Learning from Incidents - Linking incident analysis with BowTie based risk assessments

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This paper describes a potential method to improve learning from incidents by linking incident analysis on how an operational barrier performed in an event to a BowTie assessment and accumulating said data over time to demonstrate learning and performance improvement within an organisation.

Keywords: Process Safety, BowTie, Learning from incidents, Barriers, Incident Performance

Introduction

Effective learning from incidents (LFI) is critical for any organisation to achieve as the reasons leading to why incidents occur with an organisation are often not new due to repeat incidents or incidents that are very similar in nature to previous ones.

"Those who fail to learn from history are doomed to repeat it" (Santayana, 1905)

Most organisations follow a typical LFI process as below, which comes from a recent publication by the Energy Institute "Learning from Incidents, Accidents and Events" Publication 1st Edition August 2016

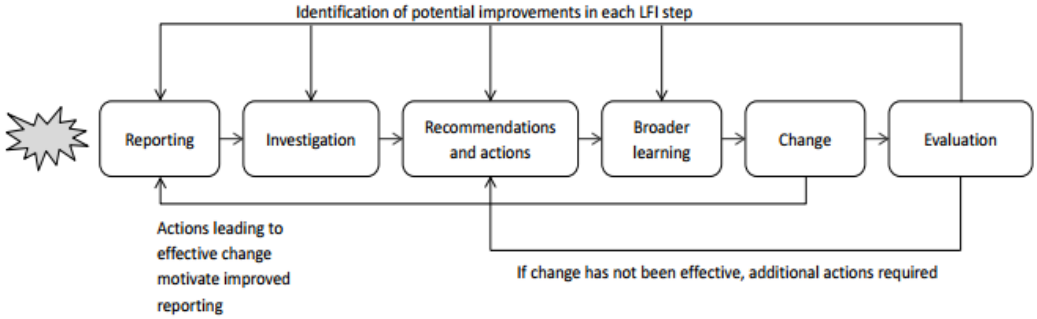


Figure 1 - LFI Process (Energy Insitiute, 2016)

Each step of the process can unfortunately lead to a lost opportunity to learn or a loss of learning potential

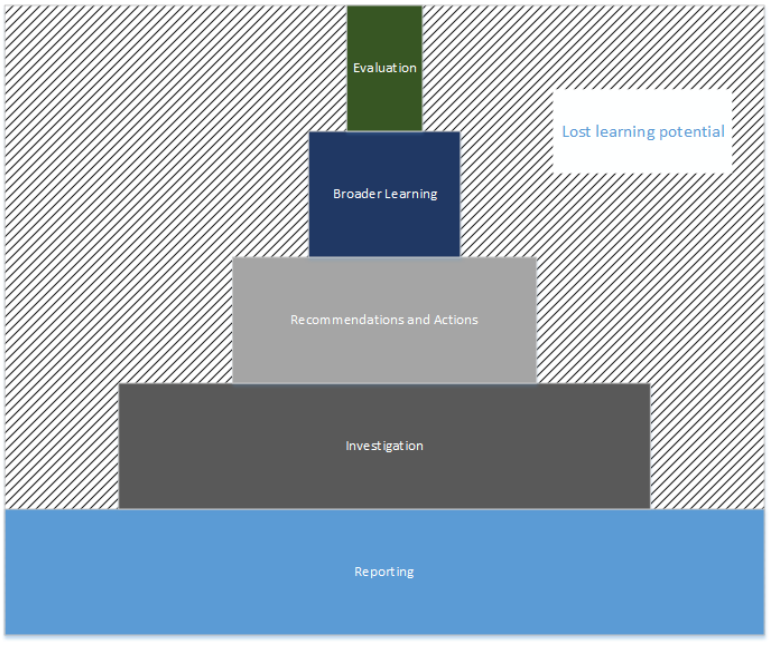


Figure 2 – Visualisation of Data from Critical Steps in Learning from Incidents (Drupsteen, Groeneweg, & Zwetsloot, 2013)

