

# **IS THE LONG-BOW BETTER THAN THE CROSS-BOW? - EMERGING ISSUES FROM MOBILISING A LONGITUDINAL STUDY ON A MEGA-PROJECT**

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Longitudinal studies of Occupational Safety and Health (OSH) outcomes in construction projects are rarely conducted, due to the financial, practical and ethical difficulties of studying people, projects and organisations over extended periods of time. Traditionally, OSH research in the construction industry is cross-sectional – taking a snap-shot, often looking retrospectively. The focus of this paper is the mobilisation of a longitudinal research study investigating OSH Policy in an eight year infrastructure mega-project in the UK. The research is examining implementation of the project’s ‘transformational’ OSH strategy in order to develop new understandings of the effectiveness of OSH interventions. The research design uses a ‘Strategy as practice’ lens and will trace the various OSH policy strands from development to their adoption as practice. The research context is complex due to the complicated contractual arrangements. The research design incorporates a rarely used ‘tracer’ methodology. During the mobilisation phase of the research project several challenges were identified including interpretation and implementation of this tracer methodology; coping with a large team of researchers; setting up ethics and governance; deployment of the team to site; consistency of data collection; managing datasets; coding reliability. The methodology adopted is time consuming and the very large datasets that are generated need to be managed. Complex research project management structures and processes are required that would not be needed for traditional cross-sectional studies. Sufficient time needs to be allowed at the start of such research projects to put the necessary systems in place. The paper will be of interest to OSH researchers and those contemplating longitudinal studies particularly those employing a tracer approach.

Keywords: Complexity, Longitudinal, Mega-projects, Occupational Health, Strategy.

## **INTRODUCTION**

This paper provides insight into the mobilisation of a unique longitudinal study of OSH policy deployment into practice on a construction mega project. The project being studied is a water infrastructure project, constructing a 25km long tunnel under a major river, and is scheduled for completion in 2023. The funding for this first phase of study, provided by IOSH (Institution of Occupational Safety & Health), covers the first three years of the eight year construction project. The project provides a unique opportunity to study the impact of OSH leadership, policy and practice over an extended period ‘in-flight’ (Pettigrew 1990) using a longitudinal approach i.e. collecting data over a longer time period or arrow flight (Woodward 1970; Chau & Witcher 2005).

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The project has a high degree of complexity (Baccarini 1996) due to complicated contractual arrangements. The management company is supervising three construction consortia and a further company responsible for the installation of the overall control system. The contract itself is based on NEC 3 plus appendix X (ICE 2013) which is designed to foster a high degree of collaboration between the parties. The research team consists of three academics and four post-doctoral researchers (RAs) at a UK university working on a part-time basis. The academics, including the project lead, provide direction and oversight. The four RAs have specialisms including: Occupational Health practice; Design; Quantity Surveying; Project Management. The team have considerable experience in OSH research including in-depth knowledge of OSH on several internationally recognised infrastructure mega projects e.g. Terminal 5, 2012 Olympics, Crossrail and Gorgon.

The objectives of this research are to reveal new approaches to achieving desirable OSH outcomes, together with in-depth knowledge of how they can best be managed through the process of implementation. The research will also identify the practical lessons, knowledge and good practice that are developed and can be shared with wider industry.

In this paper we discuss the challenges which the research team have encountered during the initial mobilisation phase of the research and the ways in which these have been addressed. This will provide insights into the use of longitudinal approaches in the OSH research field to inform debates about the ways in which H&S policy translation into practice is studied. The study is at a very early stage having only recently been mobilised and therefore the focus of this paper is on the team's experiences during this phase of the research project.

This section has provided an outline of the context of the study and the aims of the research. The following sections provide an overview of the relevant literature, issues arising during mobilisation and how they were dealt with, and reflections on the practicalities of longitudinal research.

