Learning legacy

Lessons learned from the London 2012 Games construction project

The Construction (Design and Management) Regulations 2007: duty holder roles and impact

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This project researched the extent to which the Construction (Design and Management) Regulations (CDM) 2007 helped or hindered the construction of the London 2012 Olympic and Paralympic Games by reviewing how those with duties under CDM put them into practice.

The research was based on interviews with Olympic Delivery Authority (ODA) sponsors, designers, CDM coordinators, Tier One contractors and Delivery Partner (DP) project managers on nine projects. In addition, a structured workshop was held with a range of duty holders from a range of projects.

It was found that CDM 2007 had been extended on the London 2012 construction programme, and had been implemented successfully. In particular:

- the Client (ODA/DP) had a significant impact on health and safety;
- early planning, coordination and contractor involvement were crucial;
- principal contractors shared ideas and lessons learned;
- worker engagement helped to motivate the workforce and get key messages across.

When compared with the wider construction industry, the London 2012 construction programme scored significantly higher in 27 of the 39 Influence Network factors that influence health and safety.

A range of lessons from the London 2012 construction programme is applicable elsewhere in the construction industry including:

- clients taking the leadership role;
- sharing knowledge among organisations' senior staff;
- engaging workers;
- taking initiatives to improve health and safety culture;
- allowing and encouraging workers to report 'unsafe' activities;
- integrating teams of designers, contractors and CDM coordinators early and often;
- sharing office facilities;
- focusing on getting the right competences in individuals and organisations.

Key messages

Millions of hours of work can be undertaken and a project delivered in a tight timescale without compromising health and safety

This was demonstrated across the board on the London 2012 construction programme, but was most evident in the Athletes' Village; where the large quantity of construction work undertaken within the timescale demonstrated the possibilities.

The client had a significant impact on health and safety

The ODA set the tone for health and safety from day one, and then reinforced this on a daily basis. The ODA's actions tied in with its words and gave credibility to the health and safety messages.

Early planning, coordination and contractor involvement were crucial

By appointing CDM coordinators and contractors early, advantages were gained from identifying risks early and using contractors' experience to improve buildability, reduce cost and time as well as improve health and safety. With better planning, there was less rework, quicker completion and easier handover.

Principal contractors shared ideas and lessons learned

Principal contractors, who would be competitors outside the London 2012 construction programme, shared ideas on how to solve problems, via both formal and informal routes. Near-miss (dangerous incidents that did not lead to accidents at the time but may have done under other circumstances) information was shared, giving other principal contractors advanced warning of potential problems. Information was brought into the London 2012 construction programme, shared on site, and disseminated within the principal contractors' wider businesses.

There was a culture of challenge to all significant decisions

This meant that organisations were constantly asking questions such as 'Is this the best way to do it?' and 'Can we do it a better way?' This was found to be an effective form of risk management, and introduced an appropriate culture to organisations; these discussions were also relevant for achieving construction on time and within budget.

Worker engagement helped to motivate the workforce and get key messages across

Supervisors were trained, and provided daily activity briefings for site workers so that they were aware of what was required of them that day. Senior management engaged with the workforce, and this helped to get the message across and demonstrate how seriously health and safety were taken. The point was made that engagement incurs little cost, but helps to motivate the workforce and get key messages across.

Behavioural health and safety initiatives changed culture for the better

Behavioural health and safety initiatives (for example, running forums where people learn about what behaviour causes accidents and how to avoid it) were aimed at changing culture by changing the way that people (at all levels and disciplines) viewed health and safety and their responsibilities to themselves and others. Organisations considered behavioural health and safety initiatives to have had significant impact on managing risks on site.

Introduction

Frontline Consultants was commissioned by the ODA and funded by the Health and Safety Executive (HSE) and the Institution of Civil Engineers (ICE) to review duty holder implementation of CDM 2007 on the construction of the Games.

A duty holder is any person or organisation holding a legal duty that has been placed on them by a regulation such as CDM 2007.

