A Framework for Product Recall in the Construction Industry

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Abstract

The independent review into the UK Building Regulations and fire safety following the Grenfell Tower tragedy in 2017 highlighted significant failings in traceability of construction products used in the UK, noting that the construction industry is "significantly lagging behind many other sectors" in this respect. One of the key drivers behind the need for traceability is to support product recall, such as might be required in the event of the discovery of issues in product manufacturing, testing or as a result of inappropriate product specification or substitution.

This study investigates the need and benefits for a robust product recall system for the construction industry, develops a set of requirements for such a system, and proposes a framework for its implementation. The current state of the art for construction product recall is examined and compared to industries such as automotive and food where effective recall systems have been in place for a number of years. The particular requirements for traceability of products in the construction sector are defined and discussed. The framework for a construction product recall system was developed through a series of collaborative workshops with experts from industry and academia. This paper describes the framework and discusses the challenges facing its implementation. In particular, the paper discusses and compares in detail two approaches for product recall alerting; push and pull mechanisms. The paper concludes with the identification of areas for further investigation.

Keywords: traceability, construction products, product recall, Hackitt review, digital record.

1. Introduction

The Independent Review of Building Regulations, led by Dame Judith Hackitt following the Grenfell Tower tragedy, identified deep flaws in the UK regulatory system and determined that it was not fit for purpose (Hackitt, 2018). The review identified several areas where the construction industry lags behind others, and in particular emphasised the need for significant improvements to product testing, labelling and traceability, and implementation of a more effective product recall system.

Consumers are familiar with recall of products including high profile examples in the automotive, foodstuffs and consumer goods markets (Ahsan & Gunawan, 2018), (BBC, 2016). Given the potential impact of unsafe or faulty construction products it is, therefore, important to establish how the recall process for the industry can be enhanced to reduce risks to building occupants. This research explores the need for a recall system for construction products and reviews the current approaches employed in the industry. Recall systems in other sectors such as food and drink and automotive are reviewed and criteria for improving recall are established. A series of workshops were held with industry and academic experts from a range of different fields and product recall was identified as a key use case among the 63 that were identified in relation to the broader field of traceability and the digital record recommended in the Hackitt Review. The product recall use case was developed in detail and used as the basis on which to develop proposals for implementing an improved product recall system in the construction industry.

Section 2 discusses the need for product recall in the construction industry; section 3 reviews the current approach to product recall in the industry; section 4 presents the workshops and their outcomes; section 5 outlines the aims and requirements for an optimum product recall system for the construction industry drawing on learning from other industries; and sections 6 provides discussion, conclusions and next steps for the research.

2. The need for product recall in the construction industry

The principle reason for product recall in the construction industry is to protect people from the risks created when unsafe products are incorporated into buildings. An effective system can facilitate a timely and effective response to an issue in line with the definition in the Code of Practice for consumer product recalls, PAS 7100: 2018 (Department for Business Energy and Industrial Strategy, 2018).

Industries such as automotive, food and drink and consumer products have implemented legislation and systems for product recall to address some high-profile issues related to safety and quality. The main causes of product recall are safety and quality issues (Eilert, Jayachandran, Kalaignanam, & Swartz, 2017) which may be caused by failures in good manufacturing practice, incorrect labelling and packaging and the identification of conditions that can compromise safety such as contamination (Dabbene, Gay, & Tortia, 2014). Failures in design, problems with the material and unanticipated use (or misuse) are also identified as causes justifying product recall (Eilert et al., 2017). Berman (1999) also identified that new scientific information about the dangers from a product or material previously thought safe and failure to comply with safety standards as reasons for product recall(Berman, 1999)(Berman, 1999)(Berman, 1999)(Berman, 1999)(Berman, 1999)(Berman, 1999).

All of the above issues could potentially apply to construction products, creating risks that a recall system could mitigate. Examining literature and published recall notices there is existing evidence of the need for a product recall in the construction industry. For example, in her review of Building Regulations and Fire Safety following the Grenfell Tower tragedy, Dame Judith Hackitt noted cases of fire doors being marketed as fire resistant to 30 mins failing retesting and the issues with the aluminium composite material (ACM) in cladding used on many buildings including Grenfell Tower (Hackitt, 2018).