## **LITERATURE OVERVIEW**

The majority of social science research is cross-sectional rather than longitudinal and employing quantitative rather than qualitative methods (Bryman, 2012). Menard (1991) defined longitudinal studies as those where data is collected over one or more time periods, the subjects or cases are the same or comparable from one period to the next and, the analysis involves comparisons between periods. He defined cross sectional studies as having data collected once for each item over a narrow space of time such that the measurements can be considered contemporaneous for all variables and cases.

In medieval military terms a cross sectional study can be likened to a 'cross-bow' which is relatively easy to use, doesn't need intensive training and early versions had limited accuracy, sophistication and range. The cross-sectional approach takes 'snapshots' at the time the study is conducted and the findings are then extrapolated backwards and forwards, outside of the timeframe the data was collected (Yin 2003). This method relies heavily on a combination of the recollections of research subjects and on data derived from lagging indicators. On the other hand, longitudinal studies can be likened to longbows which are more accurate, have a faster firing rate and provide more flexibility in battle but require more skill. Longitudinal studies need experienced researchers who can 'fit in' to organisations, cope with a greater rate of

data collection, and be more adaptable to deal with changes to their area of study which emerge over time. Such studies also require more commitment from industry collaborators to provide good access over sustained periods.

In his keynote at the 2014 W099 conference in Lund, Sweden, Andrew Hale challenged the research community about the lack of longitudinal studies covering OSH in construction (Hale 2014). Pettigrew (1990, p.284) stated that ‘longitudinal research in the social sciences has always been a ‘minority taste’ research into industry practice.

The research aim is to develop new understandings of the deployment of OSH strategy and effectiveness of the resultant OSH interventions in large, complex multi-site construction projects with networked supply chains. In other words the research will be monitoring change within the organisations involved in the construction project. Menard (1991) states that the two primary purposes of longitudinal research are “to describe patterns of change, and to establish the direction.....and magnitude of causal relationships”. As such, using a longitudinal approach allows the study of the OSH interventions as they unfold revealing not only their effectiveness but the ways in which OSH policies and practices intersect and intertwine with other organisational agendas. A recent study in the construction safety field revealed that from a sample of 88 papers published in 2009, 50% were quantitative, 25% were qualitative and only 10% were mixed methods (Zou et al 2014). In Occupational Safety and Health (OSH) studies, particularly in construction, have been generally cross-sectional. The paper called for more mixed methods research to improve the generation of knowledge and improve collaboration between researchers and practitioners. This aligns with the view of Menard (1991) that the term longitudinal does not describe a single method but more a collection of methods which is also the approach for this study.

The tracer methodology has its roots in seminal work by Woodward (1970), who used it as a method to explore managerial control systems across three case studies. There are specific terms associated with this methodology. Tracers are the processes which are of interest and are traced during the research. Tags are a means of identifying items or ideas that are to be followed. Manufacturing processes were selected as tracers to be followed through the control systems of the organisations. The interactions of the staff and their behaviours were observed in terms of how they were involved in planning, making decisions and carrying out tasks related to the tracer (Woodward 1970). This allowed a wider understanding of the control systems by studying smaller elements or sub-systems from which more focussed data collection could take place as the study evolved over time.

The approach was further developed by Hornby & Symon (1994) who provided a structure for examining the perspectives of stakeholders on processes with which they have participated. Cassell & Symon (1994) refer to organizational studies as being about highly complex processes which have a variety of actors over their timespan. They promoted the use of tags attached to tracers which are followed to identify the important processes and key actors pertaining to the research focus, as well as critical documents, events and activities.

Using this methodology the research team will be able to follow whichever processes and people emerge as relevant to shaping OSH outcomes rather than making an assumption that the issues and influences relevant to OSH are all known at the outset. The methodology allows a variety of research avenues to be opened up and closed

down as their relevance is established. In this respect, the method is particularly effective in examining the effect of specific interventions as ongoing activity. In other words, the aim of this type of study is to iteratively examine emergent issues collected through interviews and to build upon and respond to these in later stages of the research endeavour (Chau & Witcher 2005). The approach is particularly apposite in that it uses tried and tested research data gathering techniques (e.g. interviews, observations, documentation reviews) but within an innovative longitudinal framework. It allows data collection to be focussed in specific areas of interest thus making the dataset more manageable and enables better understanding of the wider picture by looking at small elements of the organisation rather than everything at once.

