often focuses more on compliance than on risk-based approaches, leading to outdated fire safety regulations. Shifting towards a focus on hypothetical benefits can help companies remain sustainable, compliant, and risk-averse. The bowtie methodology offers a comprehensive and visual approach to understanding and mitigating fire risks, making it an ideal tool to help predict fire scenarios more accurately and mitigate their severity while decreasing cost for the companies.

About us

Bowtie Suite is the leading provider of barrier-based risk management solutions. It's an off-the-shelf, intuitive, risk management software solution that support your organization during every step of your safety journey to enable safe and efficient operations.

Expert Profile

Louis Cleef is a fire safety manager at Rockwool, a manufacturer of stonewool building products, and guest researcher at the University of Delft, to understand this better.
Louis has been involved in fire safety for almost 40 years and currently focuses on regulations and public affairs. In 2016, he began collaborating with the University of Delft, organizing roundtables leading to the establishment of the Fire Safety Economics Foundation in 2020. Since then, they have been working on a research contract to advance fire safety in the built environment. The aim is to develop a fire safety economics decision-making framework that emphasizes value creation through optimal decision-making and microeconomic trade-offs, providing more insights into the hypothetical benefits of preventing property loss, maintaining business continuity, and minimizing social and environmental damage.

Current gaps & Challenges in Fire Safety

New additional fire risks
By collaborating, the Fire Safety Economics Foundation together with the University of Delft have identified an important gap in the current fire safety field: “the need to make buildings more sustainable and environmentally friendly. As buildings evolve and incorporate new functionalities, such as solar panels, batteries, and charging stations, additional fire risks emerge. These changes, along with the aging population, introduce new fire hazards that must be addressed but aren’t currently adequately managed.

Historical data during risk assessments
When constructing sustainable buildings, we currently rely too much and often on historical data for risk assessments. Current statistics only reflect past fire causes, which may not account for the evolving nature of buildings and their fire risks. If sustainability is considered from a fire safety perspective, different decisions would be made. These changes affect not only how a fire starts but also its development within the building. The fire itself will have environmental consequences and impact the overall sustainability of the building. It is crucial to take these factors into account to prevent severe consequences.”

Unfortunately, Louis noticed that fire safety is often underestimated in terms of impact and consequence, creating huge barriers to shifting the focus toward more effective holistically reasoned fire safety measures. “Investments in fire safety are limited because of the inability to calculate the value of avoided risks: we think in terms of costs and not values! In parallel, the acceptable social residual risk we want to bear as a society has not been determined.”

The knowledge gap within the field poses another challenge in ensuring fire safety in buildings. According to Louis, “there are four main knowledge gaps that need addressing:

- **The true financial impact of fire accidents is not well understood,** particularly the indirect costs such as environmental damage and the social impact on affected communities. The insurance industry’s rule of thumb suggests that total costs could be four times the direct costs, but these figures are not clearly defined or monetized.
- **Insufficient data for the economic evaluation of fire protection strategies.** Reliable information on the likelihood of fire occurrences is lacking, making it challenging to assess the financial benefits of preventive measures.
- **Better information is needed on the validity of fire risk assessments.**
- **Scarcity of accessible, peer-reviewed data** on the effectiveness of fire safety measures complicates the analysis and trust in current fire safety practices.”

Fire risk assessment methodology

When asked about risk assessment and where regulation can improve, Louis is adamant “Current fire risk assessments often prioritize compliance over identifying the most effective safety solutions. There is an overemphasis on ensuring the safe escape of occupants and preventing fire propagation to adjacent buildings, based on minimum building code requirements.

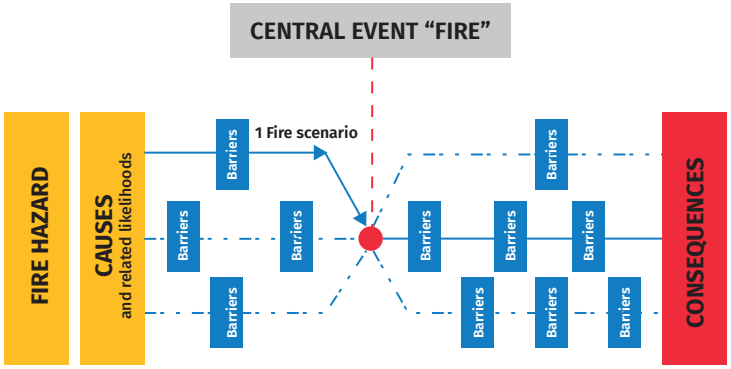
However, a more comprehensive approach to fire safety is more efficient. It is not solely about compliance but about adopting a holistic approach to doing the right things. Our goal is to intrinsically motivate building owners to prevent, protect, and mitigate fire consequences. This involves creating value through microeconomic trade-offs and optimal decision-making with multidisciplinary involvement. In this regard, we can learn valuable lessons from other industries.
Earlier, I mentioned hypothetical benefits. These benefits represent losses that never occurred due to the implementation of prevention measures or cost savings achieved through the prevention of fire incidents, along with added value generated by such prevention. Hypothetical benefits encompass all costs associated with accidents that have been avoided.
The hypothetical benefit of a risk treatment option can be considered in two ways:

1. As the difference between the highest possible costs of an accident in the current situation and the costs of an accident after applying the treatment measure.
2. As the difference between the costs of retention when taking no action and the costs of a possible accident after applying the treatment measure.