Examples of construction product related recalls identified on the OECD global product recall portal (OECD, 2019) include counterfeit products (including counterfeit fire resistant glazing), and products which did not meet the claimed fire resistance (class D against claimed class B). The portal contains a total of 231 product recall notices classified as building products (about 1% of the total 22,512 notices).

In Europe the rapid alert system for non-food consumer products, Rapex, covers consumer products that pose a serious risk to consumers. It aims to facilitate rapid exchange of information between member states about dangerous products and in 2018, more than 2250 alerts were raised. In May 2019, the Rapex system included a total of 107 notifications for construction products from 20 different countries (European commission, 2019).

Product safety is a significant potential issue in the construction industry. To reduce risks, construction products are tested and certified and under EU legislation and products requiring a CE mark must have a declaration of performance from the manufacturer (European Commission, 2019b). However, despite the safety and testing legislation and evident risks posed by unsafe products, there is currently no UK legislation for product recall in the construction sector.

3. Current approaches to product recall in the construction industry

In the absence of legislation for product recall in the construction industry there is no single, established system to support it. Some products may fall under the regulations aimed at protecting consumers, such as the UK General Product Safety Regulations 2005 that sets the requirements for products to be safe and conform with relevant standards. This legislation covers products that are “intended for consumers or likely…to be used by consumers” (The General Product Safety Regulations, 2005) and includes provision for an enforcement authority to serve a recall notice on a manufacturer where they have reasonable grounds to believe that a dangerous product has been supplied to consumers.

The construction industry relies on publicising recall notifications through websites such as Rapex and the OECD portal and sharing information between parties and trade associations. Electrical Safety First lists 12 construction product recalls on its website (Electrical Safety First, 2019). Bodies such as local trading standards offices may also issue product recall information (Chartered Trading Standards Institute, 2019) and the UK Association of Fire Investigators (UK Association of Fire Investigators, 2019). The construction industry shares some information about product recalls, for example through the Department of Health Estates and Facilities Alerts (Department of Health, 2019) and attendees at the research workshop noted that construction product manufacturers share technical bulletins with other organisations (including competitors) in order to help publicise unsafe products.

It is clear that there is a strong case for implementing a product recall system for the construction industry. Currently, in the event of design or production problems or any of the mentioned issues that might lead to product recall, the construction industry is not well served to protect the public from dangerous products. The number of different websites used to publicise unsafe products may cause confusion, and the current approach relies on building owners, managers, contractors and others in the industry proactively checking the published recall information. It also relies on these parties to have knowledge or accurate records to establish whether the effected product is in their building and then taking appropriate action.

4. Workshops

A series of 3 workshops were held with industry and academic experts to explore the requirements and develop proposals for a framework for a digital record that would support product traceability in the construction industry (Watson, Kassem, & Li, 2019). The first two workshops identified 63 use-cases that supported the need for establishing a traceability system; among these, product recall was identified as a key use-case for the industry that could be supported by a digital record. A definition of and a framework for the digital record are proposed in (Watson et al., 2019). A further workshop was held to examine this use-case in detail and to develop proposals for a product recall system.

Table 1: Sample of use-cases identified that could be supported by a Digital Record

	New buildings	**Existing buildings**
Design	• Brief from client to architect • Approved party to appointing party: submittals/approvals • Authority: manage inspections and issues relating to legislation	• Product used in building recalled • Designer: obtain as-built record of compliance • Surveyor to owner: condition survey of physical building
Construction	• Contractor: record installation, commissioning and variations • Ensuring site manager is receiving products on site in line with latest specifications • Change request from designer to contractor	• Contractor: safety during refit • Record original as-built specifications and condition • Re-roofing or roofing repairs
In-use	• Contractors: establishing suitability of replacement “parts” • Owner /contractor: usage changes or adaptation • Legislation changes	• Improved facilities management, proactive vs reactive • Owner: gain a “digital twin” for operations e.g. IoT, monitoring, bookings, route finder • Owner sells building

The use case addressed the recall of a dangerous gas boiler or a component within the boiler, and was considered in detail against a series of headings. The detailed use-case is shown in table 2.