## **ISSUES ARISING DURING MOBILISATION**

The mobilisation of the research consisted of a number of elements, some of which ran concurrently, including: establishing the research methodology; mobilising the research; establishing the governance structure; obtaining ethics approval; and, commencing the data collection and analysis phase of the project. This section describes the research mobilisation period from February 2016 (the official project start date) to December 2016 when Milestone 1 was successfully achieved. The following sections describe the issues that arose and how they were dealt with.

### **Establishing the methodology**

From the outset there was considerable debate as how the research methodology should be applied and this continued as the project progressed. A key facet of the methodology used in this study is an adapted version of the longitudinal tracer study methodology (c.f. Chau & Witcher 2005) that was originally developed by Woodward (1970). In essence, the application of a longitudinal tracer approach allows core organisational processes or phenomena to be isolated and their progress followed via insights gathered at particular stages of its development.

Tags are being used to identify the important processes and key actors pertaining to the research focus, as well as critical documents, events and activities. By tagging particular people, processes and tools the effects of interventions can be studied in real time. The choice of tags is crucially important to the success of a tracer study; they should be a relevant reference to respondents, be malleable enough to enable issues to emerge, and should offer up sufficient data to generate and develop theory. It is essential that the tags are grounded in practice and developed in collaboration with the industrial partners, to make sure that most fruitful opportunities are exploited. This is an emancipatory methodology, responding to the complex network of organisations, the approach that the people, teams and organisations are taking and focussing on the nature, complexity and risks involved.

The flexibility of the methodology caused the research team considerable problems right from the start. Each of the seven team members had their own interpretations of what it meant and how it might be deployed in practice. Team meetings would end up with long periods discussing the different viewpoints put forward and what was meant by the various terms. After several interesting but inconclusive discussions a visual representation was developed used to both to stimulate ideas *and* more importantly provide more focus. This resulted, after several more sessions, in the diagram shown at Figure 1.

