SHARING DATA, SAVING LIVES

A Regulators' Pioneer Fund report

Foreword

The Health & Safety Executive has a mission to lower the human cost of injury and ill health on construction sites. Enabling data sharing in a secure and resilient way to help businesses make better decisions is an important part of UK Government Policy. Industry is undergoing a technical revolution as information systems become more capable and far reaching. It is important therefore that HSE supports research to bring these factors together. This Report explores the potential that sharing design risk data can have in reducing the levels of risk and uncertainty encountered on the construction site. The Sharing Data Saving Lives project has explored some key practical issues around how data can be shared, and what are the blockers and enablers, incentives and disincentives that prevent this happening. The potential size of the financial gains are explored, and a logic model presented to show how these gains can be realised.

HSE values the opportunity to work with specialist research partners such as Atkins, the Open Data Institute and Metis Digital. This report opens up the issues around data sharing in the construction industry, and will provide a great basis for future initiatives in this area.

Adam Mellor

Deputy Director – HSE Science Division

Authors

Key members of the project team and authors of this report:

Zane Ulhaq (Atkins)
Gordon Crick (HSE)
Miranda Sharp (Metis Digital)
Darren Temple (ODI)
Jared Keller (ODI)
Sheng Peng (Atkins)
Andrew Jackson (Atkins)
Sam Arthur (Atkins)

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1. Key Messages

1. Enterprises understand there are potential benefits in principle to share health & safety data but are unwilling or slow to do so in practice because of security, privacy and commercial concerns. Some examples already exist in the industry where information is shared in limited circumstances, but these are typically small scale and not designed to exploit standardisation and aggregation using digital technology.

2. There are economic benefits which can accrue through sharing design risk data and improving design risk management as a result. The last major improvements to Health & Safety were seen between 2004/5 and 2009/10, if data sharing can replicate these improvements, this is equivalent to up to a 30% saving (of £198 million p.a.) in injury costs in construction.

3. Design risk data is not typically produced by the industry in a format which is easy to share, even if organisations could overcome the barriers of security, privacy or commercial concerns. This project has demonstrated a way of sharing a limited amount of generic free text and coded data on health & safety risk, which is less subject to concerns about commercial or personal interest.

4. Design risk data sharing has been demonstrated in this project to have benefits which can be realised in the short term through standardisation of terms and concepts core to design risk management in Construction. Public Sector Clients which operate across a number of regions with multiple programmes of projects are well placed to benefit.

5. No one construction industry body by itself is likely to gain the trust of the industry to share data effectively. This is due in part to the fragmented way the industry represents itself through sector specific organisations. Although the Health and Safety Executive (HSE) uniquely has a common interest in all sectors, this research clearly shows that the majority of organisations do not see the HSE being the data steward in aggregating Health & Safety data across organisations due to their responsibility as a regulator.

6. In order to build trust over the next few years the Discovering Safety Programme (www.discoveringsafety.com) is put forward as a vehicle to develop further design risk data sharing practice through its Construction Risk Library Project, which is independently funded and acts at arm’s length from the Regulator. In the longer term the development of a Data Institution or other suitable vehicle should be planned, in order to build on emerging practise where this can be shown to be effective.

7. The question of sustainability deserves particular emphasis and consideration because although the benefits of design risk data-sharing to the industry as a whole are likely to be substantial, there is a split between where the costs of collection, management and sharing are incurred and where its benefits are realised.

2. Executive Summary

There is a human cost associated with accidents and ill health. Harm to workers or others affected by construction work activity can be prevented by reducing the levels of risk and uncertainty encountered on the construction site. This reduction can be achieved by sharing health & safety (H&S) data from the earliest design stage of a project and adopting more effective risk treatments at every stage of design and planning.

In economic terms the cost of errors and rework in construction is estimated to be £5bn per year[1] in the UK (5% of project costs, varying between 0-80%), with £1bn being attributed to incidents which result in injury or harm to persons affected by construction work. UK Government Policy identifies the need to reduce this figure, and also recognises value of sharing and making available, systematic and transparent data[2,3].

This project aimed to determine how significant an opportunity there is to benefit from sharing health & safety data in the construction industry and examined the practicalities of doing so. This project has been made possible by a grant of £198,831 from the £3.7 million Regulators' Pioneer Fund launched by The Department for Business, Energy and Industrial Strategy (BEIS).

The fund enables UK regulators and local authorities to help create a UK regulatory environment that unleashes innovation and makes the UK the best place to start and grow a business.

The project team consisted of the Health and Safety Executive (HSE), Atkins, the Open Data Institute (ODI) and Metis Digital. The team had expertise in construction delivery, H&S in the context of construction, data strategies, sharing data and H&S risk data management in construction projects.

Through an extensive programme of interviews with experts and examination of relevant studies, a logic model was created which described the problem of sharing risk data from the design stage of a project, the changes and outputs needed to affect a solution, and the resulting benefits to society, employers and individuals.

Stakeholders agreed that sharing risk information and adopting best practice in risk treatment is likely to reduce the impact severity and frequency of incidents in construction. Productivity and corporate memory is also likely to be improved by the availability of a database of clearly defined risks and treatments. This may have particular value in relation to preventing rare catastrophic events. However, the balance of costs and benefits in relation to data sharing is unclear, because the evidence in the form of published data is lacking. However, the logic model does show a strong causal link between effective sharing of risk data and benefit in reducing costs.

The main benefit of sharing risk data is reducing the number and impact of incidents. However, there are two further key benefits in the logic model which accrue from data sharing which are also evidenced in this report. These are benefits to an organisation which are described in this report as “moral glow”, arising from good H&S risk management and a robust institutional memory reducing training costs. This is associated with a skilled workforce, and assured levels of competence. The

[1] https://getitright.uk.com/reports/literature-review/chapter/financial-and-economic-impact-of-error
[2] The Green Book (publishing.service.gov.uk)
[3] National Data Strategy - GOV.UK (www.gov.uk)

second benefit is described as “reduced business friction” and is associated with construction businesses who operate with less margin of uncertainty and provide greater customer confidence in construction outcomes. Such businesses attract competitive insurance offers.

The logic model could not develop a fully defined solution because of the short timescale for the project and a lack of data on relevant costs. A fully quantified assessment of costs and benefits was therefore not possible. However, significant research was completed to develop an expert reviewed idea of the nature and distribution of the benefits that might be achieved if design risk data sharing could be optimised. Some of the benefits relate to costs which have never been quantified, including loss of productivity and goodwill. The impact of data sharing was estimated in relation to historical savings that were made over the six-year period between 2004/5 and 2009/10. This period showed a significant reduction in the costs associated with injury.

If data sharing can be significant enough to replicate this improvement in reducing injury cost between 2004/05 and 2009/10, this may be equivalent to up to another 30% saving (of £198 million) in injury costs in construction. This would reduce the total economic costs in construction associated with workplace injuries and ill health down to approximately £1 billion (2018 prices). These figures underestimate the potential benefits, because they take no account of the costs of non-injury incidents, damage, and waste that are associated with uncertainties in design and planning information, and the need for rework.

Alongside research into the benefits that may accrue through data sharing, the project also investigated the practicalities of data sharing. The project was limited to a six-month period, so it was difficult to do much more than gain a snapshot in time of how projects are working with design risk data, rather than being able to study the use of design risk data through the lifecycle of a project.

Consultation with the industry took place through workshops, a structured survey, interviews and an online demonstrator. An initial workshop was held with 44 stakeholders attending, representing mainly large organisations, design consultancies, architects, infrastructure clients and contractors. There was a clear appetite from the attendees to engage with this project, both in terms of being part of the community going forward and sending information to their project teams. Stakeholders agreed that there are potential benefits to be had from sharing design risk and safety data within the construction industry.

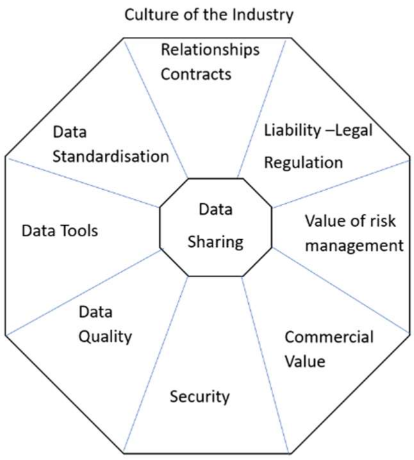
However, even in this first workshop, the positive desire for data sharing and progressive collaboration around design data was moderated by concerns around practical issues. These included security, privacy, ownership and governance in respect to data. The main ‘wants’ from attendees were around the desire for simplification, consistency and efficiency around recording and sharing design risk data. The main ‘needs’ were related to the necessity of good communication, both internally and externally between collaborators and competitors, as well as with the HSE.

The project then followed up the first workshop with a survey in order to dig deeper into a more detailed range of issues around sharing data, and to try to obtain some structured feedback on key questions. Responses to the survey revealed a high level of comfort and confidence held by participants in both their own, and their organisation’s, ability to manage design risk data effectively.

Aggregation of design risk data was scored more highly as a valuable outcome than standardisation of data. On both topics, participants rated the value of doing so higher than the possibility of executing it. Respondents recognised the importance of matching risk treatments to a risk and considered that fully automatic systems to do this would be less effective than semi-automatic systems. To explain this point, a fully automatic system would serve up an optimal risk treatment for the risk scenario, whereas a semi-automatic would serve up a number of treatment options for the user to choose between, or relevant guidance to formulate their own treatments. The survey asked how shared information should be overseen and where responsibility should sit for the overarching governance of this data. The survey recorded 32 responses from Stakeholders which listed an Independent third party highest at 45%, Industry self-regulates at 38%, and the Government Regulator at 17%.

The survey was followed up by selected interviews with representative experts from the industry. As a result of these interviews, an octagon of issues was identified which collectively described how the culture and behaviours around data sharing at the design stage needs to change. Most of these issues can be both enablers for benefit, or blockers to prevent sharing, depending on their presence or influence.

Figure 1 – H&S Data Sharing key concepts.



The project found that the key issues preventing sharing are not simple. They span across the domains of people management, skills and training, trust and human factors to the commercial and legal aspects around liability and regulation through to the professional practice areas of digital tools, data quality and standardisation.

The project used a framework of design risk data founded on the PAS 1192-6:2018 "Specification for collaborative sharing and use of structured health and safety information using BIM (Building Information Modelling)", to develop an online demonstrator. This framework is also used by the Discovering Safety programme's (DSP) Construction Risk Library project. The Discovering Safety programme is a global H&S improvement programme being run by the HSE and funded by the Lloyd's Register Foundation. One of the key use-cases in this programme is the Construction Risk Library project which looks at using H&S risk data better through improving data-related processes.

The DSP Construction Risk Library framework uses six data points to describe a risk scenario, and then seeks to match the risk scenario with an appropriate risk treatment. In the project demonstrator a simple form was used to determine how users input to this framework compares with current industry practice. The demonstrator showed effective identification, assessment, ownership and treatment of risk. The intention of putting the demonstrator online was to hold up a benchmark against which users could compare their own design risk recording method. The demonstrator provided opportunity for users to comment against each data point and entry box on the online tool.

A key finding from the demonstrator was that the risk entries on the tool, which categorised the risk, and provided essential context to the risk, were the least easy for users to transfer entries into from existing records. Reasons for this include: the format of description of labelling of risks varies very widely; the language of hazard and risk is used interchangeably; and risks are often described in very general terms. To further complicate the picture, the context, or direct circumstances in which risk may eventuate is rarely described. These factors made it very difficult for users to take advantage of any easy transfer of risk information into the demonstrator.

Working with the project online demonstrator provided the opportunity to test and simulate ways of overcoming the 3 key challenges around industry organisation and relationships, standardisation, and liability.

Through the project three types of relationships were highlighted as having particular relevance.

1) Between competitors – On the side of sharing data between competitors was a strong moral sense of this being the right thing to do, and of openness and transparency being a fine ideal. However, in practice this was swamped by commercial and legal concerns, often fuelled by an over cautious approach to legal and contractual obligations.

2) Regulator to Industry, Industry to Regulator – The project foresaw issues with a reluctance to share directly with the Regulator. A project partner, the Open Data Institute, was therefore selected to act as a trusted intermediary. However, in practice this made little difference.

3) Partnership working - The project did note successes working with those organisations that had close relationships with the project. Data sharing was facilitated by a more relational rather than transactional style of working.

A key enabler which emerged as part of a solution to meet the barriers identified is the standardisation of data. Part of a root issue is industry variation in practice, value and priority of design risk data management. Where standardised methodologies do exist, they are often associated with manual methods of recording risks. The use of 3D models, digital information management, and the use of Information standards such as ISO 19650, do offer great opportunities for progress in standardisation, and data sharing, but the practice of using them as core design risk management tools is not widespread or well developed. One possible incentive proposed was a standard audit format, approved by the Regulator, to benchmark industry practice against. A standard audit procedure could be developed based on pre-construction audits already being carried out by leading proponents in the industry, or developed from first principles.

To reduce concerns around liability for sharing data, the two strategies cited were the encouragement of a standardised data model, perhaps based on the Discovering Safety Construction Risk Library model. The second strategy involved using only generalised and anonymised coded data, or generic text. The use of technology to automate anonymisation and generalisation is a potential option, but the application of such tools is at a very early stage in the industry. The issue of security of data and combatting cyber threats is also addressed to a large extent by sharing only a select amount of generalised and anonymised data.

3. Introduction

The premise of this project is to encourage a better approach to reducing health and safety (H&S) risks by sharing data. **Data** are facts or details from which **information** is derived. Individual pieces of data are rarely useful alone. To be valuable each must be put into the correct context and shared with those that need it. Not doing this can come with a cost. The economic impact to the UK from construction errors and rework is estimated to be £5bn (5% of project costs)[4]. Incidents account for £1bn[5]. These costs are met by individuals, their families, employers and society. They could be reduced by accurate, early identification and treatment of health and safety risks at their source – i.e. when decisions are being made at the planning and design stage of projects [6,7,8]. These decisions can also be subject to optimism bias[9] resulting in a failure to prepare for, and mitigate against, infrequent but catastrophic health and safety events[10].

The importance of sharing construction data to reduce such risks is already recognised. There is a consensus that the wide adoption of construction health and safety risk data sharing will improve self-regulation and reduce the significant financial (and human) impact of incidents. One programme looking to tackle H&S improvements is the Discovering Safety Programme (DSP), a global H&S improvement programme being run by the HSE and funded by the Lloyd's Register Foundation. One of the key use-cases in this programme is the Construction Risk Library project which looks at using H&S risk data better through improving data-related processes.

The importance of data sharing can be seen in the Discovering Safety programme's SafetiBase Risk Library[11], the Building Safety Bill[12,13] and the Golden Thread report from the Buildings Advisory Committee. More generally, HMT Green Book notes the value of systematic data collected and made transparently available, as does the National Data Strategy.