The workshop participants considered the requirements and components of a traceability framework to facilitate product recall. Key aspects identified included: the need for unique identifiers for product types, assemblies, spaces and buildings; support for hierarchical (composition/decomposition) relationships between products; and supply chain information transfer and recording between parties. The workshops concluded that a digital record is essential to facilitate the traceability required for effective product recall.

Table 2: Use case for product recall

Title	Manage a product recall – a dangerous gas boiler or component within the boiler
Description	A serious fault is found in an installed product. The cause of the problem needs to be identified (design, installation, maintenance, product/component, process etc.) and immediate action needs to be taken to recall the affected products to mitigate the risks to personal safety.
Objective(s) Purpose for which the information is used	• Identify the duty-holders with risks • Manage and oversee the remediation of risk • Maintain data on corrective actions taken • Manage incidents
Stakeholders	• Duty-holders • Suppliers • Manufacturers • Joint Competent Authority • Occupants • Installer • Contractors
Information required and when required	• Number of products affected (e.g boilers) • Location of products (buildings, spaces etc.) • Products not yet sold • Parties to be contacted • Components ready to build the next product batch • Products already fixed/repaired (and which ones) • Products already scrapped (and which ones) • Product installer, installation method and approver
Sources of Information Sources of the required information. When created and by who? How is the information maintained?	• Suppliers' sales and ERP systems • Warrantee information • Retailers' and suppliers' records • Maintainers' records • Commissioning records • Common Data Environment (CDE) records • Design information • Building models (as built) • Handover data (COBie) • CAFM systems • FM tools • Asset registers
Information created / amended New information created or captured at this stage. How is this information maintained and by who?	• Records of what replaced • Disposal records • Incident records • Buildings/sites affected • Communication records • Remediation records • New asset information • People (installers) • New standards adhered to • Information created by repaired/owner/supplier/manufacturer

Future use cases How information created is used in future use cases	• Future occurrences of the issue • Service • Repair • Performance monitoring • Tennant information for use and operation
Security/Privacy considerations	• IoT presents a potential issue • Personal identifiable information, e.g owners, maintainers, legal entity
Access rights	• The appropriate party can access the appropriate data for the appropriate role
Benefits of digital record	• Digital Record provides the basis of traceability required • Transparency • Ability to query data • Time of response • Quantification of issue (e.g number of products affected) and certainty of action
Key challenges	• Transfer of ownership of the problem. • Define via dutyholders • Information veracity • Scope – defining what issues require recall • Openness and transparency vs security and privacy • Government defined and implemented solution

5. Aims and requirements of a construction product recall system

The principle aim for a product recall system is to protect people and buildings from unsafe products by facilitating a timely and effective response to an issue (Department for Business Energy and Industrial Strategy, 2018). The effectiveness of a product recall system can be attributed to four measures: i) the response rate, measured as the percentage of the total number of products affected that are recalled; ii) the accuracy of the recall – i.e. the degree to which only unsafe products are recalled rather than a larger recall that may include safe products (Dai, Tseng, & Zipkin, 2015) ; iii) the length of time taken to recall the maximum possible number of products; and iv) the cost of implementing the recall process (Ahsan & Gunawan, 2018) (excluding the costs of transportation, repair or disposal of unsafe products as these are particular to the nature of the product and safety issue).

Figures for recall effectiveness vary considerably. Response rates for product recalls are claimed to be in the region of 10-20% for electrical products in the UK (Electrical Safety First, 2019). Crumbly and Carter (2015) cite effectiveness of 40% for recall in the telecommunications industry, whereas response rates for vehicle recalls in the UK can be as high as 100% (Driver and Vehicle Standards Agency, 2018). The key difference in response rates is that vehicles are registered, enabling the registered keeper of the vehicle can be contacted in the event of recall. Consumer products are not typically registered, and Crumbly (2015) cites the lack of ‘closed loop’ systems as a contributory factor to lower recall effectiveness. Similarly, response rates for non-registered vehicle parts (such as tyres or components) tend to be much lower (52% for components recalled between 2014 and 2016 in the UK) (Driver and Vehicle Standards Agency, 2018).