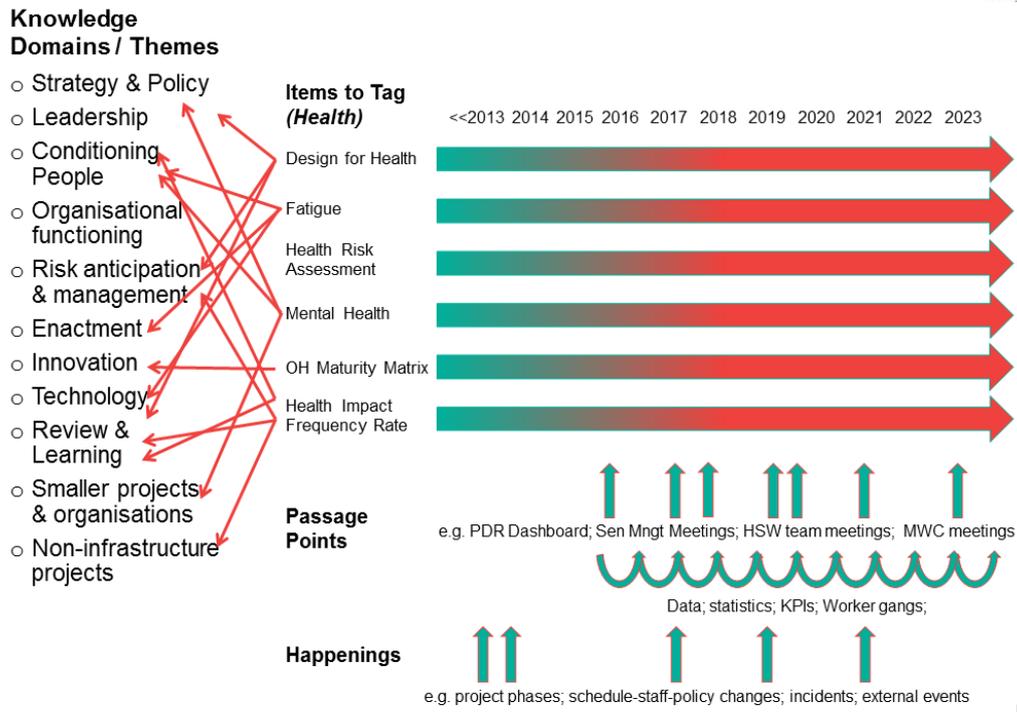


Figure 1: Tracer methodology schematic

The research team had to decide on how *they* were going to use and adapt the methodology rather than stick with the latest extant interpretation. This helped the team reach a consensus as to how the methodology was to be developed and deployed. The next task was to clarify the terminology that was to be used in the current context, namely: themes/knowledge domains; tags; tracing; passage points; and, happenings. This crystallized the team's thinking and provided a consistent message to communicate to others about the research methods.

Overarching themes, or knowledge domains shown in Fig 1 above are the key areas covered by the study which based on the OSH literature are likely to be of interest to practitioners and academics in the field of OSH strategy & implementation. Tags will be used to identify things that we are interested in such as specific interventions or initiatives (e.g. inductions, onboarding), and broader initiatives (e.g. mental health, design for health). These tagged items or ideas can be traced to see how the relevant areas of strategy are implemented over the project lifecycle, and how this implementation is affected by other factors. The things that are tagged will be subject to change as the project moves forward – for example project induction might evolve into a different format, and the research will seek to identify: the nature of the change; the causes of the change; and, the impact on other tagged items and on the project outcomes. In terms of collecting data, passage points can be used in the same way that a suitcase tag would be checked on various occasions, at different airports during its journey. In this context passage points will include meetings, interviews with key players and KPI (Key Performance Indicator) data.

Another type of phenomenon of interest is the 'stuff' that happens during the course of a project (happenings) which affects the way the project is enacted, the OSH performance and resultant outcomes. These may be internal-expected (project phases etc.); internal-unplanned (e.g. changes in key personnel or incidents); and external (e.g. BREXIT). A log of happenings relevant to the project will be maintained so that the team can check how these affect the things that are tagged.

There was also some considerable discussion of the theoretical perspectives to be used in the study. Given the topic under study was the implementation of strategy the use of a 'strategy as practice' (SaP) lens was considered a good fit by the team (Pettigrew 1990; Pettigrew 1992; Jarzabkowski 2004; Whittington 2006). Further review of the literature established that work in the 'organizational change' field (Tsoukas & Chia 2002) would also aid in understanding of how policy is translated into practice. The SaP lens will be used to examine the various OSH policy strands as they are traced from their development through to adoption as practice. Due to the emergent nature both of the methodology and the research being conducted these discussions are ongoing but are increasingly more focussed.

### **Mobilising the research**

The research team took several months to assemble. Each of the RAs were allocated roles and responsibilities for the various activities according to their knowledge and experience. Each led on one or more subject areas in addition to being allocated to build relationships with one of the joint ventures or the management company.

Following the allocation of roles and responsibilities the original research plan from the proposal was then updated and revisions approved by IOSH. A high level research plan was produced covering the initial three year research period. From this, detailed research plans were produced for individual elements of the milestone 1 deliverables. The plans for the individual elements covered; familiarisation with the topic and staff involved; data collection; data analysis and preparation of outputs. The plans are reviewed on an ongoing basis.