However, those who are required to invest and participate in data sharing may not be the ones who directly realise the benefits. This means the effect of data sharing on different stakeholders needs to be understood. This project, therefore, aimed to determine the opportunity and practicalities of sharing health and safety data. This project has been made possible by a grant of £198,831 from the

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[4] https://getitright.uk.com/reports/literature-review/chapter/financial-and-economic-impact-of-error
[5] https://www.hse.gov.uk/statistics/industry/construction.pdf
[6] Digital information technologies for prevention through design (PtD): a literature review and directions for future research | Emerald Insight
[7] https://getitright.uk.com/live/files/reports/5-giri-design-guide-improving-value-by-reducing-design-error-nov-2018-918.pdf, https://core.ac.uk/download/pdf/148364953.pdf
[8] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6238149/
[9]https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/983759/updating-the-evidence-behind-the-optimism-bias-uplifts-for-transport-appraisals.pdf
[10] https://www.hse.gov.uk/research/rrhtm/rr834.htm, https://hbr.org/2009/10/the-six-mistakes-executives-make-in-risk-management
[11] https://www.discoveringsafety.com/
[12]https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/901877/Draft_Building_Safety_Bill_Impact_Assessment_web.pdf
[13] https://www.gov.uk/government/publications/building-safety-bill-factsheets/impact-assessment-factsheet,

£3.7 million Regulators' Pioneer Fund launched by The Department for Business, Energy and Industrial Strategy (BEIS). The fund enables UK regulators and local authorities to help create a UK regulatory environment that unleashes innovation and makes the UK the best place to start and grow a business.

The project was split into two core packages:

1. **Understanding the benefits** – Here, the intention was to determine a model which would connect the action of sharing data to economic value, this would be justified by publicly available datasets and interviews. The deliverables included a logic model, a range for potential benefits and insights for future improvements on the detail.
2. **A sharing data demonstrator** – Whilst determining the benefits, the project aimed to receive data from participants to gain industry insights and lessons learnt on data sharing for H&S. The deliverables for this were findings on how to share data.

Both packages come together to discuss the value of sharing data, what is currently happening in the sector, and how to move closer towards achieving the sharing of H&S risk data nationally, improving self-regulation and reducing the severity and frequency of injuries.

4. Benefits of sharing data

This aspect of the project focussed on developing and testing a working hypothesis for the benefits of sharing health and safety risk data.

4.1. Methodology

There have already been attempts to create sustainable business cases for sharing data across organisations and sectors. Examples include the National Underground Asset Register (NUAR) and National Digital Twin programme. An initial project hypothesis regarding the benefits of sharing of H&S risk data was developed using learning from these and expert input from the Discovering Safety Programme. Three broad benefits identified from the hypotheses to test were:

- Fewer and less costly incidents and accidents in construction.
- A positive "moral glow" associated with best practice H&S risk management giving rise to increased workforce productivity and client (societal) confidence in construction outcomes[14].
- Decreased "business friction" costs associated with lack of precision in risk and mitigation, paid in the form of higher insurance premiums and contingency costs.

Interviews were conducted with 25 stakeholders from industry, academia and the public sector between Dec 2021 and March 2022. Interviewees were chosen based on their expertise, covering a wide range of areas. To generate a wider pool of interviewees, initial interviewees were asked if they had experts in their networks who we would benefit from interviewing.

The interview format included a project introduction with a focus on the initial hypotheses. Interviewees were asked of their opinion on:

- The validity of the initial hypothesis (above).
- Existing and planned work on the benefits and beneficiaries of sharing data in general, and design risk and build environment data, in particular.
- Insight and evidence of the impact on employers, society and individuals from sharing (design risk) data.

Economic benefits are easier to quantify when there is a clear understanding of what intervention is being proposed. Therefore, a lack of interventions in sharing H&S risk data limits the project's ability to forecast economic benefits with confidence. Furthermore, given the scale of uptake and change, this is likely to be incremental rather than transformative. An estimate of the economic benefits from safer design based on data sharing was undertaken through analysis of existing literature including Health and Safety Executive (HSE) books, reports and other publications in the public domain.

[14] https://iosh.com/media/1577/the-impact-of-health-and-safety-management-on-organisations-and-their-staff-summary-report.pdf

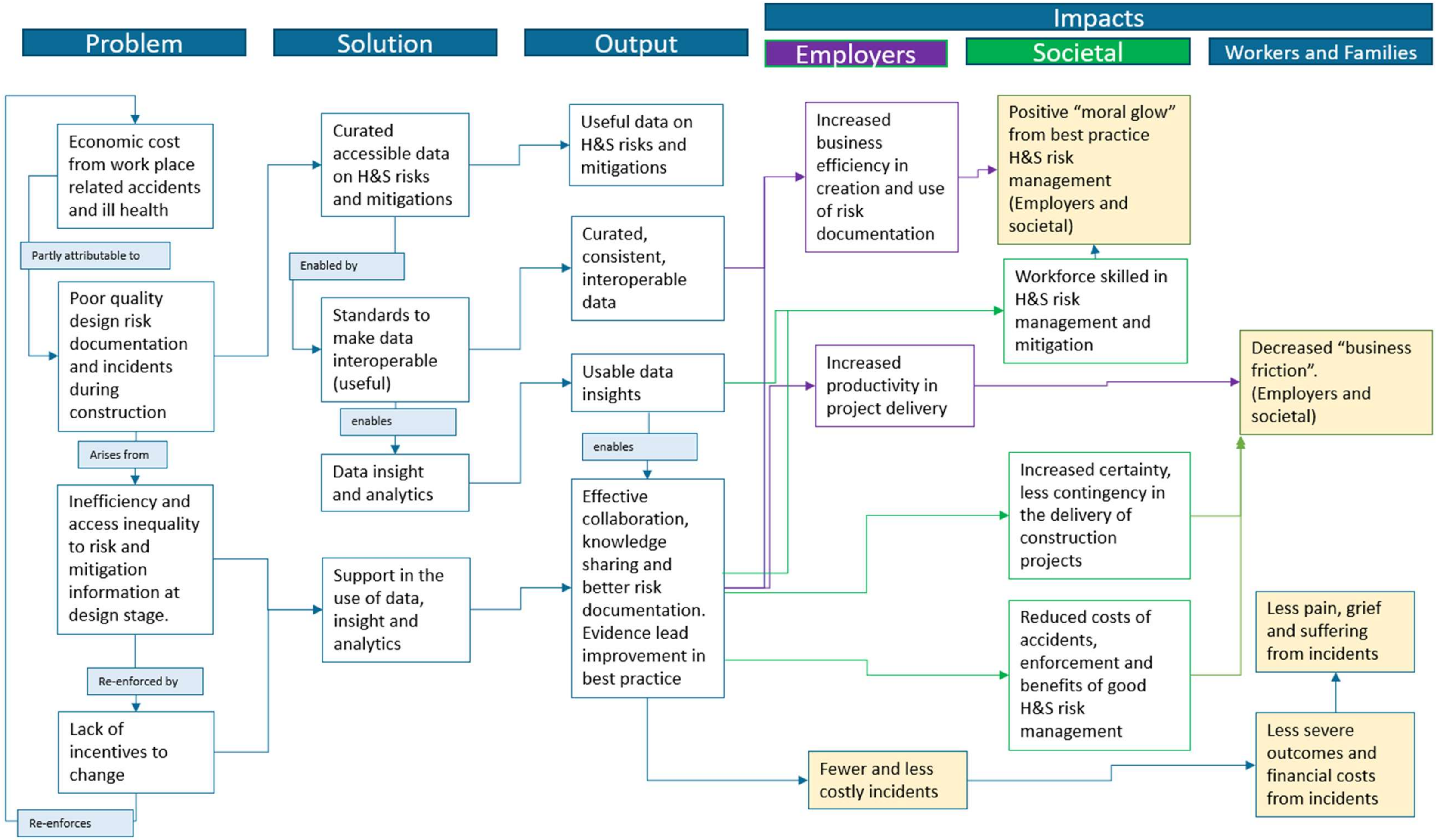
4.2. Logic Model

When trying to quantify the economic benefits, logic models are needed to align the problem being faced to a solution, this in turn creates outputs and impacts.

Through engaging leaders with experience in the H&S risk data sharing space, Figure 2 was produced as the logic model for this study. This shows how the problem of economic costs from workplace related accidents could be addressed by curated accessible data on H&S risks. This model incorporates and develops further the framework in the HSE book by Gordon and Risley[15].

[15] The costs to Britain of workplace accidents and work-related ill health in 1995/96 (hse.gov.uk)

Figure 2 - Logic Model for sharing H&S risk data.



4.2.1. Qualitative assessment of impact

Reduced incident cost

Stakeholders interviewed agreed that sharing risk information and best practice mitigation is likely to reduce the impact, frequency and severity of incidents in construction, and the costs incurred associated with them. At a project level, accessible best practice information can improve productivity at the design stage and outcomes during construction. Furthermore, a national dataset detailing risks and treatments will create an evidence base to increase the speed of industry learning, including that relating to infrequent and catastrophic events. This evidence base can be used to document the potentially significant costs and impacts of H&S incidents which are not regularly quantified or mitigated. Stakeholders agree that the balance of costs and benefits to share data and subsequently reduce risks are either unclear or not considered sufficiently attractive. This is primarily because this activity has not been investigated to date, as well as H&S being seen as a means to meet regulatory demands than for something to innovate or improve on.

Stakeholders also agree that some costs associated with H&S incidents are partially unaccounted for in the logic model, including employer's: internal investigation; support of external investigation; the risk of business failure; and the human cost to individuals of coping with a colleague's misfortune.

Positive moral glow

There is broad agreement amongst stakeholders interviewed on the positive impact ("moral glow") from good H&S risk management for employers. Stakeholders referred to a robust institutional memory reducing training costs and incident frequency.

Further, a societal moral glow was suggested with the creation of differentiated national competence in H&S design risk management and a skilled workforce capable of offering competitive services internationally.

Less Business friction in the mitigation of risks and uncertainty

The costs of H&S incidents and waste are linked, with 37% accidents occurring during rework[16]. Such costs are typically met by "contingency" budgets which act as a margin of uncertainty in delivery, undermining societal confidence in construction outcomes.

There is limited evidence of increased "business friction" for enterprises which have poor H&S design risk practices. Stakeholders agree that "poor performers" may have reduced access to opportunities[17] and find it harder to obtain competitive insurance offers. However, interviewees supporting the Building Safety Bill have found that the insurance market does not currently support an exact correlation between risk identification and insurance costs. Insurers instead focus on what processes have been defined and adhered to and claim history. However, due to the pandemic issues and market defining losses, insurers are reducing appetite and capacity. In addition, where they are underwriting, they are requesting more project-based information[18]. By introducing an

[16] https://getitright.uk.com/

[17] Bidders are often required to disclose HSE investigations as part of a tender process

[18] https://www.marsh.com/uk/industries/construction/insights/construction-insurance-market-update-2021.html

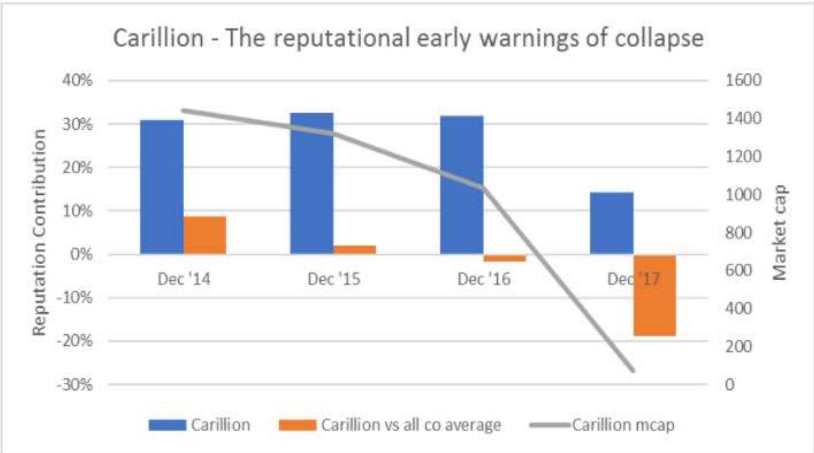
improved and consistent process of sharing data across projects and organisations, insurance companies gain more assurance and certainty, delivering value back to the industry.

4.2.2. Quantitative assessment of Impact

In the absence of a fully defined data sharing solution, it is not possible to speculate on the total impact of sharing data on the various stakeholders. An economic analysis on the result of reduced frequency and severity of accidents is included below.

Some insight into the impact of positive moral glow and negative business friction is available using the techniques and analysis from Reputation Dividend which endeavours to calculate the proportion of market capitalisation attributable to listed company reputation. Reputation Dividend suggest that good H&S risk management has an impact on the market and stakeholder perception of quality of management, quality of products and in Environmental, Social and Governance (ESG) performance. This difficult to measure effect contributes to market capitalisation with the reputation contribution turning from a contributor to a detractor as businesses fail, shown in the Carillion chart (below):

Figure 3 - Carillion Chart – courtesy of Reputation Dividend



4.2.3. Proposed solution

It should be noted that the groups who will need to invest to create a data sharing solution (designers and data stewards) are not those who will necessarily benefit from the solution (contractors, clients and society).

There are many significant barriers to the implementation of any data sharing solution, outlined below:

Table 1 - Proposed Solution

Issue	Problem	Steps to implementation
"Technical" data concerns	Enterprises are happy in principle to share data but unwilling or slow to do so in practice because of security, privacy and commercial concerns	Advice exists[19] but needs to be developed with learnings from the live demonstrator and NUAR
Effort in contribution	H&S risk data requires effort before it can be collated and analysed at a population level and therefore deliver value to users and society	The Discovering Safety Programme and ODI data institution work will support user engagement towards a solution.
Securing of benefit	The investors in data and data stewardship do not realise the benefits	The demonstrator project supports cost identification and the benefits mapping work has helped to identify potential beneficiaries

In addition, any solution should complement the implementation of the National Data Strategy and Building Safety Bill.

4.3. Economic Benefit

After defining the impact from interventions through better risk data and management, the scoping of potential economic benefit can be determined. To tackle this, the Project used supporting data from the HSE's publicly available records outlined later in 4.3.2. It should be noted that this focuses on the economics of incidents occurring and not how the better planning of projects through better H&S practices delivers programmatic value.

Many of the benefits discussed above specifically fall outside the costs measured not only by HSE but also those measured by enterprises, individuals and society. Specifically, HSE notes[20] the unquantifiable costs associated with reduced productivity, as a result of injuries or absenteeism and loss of goodwill and reputation of the firm with its workforce, customers and the local community. In addition, the formal costs of investigation in available data are only attributed to HSE, any cost to the injured person's employer is not recorded. Interviewees formed the view that this was at least equivalent to HSE costs.

