Can human factors help improve health and safety performance within the UK Construction Industry?

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SUMMARY

Health and safety performance within the UK Construction Industry has shown no meaningful improvement for the last decade or so. Traditional approaches to health and safety management are not making an impact on accident/incident/ill health rates. This paper proposes that wider adoption of human factors can provide benefit within the UK Construction Industry, whilst recognising some of the real-world challenges within the sector.

KEYWORDS

Construction, Safety, Risk

Introduction

Statistics published by the Health and Safety Executive demonstrate that the UK Construction Industry is under performing. In 2024/2025 the sector was responsible for 28% of all workplace fatalities, with 4,050 recorded non-fatal injuries and 78,00 workers suffering from work-related ill health (HSE 2025). With these figures showing a very limited reduction since 2012/2013.

Human factors is a discipline which focuses on how the individual functions within the wider system i.e. how construction workers interact with their work environment, tools, technologies and the wider project team. A key aspect of human factors is designing work to fit people, designing systems that align with human capabilities and limitations, rather than expecting people to adapt to fit the work. This is an area that the construction industry could improve.

Risk management is widely adopted within the industry as required under the Management of Health and Safety at Work (MHSW) Regulations 1999 and the Construction Design and Management (CDM) Regulations 2015 specify the need to carry out risk assessment adopting the general principles of prevention to control risks as far as is reasonably practicable (MHSW Reg.4 Schedule 1 and CDM Schedule 1).

This paper discusses where human factors could enable more effective risk mitigations (aligned to the general principles of prevention) where consideration is given to the interaction of the individual, their capabilities and limitations, within the wider system of construction work. The paper then adopts this approach (human factors techniques aligned to the general principles of prevention) to review case studies of two different accidents from within the sector. For both case studies the following questions are explored:

- What is the system and what is the human interaction?
- How can the system and the human interaction be improved?

The paper establishes the benefits and potential barriers for improving safety performance from integrating a human factors approach within existing risk management strategies for enhanced safety performance within the UK Construction Industry.

Relevance of Human Factors for UK Construction Industry

The UK Construction Industry is different to other sectors such as aviation, nuclear, rail and healthcare that have a more established approach to human factors and is lagging behind in the adoption of human factors as standard practice. However, some of the characteristics associated with the UK Construction Industry are quite different to those in other industries which may be delaying the widespread integration of human factors in the industry.

The organisation of construction work is complex with multiple organisations working together to form a quasi-organisation delivering construction projects for a limited period of time (Stiles 2018). The industry is dynamic with the duration of construction work varying from a day to several years duration, for both individuals and companies. Construction sites change on a daily basis making it more difficult to plan work, co-ordinate interfaces between work/workers and manage change. The workforce tends to be peripatetic and multicultural which can influence the effectiveness of communication (Winkler and Irwin 2003). The work itself is hazardous with extensive use of tools, plant and machinery, in difficult work environments, restricted space and exposure to UK weather patterns. This can be further compounded by the project programme for completion of the work and restrictions on available budget. The UK Construction Industry has shortage of labour which can affect resource schedules and having competent people available to do the work (CITB 2025). All of these are considerations which may inhibit the successful adoption of human factors approach within the sector.

From a review of over 100 construction accidents issues between workers, teams, the workplace, equipment shortcomings and deficiencies in risk management were all relevant factors (Haslam et al 2019). Oluwafemi et al (2024) found within UK construction 75% of falls from height were caused by human factors including fatigue, mental slips, and organisational pressure. In relation to Malaysian construction project procurement processes Thevendran and Mawdesley (2004) state "*human factors are unequivocally the single most important element that can affect success"*. The UK Construction Industry may have a potential 'gap' by not wholly adopting a human-centred approach that is associated with human factors which is explored further in this paper.

The General Principles of Prevention

The general principles of prevention ranks risk management strategies in order of their effectiveness, as shown in Figure 1.