Accuracy of product recall will primarily be affected by the ability to identify the specific products that need to be recalled and target the recall at just those products. Accuracy can be supported by uniquely

identifying product types to a suitable level of granularity, recording sufficient meta-data about the product to determine whether a product has been affected by the factor causing the recall (manufacturing dates, component materials information, testing methods, testing organisation, lot or batch numbers) and having traceability mechanisms in place to establish where affected products are (so that recall requests are targeted rather than broadcast).

The speed of recall will be influenced by how quickly the location of affected products can be established and remedial activities instigated. The recall cost will be influenced by the accuracy with which products can be identified, whether location information is available and the mechanism used to contact the appropriate stakeholders; broadcast, push and pull mechanisms outlined below.

Based on the 4 measures of recall effectiveness above, the authors propose that an optimum product recall system should:

- *minimise the time and cost required to accurately trace every affected product to its location and*
- *alert the dutyholder for that location to the issue and the action(s) they should take.*

The authors consider location to include the location of a physical product in the supply chain or installed in a building and also to include the location of a digital representation of the product within the "information chain" of design and requirements data. The authors also adopt the Hackitt Review's definition of dutyholders as client, principal designer, designer, principal contractor and contractors as a minimum (Hackitt, 2018). The authors suggest that this list should be extended to include manufacturer, distributor and compliance agencies for the purposes of supporting product recall. Adopting the above definition would require a product recall system that should:

- Alert designers and compliance agencies (such as building control) to a safety issue with a product (or product type), enabling them to remove that product from current design projects avoiding time and expense later in the project.
- Alert manufacturers suppliers and distributors, to withdraw products in the supply chain from sale.
- Alert contractors in order to prevent installation of unsafe products or remove those already installed.
- Alert clients and building occupants, to take appropriate actions.

Examining the requirements for a product recall system in more detail, four components need to be in place.

First, a mechanism for uniquely identifying products is required. This should support identification of:
i) generic product types (to facilitate recall of all products of the same type, that might have been manufactured by different companies) for example all warm-air hand driers manufactured to a particular standard.
ii) product types specific to a manufacturer. To facilitate recall of a specific product type for example when issues with design or manufacturing are discovered. Company ABC, dryer model HD-123
iii) a product instance. To facilitate recall of an engineered-to-order product and to track which instances of product have been successfully recalled or modified.

Second, additional data is required about the products at each of these three levels. At instance level, manufacturing information such as batch or lot information, manufacture date should be available to facilitate targeted recall. At manufacturer type level, metadata should include testing and compliance information to support recall in the event of discovery of issues with a particular test procedure or testing facility. This information is essential for recall accuracy, so that only products affected by the issue are recalled (Wowak, Craighead, & Ketchen, 2016), (Dai et al., 2015) and at the correct level (Dai et al., 2015).

Third, a mechanism is required to establish where products are, both in the supply chain so they can be

withdrawn from sale and within buildings so they can be recalled. Within a building, this requires information linking a product component to any parent product (e.g. the internal motor to the hand dryer it is part of) then linking the parent product to the space it resides in (e.g. washroom 001) and the space to the building. This traceability information is critical to product recall in other industries enabling firms to determine the path a product has taken to reach its current location (Wowak et al., 2016).