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[19] https://www.cpni.gov.uk/security-minded-approach-open-and-shared-data, https://www.cpni.gov.uk/system/files/documents/06/e9/Triage%20Process%20for%20the%20publication%20or%20disclosure%20of%20information.pdf

[20] https://www.hse.gov.uk/pubns/priced/hsg101.pdf page 47

4.3.1.Supporting data

HSE first produced aggregate estimates of the costs to Great Britain of workplace accidents and work-related ill health for 1990/91 in a seminal report by Davies and Teasdale[21], separately identifying costs to the individual, to the employer and to society. These estimates were updated for 1995/96 by Gordon and Risley[22], with an interim update for 2001/02[23]. Since the interim update, significant changes in methodology have been adopted in the HSE Costs to Britain Model and therefore estimates presented thereafter are not directly comparable to what was previously prepared on a like-for-like basis.

Headline changes in the methodology have been outlined in Appendix 5 of a research report[24] published in 2011 with regards to the costs to Britain of workplace injuries and work-related ill health in 2006/07. We have reviewed all aforementioned books and reports and found that the original book by Gordon and Risley with regards to the cost to Britain in 1995/96 provides a sound (although known to be incomplete) foundation for establishing a benefit framework due to its comprehensive approach and thorough explanations. This helps categorise different types of impacts and economic costs associated with workplace injuries and work-related ill health. Information in this book was therefore used to inform the development of the logic map and economic model following the central government's guidance on evaluation in the Magenta Book[25].

Relevant data published by HSE from 2004/5 to 2018/19 has also been examined, including the aforementioned research report on the 2006/07 costs and a separate report[26] for the 2018/19 costs. These reports and dataset give a high-level and more up-to-date articulation of the economic costs of workplace injuries and work-related ill health, taking into account the evolution in the methodology adopted by the HSE since early 2000's.

Due to 2018 being the last undisturbed financial year since the pandemic, global conflicts and their resulting economic impacts, use of this data is more representative in lieu of any up-to-date information that may be available.

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[21] Davies, NV and Teasdale, P, 1994. The costs to the British economy of work accidents and work related ill health. HSE Books ISBN 0 7176 0666 X

[22] Gordon, F, Risley, D, and EAU economists, 1999. The costs to Britain of workplace accidents and work related ill health in 1995/96. Second Edition. HSE Books ISBN 0 7176 1709 2 (The costs to Britain of workplace accidents and work-related ill health in 1995/96 (hse.gov.uk))

[23] Interim update of the 'Costs to britain of workplace accidents and work-related ill health' (parliament.uk)

[24] RR897 - The costs to Britain of workplace injuries and work-related ill health in 2006/07 - Workplace fatalities and self-reports (hse.gov.uk)

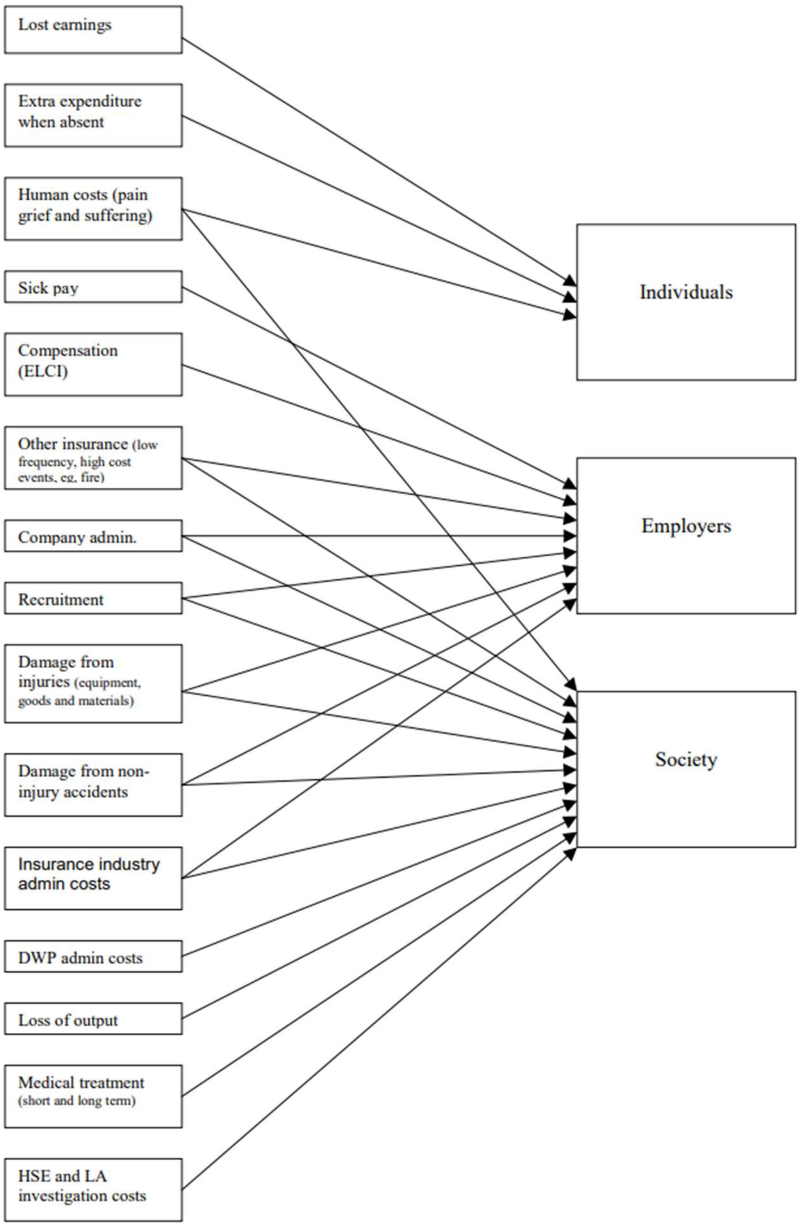
[25] HMT_Magenta_Book.pdf (publishing.service.gov.uk)

[26] Costs to Britain of workplace fatalities, self-reported injuries and ill health, 2018/19 (hse.gov.uk)

4.3.2.Determining the total savings available

An illustration of the range of economic costs relevant following the approach documented in the HSE book is presented in the figure below, with indication of relevant cost bearers. This illustration originated from the aforementioned HSE 2001/02 interim update.

Figure 4 - Range of economic costs – 2001 interim update, footnote 31



It should be recognised that in some cases, a cost to one cost bearer (individuals, employers or society, as seen in Figure 4) is an equal and opposite benefit for another bearer. For example, sick pay represents a cost to the employer but is an equal and opposite benefit to the individual who receives it, so at the societal level the sick pay cancels out to zero. These are 'transfer payments': a cost from employers transferred as a benefit to individuals.

Table 2 summarises estimates of total costs of workplace injuries and work-related ill health presented in historic reports examined. Figures summarised in the table are not directly comparable as they were based on different methodologies and limited by the level of details presented in the relevant reports.

Although these figures are not a direct replacement to each other in different years, this table still provides an overview of historic estimates. It may be observed that overall, the costs associated with workplace injuries and work-related ill health as a percentage of the GDP marginally reduce over time, and the costs associated with the construction sector are a small fraction of the overall cost, generally in the order of £1 to 2billion.

Table 2 - Collated estimates of costs to the economy in historic reports (£ billion).

Data source	Price base	All sectors				Construction		
		Low**	High**	Central	% of GDP	Ill health	Injuries	Total
1995/96	95/96	14.5	18.1	16.3	1.0 to 1.3%	*NA*	*NA*	2.11*
2001/02	2001	13.1*	22.2*	17.7*	0.8 to 1.3%	*NA*	*NA*	*NA*
2006/07	2006	14.7	18.3	16.5	0.8 to 1.0%	0.92	0.67	1.59
2018/19	2018	15.1	17.3	16.2	0.7 to 0.8%	0.56	0.66	1.22

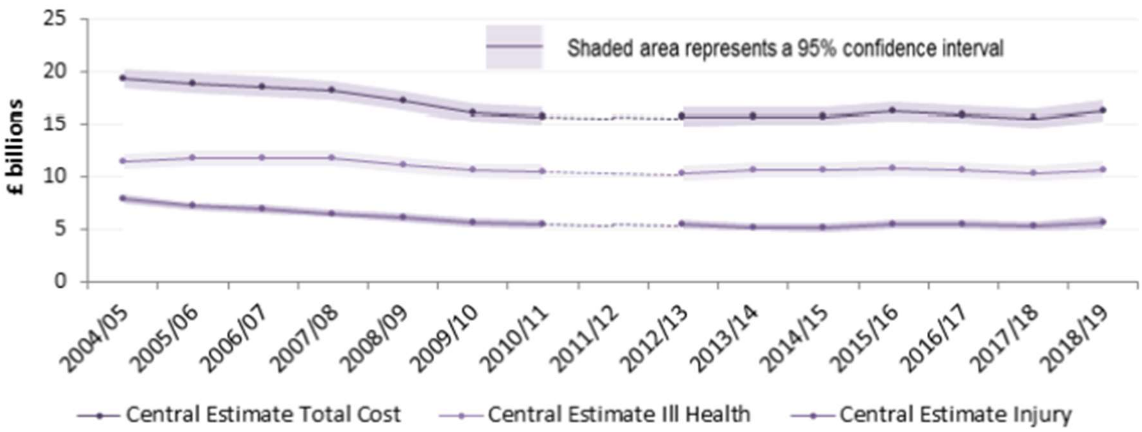
* Figures were either synthesised or selected based on professional judgement due to documentation available or the evolution of methodology over time

** Definition of Low and High estimates varies over time. They represent a 90% confidence interval for 2006/07 figures, and 95% for 2018/19.

4.3.3.Cost trends and distribution

More comparable estimates of the same costs are available between 2004/5 and 2018/19 based on information from the HSE's Costs to Britain model. These are presented in the chart below with all monetary values in 2018 prices (chart originally presented in HSE's 2018/19 statistics).

Figure 5 - Cost Trends



It can be observed that the total cost (across all sectors) fell by approximately 17% from £19.3 billion to £16.1 billion between 2004/5 and 2009/10. This is mainly driven by a reduction in the number of workplace injuries. The overall reduction in the injury costs was found by HSE to be statistically significant (from £7.90 billion to £5.57 billion in 2018 prices between 2004/5 and 2009/10). The fall visible in ill health costs over the same period was not found to be statistically significant. Since 2009/10, both injury and ill health costs have remained broadly level.

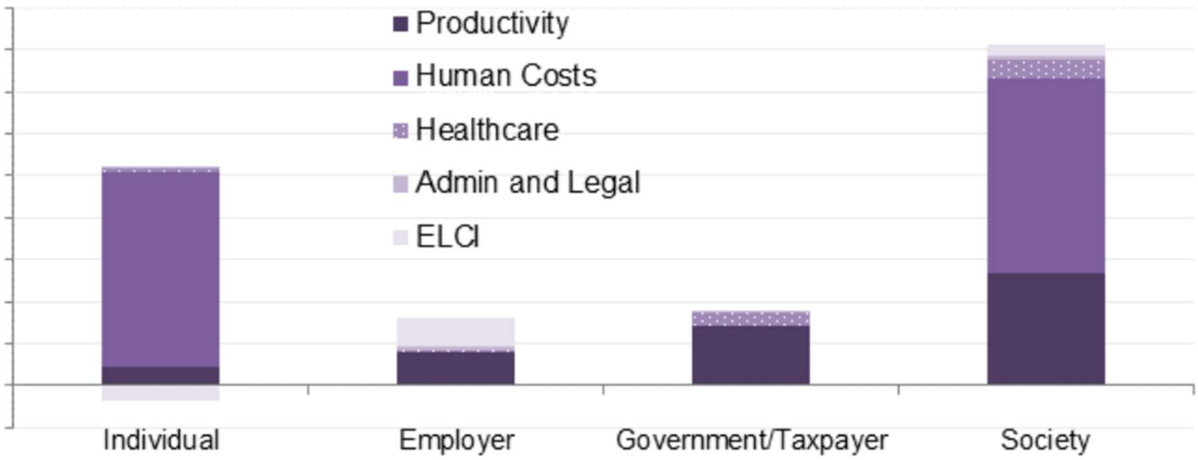
There are insufficient details in the time series data by sector to ascertain whether the trends observed across all sectors apply to construction alone. The latest estimate on construction related economic costs associated with workplace injuries and work-related ill health is from the 2018/19 estimate, which is based on the average annual number of workplace injuries and work-related illnesses for the three years from 2017/18 to 2019/20, as presented in the table below.

Table 3 - 2018/19 estimates of injury and ill health costs with 95% confidence intervals associated with the construction sector (£million).

	Central	**Lower**	**Higher**
Ill health	561 (46%)	387	735
Injury	659 (54%)	473	844
Total	1,220	NA	NA

Figure 6 illustrates how the total cost of £1.22 billion in the construction industry may distribute across different cost bearers based on the distributional pattern observed across all sectors. The total cost of £1.22 billion is represented by the cost to society (the rightmost column). This figure represents the latest estimate on the relative distribution against which potential economic benefits can be claimed for data sharing for safer design in construction.

Figure 6 – Costs against cost holder types



Please note that this chart is for illustration and not to scale.

Note: ELCI represents Employers' Liability Compulsory Insurance

4.3.4. Headline findings

The impact of the counterfactual (not sharing data in a consistent and transparent approach across the sector) would be missed opportunities in reducing the economic costs associated with workplace injuries and work-related ill health in construction. Such savings could be claimed as the economic benefits from sharing data (in a consistent and transparent approach across the sector) for safer design in construction. No attempt has been made to estimate the societal benefits of either greater certainty in output from reduced accidents and incidents in construction projects or from the upskilling of the design and construction communities in health and safety risks and mitigation.

The lack of details on specific proposed data sharing solutions (given its conceptual status) limits our ability to explore quantitatively its economic benefits with confidence and specificity. A glimpse of the potential impact may be speculated with reference to what has been achieved historically across all sectors.

The most significant improvement (i.e. savings in costs associated with workplace injuries and work-related ill health) occurred during a six-year period from 2004/5 to 2009/10, where injury costs across all employment sectors were reduced from £7.90 billion to £5.57 billion (2018 prices), approximately a 30% reduction. Over the period, the changes in ill-health related costs have not been found to be statistically significant. Both cost elements (injury and ill-health related) remained level from 2009/10 to 2018/19

It was inferred from the observations that reduction in ill-health related cost is a lot more difficult to achieve as this cost has not changed materially since 2004/5. The 30% reduction in injury costs to 2009/10 may be attributed to improvement in the safety practice, regulation, training and awareness. We have taken the last period over which a change was statistically significant as the potential for improvement across the construction sector.

If data sharing can be significant enough to replicate this improvement in reducing injury cost between 2004/05 and 2009/10, this may be equivalent to up to another 30% saving (of £198 million) in injury costs in construction. This would reduce the total economic costs in construction associated with workplace injuries and ill health down to approximately £1 billion (2018 prices). The amount of monetary benefits equivalent to different assumed percentages of savings and the resultant total economic costs in the construction sector are illustrated in the table below. Please note these are not economic forecasts, but just illustrations of what benefits may be achieved. The figures also exclude the potential benefits described in 4.3 above.