The objectives of this research were to:

- review the effectiveness of CDM 2007 against the criteria set by HSE for the revision of CDM 1994;
- assess the extent to which CDM assisted the management of health and safety during the construction of the Olympic Park;
- identify examples where CDM produced health and safety and business benefits;
- identify any requirements within CDM which affected performance or were burdensome;
- capture any good practices.

Approach

The following duty holders were interviewed (where available):

- ODA Sponsor
- Tier One contractor
- Design Manager
- CDM Coordinator
- Project Manager

For the following projects:

- Velodrome
- Broxbourne
- Structures, bridges and highways
- Olympic Stadium
- International Broadcast Centre/ Media and Press Centre
- Logistics
- Athletes' Village
- Landscaping and Public Realm
- Eton Manor

Interviews were also undertaken with:

- the ODA's Head of Health and Safety
- three HSE Inspectors who had worked on the Games

A structured workshop was held with a range of duty holders from a number of projects.

Detailed findings are contained in a research report which will be available on HSE's website.

Aerial view of the Olympic Park during construction

CDM provided a common framework that supported good construction practice on the London 2012 construction programme.

The implementation of CDM 2007 on the London 2012 construction programme

The ODA appointed a CDM Integrator on the Park to manage the CDM coordinators – given the size and complexity of the London 2012 construction programme, over 30 CDM coordinators were appointed from a number of organisations; the CDM Integrator's aim being to produce a uniformly high standard of CDM coordination with a common approach.

Relatively early appointment of CDM coordinators – either at an early stage in the design process or as part of a design and build team. This was part of the ODA's strategy to ensure health and safety was central to all aspects of construction.

Continuity of CDM coordinators – by transferring CDM coordinators from the designers to the contractors once the contractors had been appointed so that information and discussions from the design stages are available to the construction team.

CDM coordinators monitored the Construction Phase Plan and reported on their findings to ensure that the Plan remained a 'live' document during the life of the project.

The complexity and scale of the programme, along with the need for a large number of contractors to work in a relatively small area had a definable impact on the implementation of CDM – the Olympic Park site was divided into a large number of individual land areas where a principal contractor had sole control and then handed the land area over to another principal contractor, complete with documentation.

While health and safety has been an ODA priority from day one, changes in culture have been noticed with time – the emphasis put on behavioural health and safety initiatives, training and daily briefings, has led to a noticeable change in the culture.

Both the outcome and process were positive, and they can be replicated elsewhere – competency and training for all supervisors; senior management team engagement with the workforce; openness in discussions and sharing of lessons; and on-going review of the Construction Phase Plan could all be implemented elsewhere.

Compliance with the workplace regulations was audited – audits ensured that the Regulations had been met during the design process.

The health and safety files were prepared by principal contractors for handover to the client – these were prepared in a standard site-wide format defined by the DP and submitted to the relevant coordinator.

Although the approach was driven by regulatory requirements, it would have probably been undertaken in a similar way as part of good construction practice – CDM did give a common framework and back-up if necessary.

There were few negative aspects, but the main ones identified by interviewees centred around the amount of paperwork required by the construction programme – in particular the paperwork associated with the handovers of land areas.

Business benefits could be linked directly to good health and safety performance and CDM.

Benefits and fit of CDM 2007 on London 2012 construction programme

There were instances where health and safety benefits could be linked directly to CDM – given how low the accident frequency rate was, it seems likely that CDM contributed, and significant and tangible changes were made as a result of meaningful design reviews affecting both construction and legacy use.

Business benefits could be linked directly to good health and safety performance and CDM – the low accident frequency rate minimised lost time and avoided damage to reputation.

Good construction practices were brought into and developed on the London 2012 construction programme and were already being applied elsewhere – good construction practices were flowing into and out of the London 2012 construction programme by a number of routes including the Safety, Health and Environment Leadership Team (SHELT) forums.

CDM roles and structures match the natural mechanisms for undertaking contractors' business – amongst the Tier One contractors, in particular, it was suggested that CDM dovetails with their way of doing business and that it would be done this way anyway.