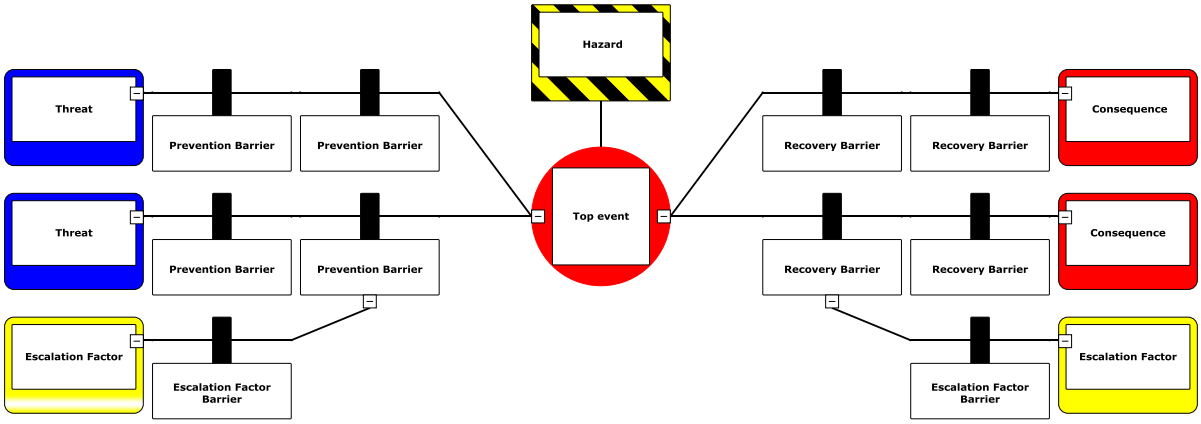
When considering a number of incidents occurring within an organisation, the lost learning potential becomes massive.

Organisations can treat incidents in silos, which leads to a lack of consistent trend analysis occurring in the organisation and little sharing of issues. So there should be no surprise that incidents are repeated events or events that are very similar in nature to previous incidents across the organisation.

This paper discusses linking incident analysis, specifically barrier performance, to the BowTie method to help close the loss learning potential gap.

BowTie Method

A BowTie is a diagram that visualises the risk you are assessing. The diagram is shaped like a bow-tie, creating a clear differentiation between proactive and reactive risk management. The power of a BowTie diagram is that it gives you an overview of multiple plausible scenarios, in a single picture providing a simple, visual explanation of a risk that would be much more difficult to explain otherwise.



Definitions of the elements in the BowTie method;

- **Hazard** - The start of any Bowtie is the Hazard. A Hazard is something in, around or part of the organisation which has the potential to cause damage.
- **Top event** - Once the Hazard is chosen, the next step is to define the Top Event. This is the moment when control is lost over the Hazard. There is no damage or negative impact yet, but it is imminent. This means that the Top Event is chosen just before events start causing actual damage. The Top Event is a choice though, what is the exact moment that control is lost? This is to a large extent a subjective and pragmatic choice.
- **Threat** - Threats are whatever will cause the Top Event. There can be multiple Threats. Try to avoid generic formulations like “Human error”, “Equipment failure” or “Weather conditions”. What does a person actually do to cause the Top Event? Which piece of equipment? What kind of weather or what does the weather impact?
- **Consequence** - Consequences are the results from the Top Event. There can be more than one Consequence for every Top Event. As with the Threats, people tend to focus on generic categories instead of describing specific events. Try not to focus on Injury/fatality, Asset damage, Environmental damage, Reputation damage or financial damage. Those are broader categories of damage rather than specific Consequence event descriptions. Try to describe events like “Car roll over”, “Oil spill into sea” or “Toxic cloud forms”. Besides containing more specific information, you’re also helping yourself to think more specifically when coming up with Barriers. Think how you want to prevent “Environmental damage” versus “Oil spill into sea”. The second is an actual scenario which makes it much easier to come up with specific Barriers.
- **Prevention and Recovery Barriers** - Barriers in the Bowtie appear on both sides of the Top Event. Barriers interrupt the scenario so that the threats do not result in a Loss of Control (the Top Event) or do not escalate into an actual impact (the consequences). There are different types of Barriers, which are mainly a combination of human behaviour and/or hardware/technology.
- **Escalation factor & Escalation factor barrier** - Barriers are never perfect. Even the best hardware barrier can fail. Given this fact, what you need to know is why a Barrier will fail. This is done using the Escalation factor. Anything that will make a Barrier fail can be described in an Escalation factor. For instance, a door that opens and closes automatically using an electrical mechanism might fail if there’s a power failure. Warning: be careful with escalation factors. You do not describe all the potential failure modes. Only describe the real weaknesses of your control framework and how you want to manage that. The logical next step to manage Escalation factors is to create Barriers for you Escalation factors, aptly named Escalation factor barriers. In this case it could be a backup generator.