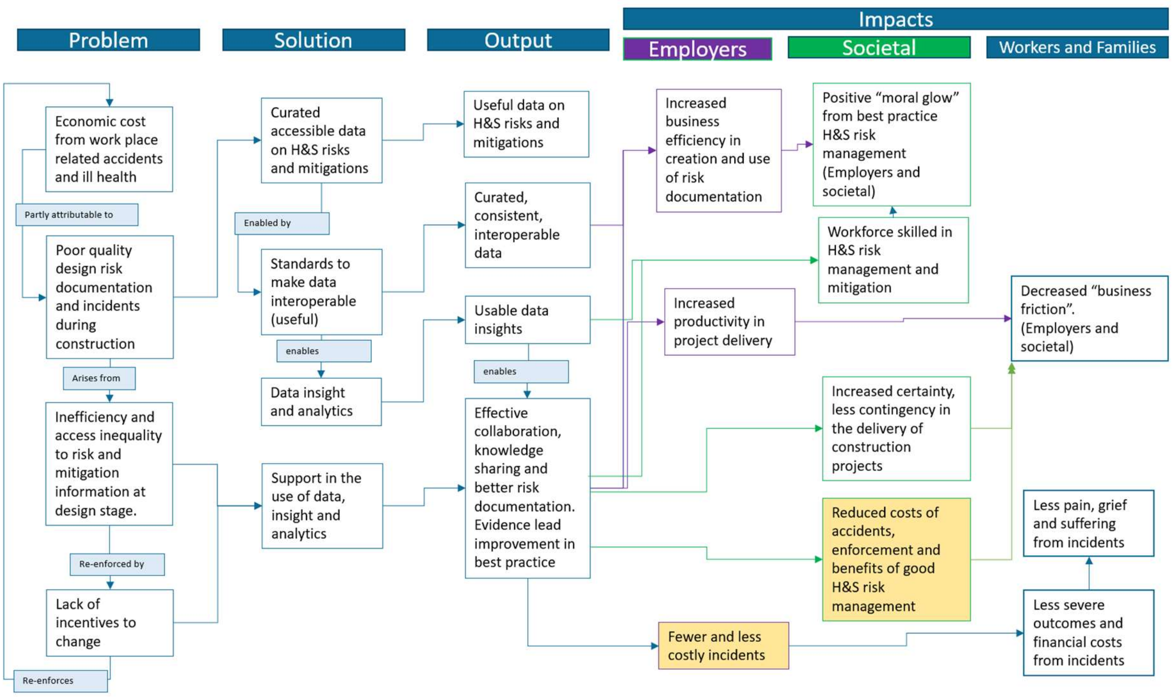
Table 4 - What-if tests - Illustration of annual monetary benefits equivalent to the assumed percentage of savings in injury costs (2018 prices in £million/annum).

	2018/19 Central (Reference Case)	Assumed savings in injury costs from data sharing in safer design		
		30% saving	20% saving	10% saving
Ill health	561 (46%)	0	0	0
Injury	659 (54%)	198	132	66
Total	1,220	198	132	66

Note. A decreasing/compounding trend from improved risk management has not been included for these savings and therefore, only captured annually.

The above assumed savings do not cover the full extent of impacts and instead focus on the two boxes as highlighted in Figure 7. It should therefore be noted that more annual savings could be realised from the £1.22bn as well as from efficiencies on projects/programmes from better planning as a by-product of better risk management. In order to identify these impacts and a trend, further detailed work would need to be carried out.

Figure 7 - Logic Map highlighting reports assumed impact categories.



5. Sharing data practicalities

This aspect of the project focussed on determining practical steps to sharing H&S risk data.

5.1. Approach

The potential benefits of sharing and managing risk data can only be realised through effective application. This is not straightforward. This element of the project sought to determine practical ways to achieve this that would be sustainable in the long-term.

Although looking at the long-term, the approaches used also had to consider the project's fixed funding timeframe (6 months) and the limitations associated with this. These include:

- Construction projects (and the assets they produce) typically exist over a much longer timeframe. Research into the practical impact of sharing data would need to be done over an extended period.
- Participants requested the deletion of shared data at the project's conclusion. This limits the lifespan of its value.
- The different governance arrangements required between short and long-term projects.
- The challenge of engaging representative of wider industry interests (commercial, insurance, finance etc.) and getting them to participate.

To address these issues the project focussed on the following two approaches:

1. Establishing the practical issues associated with data sharing in the construction industry through industry engagement, and;
2. Developing a demonstrator to test data capture and sharing.

5.2. Methodology

The initial methodology focused on using a series of workshops with industry representatives. The objectives were to obtain their views, ask them to share data and then work with them on the insights gained.

An initial online workshop was run on the 22nd of November 2021. It was focussed on how organisations currently share data and what the primary barriers are within the sector. There were 44 attendees from across the construction industry. They included engineers, architects, regulators, asset owners, software vendors and data analysts. After this workshop it was clear that obtaining data from these attendees was likely to be slower and more difficult than anticipated. An in-depth survey and interview process was therefore included to gain more structured feedback.

The survey focused on gaining key insights relevant to sharing and collecting design risk information. It ran between 17 December 2021 until 14 January 2022. Seventy-two organisations and individuals were invited to participate. They were identified from the initial workshop attendees and stakeholders. Thirty-two responses were received (44% return rate). Most were part of a large organisation - 70% having over 1000 employees and 93% having over 100.

Insights from the survey informed the development of the demonstrator. This demonstrator focused on the core issue of standardisation. This was selected because:

- The other key areas were covered in the survey and planned interviews.
- It was not feasible to address them using the demonstrator within the project's timeframe.

The demonstrator involved creating an online tool that allowed participants to submit their risk data in a standardised format. The format used a simplified set of Risk Classification Terms. It was an adapted version of Annex A from Industry Standard PAS 1192-6:2018 (Specification for collaborative sharing and use of structured health & safety information using BIM). As part of an industry initiative to improve the capture of H&S risk data, SafetiBase was developed. SafetiBase is an offering from 3D Repo (a software group) that allows the user to capture their H&S information in line with PAS 1192-6. 3D Repo worked together with Atkins and other industry partners to further develop the schema that they use.

The demonstrator's version considers updates from the SafetiBase team (3D Repo and Atkins) and the Discovering Safety programme, commonly referred to as the Discovering Safety Risk Library.

Table 5 - Risk Classification Terms for demonstrator

Name	Description	Entry detail
Risk Description	Describing the risk	Free text
Designer Focus	Activity/Stage of the asset lifecycle relevant to the designer	Multiple choice (18): 1. Install construction 2. Maintenance 3. Operation 4. Use 5. Demolition, removal 6. Ageing 7. Commission, site tests 8. Component manufacture 9. High impact events 10. Life extension 11. Material disposal or re-use 12. Material sourcing 13. Modification 14. Post processing 15. Preliminary investigation, tests & prototypes 16. Storage, transport, logistics 17. N/A 18. Other

Construction Scope	High level description of the type of construction work, based on CIRIA C755	Multiple choice (41): 1. Access (onto and within site) 2. Atria 3. Bridge construction 4. Bridge maintenance 5. Cleaning of buildings 6. Deep basements and shafts 7. Electrical services 8. External cladding 9. General civil engineering, including small works 10. General concrete 11. General excavation 12. General steelwork 13. Ground stabilisation 14. In situ concrete 15. Lifts, escalators and auto walks 16. Masonry 17. Mechanical services 18. Piling 19. Pipes and cables 20. Precast concrete 21. Prestressed, post tensioned concrete 22. Public health services 23. Railways, working adjacent to, maintenance of 24. Refurbishment of existing buildings 25. Retaining walls 26. Roads, working adjacent to, maintenance of 27. Roof coverings and finishes 28. Site clearance and demolition 29. Site investigation and remediation 30. Site layout 31. Stability and erection of structural steelwork

		32. Surface coating and finishes 33. Surrounding environment 34. Timber 35. Trenches for foundations and services 36. Under pinning 37. Windows/glazing including windows cleaning 38. Work in coastal and maritime waters 39. Working over/near water 40. N/A 41. Other
Risk Category	Based on Annex B PAS 1192-6	Multiple choice (33): 1. Event: Electric shock 2. Event: Fire or explosion 3. Event: Loss of control 4. Event: Machinery guarding 5. Fall: Collapse of BMU (Building Maintenance Unit) 6. Fall: From ladder 7. Fall: From MEWP (Mobile Elevated Working Platform) 8. Fall: From open edge 9. Fall: From scaffold 10. Fall: Slip or trip on the same level 11. Fall: Through fragile material 12. Handling: Materials handling 13. Handling: Mechanical lifting operation 14. Handling: Working overhead 15. Material effect: Asbestos

		16. Material effect: Chemical 17. Material effect: Lead 18. Material effect: Silica dust 19. Material effect: Wood dust 20. Mechanical effect: Loss of control using hand or power tool 21. Mechanical effect: Noise 22. Mechanical effect: Vibration 23. Struck: By falling object 24. Struck: By machinery or part 25. Struck: By moving vehicle 26. Struck: Overturning plant or moving machinery 27. Trapped: Asphyxiation 28. Trapped: Confinement 29. Trapped: Crushed by excavation 30. Trapped: Drowning and flooding 31. Trapped: Unintended collapse 32. N/A 33. Other
Risk Factor	Attribute or property of the element, location or construction scope which is a specific pre-cursor, pre-condition or trigger to a risk event	Multiple choice (28): 1. Material: Asbestos 2. Material: Dust 3. Material: Lead 4. Material: Strength 5. Physical: Collapse 6. Physical: Connection 7. Physical: Contact with moving vehicle 8. Physical: Edge 9. Physical: Fragile 10. Physical: Gas release and ignition 11. Physical: Length

		12. Physical: Noise 13. Physical: Opening 14. Physical: Size 15. Physical: Spacing 16. Physical: Weight 17. Task: Change design 18. Task: Cleaning glazing/window 19. Task: Cleaning machinery 20. Task: Excavation 21. Task: Lifting 22. Task: Manual handling 23. Task: MEWP (Mobile Elevated Working Platform) 24. Task: Site management 25. Task: Temporary structure 26. Task: Welding 27. N/A 28. Other
Element type	The hardware element in the risk scenario, this can be a building element or product, such as a slab, wall, roof etc., a temporary structure, an excavation or trench, a piece of plant or equipment or lifting accessory, or even a hand held tool	Multiple choice (22): 1. Ceiling 2. Cladding 3. Column 4. External wall 5. Flat roof 6. Frame/beam 7. Guard rail 8. Internal wall 9. Isolated foundation 10. Lift 11. Mechanical equipment 12. Pitched roof 13. Raft foundation 14. Ramp 15. Slab 16. Stair 17. Temporary structure 18. UG gas pipe 19. Wall foundation 20. Window 21. N/A 22. Other

Location	Location in relation to the risk or risk factor, not by absolute co-ordinates	Multiple choice (17): 1. High level: Between joist 2. High level: Near edge 3. High level: Near openings 4. High level: Scaffolds 5. Mobile plant: BMU (Building Maintenance Unit) 6. Mobile plant: MEWP (Mobile Elevated Working Platform) 7. Site logistics: Confined area 8. Site logistics: Crane area 9. Site logistics: Excavation area 10. Site logistics: Exposed area 11. Site logistics: Pump area 12. Site logistics: Traffic route 13. Site logistics: Welding area 14. Site work area 15. Site work area: Plant room 16. N/A 17. Other
Likelihood	How likely is a risk to occur	Free text
Severity/Consequence	How severe is the risk if it eventuated	Free text
Owner identified	Who owns the risk	Yes/No
Treatment Description	Describing the treatment	Free text
Treatment Type	How the treatment was dealt with (ERIC)	Multiple choice (6): 1. Eliminate 2. Reduce 3. Control by subsequent design 4. Inform 5. N/A 6. Other
Treatment Stage	Categorising treatments based on stages	Multiple choice (6): 1. Preliminary design

		2. Detail design 3. Pre construction 4. Site work, temp works, change control 5. N/A 6. Other
Treatment Scheduled	Is the treatment planned	Yes/No
Further Comments on Recording Risk	Further comments	Free text
Further Comments on Recording Treatment	Further comments	Free text

Responsibility for building, hosting and operating the demonstrator was placed with the Open Data Institute as one of the project partners. This was a project strategy to defuse any concern that data shared might be transferred across to the regulator. It was supported by stakeholders and was central to project delivery.

The final workshop was held on Monday 7th February 2022. It began with a summary of findings up to that point, including a recap of the first workshop and the insights gained from the survey. This was to ensure participants felt part of an iterative cycle of information gathering and dissemination, to understand that this project is focussed on sharing data for the benefit of the community itself.

A reasoned description of the demonstrator then preceded some dedicated exercise time. Attendees were invited to explore using the tool and to upload example risk entries they had been requested to prepare in advance. This process seeded a final group discussion which highlighted several points concerning risk data handling in general.

Following the workshop, information about the demonstrator was emailed to those who could not attend. It remained live and open for a period of three weeks to allow as many users as possible to engage with it. Additional material was also provided to project organisers for use in the form of several raw anonymised risk registers.

Interviews were also held with five industry experts between 01– 10 March 2022. These interviews focussed on issues relating to design risk and treatment data sharing, the survey outcomes and the live demonstrator. The findings are combined with the survey results below to protect the anonymity of interviewees.

5.3. Findings

5.3.1. The Initial Workshop

Attendees demonstrated a clear appetite to engage with the project at this workshop. This was both in terms of being part of the community going forward and sending information to the project team; although this did not translate into practice as the project progressed. They also agreed with the principle that sharing design risk and safety data within the construction industry has potential benefits.

Discussions about the challenges and solutions followed. Attendees shared their views about organisational concerns when it comes to data sharing in practice as well as their experiences of how to overcome these challenges. Key themes were:

- Data must be structured and standardised to facilitate its sharing and aggregation.
- Organisational culture can be a barrier to sharing. This will take time to influence.
- Organisations differ in terms of size and budget. Smaller players face different challenges to bigger firms. They may perceive the benefits differently as well.