CDM needs to be embedded in projects from the outset and associated with quality management to ensure that it is aligned with business practices – given the acceptance of the need for quality management within construction projects, there is a need to stress to the wider construction industry how CDM fits within a quality management framework and that careful thought will significantly reduce any administrative burdens in this respect.

Provided it is implemented correctly, CDM should not be a disproportionate burden or an impediment to efficient construction management – the key provisos are that CDM needs to be implemented 'properly' and from the outset.

Requirement	– A roof that followed the profile of the cycle track – Completion within a tight timescale
Complication	– The roof has complex geometry
Solution	– A cable net solution was proposed initially by the design team – Cost consultants suggested that a steel roof be used instead as it was cheaper – When the principal contractor was appointed, it revisited the cable net roof and found that although the cable net roof was marginally more expensive it had significant benefits
Benefits of the cable net solution	– It reduced the construction programme by six months – The assembly could be done at ground level and jacked into place, avoiding the need for work at height – The roof is now maintenance-free, avoiding the need for work at height during operation
Comment from team members	– Neither the contractors nor designers could have come up with the final solutions on their own; an integrated team gave the best solution – Input from HSE operating in an advisory mode was valuable

Table 1: Benefits gained from CDM in the construction of the Velodrome roof

The implementation of CDM 2007 on London 2012 showed that HSE's objectives for CDM 2007 had been met.

The effectiveness of CDM 2007

Given the start date of the design and construction work, most of the work on the London 2012 construction programme was undertaken under CDM 2007 and, as such, respondents' comments referred to CDM 2007 in absolute terms rather than in relation to the previous CDM 1994 Regulations.

It was evident from the comments provided in this project that many of the issues that have been raised as problem areas with the implementation of CDM 2007 by the wider construction industry were not perceived to be problems on the London 2012 construction programme. In particular:

Early appointments were made – CDM coordinators and contractors provided early input to the design.

Commercial pressures did not hinder the implementation of CDM – planning, coordination and cooperation were seen as essential in addressing those commercial pressures (budget and timescale).

Multiple work areas requiring their own principal contractors were accommodated – the Park was split into a series of land areas; each of which had a separate principal contractor for the duration of the relevant construction work and was then handed over to the next principal contractor along with the relevant documentation.

Integrated risk management was the preferred approach – it was seen as necessary to address and balance the health and safety, technical, financial, timetable and environmental risks.

In addition, the research identified:

Overall the view was that CDM 2007 is clear and is easy for duty holders to understand what is required of them.

CDM 2007 was appropriate for use with the forms of contract used on the London 2012 construction programme – in particular, it complements the NEC3 form of contract used in the Park, although some interviewees thought that CDM 2007 was independent of the type of contract used.

Paperwork had reduced in some areas, but the programme itself required significant amounts of paperwork – while there had been a reduction in the paperwork resulting from generic risk assessments, the construction programme as a whole required significant paperwork.

There has been significant coordination and cooperation, but it was difficult to allocate this to the influence of CDM – while the early appointment of contractors and CDM coordinators was significant, coordination and cooperation has also been driven by co-location, and designers wanting to work with the best contractors to get the most out of their design, and the NEC3 contract.

On balance, CDM 2007 simplified the assessment of competence – duty holders had experienced less competency-related paperwork as the pre-qualification questionnaire had been streamlined.

There were other significant influences on health and safety on the London 2012 construction programme in addition to CDM.

Influences on health and safety

Besides CDM, client leadership and contractor-led initiatives had a major influence on health and safety on the London 2012 construction programme.

Client leadership

The ODA stated that health and safety is its number one priority from the start, and has reinforced this message consistently – the ODA influence and strong leadership has been cited consistently.

Constructing the programme in the glare of the world's media – this puts extra pressure on organisations to 'get it right'.

Contractor-led initiatives

Each of the Tier One contractors had their own initiatives and targets for reducing injury and ill health – while they all had different terminology, they were aimed at a common purpose.

Daily activity briefings for site workers so that they were aware of what was required of them that day.