The BowTie method visualises the unwanted scenario and demonstrates what barriers are in place or should be in place to manage those scenarios.

Linking Incident Analysis with a BowTie

During the incident investigation phase barriers that should have prevented the unwanted scenario are identified, these can be elements of a procedure or piece of hardware etc. and the investigation establishes good or poor barrier performance during the event.

By linking the performance of these identified incident barriers to a BowTie allows a number of benefits to be realised;

- An organisation to lock learning into corporate memory, and over time as more and more incidents get mapped to that BowTie, an organisation builds up a profile of positive and negative performance of barriers from their incidents.
- By establishing a connection of barrier performance to risk management BowTies, an organisation has a picture of real barrier performance against its proactive risk assessments and can take corrective action to improve performance and ultimately demonstrate that the change has improved performance over time as negative performance turns positive against the problem barrier.

Using the example of storing flammable liquids in a storage tank and monitoring overfill events, specifically the performance of the high level trip system. So specific trip system performance whether positive or negative performance can be mapped to a generic barrier.

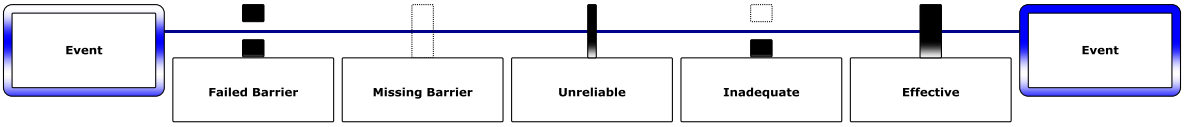


Figure 3 - Definitions of performance

Definitions of barrier performance in an incident:

- **Failed barrier** - Most barriers in an incident analysis will be in a failed stated. A failed barriers was correctly implemented at some point, and then for whatever reason stop performing its function. This could be because the barrier is removed, turned off, fails when challenged or is just broken continuously.
- **Missing barrier** – a barrier is missing if it has never been fully implemented. For instance, a fire extinguisher that was specified in a standard, but never acquired. Implementing a barrier is a long process. It requires identifying the need for it, specifying it, acquiring it, installing it and activating it. If this process breaks down anywhere before the barrier is activated, it is a missing barrier.
- **Unreliable Barrier** - The barrier functioned as planned and incident did not escalate further and there is evidence that it might not function in the future without corrective action.
- **Inadequate Barrier** - a barrier that works according to its specification, but do not stop the incident from progressing. They might have no effect or a minor effect. These barriers are classified as inadequate.
- **Effective barriers** - The barrier functioned as planned and incident did escalate further and there is high confidence it will continue to do so.

Figure 4 - Linking specific incident failures to a generic barrier, shows how a set of individual incident barriers can be mapped to a parent of those barriers, along with indication of each individual barriers performance,