The idea of hypothetical benefits is crucial because current decision-making in fire safety often relies on gut feelings rather than data-driven analysis. Our goal is to motivate building owners to adopt fire safety measures by highlighting the potential benefits, such as reduced property damage and improved business continuity.”

Bowtie and LOPA Framework

To effectively visualize fire incident scenarios, the Bowtie framework has been adopted by Louis and his team. This framework integrates the entire concept of risk management.
As Louis explains, “The left hand side of the Bowtie represents the likelihood of a fire, while the right hand side represents the impact of a fire. By using this Bowtie approach, we can assess the potential impact of a fire probabilistically, allowing us to monetize and evaluate the expected consequences.”



The Bowtie methodology consists of two sides – the threat of making the risk happen on the left hand side, and the consequences of the risk happening on the right hand side, each containing barriers. In this case, “The barriers on the left hand side aim to reduce the likelihood of a fire occurring, forming what is known as the ‘fault tree.’ In this tree, the probability of a fire event increases with each failed control measure. Conversely, the barriers on the right hand side aim to mitigate the severity of the fire’s consequences, forming the ‘event tree’.”

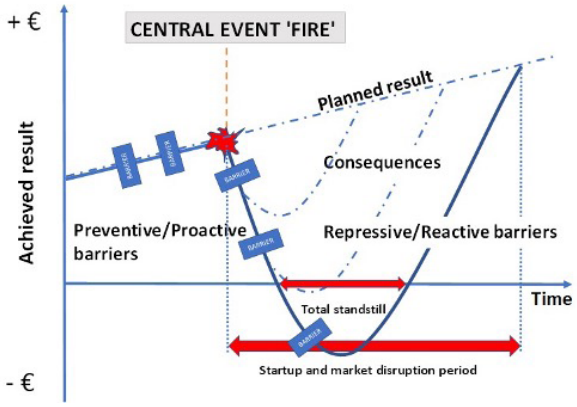
Louis continues “For example, technical mitigation barriers such as sprinklers and non-technical preventive barriers like evacuation procedures, training, guidelines, and policies all play a crucial role. These barriers stand between a fire hazard and the total loss of a building. By evaluating the performance of these barriers, one can assess the probability of expected consequences and determine the optimal balance between preventive and repressive measures.
To complement this approach, the Layer of Protection Analysis (LOPA) framework allows for the inclusion of the Probability of Failure on Demand (PFD) for all preventive and repressive barriers. This enables the calculation of the total consequences of a fire incident. By comparing two different scenarios—one with the barrier and one without—you can determine the hypothetical benefit of that specific fire safety measure.”

By integrating the Bowtie and LOPA models, fire incident scenarios can be effectively visualized and assessed. These approaches enable a comprehensive evaluation of both the likelihood and impact of fire events, as well as the performance of preventive and repressive barriers. This holistic analysis facilitates informed decision-making to optimize safety measures.

Preventing business disruption

When reflecting on the future of fire safety in construction Louis Cleef believes that “a crucial improvement would be to incorporate fire safety considerations into environmental assessments. This is increasingly important due to rising fire risks, such as those associated with the energy transition. While it is essential to include broader attributes like economic and social considerations, the true financial impact of fire accidents, especially indirect costs such as environmental damage and social impact on affected communities, is not well understood. These attributes are often underrepresented due to the difficulty in calculating the value of avoided risks.

To prevent business interruption due to fire incidents, companies can utilize preventive and repressive barriers as outlined in the Bowtie framework. Evaluating the performance of these barriers involves assessing how effectively they reduce the likelihood and severity of fire incidents. By doing so, companies can estimate potential consequences, including downtime and financial losses, and identify weaknesses in their fire safety measures. This comprehensive approach helps ensure business continuity and minimizes the financial impact of fire-related disruptions.



Comprehensive fire safety measures can be implemented through integrated decision-making, which involves better stakeholder selection, greater involvement, risk identification through improved information sharing, and transparent demarcation of responsibilities. Stakeholders, such as banks, insurers, and building owners, are central to this research while having different risk tolerances and objectives. For example, a bank needs to ensure the value of its fixed investments, considering both sustainability and fire safety objectives. By understanding stakeholder interests, we can develop a decision-making framework that aligns with their needs while promoting fire safety.”

Incentive and expected outcomes

When asked what should be the expected outcomes, Louis states “As the world becomes increasingly urbanized, it is essential that our built environments are safe. To encourage building owners to prioritize better fire risk assessment, calculating the hypothetical Internal Rate of Return (IRR) and the Payback period for safety measures can inherently motivate investment. With a comprehensive understanding of fire risks, building owners are in a stronger position to negotiate with insurers and potentially request a reduction in premiums. Implementing this framework could lead to several positive outcomes. It could help predict fire scenarios more accurately and mitigate their severity, resulting in less societal and environmental damage. The framework would encourage more proactive, risk-seeking behavior in terms of fire safety, leading to the recognition of hypothetical benefits, both short-term and long-term. Ultimately, it aligns fire safety with sustainability goals and promotes a safer built environment as urbanization continues to grow.
I believe this research could significantly contribute to preventing major fires in the future, and I hope it helps move the industry towards a more proactive and ethically driven approach to fire safety.”

For more information about the Dutch Fire Safety Economic Course, visit their website here.

Apply the bowtie methodology in your fire safety assessment

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