Health and safety training for site supervisors led to an increase in skills and awareness that was cascaded down among the rest of the workforce.

Behavioural health and safety training for site workers – this helped change the culture.

Near-miss reporting also helped in changing the culture once workers realised that it was acceptable to raise issues, and they would not be considered as trouble makers for doing so.

Comparing the London 2012 construction programme with the wider construction industry in Great Britain

Approach

Comparison between the implementation of CDM on the London 2012 construction programme and that in the wider construction industry in Great Britain (GB) has been undertaken by comparing the results from this study with those obtained from recent research with the construction industry. Workshops have been held with participants who work in a range of roles within the construction industry where participants weighted the importance and quality of 39 Influence Network factors (see Figure 1) influencing health and safety.

Neither the GB construction industry workshops nor the London 2012 construction programme workshop are truly representative of either the construction industry in Great Britain or the London 2012 construction programme due to the small number of participants. However, we could examine the findings to identify broad trends and identify common themes and differences.

Workers lifting the Velodrome roof into place

The Influence Network uses the typical factors that influence risk, based on research and industrial experience.

The Influence Network

The Influence Network allows workshop participants to have a structured discussion about a range of possible factors that may or may not influence health and safety in construction. It provides a framework from which to assess the impact of CDM on health and safety on construction sites.

The Influence Network uses the typical factors that influence risk based on research and industrial experience.

The technique has been used in over 30 workshops for HSE, other regulators and companies in a range of sectors, for example, to investigate work at height and the implementation of CDM. Further information on the Influence Network technique is available in HSE Research Reports (for example, HSE Research Report 235: Improving health and safety in construction Volume 6 – Generic model for health and safety in construction[1]). Figure 1 shows the Influence Network model used in this comparison.