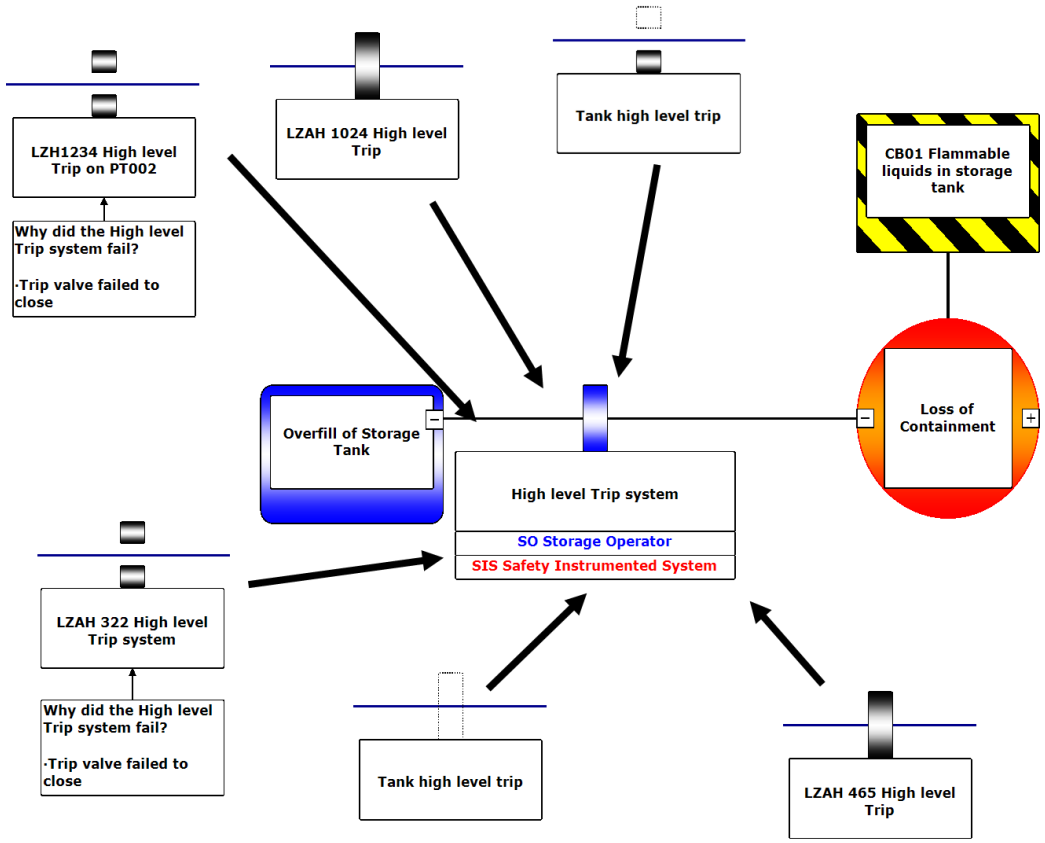


Figure 4 - Linking specific incident failures to a generic barrier

So accumulating the incidents together over time for the high level trip system performance across an organisation can begin to look like Figure 5 which is giving a summary of the individual incident barrier performances.

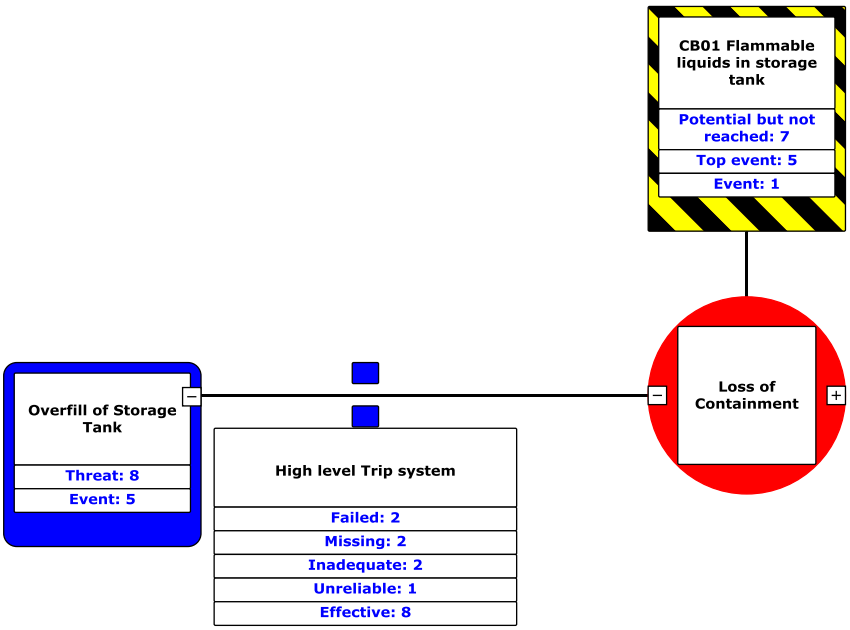


Figure 5 - Accumulated incident performance (corporate memory)[1]