The initial team meetings were sometimes a little unproductive as the team strived to develop the processes necessary to manage the project. As with any new team &/or project the personalities involved need time to 'gel' together (or not) into a cohesive performing team. Geography was an additional challenge with two RAs living 1-2 hours' drive away from the University and the project being studied being a two hour train journey away; and involving sites located all over the city. This was mitigated by having weekly meetings at the University in person if possible or via skype. Other collaboration tools were used with varying degrees of success: One note; Slack; Google docs; and, good VPN (Virtual Private Network) access to the shared drives. The meeting structure has evolved over time as different approaches were tried and discarded if found not to work. The RAs meet together and with the lead academic every two weeks and as a whole team monthly. There are separate monthly meetings between the main site-based researcher and/or the lead investigator with the industrial HSW (Health, Safety and Wellbeing) Director and HSW Lead, and regular meetings with the IOSH project manager.

After nine months, several particularly useful project management processes have been introduced including: the use of a standard slide pack as the review meeting agenda and to capture actions; adoption of a rotating chair and minute taker to enable the leadership role to be shared across the RAs; and producing a document where the responsibilities of each team member (including ownership of particular key files, processes and records) were outlined to give greater clarity of what was required from each person.

There were considerable advantages to having four RAs as they have a vast range of experience and many ideas resulting in cross pollination. There were also some important disadvantages in terms of the extra time needed to share information, the time needed to reach consensus, and coping with different styles of working. There

was also an inherent perception amongst others involved that we had four RAs, who were 100% attached to the project and it was easy for them to forget the 1.6 FTE time restriction. A key consequence of having four rather than two RAs was the increased percentage of available researcher time spent at meetings – so that a one day meeting involving all four researchers used up half of the week's total allocated time on the project. There were also recurrent challenges meeting deadlines for written outputs due in part to the pressures of each RA needing to simultaneously work on their own outputs and comment on those of others. Better research planning and realistic allocation of time to the RAs will be required as the research progresses. For example, it was suggested that for future outputs there will be a lead writer and a second support person to minimise the number of team members involved.

A key enabler to building an effective research team was the fact that the personalities involved were able to reach a suitable compromise position for any issue that came up during the mobilisation. This point should not be underestimated as research staff and academics are, by the nature of their work, often highly skilled at putting a viewpoint across and defending it against all-comers. With a less collaborative team, it would have been much more difficult to make progress. A good example of dealing with this was the use of a rotating chair for the project meetings rather than selecting one RA as the leader. On the other hand a more autocratic approach may have been more task focussed but less effective as it would stifle debate and creativity. The methodology allows a lot of flexibility in how data is collected and analysed which suits a more cooperative approach to an emergent topic of study. What was needed was better project management which was eventually achieved through the meeting structure and rotating leadership model that evolved.

A series of initial research questions were developed to guide the investigation and collection of data, namely:

- How does OSH policy translate into practice on major construction projects?
- How does OSH policy propagate through complex organisations created by mega projects?
- How effective are the OSH interventions that are implemented on mega-projects and how have they been managed?
- Which findings will be of most relevance & use to industry practitioners & researchers?
- How do people cope with complexity and change in mega-projects?

These research questions are emergent due to the longitudinal nature of the research and the topic(s) under investigation. At research team project meetings the topics are reviewed to determine which topics will remain under active investigation.

### **Governance**

The governance for the project is a vital area given the research topic and duration. There are multiple stakeholders whose needs must be taken into account and managed and so a number of groups have been set up. An overall steering group represents the main stakeholders in the research and other key industry representatives. This includes IOSH as the main funding body which is keen to see that there is a focus on practical outputs for OSH professionals, as well as wider social and economic impact. In addition, there are two reference groups, from industry and academia, to provide sounding boards for findings and to maximise the applicability in terms of impact and benefit to the broader construction industry (e.g. smaller projects and other

construction sectors) and the research community. Formal reports will be produced annually with interim reports issued as necessary.