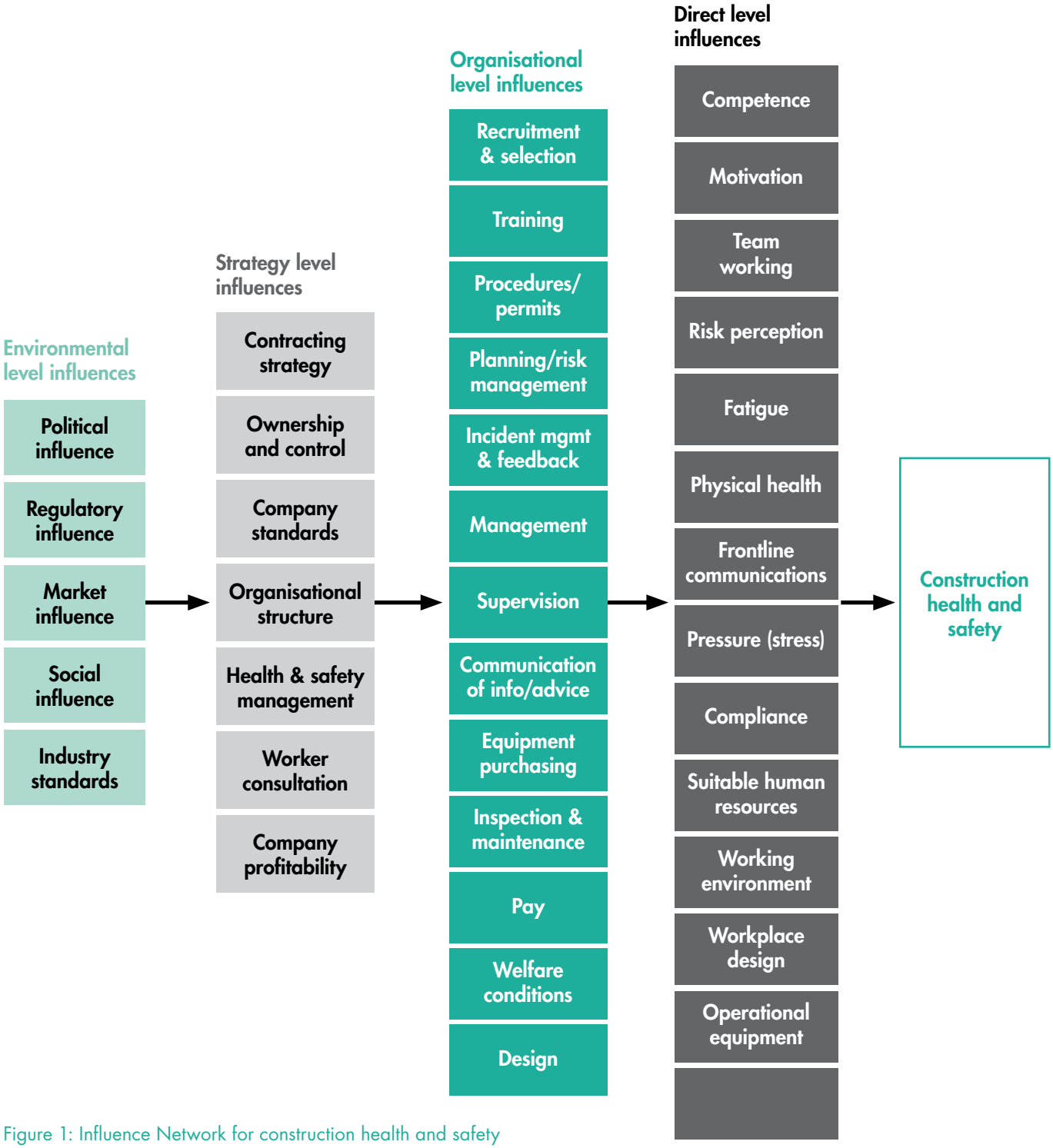

Figure 1: Influence Network for construction health and safety

The quality ratings were significantly higher for the London 2012 construction programme than the GB construction industry as a whole.

Relative quality of individual factors

The ratings provided by participants for 27 factors were significantly higher for the London 2012 construction programme than the GB construction industry as a whole. In this case, 'significantly higher' is assumed to be where the mean ratings are at least two higher. This indicates that on average:

Direct level

There are **sufficient** suitable workers on the London 2012 construction programme, and those workers are more **competent**, work better in **teams**, are in better **health**, have better **front-line communications**, operate under less **pressure**, and are more **compliant**; they also have access to better **safety equipment/ personal protective equipment**.

Organisational level

Organisations on the London 2012 construction programme: have better **recruitment and selection** methods; provide better **training**; have more effective **procedures/permits, planning/risk assessment and incident management/feedback**; have better **management** and **supervision** and provide better **welfare conditions; design** is also of higher quality.

Strategy level

Organisations on the London 2012 construction programme: have a better **contracting strategy**, provide better **ownership and control**; have more effective **health and safety management**; undertake better **worker consultation**; and have better **company profitability**.

Environmental level

Organisations on the London 2012 construction programme are benefiting from higher ratings in all five influences; in particular, the **political** and **regulatory** influences have much higher ratings, perhaps reflecting the significant political and regulatory interests shown in such a high profile programme; also, the **market** influence is better as the organisations working on the London 2012 construction programme have been 'protected', to some extent, from the effects of the economic downturn elsewhere in the construction industry.

Variability in the quality of factors

At the workshop on the London 2012 construction programme, the participants assigned high scores (implying high quality) to many of the factors influencing health and safety.

It was noticeable that where the factors could be controlled by organisations in the London 2012 construction programme, the factor ratings were very high with little variability (for example, **training** and **compliance**). However, where control was less easy, there was greater variability (for example, **risk perception**).

Importance of individual factors

The most significant factors at each level of the Influence Network were identified for both the GB construction industry workshops and the London 2012 construction programme workshop. The findings at each level were:

Direct level

Two of the five factors (**competence** and **front-line communications**) are common between the GB construction industry and the London 2012 construction programme workshops. **Motivation** and **compliance** were considered more significant factors in the London 2012 construction programme than **team working, risk perception and pressure/stress** in the GB construction industry. The importance of **compliance** in the London 2012 construction programme workshop possibly reflects the highly controlled and organised approach taken on the Olympic Park site. The importance of **pressure/stress** in the GB construction industry workshops possibly reflects the pressure of the current economic downturn on working hours, deadlines and resources.