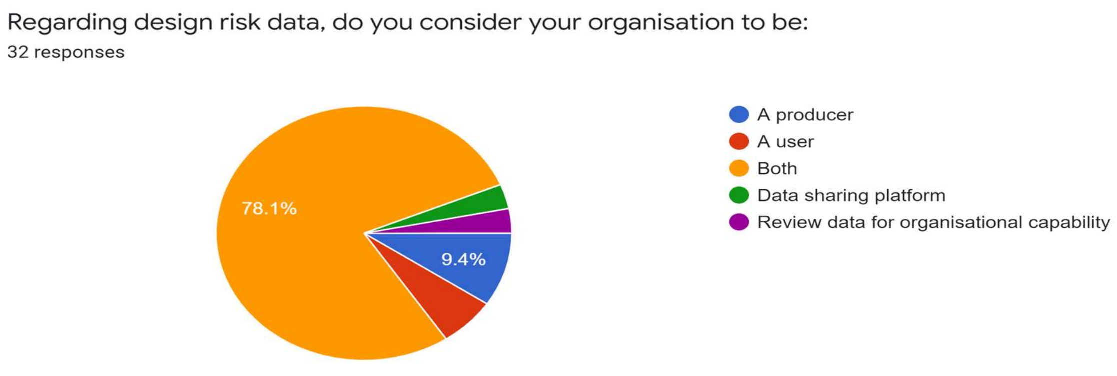
Attendees also had an opportunity to communicate what they would want and need in order to feel confident in sharing data with the project. The main 'wants' were for simple, consistent and efficient design risk data recording. The main 'needs' centred around good communication - both internally and externally, between collaborators and competitors, as well as with the HSE. The main concerns expressed regarded security, privacy, ownership, and governance. There was strong agreement about the need for confidentiality and non-disclosure agreements before data sharing could proceed.

5.3.2. The Survey

Further data from the survey is presented in Appendix A. The key findings from the survey were:

- **Producer or Benefactor?** Most respondents (78%) considered their organisation to be both a producer and a user/benefactor of design risk data. The next largest category (just 9%) accounted for those who just produced such information. This shows that a majority of participants have something to contribute and benefit from. The scale of this benefit is currently unknown.

Figure 8 - Survey responses on the nature of respondents' organisations



- **Effectiveness of design risk data use:** Most considered their organisation to be relatively effective when working with design risk data. All respondents, bar one, rated their organisation at least three on a five point scale. The modal response was a rating of four. Respondents gave broadly similar ratings when asked to consider their own personal effectiveness with design risk data was quite similar. These responses indicate a broad level of comfort with current design risk data practices.

Figure 9 - Survey responses on organisational effectiveness with design risk data

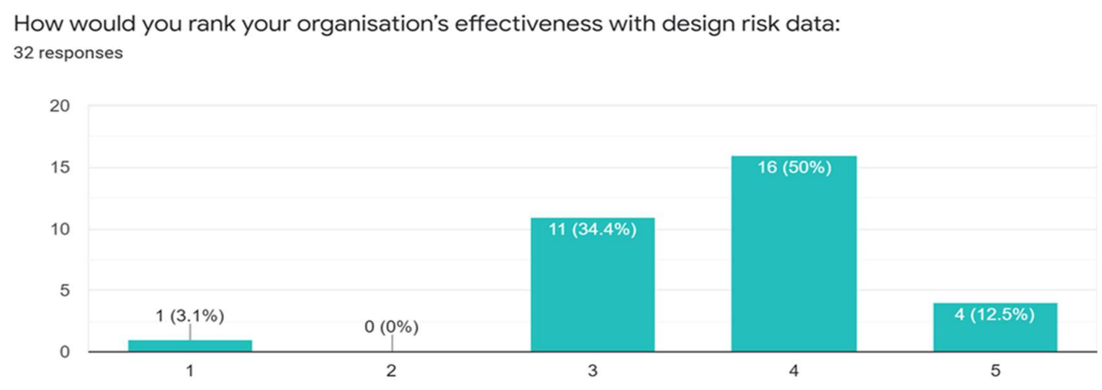
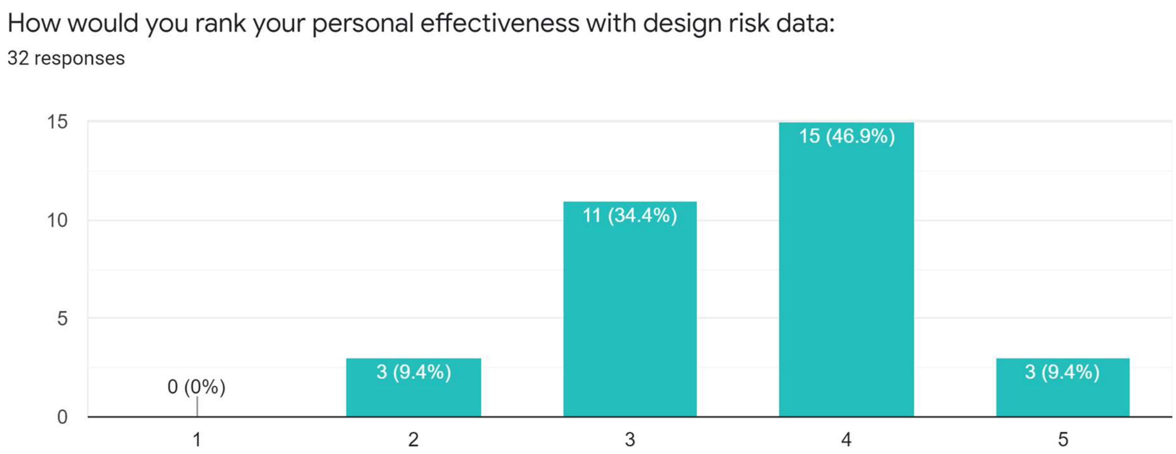


Figure 10 - Survey responses on personal effectiveness with design risk data



- **Issues Impacting on Data Sharing:** The survey identified several difficulties that may impact on a company sharing design risk data. These include:

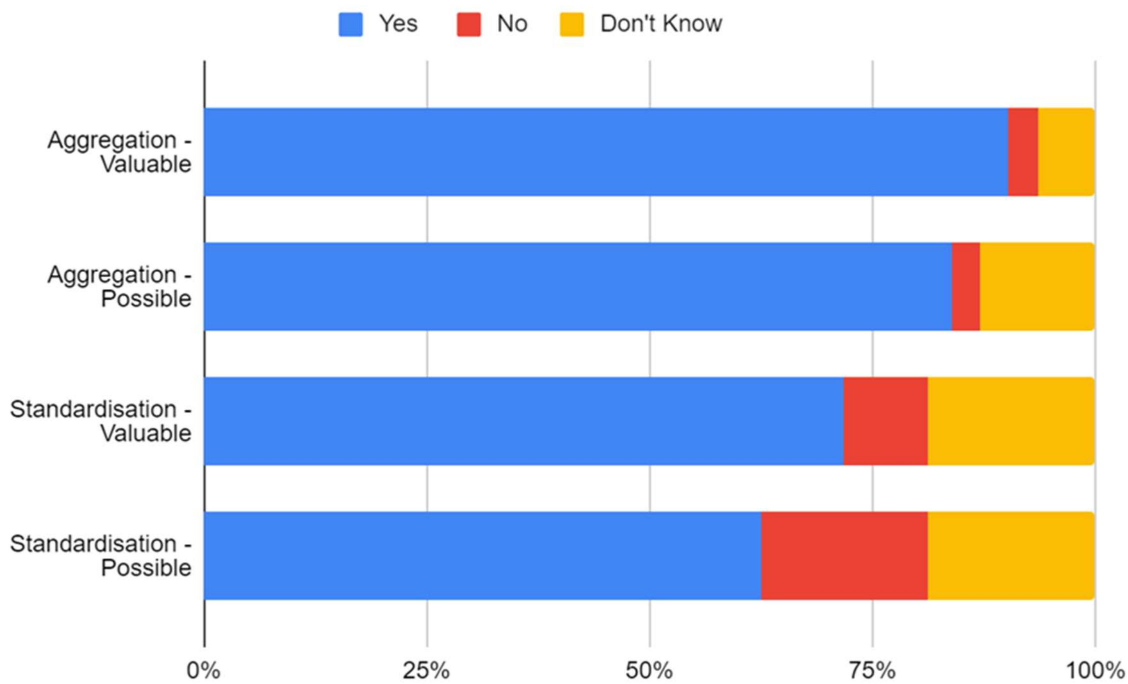
  – Over-Complication: Design risk data needs to be as simple as possible and free from unnecessary complexities.
  – Arbitrary Scoring: Limiting the use of risk scores. These are often subjective and / or produced without suitable rigour meaning they have limited value.
  – Long descriptions: Risk descriptions should be simple and to the point. Many go into too much detail that does not add value.
  – Assumptions: Detailing assumptions linked to each risk also takes up space and does not add value.
  – Duplication: Including the same risk under slightly different scenarios.

– Ownership: Clarity on who owns the risk and is accountable for its mitigation is seen as a particularly important.

Survey participants identified that data needs to be simplified and standardised to align it with all users and other industries. This includes the need for guidance. Respondents indicated that a broader set of tools (which includes an audit format with agreed data fields and formats) would be a significant incentive for their organisation to commit to changing how they currently capture and share such data.

The survey allowed respondents to list the risk and treatment options that they most supported. This was to identify priorities. For risk the favoured options related to 'Likelihood' and 'Severity/ Consequence'. For treatments this was 'Type', 'Mitigation' and 'Status'. Clarity of ownership was another distinct priority. This is to drive tasks to meaningful action. There was strong support for aggregating design risk data and less support for standardisation (see Figure 11). There was also strong support for semi-automated risk-treatment matching with low support for this being fully automated. This indicates respondents recognise the importance of having oversight of the risk treatments and that the process of risk-treatment matching has a medium to high level of difficulty.

Figure 11 - Survey responses on the value and possibility of design risk data aggregation and standardisation

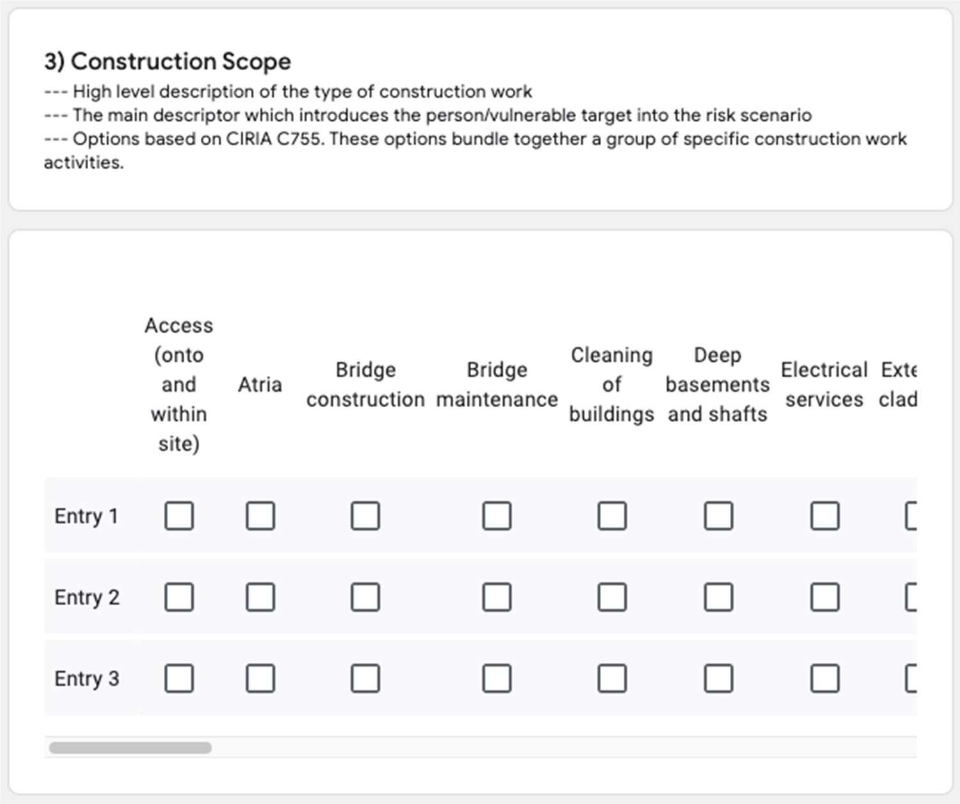


The survey asked respondents about governance arrangements for data sharing and where responsibility should sit. An independent third party was the most popular options (45%) followed by industry self-regulation (38%). The least popular option was a government regulator (17%). The survey, workshop and interviews all identified a clear hesitation about working with a regulator in this area.

5.3.3. Demonstrator

The creation of a live demonstrator was a key focus of the project. The ambition was to create a benchmark tool which would enable industry to input data that could be assessed against a standard data capturing format as seen in Table 5. It also provided the opportunity to test ways of overcoming three key challenges - industry organisation and relationships, standardisation, and liability.

Figure 12 - Example screenshots of demonstrator



8) Likelihood

--- This may be recorded in a number of ways, so the input is free text to allow flexibility
--- If you record this as a numeric value, then please note the scale you use as well as the value itself
--- Note that the product of "Likelihood" and "Severity / Consequence" is often referred to as "Risk Level"

Entry 1

Your answer

Entry 2

Your answer

Entry 3

Your answer

11) Treatment Description

--- 500 characters max. for each entry

Entry 1

Your answer

Entry 2

Your answer

Entry 3

Your answer

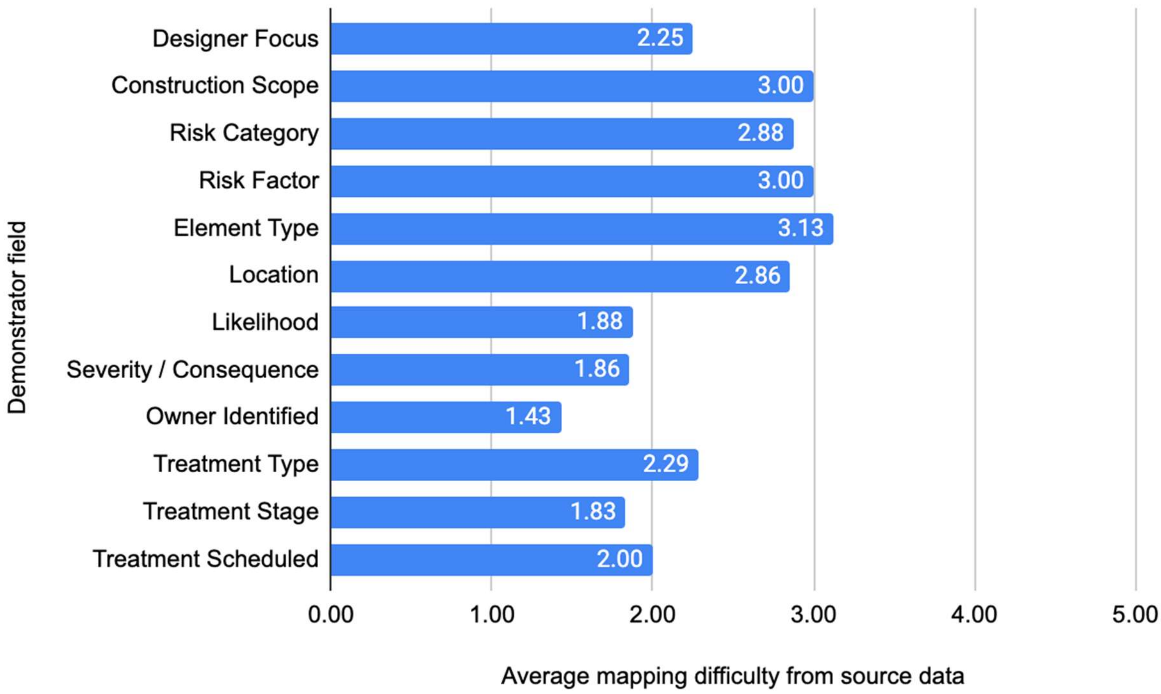
A 1-to-5 scale was used to rank the difficulty users had when mapping their source document to the demonstrator fields - 1 being most easy and 5 being most difficult. The average value for all twelve fields was 2.45 with the lowest score being 1 and the highest 4.2.