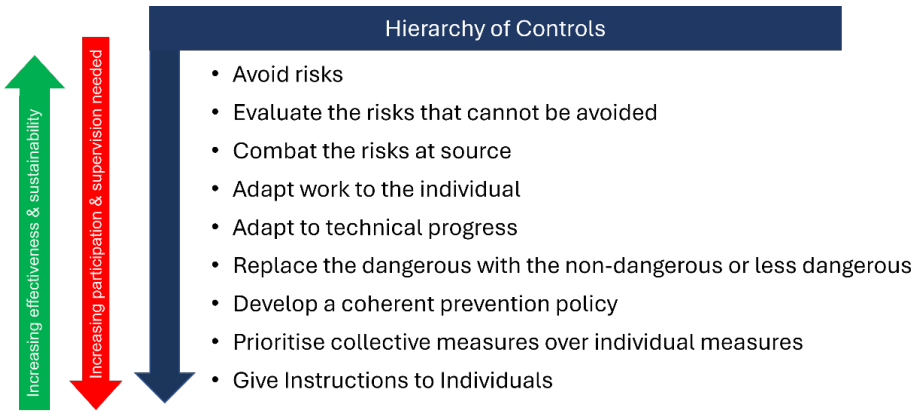

Figure 1: The general principles of prevention

This paper outlines some of the human factors tools that complement the hierarchy of risk mitigations with relevance for the UK Construction Industry in order to aid greater adoption of human factors. This is followed by review of those human factors tools aligned to the general principles of prevention for two case studies of construction-related accidents.

At the top of the hierarchy the risk strategy is to eliminate, evaluate risks which cannot be avoided, and combat risks at source. Hierarchical task analysis identifies high risks tasks and/or unnecessary steps in a process that can be removed or automated. Human error identification (e.g. SHERPA) systematically predicts where human error could occur which allows for task redesign. Human-centred design focuses on elimination of hazards aligned to worker capabilities and limitations. Error modes and effects analysis predicts risk arising from human and system errors. When deployed early in the preconstruction phase of a project (design, planning, mobilisation) these tools enable a shift for proactive rather than reactive risk management.

Adapting work to the individual are typically administrative level controls. Physical ergonomics where the workplace and tools are fit for the individual e.g. (HSE MAC tool for manual handling, anthropometric analysis for workplace design). Cognitive ergonomics focuses on determining mental capacity through cognitive task analysis, workload assessment (e.g. NASA-TLX) which is useful for simplifying permit to work processes. Organisational ergonomics consider human variability and wellbeing, rostering, fatigue, supervision, and culture. Using such tools increases understanding of capabilities and limitations and therefore can be considered within risk mitigations resulting in more effective risk management during construction work.

Adapting to technical progress spans between administrative and engineering controls ensuring that new technology supports the worker. Human-machine interface tests how intuitive and error-proof the interface is e.g. dashboards on construction plant. Resilience engineering tools (e.g. FRAM, STAMP) assess system adaptability and variability, one such example of potential use would be handover between human and autonomous system when using drones using for site surveys.

A human factors approach includes participatory ergonomics where engagement with workers in task design and risk assessment identifying opportunities to eliminate hazards early in the planning process e.g. offsite fabrication to avoid work at height on a construction project where there are more variable environmental factors to manage.

Approach for Review of Accident Case Studies

The two case study examples cover different types of construction related work: falls from height and person trapped by something. Both of these accident types are the top two classifications of fatal injuries in the construction sector as reported by Health and Safety Executive (2025). Two case studies have been chosen which the author had personal involvement in the investigation that followed each accident. This enables a good depth of understanding of the sequence of events, investigation findings and stated recommendations for both accidents. The organisations have provided consent for these accidents to be used as a case study for promotion of learning in an anonymised manner.

This paper answers two questions in relation to both case studies. What is the system and what is the human interaction? And how can the system and the human interaction be improved?

Case Study A Fall from Height

This accident involved an individual falling from a ladder landing on a concrete floor causing immediate injury to back and a broken ankle. This individual was working for a joinery company, a small company employing less than 30 people, engaged by a Principal Contractor to carry out work on a project for the new construction of a building. The investigation concluded that the injured

person lost balance whilst climbing a ladder for access onto a scaffolding platform. The identified causal factors include:

- Use of ladders when carrying materials was inappropriate. Alternative suitable access should have been provided – unsafe demands.
- Change to the original access plan and provision by the Principal Contractor from staircase to ladders was not risk assessed – design change.
- Inspection of ladders on scaffolding and maintenance regime ineffective – weak inspection controls.