The governance structure provides the necessary independent oversight through the steering group and input from the reference groups. The management of these groups requires significant amounts of time making preparations and arrangements for meetings and associated workshops. This has, on occasions, threatened to detract from the main research activities of collecting and analysing data. It is important that the governance process is proportionate and adds value to the overall research over the life of the project.

### **Ethics approval**

Approval from the University Ethics Committee was required. The submission made to secure this included consideration of the following: project details; research team experience in methods proposed; participant information; observation/recording; consent; participant withdrawal; storage of data and confidentiality; incentives; risk assessment; declarations. As the research was mobilised a number of research protocols and related documents were developed: research overview; consent form for recorded interviews; information sheets for interviews, observation, and meetings; action research log; and researcher diary.

There were several minor issues in relation to ethics. The first was the lack of understanding by the Ethics Committee of the realities of carrying out research on live construction sites. This was overcome by revising some of the initial material in the submission and by meeting with the committee chair to discuss the research. The need for written consents for recorded interviews can discourage participation by some subjects and, in fact, in two cases participants were happy to be interviewed and recorded but unwilling to sign a consent form. These interviews proceeded with hand written contemporaneous notes being taken instead of recording.

In the case of a longitudinal study there are a greater number of consents to be obtained and there is the issue of researchers influencing outcomes in the organisations being studied. As participant observers, there is the risk that the researchers may influence the activities under observation. Some of this may be incidental but some will be a direct result of the role the research team is playing particularly as the project is keen to learn from the research team's work and to adapt what they are doing. There is, therefore, an element of 'action research' in the approach. A protocol has been developed which includes a log for documenting any activities that may influence how things are done.

### **Data collection and analysis**

Data collection will be mainly based on qualitative methods using interviews, archival analysis; observation. In addition, focus groups and surveys will be employed as a means of triangulation for any findings. The management company has been very supportive of the research from board level downwards. Involvement in the research was contractually written into the Works Information and this was seen as part of the transformational approach to OSH. The process of getting access to work on the project was complex and consists of three stages on three or more separate days: attendance at the central onboarding facility (COF) for security and health checks ; attending the employer's project induction centre; and, finally site induction for any site to be visited (including office locations). All researchers are required to have a Construction Skills Certification Scheme (CSCS) card as this is a requirement of all

those working on the project, including office staff. Anyone who wishes to enter the tunnels will need to attend a tunnel safety training scheme course.

Initially, the team had to learn about many different things at once but this had to be balanced against the need to work within the allocated research team resource. The project OSH policies have to dovetail with those of the tier one joint venture contractors (and their parent companies) and they are, therefore, likely to take different paths as the work progresses. Interviews with the key practitioners acting at these intersections will be used to reveal the interrelationship between these policy trajectories. The study of the phenomena emerging at these intersections will include reviewing specific OSH-relevant metrics (e.g. accident/incident data) and other data (meeting minutes, documents, newsletters etc.) in order to explore the contexts and effects of policy implementation over time.

Building relationships has been important and locating the team members alongside specific units of analysis was important i.e. one researcher for each contracting consortia and one for SI (Systems Integration) and the management company. This will allow the team to have a deeper understanding of the politics involved in the project and the drivers in different parts of the project. There are geographical and logistical issues due to the large number of sites (24 main sites and a main office eventually), their accessibility, and the need to attend meetings at various times of the day. All this led to some initial inefficiency but this has been overcome by better visibility of the on-site activities of the research team members and better planning through calendar sharing.

Over time the data set has grown rapidly and the data analysis needs to be carried out in a timely and efficient manner. Not knowing what might become important may lead to continuing to collect data which might or might not be needed at some point in the future. In the first nine months the team carried out 49 interviews, observed 57 meetings and have undertaken one survey. To aid the management of the data the team is starting to index files using meta tags (not to be confused with the longitudinal methodology tags) within an overall shared file structure accessed via a VPN connection when away from the University.