Organisational level

All five factors (**management, supervision, training, planning/risk assessment and communication of information/advice**) are common between the GB construction industry and the London 2012 construction programme workshops.

A range of lessons is applicable elsewhere in the construction industry, and many relate to the way of working rather than extra expenditure.

Strategy level

Company standards was the only common factor between the GB construction industry and the London 2012 construction programme workshops. **Company profitability** being the most significant factor in the GB construction industry workshops possibly reflects the influence of the economic downturn. In the London 2012 construction programme workshop, the importance of formal **health and safety management systems** and **worker engagement** were stressed.

Environmental level

Regulatory and **market** influence are the two key factors in the London 2012 construction programme.

Lessons for the wider construction industry

While it was recognised that some of the lessons learned on the London 2012 construction programme would only be applicable to other large programmes, the following lessons were highlighted as being transferable to other construction projects:

Clients taking the leadership role – this sets the tone for how health and safety (and other issues) will be addressed.

Sharing knowledge among senior staff in different organisations – this would learn from the SHELT forum and allow senior staff to share knowledge and address issues.

Worker engagement – it was pointed out that engagement incurs little cost, but helps to motivate the workforce and get key messages across. These messages can be relatively simple as shown by the following comment:

'Do you feel safe on site?' was a key driver. (Interview with project sponsor)

Behavioural health and safety initiatives – to make people responsible for their own health and safety, and the health and safety of others.

Allowing and encouraging workers to report 'unsafe' activities – this sends the message to workers that their views on health and safety are both sought and taken seriously.

The need to integrate early and often – the best solutions (in terms of buildability, cost and programme as well as health and safety) often came from organisations working together; by appointing CDM coordinators and contractors early, advantages can be gained from identifying risks early and using contractors' experience.

Sharing office facilities – to encourage coordination and cooperation; it also ensures that issues are resolved quickly as the right person is available to talk with.

Focus on getting the right competences – the levels of competence required of all staff on the London 2012 construction programme were set high.

It is interesting to note that many of these lessons relate to the way of working as opposed to spending extra money to get results. While there may be a temptation to think 'they had the money to get it right on the Olympics', many of the lessons identified do not necessarily require significant expenditure but the adoption of a culture and way of working that are more integrated and compatible with CDM (and also managing environmental, technical, financial and programme risks). The comment below shows how culture interacts with regulations:

'If you have the right culture then you do not need the regulations to such an extent.' (Interview with principal contractor)

While one of the objectives of the learning legacy work is to transfer the lessons of the London 2012 construction programme to other construction projects, a key mechanism for doing this will be via the large numbers of people who have worked on the sites, received training and experienced the way of working. Suggestions were made that this could amount to over 30,000 people who will take the lessons elsewhere.

Reference

1 Bomel (2004) HSE Research Report 235: Improving health and safety in construction phase 2 – depth and breadth. [Online] Health and Safety Executive. Available from: www.hse.gov.uk/research/rrhtm/rr235.htm (accessed 29 September 2011).

Peer reviewers

– Geoff Lloyd, HSE, Construction Policy Unit
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Related research

This research summary is part of a suite of research projects and independent evaluations undertaken on Health and Safety on the London 2012 construction programme comprising:

– Leadership and worker involvement
– Site communications and other health and safety Initiatives
– CDM 2007 Regulations: duty holder roles and impact
– Safety climate tool and measuring site culture
– Health and Safety in the supply chain
– Occupational health programme provision on the Olympic Park and Athletes' Village
– Food safety and sustainability
– Preconditioning for success

All the research papers should be read in conjunction with the paper below which provides an overview of health and safety on the London 2012 construction programme:

– Delivering health and safety on the development of the London 2012 Olympic Park and Athletes' Village.

Full research papers will be published by the authors at a later date.

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