Adopting a human factors approach to the investigation findings has established that the employer (a SME) planning the work activity did not adopt a human-centred approach and failed to consider how people would safely use the ladder to access the scaffold platform. The inherent risks were not eliminated or evaluated by those planning the work. Hierarchical task analysis carried out in the planning of the work would have broken down the task into individual steps (need to access the scaffold, need to carry materials, climb the ladder and transition onto platform) and identified physical demands, hand occupancy, balance points and decision points. This analysis would have established that climbing the ladder without three points of contact increases the likelihood of a fall.

However, the original plan was for a staircase access onto the scaffolding which was subsequently changed due to interface with other construction work restricting space in that area. This change in design of the scaffold system was not sufficiently assessed by the Principal Contractor. Human-centred design is focused on eliminating hazards cognisant of worker capabilities and limitations. Carrying out a design change impact review would have identified the additional risk from use of a ladder rather than a staircase; identifying risk from loss of stability, increased reliance on the individual balance, increased physical load on those using the ladder, and the suitability of the work area at the base of the ladder. A specific assessment of error modes and effects analysis would have identified the reduced margin for error associated with this design change. The general principles of prevention requires employers to adapt work to the individual. A physical ergonomics assessment would have identified whether the ladder at that particular location was the right equipment for the individual carrying out the task, but this would have been the responsibility of the employer (a SME) rather than the Principal Contractor.

A greater understanding of human factors thinking in the planning stage would have assumed that workers are likely to carry tools, time pressure exists and workers may not always behave optimally. Human-centred access design was overlooked in this case study example.

Towards the lower end of the general principles of prevention are administrative controls such as permits to work. Work at height is often classed as a safety critical task and therefore identifying this as a safety critical task could have improved the risk control for the activity through a permit to work system. Safety critical task identification is not commonplace during the construction phase of projects within the UK construction industry, whilst permit to work systems are in place on the majority of construction projects.

The scaffold and ladder access was not managed by the employer of the injured person but by the Principal Contractor. Whilst there was clear responsibility for who was responsible for providing and maintaining the scaffold and ladder there was an over-reliance and assumption that this was being carried out sufficiently by contractors on the project. Safety assurance and human reliability checks would have established clear ownership for the inspection of the ladder, inspections to be carried out using human-factors informed checklists, and deployment of visual markers to identify the ladder was safe to use. Carrying out a ‘work as imagined versus work as done’ gap analysis would have helped to monitor behaviour of those using the ladder access.

The initial investigation focused on human error (loss of balance) and identified three causal factors. This review has identified that this accident arose from a system design failure and has identified several opportunities for human factors techniques to be considered in future planning of similar work.

Case Study B Person Trapped by Something

This accident involved an individual sustaining a trapped leg between a steel beam and the ground causing severe lacerations and a broken leg. This individual worked for a shot blasting company, a small company employing less than 10 people. They were engaged by a Principal Contractor to repaint the steel beams in a compound/yard area. The investigation concluded that the individual was standing too close to the steel beam. The identified causal factors include:

- Controls for maintaining beam stability were not identified during the planning of the task (and no exclusion zone in place) – poor task planning and inadequate risk assessment.
- Insufficient number of trestles to safely store all steel beams – storage/resource planning.
- Lack of supervision in this area of the yard – safety leadership and culture.

Adopting a human factors approach to the investigation findings for this accident has identified common human and organisational factors around risk perception, work planning, risk controls and supervision.

At the top of the general principles of prevention is the need to eliminate and assess risk and then combat the risk at source. The planned safe system of work did not identify the risk from handling and incorrect positioning of the steel beams for the painting activity, coupled with limited anticipation of the failure modes. Completion of a hierarchical task analysis during the planning of the work could have identified the different steps involved in the task including stacking and stabilisation of beams during delivery, temporary positioning and storage, as well as movement and handling during painting. Attention should have been drawn to human positioning and potential failure scenarios.