The average mapping difficulty for each individual demonstrator field is shown in Figure 133. They can be judged against this baseline score. Some fields are known to be common throughout the community, such as 'Likelihood' and 'Severity / Consequence'. It is therefore unsurprising that they had average mapping difficulty scores of 1.88 and 1.86, respectively. It should be noted that despite their use appearing to be common, several critical comments were directed towards risk matrices formed by using these two fields. The lowest score of 1.43 was for 'Owner identified'. Again, this is unsurprising as it is essentially a binary field.

Conversely the highest score of 3.13 was for the 'Element type' field. Many submissions took advantage of the ability to select more than one option for multiple choice fields. It shows that submitted entries often didn't fall neatly into one particular option.

These findings are interesting. They clearly highlight a preference in the industry around the basic health and safety data requirements. However, these fields alone do not allow for greater insight. This requires additional fields which allows for more filters, more insights and better connections between clusters – creating links that before may not have been known.

Figure 13 - Average mapping difficulty for demonstrator fields



Feedback revealed some additional things that participants would have liked to have seen:

- The content of the schema on vehicles, machinery, and also biological issues did not cover the extent and granularity that some users wished.
- Expansion of other categories was also desired to cover a range of disparate activities from traffic signalling to pumping,
- Further situation categories were requested such as temporary works and water-based environments.
- Some users highlighted a desire for more situational issues where the main factors are not so related to physical elements.
- Some mention was made of a need to better accommodate managerial, financial, and environmental factors too, showing a misunderstanding of H&S risk registers.

Further insights were gained by examining the small cache of redacted risk registers provided to the project. This allowed entries to be observed from an overarching perspective when compared to those uploaded by online users. The latter may have suffered from selection bias or entry error.

It was not uncommon to have a number of missing fields for a given entry in many of these risk registers. This indicates that these fields are either somewhat superfluous, difficult to complete or lacking quality control. A tight end-to-end process should have most fields entered if the risk register is designed well enough for a specific range of needs.

For completed information it was clear that a number of risk registers favoured having certain information over multiple fields where the demonstrator had one. For example, some risk registers had separate free text fields for ‘Event’, Cause’ and ‘Impact’ or had similar fields to that effect. In the demonstrator approach these were all bundled together in the single free text field for ‘Risk Description’.

Conversely, they also combined certain information within one where the demonstrator has multiple fields. Certain risk registers had risk description fields that explicitly prompted the user to insert details for aspects like location. This has its own independent field in the demonstrator. Only one of the available risk registers had this.

The examination of complete risk registers showed ‘Likelihood’ and ‘Severity / Consequence’ matched best in addition to free text fields of risk and treatment descriptions. This mirrors the findings from the data uploaded to the online tool. These fields seem to provide the accepted base case for what a risk register currently looks like.

Further in line with the findings from uploaded data, there was a noticeable disparity between some of the prominent multiple choice demonstrator fields and the information in the available risk registers. The ‘Designer Focus’ and ‘Construction Scope’ demonstrator fields had some degree of matching with a few risk registers, but more so when the essence of the information was considered rather than the exact options. The ‘Risk Category’, ‘Risk Factor’ and ‘Element Type’ demonstrator fields were virtually unmatched across any of the available risk registers.

From the other perspective, it was clear that the community favoured certain aspects of information that the demonstrator approach does not cater for at all – intentionally omitted, although it is available in the 3D Repo platform. A common theme throughout the available risk registers was a sense of time progression, in terms of pre-treatment and post-treatment status, including residual risk information. Other things that were seen include not only measures of a singular likelihood, but rather estimations of worst-case, best-case and most-likely case scenarios.

All of these observations raise valid questions about both the type of content and the level of detail needed in a standardised risk data schema, to provide a basis which is both rich and nuanced enough to satisfy needs, without resorting to unrestrained free text in all fields. It is preferable to keep as much as possible on such a quantised basis, given an appropriate level of flexibility, as this has a number of benefits over free text. A user can then become well acquainted with the relevant options for their specific area, and so more readily complete such a risk assessment than continually striving for appropriate free text descriptions.

This in turn has the added benefit of being better understood by others, by ensuring that all users subscribe to a common language. It is the chain of process and communication that forms the real core of needs being addressed here, beyond simply recording the issues. Free text has its place as an overview, but is highly dependent on the style of the author and can be subject to misinterpretation.

Furthermore, a controlled set of discrete options may also lend itself better to automated analysis such as those available in 3D Repo. If applied to enough data from a large-scale data sharing scheme over a period of time, it may be able to discern patterns that could lead to practical guidance on how to steer practices for the better, with statistically apparent results. Such goals are paramount, being the culmination of data, communication and action.

The project survey of existing risk registers indicates that the Discovering Safety data model (Table 5) overlaps significantly but not perfectly with the information commonly captured in such registers. Some revision and modification of the data model may help to increase its utility and ease adoption.

Table 6 - Overview of observations comparing risk register data, both received from the online tool and those in hand, to the demonstrator approach developed for this project

Characteristic	**Current Data Processes**	**The Demonstrator (Benchmark)**
Risks are described using standard terminology	The format of description of risks varies very widely	Coded categories of risk are standard, but a free text description is permissible
Risks are described in specific terms	The language of hazard and risk is used interchangeably, risks are often described in very general terms	Assumes that a single risk is capable of assessment with likelihood and severity score
Risks are identified in a way that eliminates or reduces uncertainty about how these will be managed by design	Variable	Focuses on a level of granularity which forces analysis and is designed to reduce uncertainty

Risks are described in context of data such as location, product or element and construction scope	The context, or direct circumstances in which risk may be eventuated is rarely described	Includes standard data points which help define the risk context
The designer focus in adding a risk is clear i.e. component specification, install construction, operations, maintenance, cleaning	This is sometimes the case	Provides a menu of 16 categories of designer focus to select from
The information is machine readable and capable of consistent interpretation	Variable	Built with this end in mind, including data points like 'Risk Factor' which may appear superfluous to human reasoning
Risks are identified in a way that means they can be readily accepted by a 'Risk Owner' and actioned	This is normally the case	Explicitly names a risk owner and attributes the risk to a project workflow
Risks are clearly linked to a 'Risk Treatment' i.e. any action that may be necessary to eliminate, reduce, control or provide information about the risk	This is sometimes the case	Explicitly links a risk to a treatment, and a workflow to action this going forward

It was also found through observations and interviews that there was a benefit that can be achieved through sharing data using a structure similar to that in the Demonstrator (Table 7).

Table 7 - Potential benefits of standardising and aggregating risk and treatment data

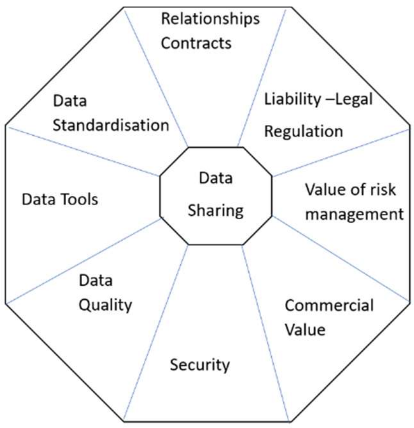
What's the change?	**What's the benefit?**
Adoption of alphanumeric coding and automated anonymisation of key terms across the design industry	Defuses any concerns about sharing project specific or commercial in confidence data. Only coded and processed information will be shared.
Standardisation of risk descriptions	Ensures consistency of approach between task teams in a single project, and then opens up the possibility of consistent management of risks and treatments across projects and between employers Enables metrics and measures to be developed Enables digital technologies to be implemented Facilitates risk data sharing

More specific descriptions of risk in context	Enables risk to be managed in context of specific workflows and visual scenarios to be developed for training and briefing Opens up the possibility of machine assisted design processes, where risk knowledge can be automatically prompted by identification of a risk Enables direct transfers of risks into treatment plans, where through multiple project stages actions can be planned to manage a residual risk in an optimal way Facilitates early identification of temporary works or other additional resources which may be required to manage risks
Aggregation of risks across projects and employers	Enables feedback mechanisms to be developed so any one project could compare a design risk profile against generalised data held in common Enables prioritisation of risks and economies of scale and efficiencies and quality to be realised where many similar risks are all being addressed Opens up the possibility of cross industry cooperation in dealing with common risks through standardised processes
Specific ownership of risk and treatment workflows	Enhanced management of the more common risks that occur at scale Easier identification of exceptions where cross industry collaboration might enhance treatment, or where specialist/expert help may be required

5.3.4. Interviews

The one-to-one interviews yielded valuable feedback on the detail presented in the demonstrator, survey findings and the overall project outcomes. In an effort to summarise the outcomes of both the lessons learnt in the survey and interviews, eight core areas have been outlined which enable the effective sharing of health and safety data, these are shown in Figure 14

Figure 14 – Core areas of sharing H&S data



Each area was explored during the interview phase. The information gathered was combined with survey findings to protect the anonymity of interviewees and are captured in Table 8.

Table 8 - Interview comments illustrating the eight core areas

Core Area	Comments				
Relationships Contracts	Most architects and many engineers work in small businesses, where BIM is not widely used	Sharing information about our wellbeing and health and safety should be a given. The concern is what kind of format it needs to be in? As a designer I should be looking actively to put data into that.	The way we organize the industry contractually is a mess. It's done to minimize commercial risk rather than for safety	The Construction Industry is not one "thing". It is fragmented and compounde d by huge variety in size, capability and activity of designers	"Need the last 100 metres of communicatio n from office to workforce" This reflects the importance of ensuring information chains are complete.
Commercial Value	Industry lacks an understandin g of the value of design risk data	There are no metrics or ways of measuring quality of design risk data	Industry has large amounts of data. This is more beneficial when aggregated	Every designer thinks their design is unique, but it is not. We need to share risk learning and we need to show the cost. We need to show what the redesign impacts would be on the steelwork and the fire strategy.	It is very important for young and partly trained architects that they do understand risk management properly. I think sharing risk information could be a benefit there.
Value of risk management	Engineers or designers fill in bits of paper for no real reason - other than perhaps the rather naive view that it	I would like to see designs where each RIBA stage has a pot of risks identified which are prioritised in terms of how	It is important to take account of contextual information relating to risks. There are operational,	Reducing risk is obviously beneficial, but how are you to justify that as being a proportionat	Risk managements needs to work in practice, not just satisfy a quality audit. There is an importance in separating

	will satisfy HSE if they get a knock on the door	they will affect the cost and value of the build. This costs us £1,000,000 up or down	functional and construction issues that have commercial program impacts that can affect safety and vice versa	e cost. There is no accepted way of doing it.	out the significant residual risks.
Security	The industry is risk averse because of the lack of understanding of security protocols	I do have experience of sharing health & safety risk data, but it is a sensitive problem. Anybody can misuse your data for their own purposes.	Misinformation is a significant problem	"Weak points" in infrastructure are dangerous to know	Aggregation can create new security threats
Liability –Legal Regulation	There is a need for mutual respect. Everyone must give and take	Collaboration is very important, more than co-ordination. It needs professional trust	There are two reasons why people may be reluctant to share openly. One is fear that poor practise might get to the Regulator. The other is fear of getting sued somewhere down the line	It should be total transparency for health and safety information in my opinion. I think there should be no secrets.	There may still be some mindsets that would rather control information and stop it leaking out. Companies who haven't got particularly good safety performance might not want to share data.
Data Quality	It's pointless separating the risk information from the contextual information. It goes hand in hand, we need one with the other.	I think a core principle should be making sure that the information is correctly structured with clear rules on how to achieve that.	Data sharing needs to start early in the project process.	It seems quite progressive to be talking about sharing data. It's about collection of information and creating insights from it, which I	You need to know the quality of information that you share is correct. The quality of information being shared will be very important. Hopefully it

	Regional context and urban vs rural, makes a difference.			think could be valuable.	has a minimal amount of subjectivity around it.
Data Tools	Record risks against designs in a visual way. It means you actually get a sense of how design decisions have improved safety	The majority of architects work in small businesses, where BIM is not widely used.	I think the challenge is a lot of manual manipulation of data. A lot of the systems aren't connected.	Imagine a filter that sorts projects with good treatments, then having a quick scan and going OK, that one looks like it was £100,000 to implement to save 10 million / 5 years let's get in.	A risk that can be tracked throughout the whole development of the design, why aren't you doing something about it? Why haven't you reduced it?
Data Standardisation	I am starting to work towards projects being less autonomous in my own company, not reinventing the wheel when you are close enough. Definitely worth sharing risk learning within companies.	I think the really critical bits of risk treatment information are rarely written down. These are the cost of implementation and cost reduction or risk reductions in a financial sense.	My preference would be having data sharing tied up, through the government and the building regs.	It should be total transparency for health and safety information in my opinion. I think there should be no secrets.	Any data sharing needs to take the unusual into account; from tunnelling to, restoring the 1700s buildings. Pre-selected stuff doesn't necessarily fill this gap. You can give a good guide, but it can't really drive it down to excellence. Users of the system need to be able to add their own data

6. Discussion

The project found clear agreement amongst workshops attendees and interviewees that data sharing is a good idea. Sharing of data is happening in specific, limited initiatives across the industry such as Collaborative Reporting for Safer Structures (CROSS UK) and the Designer's Initiative on Health and Safety (DIOHAS). These initiatives are effective but focus on specific user groups.

This project demonstrated that whilst data sharing is perceived to be a good idea, in practice delivery is difficult. To look at this in more detail, this section discusses these difficulties under three key headings, Benefits, Understanding and Governance.

6.1. Benefits

Benefits are what drive the purpose of any endeavour, without determining benefits, there are few mechanisms to incentivise groups. This project recognised, in both the survey and interviews, that there was a strong belief that there would be a benefit in sharing industry data, however, there were few organisations willing to act on this belief. The possible reasons for this are explored later in the discussion. The focus here is on how understanding the benefits can tackle this problem. The first point to explore is how benefits at the societal (macro) level can be delivered by surfacing the benefits at a project (micro) level.