[1] The data in Figure 5, Figure 6, Figure 7 and Figure 8 has been generated for demonstration purposes

Analysing performance and effect of corrective action

As there are dates associated with each investigation and along with recommendations and corrective actions, it becomes possible to view barrier performance and subsequent change / improvement as a trend over time rather than just raw numbers as in Figure 5 - Accumulated incident performance (corporate memory).

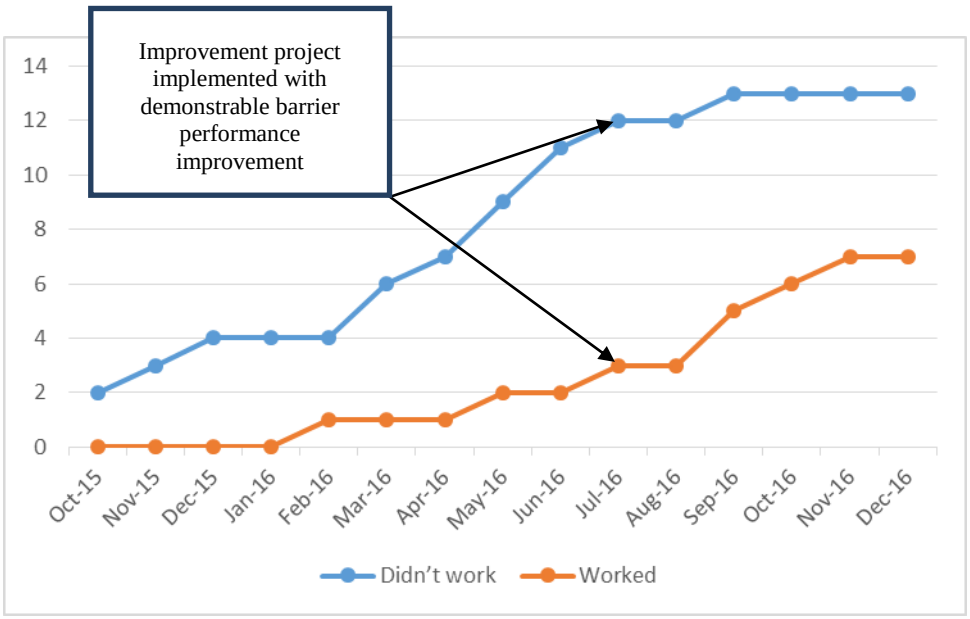
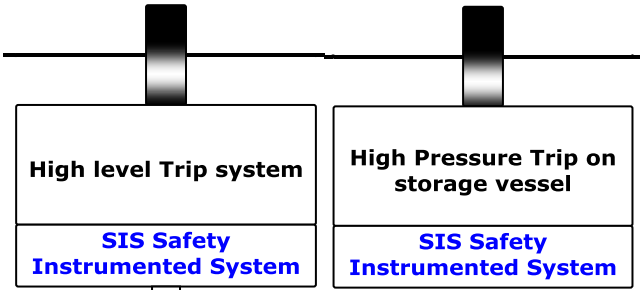


Figure 6 - Performance trending

There are multiple attributes that can be applied to a barrier within a BowTie, for example the high level trip system in Figure 4 could be part of a site or whole organisation's safety instrument system (SIS) group. So we can add that attribute to our parent barrier, and other trip systems.



So the performance of the group can then be visualised as trends, either local for a single site or global for the whole organisation.

Figure 7 gives the performance of all the SIS items in the organisation, giving an overview of five classifications of performance of barrier in the group involved in an incident. Figure 8 is showing the same data accumulated over time to show the trend of each classification over time.