This accident identified the importance of the physical work environment and the need to adopt a human-centred approach for work within the yard. Engineering risk controls would consider the best design and selection of equipment to maintain stability of the steel beams via trestles, mechanical chocks etc inherently designing safety into the work activity. Adopting collective measures for risk management would also include installing physical barriers to identify safe and unsafe places within the yard, keeping people away from entrapment hazards. Other such examples include painted exclusion zones and clear demarcation in the yard, to warn people of safe positions and access routes. A greater knowledge of human limitations would support more effective risk controls where exposure to hazards is designed out, with less reliance on individuals doing the right thing all of the time and making safe behaviour the default.

The documented risk assessment identified the need to position the steel beams on trestles, but on the day of the accident there was insufficient trestles and space in the yard for all of the beams. The planned risk controls were reliant on individuals experience and diligence in carrying out the task safely adopting a ‘work around’. A capacity planning review prior to the work commencing would have considered maximum beam storage limits, confirmed adequate trestles available as well as planning for overflow arrangements. This would have reduced the reliance on individual work arounds at a local level and deter normalisation of risk resulting in a more positive perception of risk amongst the team. The general principles of prevention states replacement of dangerous with none or less dangerous, towards the lower end of the hierarchy - sixth out of nine levels of risk control. Better planning of the storage and resources needed to complete the work safely would

have specified a less dangerous working practice. In the absence of this level of risk control the organisation ended at the bottom of the hierarchy reliant on giving instructions to individuals.

Risk perception is often reliant on good situational awareness and understanding the risk, in this case the risk of beam instability. This was found to be lacking amongst the team involved in the work activity. Increasing the competence and awareness of entrapment risks through toolbox talks, storytelling and sharing real scenarios can support improved risk perception. High standards of communication within the work team can also help support situational awareness for dynamic and mobile tasks where emergent hazards and risks are highlighted by the team at the specific time.

The supervisor is an essential aspect of any coherent prevention policy, and on this occasion that was missing. The allocated supervision did not walk out and supervise this particular work activity due to other work demands being prioritised. A lack of supervision reduces reinforcement of site safety rules and behaviour correction, degrading the importance of safety. Good supervision would conduct frequent walk arounds to avoid drift, reinforce exclusion zones and challenge any unsafe positioning by members of the team contributing to a positive safety culture. Frontline leadership training would equip supervisors in adopting these positive behaviours empowering others to stop work and challenge unsafe situations as the norm.

The initial investigation focused on the decision by the individual becoming ‘too close’ and also identified three causal factors. This review has identified that this accident arose from a systemic weakness in planning, resource allocation, and safety culture. There are opportunities for human factors techniques to be considered in making improvements for this organisation.

What are the benefits and barriers to adopting a human factors approach?

Having outlined the rationale for greater attention to human factors within the UK Construction Industry, this section examines both the potential benefits and the practical barriers associated with its adoption. While the advantages are often articulated in terms of improved safety performance, reduced errors and stronger workforce engagement, implementation is unlikely to be straightforward. Organisational culture, commercial pressures, fragmented supply chains, and limited awareness or capability can all constrain progress in the adoption of human factors. A balanced consideration of these enabling and inhibiting factors is therefore essential to move the discussion beyond promotion and toward a realistic understanding of what adopting a human factors approach entails in practice. Table 1 summarises the benefits and barriers of adopting a human factors approach within the UK Construction Industry.