6.1.1. Micro to Macro

A key problem is that the beneficiaries of data sharing are not always those who bear the costs. The project notes that a short-term study is unable to tie into construction design projects/programmes and demonstrate value throughout these longer timescale projects. For that reason, a good focus would be for micro-level benefits to be derived at the project, programme and organisational levels. This will link principles required to establish the data sharing endeavour at a macro-level and micro-level. This creates an incentive for an organisation to act for their own benefit without having to focus too heavily on the wider economic value.

For example, to tackle organisation incentivisation, standardisation could be the initial focus. Creating a standardised structure for an organisation to operate its design/construction H&S risks will invariably provide greater insight: allowing the targeting of specialist knowledge; providing a clear structure for insurance brokers and providing greater organisational assurance – reducing costs. In this example, if multiple organisations standardised in the same way for their own benefit, this would start to solve the national problem of how to provide a similar structure that everyone can follow.

When considering how to tackle the organisational issues, it is important to make sure these tie to the national problems, so that the solution can be appropriately scaled.

It should be noted that micro-incentives can be instilled through macro-levers, such as through policy development. Negative incentives are usually the initial focus for incentivising groups. However, whilst they are important, it is better to consider the positive, organisational incentives first before turning to the industry levers.

6.1.2. Connecting H&S to delivery efficiencies

Through the benefits work, it was only possible at this stage to focus on datasets that existed and provided enough rigour to develop a conservative estimate of savings. However, the logic model shows value far beyond that which has been proposed. In order to recognise this, clear links need to be made between organisational/programmatic improvements similar to Paul O'Neill's safety-first approach as Alcoa's CEO[27]. More of this type of work can help link infrastructure performance improvements unlocking further savings beyond the projected reduced welfare spend on injuries.

In addition, once a solution has been confirmed, the benefits and associated incentives can be determined, driving a more focused effort on the true economic value.

6.2. Understanding

Education is a cross-cutting theme for the findings which shows of a lack of awareness/knowledge of the value of H&S, design risk management, data and data sharing. This lack of knowledge makes it difficult to perceive value and take meaningful next steps. Trust in H&S risk data sharing, data standards and organisational relationships are areas where awareness is needed.

6.2.1. Trust in H&S risk data sharing

The initial workshop and survey into data-sharing within the industry highlighted a number of concerns acting as barriers to data-sharing, ranging from legal and compliance questions through to concerns about ownership and governance. These findings suggest that decision-makers need both education concerning the risks and benefits of H&S information-sharing, and support in assessing these before they feel equipped to make decisions with confidence in this area.

A lack of clarity and resulting reluctance regarding data-sharing decisions is not unique to the construction sector. In response to this persistent cross-sectoral challenge, the ODI has begun to explore the feasibility and utility of a simple decision-tree online tool to address the fear, uncertainty, and doubt often encountered in the preliminary stages of data-sharing between organisations[28].

It should be emphasised that the purpose of this tool is to raise discussion, debate, and awareness of the issues potentially involved in information sharing, rather than to issue binary 'yes'/'no' judgements about doing so; as such it is not a 'magic bullet' for managers. With content customised to fit the needs of the construction industry, however, such a tool may provide a relatively low-cost and low-maintenance way for organisations to assess and, ideally, begin to embrace data-sharing as a practice, as well as to mitigate the risks attendant upon this.

6.2.2. Data standards and tools

The logic model identifies *data standards* as a single solution that enables both data analytics and the creation of curated accessible H&S risk data; onward outputs from this then include useful data

[27] https://www.forbes.com/sites/roddwagner/2019/01/22/have-we-learned-the-alcoa-keystone-habit-lesson/?sh=598fff8158ba
[28] Prototype to help identify and manage risk when sharing data – The ODI

on risks and mitigations, curated consistent interoperable data, and usable data insights. Furthermore, the potential role of data standards in furnishing a solution to data sharing barriers is well-understood within the industry: 72% of respondents to the survey felt that 'an industry-wide standardisation of design risk data would be valuable to [their] organisation'. Confidence in the feasibility of such a solution was more muted; nevertheless, 63% of respondents believed 'an industry-wide standardisation of design risk data would be possible', with 19% being uncertain.

Addressing such restrictions and variability are, however, part and parcel of the normal process of standards development. PAS 1192-6 in 2018, the Discovering Safety programme and the development of ISO 19650-6 are tackling the standardisation challenge. The PAS, a publicly available specification in Britain, has developed the initial structure for detailing H&S risk data and DSP is developing this further. The international standard, ISO 19650-6, is currently in development. This international standard builds off PAS 1192-6 and DSP, consolidating experience into new requirements and pushing this standard to an international community.

To add to this, companies like 3D Repo are implementing these standards as part of their wider software offering, embedding H&S risk data sharing principles at the core of their offer[29]. However, it seems the industry still needs to be made aware of these and the development of a guide would be beneficial in precipitating widespread implementation of best practice from clients through to appointed parties.

We recommend that the ISO 19650-6 standard under development incorporates these learnings and promotes the adoption of this standard by organisations and, in particular, software vendors within the sector. Such adoption will allow data collection to be standardised at point of entry - and hence to be readily and meaningfully shared and reused as appropriate. Ongoing use in current H&S systems will furthermore ensure that the information thus gathered remains current and relevant, rather than being left as a historical exercise.

6.2.3. Organisational relationships

During the survey, participants expressed a clear preference to not share their data with HSE and placed a government regulator as being the last group they would want as a data steward. Whilst the industry perception is that the HSE's remit is primarily to prosecute, it has a broader role "to prevent work-related death, injury and ill health". The industry focus should be on improving health and safety performance in collaboration, including with the HSE. This will help to reduce accidents across the sector and improve economic outputs. This may not involve sharing data with HSE, but it will require co-operation and an improvement on the current approach.

The industry's current method of project delivery involves a lot of information and responsibility handover. This is true for H&S information also. As a result, the decision and actions made during a project, including the information that is captured about them, impact whether an incident occurs or not. Workshop participants may not be familiar with the new methods in which H&S risk data can be used effectively. Therefore, their perceived effectiveness can only be as good as far as their awareness extends. It should also be considered that there are negative connotations in admitting any negligence.

[29] https://3drepo.com/white-paper-digitising-health-and-safety/

Currently, the industry is predominantly influenced by “guilt culture” dynamics – expecting punishment for negligence. Whilst a weak positive dynamic exists in the form of keeping up the public image, the industry needs to incorporate a more mature approach. This could move towards internalising questions such as “Would I like to be injured myself? Are my actions and decisions therefore appropriate?”. This can be embedded within the industry through education of ethics (responsibilities/impact) in H&S risk management and promoting organisations to work better together.

This presents a more general challenge identified with changing the culture of the construction industry. It will be far more difficult than changing the culture within one organisation. There is a collective challenge across a whole set of stakeholders, clients, designers and contractors.

6.3. Governance

Discussions with stakeholders failed to clearly identify a recommendation of who should undertake any effort for sharing H&S risk data nationally in the long-term and how it should be funded, supported and governed. This section looks to address this, noting that a single entity may not be the answer.

6.3.1. Supporting bodies

Any entity that is created/re-purposed/appointed to undertake the development of this structure can take solace in the fact that a number of areas requiring attention are already being tackled and supported by different bodies across the industry. This entity can work together with the following groups against their respective areas – this group will likely change with time:

- Security: Centre for Protected National Infrastructure.
- Standards and Guidance: UK BIM Framework, British Standards Institute, BIM4H&S and International Organisation for Standardization (ISO).
- Benefits and approach: National Underground Asset Register.
- H&S risk data sharing & enabling tools: 3D Repo & Atkins (SafetiBase), Discovering Safety Programme.
- Industry Knowledge: Construction Industry Advisory Committee (CONIAC) and Construction Leadership Council (CLC).
- Industry engagement: Construction industry institutions (ICE, IET etc.).
- H&S Sharing: Collaborative Reporting for Safer Structures (CROSS UK) and the Designer’s Initiative on Health and Safety (DIOHAS).
- Data Sharing principles: Open Data Institute.

6.3.2. Security

One of the most common risk mitigations for data sharing is the removal or masking of sensitive information. The most common kind of information requiring such treatment is personal data, as defined by legislative instruments such as the General Data Protection Regulation. However, other kinds of data – for example, security or commercially-sensitive data will often also require shielding in the construction sector.

At a smaller scale, information-screening of this kind can normally be managed manually, with sensitive data being removed prior to sharing. At a larger scale, however, the use of automated techniques becomes necessary to ensure shielded data does not enter the common store. A wide range of these techniques are available, with the precise technology and approach adopted depending on need and feasibility.

Over the longer term, the construction industry as a whole will need to assess the range of technologies available and their applicability to use-cases within this sector. The need for such an evaluation is at present remote. Should the industry mature in its data sharing practices, however, the potential for widespread and well-judged application of privacy-enhancing and other technologies to improve H&S information sharing will be considerable.

6.3.3. Organisational framework

Given the complexity of the construction sector and the barriers and challenges identified by this project, undertaking a national data sharing initiative would be difficult for the industry working in a decentralised way and will therefore [arguably require] an organisation - or small group of organisations.

In order to realise the benefits of sharing H&S risk data, a data institution[30] could be designed to: help develop the necessary infrastructure, including fostering the adoption of new standards and technologies; act as an independent gatekeeper of sensitive H&S risk data contributed to it by industry members; generate benchmarking and insights based on that data and distribute those insights back to members; and, where appropriate, facilitate safe access to some of the data it stewards, possibly to members of the industry, software vendors or to a regulator in order to facilitate oversight while protecting sensitive information.

With a remit that benefits the sector, it becomes important to determine who should manage this organisation (or collection of). Some of the factors influencing this decision will be:

- Perceived neutrality and trust of stewarding organisation.
- Independence of organisation from the various members of the ecosystem.
- Capabilities of the organisation.
- Securing long-term and industry-wide buy-in from members of the industry.
- Long-term sustainable resources, funding and revenue streams.
- Internal incentives aligned to reducing incidents and the collective economic burden.
- Instruments to mandate/incentivise the cooperation of industry organisations.

[30] https://theodi.org/article/what-are-data-institutions-and-why-are-they-important/

The question of sustainability deserves particular emphasis and consideration because although the benefits of H&S risk data-sharing to the industry as a whole are likely to be substantial, there is a split between where the costs of collection, management and sharing are incurred and where its benefits are realised.

Sharing H&S risk data for the greater benefit of the industry is a collective action problem. The question of how to initiate collective action is a difficult one. One problem which surfaces is that of the free rider, creating a "burden on a shared resource by use or overuse by people who aren't paying their fair share for it or aren't paying anything at all"[31]. This is particularly a problem where upfront costs to establish a collective system are significant. In the case of a data sharing vehicle set up to benefit a wide range of users, the individual organisational benefits can be realised by remaining passive, not sharing data, and waiting for other organisations to take the initiative – creating individual value from no action. This is further complicated by those who are interested but do not want to take the first step, waiting for others – to learn from their successes and mistakes. Further work needs to be carried out to find out the most appropriate approach needed to realise the benefits of data sharing.

There are existing data institutions to draw inspiration from and compare their approaches to the use case of sharing H&S risk data across the construction industry. Some examples are explored here.

Public-sector

DEFRA is an example of a regulator or government body performing the roles of data institution. For instance, since 2015 large retailers in England have been required to report information to Defra regarding the total number of single use carrier bags sold, the gross proceeds, any costs incurred and the use of the net proceeds. Retailers can be fined if they don't submit records on time. Data is collected via an online survey tool which includes automatic calculations for some fields to assist the retailers with entering data into the system.

In principle this example could transfer to health & safety provision in Construction. However, the comparison and any potential application would need careful consideration. In the DEFRA example above, a system was created to request data to monitor the effect of a policy to reduce carrier bag use. HSE already operates a Fee for Intervention System which is designed to recover costs on the "polluter pays" principle. However this system is focused on work carried out where a Material Breach is detected, and only on a reactive basis.

The industry

It would also be possible for members of the construction industry to perform the roles of a data institution. This could be done by a single organisation or a group of organisations working in concert. For instance, an existing construction or design firm could take on the roles of developing and maintaining standards and other infrastructure for the sector, acting as a gatekeeper for data held by other organisations or facilitating safe access to data under restricted conditions. However, a single firm would likely struggle to persuade competitors to take part in such an arrangement.

Alternatively, a group of organisations within the industry could use decentralised technologies and distributed governance processes to enable collection, management analysis and access of H&S risk data on terms that are suited to the group. In the pharmaceutical industry, for instance, a group of

[31] https://www.investopedia.com/terms/f/free_rider_problem.asp

ten pharmaceutical companies has joined together to form MELLODDY, a project that aims to "enhance predictive Machine Learning models on decentralised data of 10 pharmaceutical companies, without exposing proprietary information." These types of decentralised approaches can struggle, however, to achieve sustainability without significant support from members of the industry and can, without appropriate forethought and stakeholder management, suffer from a lack of direction.

An independent body

There are numerous relevant examples of independent third parties that perform the roles of a data institution. These can be for profit or non-profit. HiLo is an example of an independent commercial data institution which operates within the shipping industry and supports the sharing of safety and accident data in the maritime sector. HiLo gathers data from shipping companies and analyses the aggregated dataset in order to provide actionable benchmarks and meaningful insights back to its members. Financially, HiLo receives subscription fees for its insight service but initially struggled to attract new members, wrestling with trust issues due to being independent. As a group, rather than delivering economic value for an industry, it focuses on delivering individual value for its subscribers – its discretion being a function of its trust mechanism.

It should be noted that the industry has independent organisations such as CROSS UK and DIOHAS to foster greater sharing of H&S learning between organisations. Whilst these organisations cater for specific needs, perhaps they could serve a function of a wider H&S data sharing ecosystem.

In the survey we asked who should be put in charge of overseeing the aggregation of H&S risk data. 45% said an independent third party, 38% said the industry itself and 17% said a government regulator. This suggests that there is an appetite within the industry for an independent third party, however these results would need to be confirmed through further and more widespread engagement with industry stakeholders. Indeed, an important next step should be working with members of the construction industry to explore in greater depth the various technical and institutional options outlined here in order to understand which are most suitable and acceptable for the industry.

7. Recommendations and Next Steps

Sharing H&S risk data is technically feasible and has merit. There are data standards that exist in the industry already and there is demand in the community for data-sharing. There is work needed to develop an organisation that can help the industry share its H&S risk data. Some initial activities can help to improve the success of this organisation, these include:

Benefits:

- Economics study: Quantify the benefits to businesses in better H&S risk data management.
- Economics study: Further explore the other areas of potential benefits, testing the logic model developed in this project.

Understanding:

- Seminars/Papers/Training: Highlight the value of H&S risk management in project delivery.
- Develop a guide: Detail best-practice and standards for H&S risk data management via the UK BIM Framework or equivalent body.

Governance:

- Identify the remit: Explore the purpose of this vehicle, highlighting what is in scope.
- Funding plan: Determine a funding plan linked to long-term revenue streams, ensuring alignment between funder requirements/incentives and organisational incentives.