A key area of discussion has been the use of NVivo for coding and analysing data which is labour intensive. Coding and indexing data is not made easier by the evolving nature of the research questions which increases the risk of data having to be repeatedly recoded or refiled. Gaining agreement on coding structure has been time consuming. Consistency of coding between different researchers will need to be managed. The team is already on its second iteration of the shared file structure and is about to relaunch its third coding structure.

## **REFLECTIONS ON UNDERTAKING LONGITUDINAL RESEARCH**

So is the longbow better than the crossbow? The answer is simple - it depends... on where you are in the battle cycle; how much fighting resource you have at your disposal; where the battle is taking place; how skilled your troops are; and, how you plan to overcome the tactical challenges presented. Longitudinal research is similarly challenging.

The challenges identified in mobilising this research have included the interpretation of a little used longitudinal methodology within a large research team; setting up

governance for long periods of study; ethical considerations; data overload from too many lines of inquiry and easy access; consistency of data collection; the challenges of inter-rater reliability in coding. Other features which have been covered in less detail have included: frustration at ‘missing’ the action; the inherent uncertainty in working with ideas of organisational becoming. Further publications during the course of the research projects will be able to provide more details on specific challenges.

Carrying out longitudinal research on this scale is a significant undertaking and the team have a large amount of data which they need to make sense of in order to meet the research aims and objectives. The team have worked hard to mobilise the methodology and devise a project management approach that suits the needs of all stakeholders. The project is at a stage where the team needs to become more focussed and concentrate on producing high quality outputs. The processes introduced e.g. meeting structure, indexed shared file structure are starting to regulate how the team operates and make it more efficient and effective within the resource constraints. The opportunity, provided by this unique study, to make a difference in how learning about OSH in megaprojects is generalised for use by wider industry needs to be carefully managed to a successful conclusion. This is being made easier by the unrestricted access to all areas of the project – both people and data. The team are totally committed to the task but will need to bring all their experience to bear.

From a research community point of view the study has already revealed some interesting insights into the application of longitudinal studies versus cross-sectional approaches. The relative advantages and disadvantages of the two approaches from the mobilisation of this study are outlined in Table 1.

*Table 1: Longitudinal (Longbow) v Cross-sectional (Cross-bow)*

<b>Longitudinal</b>		<b>Cross-sectional</b>	
<b>Advantages</b>	<b>Disadvantages</b>	<b>Advantages</b>	<b>Disadvantages</b>
Multiple data sources	Too much data; complexity of data	Short timescales	Limited data
Rich data	Time taken to mobilise	Quicker results	Triangulation can be challenging
Opportunity for triangulation	Longer to produce outputs	Lower cost	Limited understanding of context
Better understanding of context	High cost	Requires limited time on-site	Interpretation of results can be difficult
Better interpretation of results	Researcher objectivity – risk of going native	Ethics easier	Difficulties in verification of results
Verification of results	Changes in team	Reduced researcher bias	Remote working
Better validity of outputs		Smaller team	
		More focussed	

It is too early in the project to draw firm conclusions regarding the benefits of using a longitudinal approach, and whether the benefits outweigh the challenges encountered. Certainly the team can see mistakes being made and fixed that may not have been revealed in a cross sectional approach. Similarly, the team will be able to observe how OSH policies and interventions are developed and then discarded or changed during implementation.

## CONCLUSION

A key feature of a longitudinal approach is the rich dataset which is both an advantage and a disadvantage. How it is managed will be key to the success of the project. Longitudinal studies with large teams need to allow time for setting up the project structures and processes required to manage the research activities. These are generally less complex with cross-sectional studies.

The dataset emerging from this work will afford insights into the ways in which OSH policy instruments are enacted, mediated, translated and appropriated by a broad range of strategy actors engaged in the project. Understanding how OSH plays out within and across project-based temporary multiple organisations will allow for domain-specific insights to be generated to address some of the specific issues that arise in this hazardous sector.

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