Table 1: Benefits and barriers of adopting human factors in UK Construction Industry

Benefits of Human Factors	Barriers to Adopting Human Factors
• More focus on humans and interaction within the system they are working within • Resource capacity planning and resilience engineering • Greater knowledge of human capability and limitations • Clear identification of error modes – more effective risk assessment • Participatory approach with workers for risk management	• Complex organisational structures – time-bound • Lack of clear responsibilities for management of safety risk • Peripatetic and multicultural workforce • Labour shortage • Time and budget pressures • Hazardous work • Levels of safety culture maturity • Variability of work and work environment

The opportunity for human factors to support an improvement safety performance is apparent. Similar to the study by Haslam et al (2019) the two example case studies identify deficiencies in risk management, and insufficient planning involving the work, workplace and equipment. Prior to these accidents there were little consideration for the humans operating within the wider system. Adopting a human factors approach offers a structured means of designing systems that are better aligned with the realities of construction work whereby organisations can better anticipate variability and manage performance under pressure. A human factors approach places greater emphasis on the human element and the interactions within the wider socio-technical system in which individuals operate, for more proportionate task allocation, clearer communication and more realistic performance expectations rather than focusing solely on procedures or compliance. Human factors also promotes a participatory approach to risk management, actively involving workers in identifying hazards and shaping practical, workable solutions. With an aging workforce, labour shortages, and retention challenges in the industry improvements in resource capacity planning and the application of resilience engineering principles would be beneficial.

Human factors practices can help improve safety performance safety risk management in a proportionate manner. Integrating human factors within the general principles of prevention provides opportunity to enhance the established risk management strategies with a greater understanding how an individual functions within the wider system, their capabilities and limitations. With reference to Case Study A – fall from ladder, if the use of the ladder was a one-off task just for one individual it may not be reasonably practicable to undertake hierarchical task analysis, physical ergonomics assessment, safety critical task identification and human reliability checks. Similarly, Case Study B – person trapped by something, hierarchical task analysis, capacity planning review, leadership training may be a greater investment of resources, time and cost than the risk from the one-off task. Therefore, it is recommended that adopting a human factors approach would be better focused initially at the level of a construction project, inclusive of the whole project scope of activities rather than solely task and activity focused. For example, carrying out hierarchical task analysis for the use of all ladders on a construction project may be more beneficial than focusing on one specific use-case (especially when resource capacity is limited). A further example of developing supervisory skills through a safety leadership training programme that individuals can take from project-to-project would be valuable for the wider industry not just one single project.

Whilst there are clear benefits of adopting a human factors approach within the UK construction industry, there are also several barriers to consider which may negatively impact on the successful deployment of human factors in practice.

Construction projects are complex organisational structures (Winkler and Irwin 2003), typically time-bound (Stiles 2018) with a high level of variability often involving multiple contractors and shifting responsibilities, which can obscure clear accountability for the management of safety risk. This was identified within Case Study B. A peripatetic and multicultural workforce adds further complexity, requiring consistent communication and shared understanding across diverse teams. Labour shortages intensify production pressures, while challenging programmes and budget constraints can shift priorities in favour of immediate deadlines rather than longer-term system design improvements. The hazardous nature of construction work, combined with variability in tasks and working environments, makes standardisation challenging. Full adoption of human factors techniques for every risk assessment prepared for construction work may be disproportionate. For example, it would a significant investment of time, capital expense and competent resource to undertake hierarchical task analysis for all of the safety critical tasks carried out on just one construction project. Subsequently extensive deployment of human factors may be inhibited. The variability of tasks, projects, environments, and organisational arrangements within the construction

industry inhibits the ability to scale and standardise practices that are more readily deployed in comparatively stable and controlled sectors such as aviation, manufacturing. Together, these factors create a challenging environment for embedding human factors in a consistent and sustainable way.

This paper has sought to highlight the tangible value that a human factors approach can bring to the UK Construction Industry for enhanced safety outcomes. The intention is not to present human factors as a silver bullet, nor to underestimate the commercial, cultural, and resource pressures under which the sector operates. Rather, it is to promote a pragmatic, evidence-based integration of human factors principles that aligns with existing practices and constraints. It is recommended that further studies are carried out to determine the most appropriate adoption of human factors aligned with a targeted risk-based approach, providing greater clarity on where human factors can provide greatest positive impact on safety performance of the UK Construction Industry.

By adopting a realistic, incremental approach, the industry can move beyond the current plateau of safety performance towards a more resilient future in which people are recognised not as liabilities to control, but as assets to support and enable.

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