8. Acknowledgements

List of Organisations who contributed to the benefit mapping for the project:

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BEIS
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CROSS
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Fladgate
Get it Right Initiative (GEIRI)
HSE
Infrastructure Projects Authority
ODI
Reputation Dividend
RPC
RSA
Sir Robert McAlpine
Watch me Think

List of Organisations who contributed to the workshops and survey (please note that only the organisations who have consented to being credited are listed):

3D Repo Ltd.
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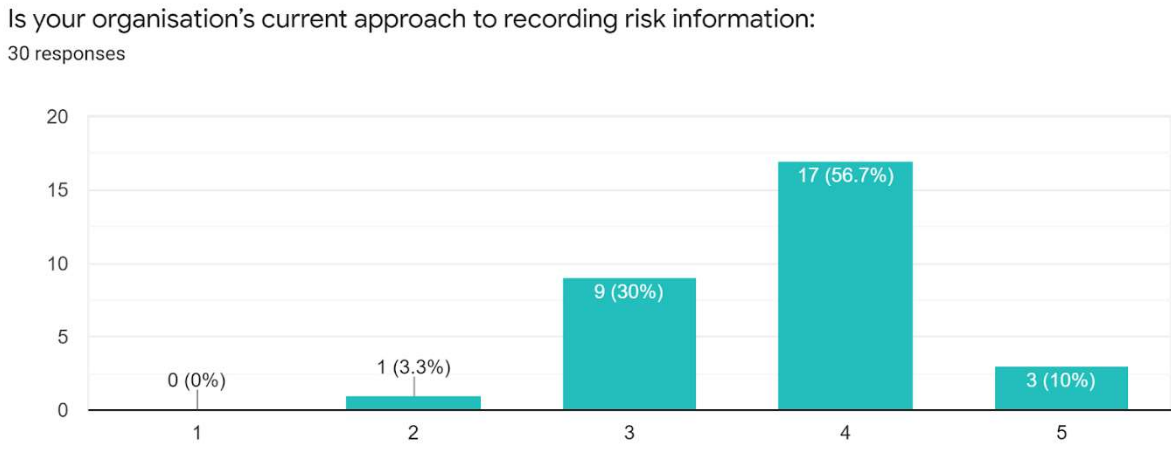
Arcadis UK Ltd.
Argent (Property Development) Services LLP
Arup Group Ltd.
Binnies UK Ltd.
Bourne Group Ltd.
Capita Ltd.
Construction Clients Leadership Group Ltd.
Geospatial Commission - Cabinet Office
Heathrow Airport Ltd.
Jacobs Engineering Group Inc.
Kier Highways Ltd.
Lloyd's Register Foundation
Mott MacDonald Ltd.
National Highways
Safety Schemes in Procurement (SSIP) Ltd.
Smart DCC Ltd.
Telent Technology Services Ltd.

9. Appendices

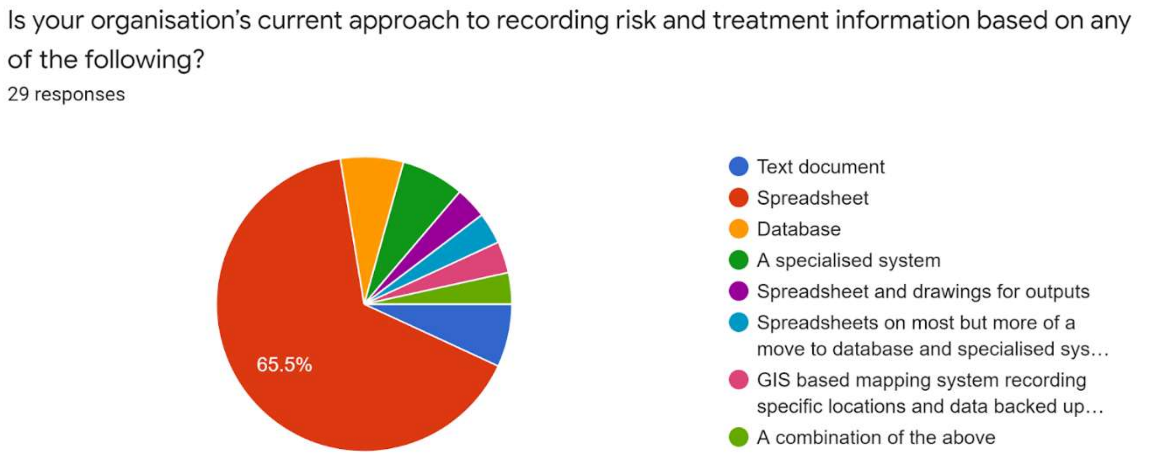
9.1. Appendix A: Additional survey data

Current practices

- The majority of respondents indicated that their organisation's current approach to recording risk information was at least average to good (1 = Terrible, 5 = Excellent)



- This risk information is most often collected by a combination of free text and drop-down menus, or free text alone
- The majority (66%) of respondents' organisations use spreadsheets to track risk data



- 48% of respondents find their current process easy to use, 48% sometimes find it easy to use and 4% don't find it easy to use at all

- Respondents listed the following when asked about incentives or obligations that their organisation would need in order to change its current approach to the way that design risks and treatments are recorded:
    - Removal of complexity
    - Industry guidance/standardisation
    - Alignment of approach with other industries
    - Better tools
    - More effective audits
    - Demonstrable benefits
    - Early buy-in

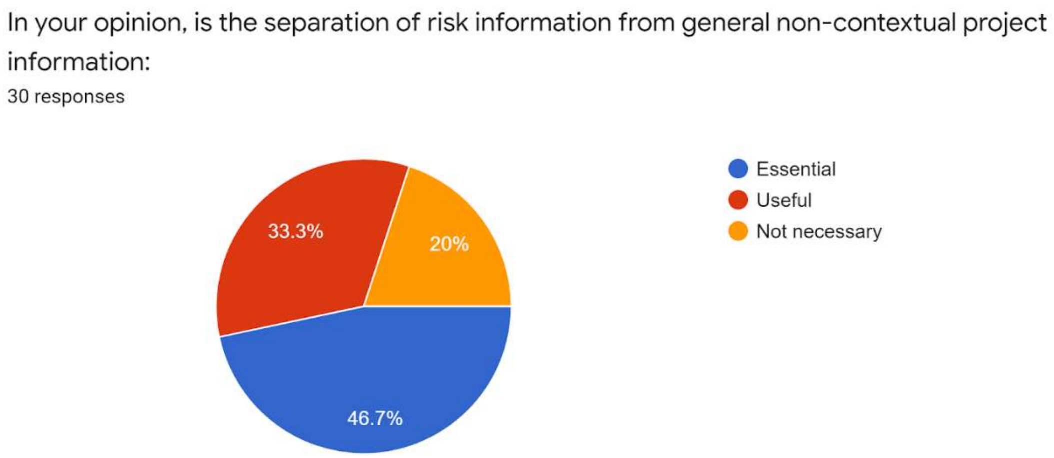
Risk fields

- Respondents listed the following when asked about fields in design <u>risk</u> data which were deemed required:
    - Likelihood
    - Severity
    - Consequence
    - Risk identifier
    - Risk/accountable owner
- Respondents listed the following when asked about fields in design <u>risk</u> data which were deemed useful but not required:
    - Further information on risk
    - Project stage
    - Several other different and unique responses, indicating less agreement on what is useful rather than essential when it comes to design risks
- Respondents listed the following when asked about fields in design <u>risk</u> data which were deemed as causing confusion:
    - Overcomplicated quantification
    - Long descriptions of causes
    - Arbitrary scoring systems
    - Duplication

Treatment fields

- Respondents listed the following when asked about fields in <u>treatment</u> data which were deemed required:
    - Type
    - Mitigation
    - Status
    - Owner
    - Risk level
- Respondents listed the following when asked about fields in <u>treatment</u> data which were deemed useful but not required:

    - Residual risk information
    - Assumptions
    - Outcome
    - As with risk fields, there was little consensus with this question as opposed to the previous one on the essential fields
- Respondents listed the following when asked about fields in treatment data which were deemed as causing confusion:
    - Overcomplicated quantification
    - Long descriptions of mitigations
    - Lack of clarity on ownership
    - Duplication
- When asked if the separation of risk information from other general non-contextual project information was essential, useful or not necessary, the majority (80%) responded that it was either essential or useful

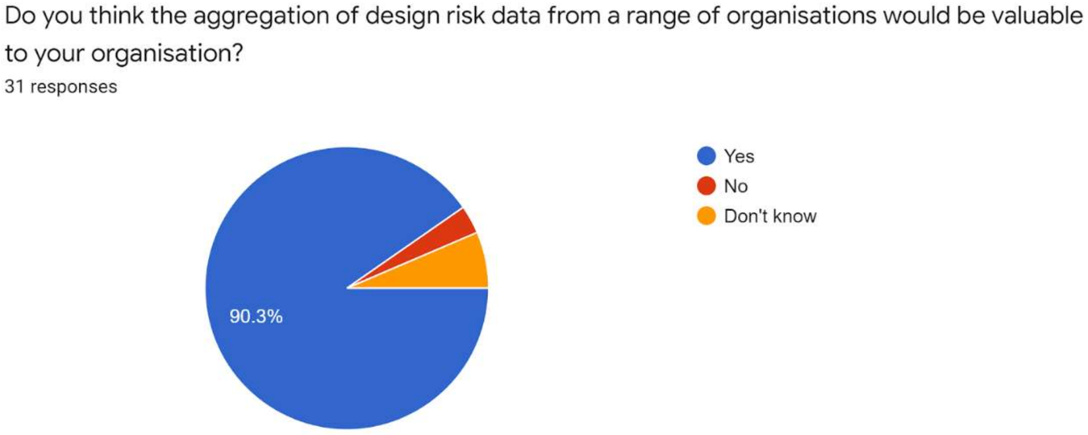


Standardisation

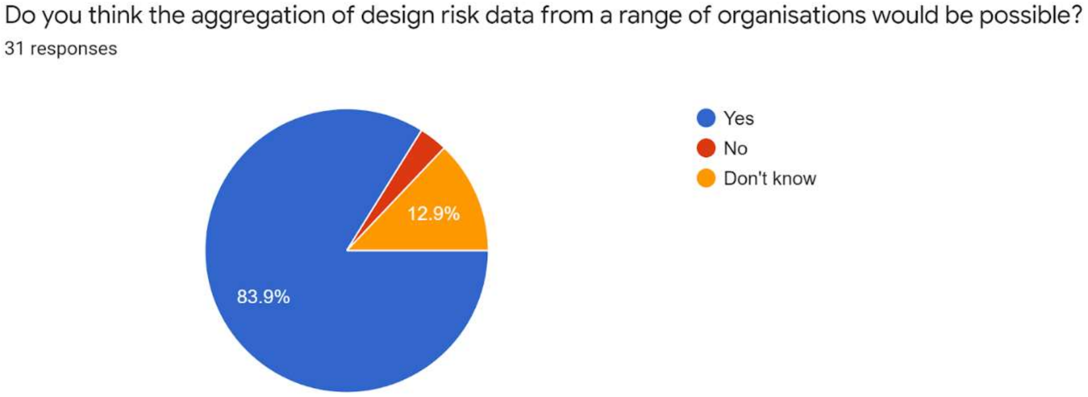
- When asked if their organisation finds industry-wide standards valuable, the majority (72%) responded with 'Yes', 19% said 'No' and the remainder did not know
- 63% of respondents think industry-wide standardisation of design risk data would be possible, 19% thought it would not be possible and the remaining 19% did not know
- Respondents listed the following when asked about incentives or obligations that their organisation would need in order to adopt industry-wide design risk data standards:
    - Clear identification of best practice
    - Guidance
    - Elaboration of the benefits
    - Better recognition in the industry

Aggregation

- A high majority of respondents indicated aggregation of design risk data would be valuable to their organisation



- A similarly high majority of respondents indicated that the aggregation of design risk data would be possible

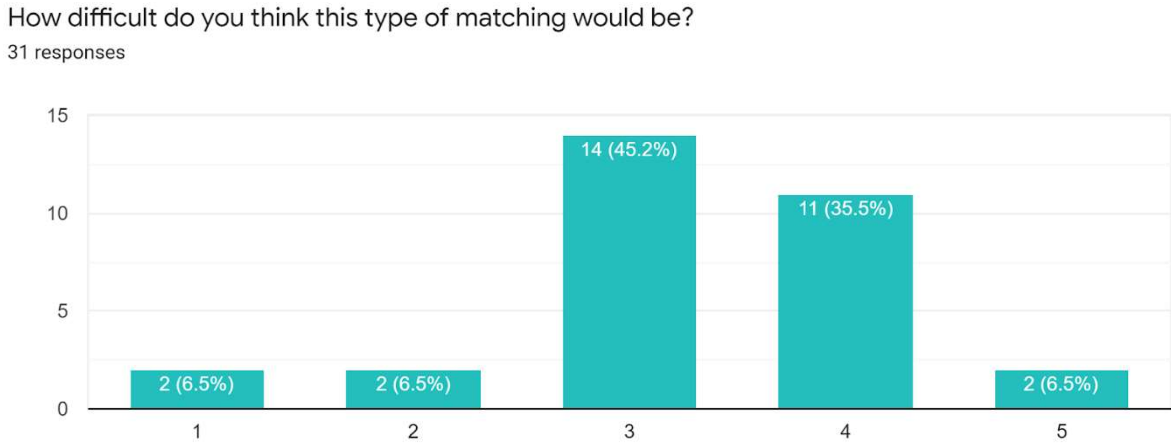


- 90% of respondents stated that analysis of aggregated design risk and treatment data could lead to valuable capabilities, only 1 respondent (2%) said no it would not lead to valuable capabilities, the remainder responded that they didn't know
- When asked about who respondents would feel most comfortable overseeing this process, 45% said an independent third party, 38% said the industry itself and 17% said a government regulator
- Respondents listed the following when asked about what assurances they would need to participate in a data aggregation scheme:
    - Confidentiality
    - Anonymous data submission (i.e. can't be tracked to the submitting organisation)
    - Terms of reference
    - An overseeing body
- Respondents listed the following when asked about what would need to be implemented to be confident in aggregated data being analysed:

- Industry acceptance/endorsement
- Defined permission levels
- Uniform collection format

Matching risks to treatments

- 72% of respondents indicated matching design risks to treatments would be useful, 9% indicated it would not be useful and 19% did not know
- The majority of respondents indicated that they believed this kind of matching to be moderately difficult (1 = Very easy, 5 = Very difficult)



- 72% of respondents indicated that they believed this matching could be done in a semi-automated way, 13% indicated that it could be fully automated, 10% indicated that it could only be done manually and the remainder did not know
- Current approaches of matching design risks to treatments is seen as either below average or slightly above average on the whole (1 = Terrible, 5 = Excellent)