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A case study of machinery maintenance protocols and procedures within the UK utilities sector

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Dedicated to Mrs. June Edwards, a lady of great distinction who preserved the health and dignity of others for many years. A loving mother and grandmother, without whose help, this work and many achievements would not have been possible.

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ABSTRACT

Failure to conduct periodic fixed-time-to (or scheduled) maintenance on off-highway plant and equipment represents a significant health and safety hazard and major litigation risk for utility contractors completing service excavation and reinstatement works on public highways. Mini-excavators are a ubiquitous mobile plant item used for such tasks and have recently been responsible for several major injuries and fatalities involving workers and members of the public in the United Kingdom (UK). The research utilises the method of triangulation to examine the maintenance practices of utility contractors in the UK. Findings from the research reveal that a combination of prevailing market forces and internal 'company' pressures have inadvertently removed knowledgeable and trained operators, site foremen and managerial supervisors from hands-on maintenance inspections. Rather, 'virtual' maintenance protocols and procedures are adopted by head office but rarely fully implemented on-site. The research concludes with pragmatic recommendations and direction for future research.

1. Introduction

A typical machine used for the excavation and reinstatement of utility services is the mini- (or compact) excavator (Edwards and Holt, 2011), which has often been referred to as the industry's Swiss Army Knife, given its inherent versatility in design and application. These machines can be used for materials handling, concrete crushing, demolition and compaction, in addition to excavation works (Salcudean et al., 1997; BSI, 2006). Unfortunately, in recent years, an increasing number of incidents have occurred involving mini-excavators, including: inadvertent activation of machinery controls (Fox, 2014); instability (Edwards and Holt, 2011); hitch detachment (OPERC, 2008a); inadequate visibility leading to struck-by and/or crushing (Edwards et al., 2004; HSE, 2009); load detachment or struck-by during lifting operations (HSE, 2014a); and service strikes (HSE, 2014b). These incidents present a significant health, safety and litigation risk and often machine maintenance is a contributory factor.

Despite their popularity, research into mini-excavator safe operation and maintenance in practice remains scant (Edwards and Holt, 2014). Rather, most research that has been conducted tends to focus upon engineering design, operation simulation or ergonomic design and operator comfort. For example, Budny et al. (2003) investigated the control of excavation processes by applying load-independent hydraulic valves. Karlinski et al. (2008) examined the passive safety of operators and the protective structures inherent with machinery design. Wallace and Cheung (2013) evaluated a dust suppression system fitted onto the machine for controlling environmental pollution in demolition and construction operations. Ha et al. (2000) developed a robotic application for bucket digging trajectory whilst Smith (1999) and Smith et al. (1999) developed models for productivity and earth moving performance measurement.

Given the paucity of practice-based research conducted hitherto, and the aforementioned rise in incidents, this research aims to investigate the machinery maintenance protocols and procedures

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being used by utility contractors for their mini-excavators on site. Specific objectives include to:

- determine current deficiencies in on-site maintenance practice and procedure;
- provide recommendations for mitigating risks that could result in injuries or accidents; and
- recommend future research that is required to ensure safe working practices when operating and maintaining plant and equipment.

As there has been limited research to examine risk mitigation for machinery within construction, a research approach that is able to systemically accrue multiple viewpoints is required to obtain a balanced understanding of their occurrence.

2. The UK utilities sector

The utilities sector (electricity, gas, telecommunications and water) provides vital services that facilitate economic and social development, and are a prerequisite for eradicating poverty (ILO, 2009). Within the United Kingdom (UK), various statutory instruments ensure a continuance of reliable, universal access to utilities within a competitive market; these include: the Energy Act, 2013 (HMSO, 2013); the Fuel Poverty (England) Regulations, 2014 (HMSO, 2014); and the Utilities Act, 2000 (HMSO, 2000). However, a report by the regulator 'The Office of Gas and Electricity Markets' (Ofgem) and the Office of Fair Trading (Ofgem, 2014) found that amidst the public's growing distrust of the six largest utility companies, suppliers' profits were increasing despite no evidence of them attempting to reduce their own costs or improve customer experience. As competition was not working as it should, Ofgem applied for a referral to the Competition and Markets Authority (CMA) (CMA, 2014). Some utility companies have already begun to respond to, for example, Ofwat's PR14 business plan (Ofwat, 2014), by reducing wholesale and retail expenditure through measures such as voluntary redundancies (Welsh Water, 2014).