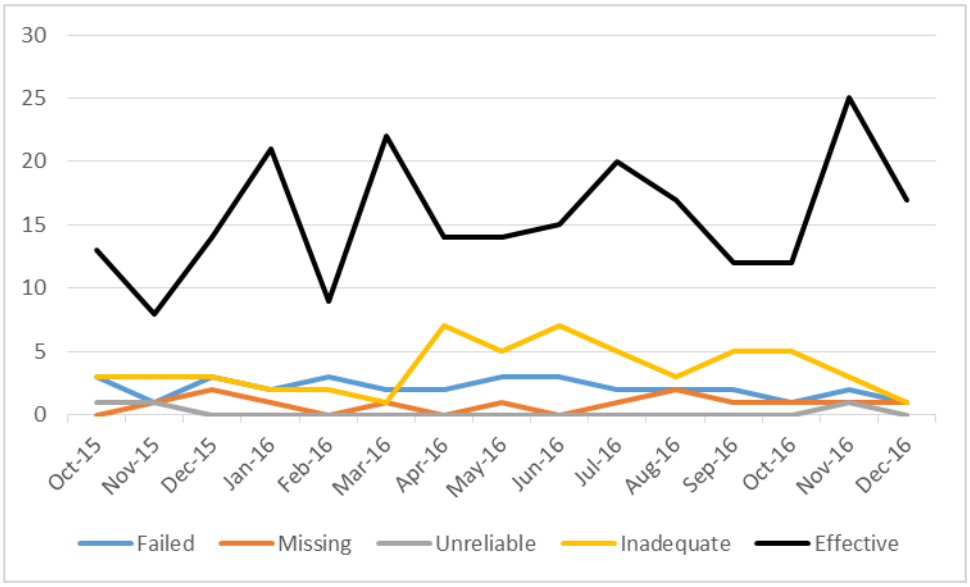


Figure 7 - SIS Barrier Group performance overview

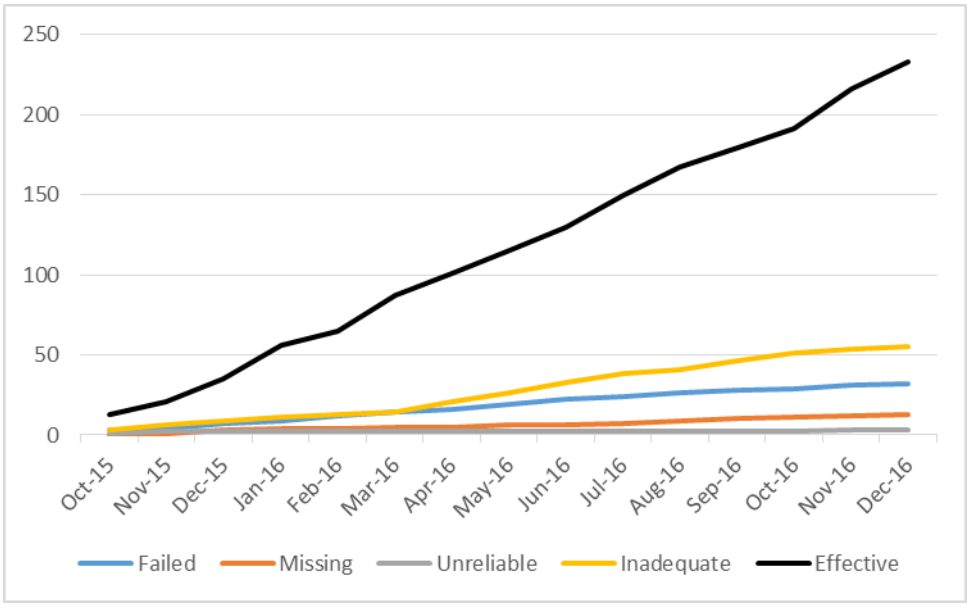


Figure 8 – Accumulated SIS Barrier Group Performance

As demonstrated above, linking incident analysis to a parent barrier on a BowTie can allow an organisation to retained learning and demonstrate improvement following incidents.

References

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