The prevailing government's National Infrastructure Plan sets out an ambitious £100 billion (UK sterling) investment in infrastructure to ensure a continuance of economic growth (UK Trade and Investment, 2014). Such investment has created significant opportunities for both the maintenance of existing services and additional improvements, which include new services, and stimulated employment opportunities (despite efficiency gains sought). Works are undertaken either by the utility company directly, by a contractor(s) or a partnership between them and other members of their supply chain (including plant hirers). Automation is a predominant feature of utility works because it can augment productivity performance (Edwards et al., 2003) and meet efficiency gains sought by government. However, despite the abundance of forthcoming contract work, there is a growing perception amongst professional contractors and hirers within industry that machinery is being used irresponsibly and maintained inadequately in order to drive down productivity costs and meet insatiable utility company demands for profits. This economic-political backdrop, combined with anecdotal practitioner evidence, affords further justification for this research.

3. Research method

Triangulation is an approach that accommodates both qualitative and quantitative methods of inquiry, thus enabling a stronger research design to be accrued, together with more comprehensive research findings. The triangulated approach adopted for this research relied upon the use of interviews, documented sources, focus groups and on-site observations. The four collaborating utility contractors sought research via an independent academic institution that would suitably isolate the investigation from inter-organisational and inter-departmental influences (i.e. health and safety, production and so on). Anticipated benefits included the generation of an impartial account of current practices and the development of guidance to improve practice, thus yielding maximum impact.

3.1. Data collection

Data was collected predominantly through interviews, video footage and images taken using a Canon EOS550D camera; additional hand written notes were also taken to record impromptu meetings or telephone calls. Previous research (Edwards and Holt, 2014) has shown that audio-visual records of maintenance experiences on-site provide an elaborate account of contemporary practices through the exploration of worker experiences and additional interrogation of the images recorded. They also afford sponsoring organisations the opportunity to learn from everyday experiences of workers and site managers.

3.2. Operational approach

The operational approach adopted for this research encompassed three core stages: (1) pilot work; (2) a stakeholder focus group; and (3) on-site machinery inspections (Fig. 1).

Pilot work was sub-divided into three activities. First, formal meetings held with sponsoring utility contractors sought to clearly define the research scope and agree formal contractual terms and conditions. Second, a random sample of workshop based fixed-time-to (or scheduled) maintenance (typically 250, 500 and 1000 h service) and daily maintenance records were inspected. Scrutinising these records allowed a clear understanding of maintenance procedures and practice to be developed. Third, unstructured interviews with stakeholders sought to ascertain the validity and reliability of the research tools, and also to identify any practical problems faced by the research team (Cholasuke et al., 2004). Typical questions posed sought to elicit information on the types of faults found and common reasons for these. Key stakeholders included self-nominated representatives from the utility contractors (4 no.) and members of their supply chain, e.g. plant hirers (4 no.), sub-contractors with owned plant (30 no.) and original equipment manufacturers (OEMs) (5 no.). A stakeholder focus group held at circa twelve monthly intervals, presented members of the group with an opportunity to review progress and inspection reports, and provided invaluable feedback and additional research direction. The on-site machinery inspections extended over a three-year period (2013–2015), during which machinery inspections and accompanying site visits were completed in 10 major UK cities and their surrounding suburbs. In total, 289 (no.) machines were inspected during this period.

4. Pilot study

Initial meetings with utility contractors revealed that they had recorded a number of major incidents involving mini-excavators (weighing ≤3 ton) in recent years. These incidents had led to concerns about corporate reputational damage, an elevated risk of litigation and importantly, the prevention of fatality involving workers and/or members of the public. The research scope therefore focused upon ≤3 ton mini-excavator machines working on utility excavation and road/pavement reinstatement activities on public highways. These machines use a variety of attachments, including buckets and impact hammers, supplied by high-pressure hydraulic lines connected to the implementation circuit and