Fourth, there needs to be a mechanism to directly alert the current owner or holder of the product to the recall. Three alerting mechanisms are identified:

i) 'broadcast' alerting. This approach is common with many current recall approaches due to the lack of mechanisms (such as registers) to link the product to a 'dutyholder' who can be contacted. Typically, broadcast alerting involves traditional advertising and social media which are the most common mechanisms through which consumers see or hear product recall information (traditional media 79.8%, online media 53.6%) (Ipsos, 2019). This option was discounted in the workshops due to the high costs, low response rates and slow performance.

ii) 'push' mechanisms. Response rates, accuracy and speed can be optimised, and recall costs reduced if alerts are directed only to dutyholders known to have one or more of the products affected. This is the mechanism employed in current vehicle recall systems, supported by vehicle identification linked to a register of current 'keepers'. For construction product recall this would require unique identification as described above together with registers of dutyholders, buildings and products within the buildings, and linking relationships to enable the dutyholder responsible for the effected product to be identified and contacted.

iii) 'pull' or 'look-up' mechanisms. An alternative approach to push alerting is for dutyholder systems to periodically check for issues by accessing recall information from a register of recalled products. An automated look-up system could offer the same improvements to response rates and accuracy as push alerts and dutyholder systems could check frequently enough to provide reasonable speed. A recalled product register could be held centrally or distributed (e.g. each manufacturer holds its own product recall information). Again, this approach relies on a system for unique identification of products. The workshop discussed the relative merits and drawbacks of both push and pull alerting.

Push alerts

The example of the automotive sector suggests that this approach can be effective, given the high recall response rates achieved for vehicles. However, this may be particular to vehicles, where owners need only register a small amount of information to enable them to be contacted and this is related to a single identified object (the vehicle) through one ID – the vehicle identification number (VIN). The manufacturer retains responsibility for managing the information about the component parts and the relationship of these to the car. As the manufacturer can theoretically record information identifying all of the component parts of every vehicle, they can push alerts out to registered keepers in the event of recall. A similar model exists for white goods and the "register my appliance" system (Association of manufacturers of domestic Appliances, 2019), but this is a partial solution as registration is voluntary so a combination of push and broadcast alerts have to be employed to improve response rates.

Adoption of this model for the construction industry would require registering all products. Registration could be held centrally (as with vehicles) or with the responsible manufacturer. Product registration could be the responsibility of the contractor at handover, or the building owner, but this will very likely represent a significant administrative burden unless automated through tagging of products (i.e. radio frequency identification) and scanning at the point of installation.

Such a system would require registers of products, assemblies, spaces, buildings and owners, facilitated through unique ID systems for each. Relationships recorded against these IDs could be used to establish which products are contained in which spaces of buildings and who the building owner is. Product attributes can be stored against both product type and instance.

The workshops identified a number of issues with this approach. If product manufactures are responsible for maintaining the product registers, mechanisms would need to be put in place to transfer the register to another body in the event of a manufacturer ceasing to trade. The alternative is to have centrally held registers, independent of the manufacturers. Long-term maintenance of data currency (required due to the lifespan of most buildings) is also a significant issue. Buildings are adapted and products are frequently maintained, repaired and replaced in buildings and to maintain accurate product registers would require building owners to update the registers by sending information about all changes to the register keepers, which is also a significant burden. Workshop participants considered data security as a potential issue for central registers that recorded the component products in all buildings and the sheer scale of information storage requirements is likely to present a significant challenge.

Pull mechanisms

A framework to support pull notification of recall was also considered. Workshop participants noted that many building owners will already have CAFM or other management systems that record information about the products within a building. The Hackitt Review also recommends that owners, as dutyholders, should be required to maintain accurate digital records of a building. A framework could employ a central product database to store information about recalled products with unique identifiers (UIDs) associated with all product types. Assigning the same product type UIDs in dutyholders' digital record systems would support recall systems 'polling' (making a regular query of) the central product database for recall updates on a regular basis.

This approach requires manufacturers to register product types with the database. The database could potentially be developed as an extension of the CE marking system that operates in Europe (European Commission, 2019a), to create a national product database (NPD). Issues potentially leading to a product recall could be raised with a manufacturer or the body responsible for the (NPD). A UID associated with a product supports backwards traceability to identify the manufacturer. If determined necessary, a recall is initiated by flagging the product type in the NPD. Dutyholders would be alerted if affected products are identified within their digital record when it next polls the NPD. This approach provides clear lines of responsibility and data ownership in line with Hackitt Review recommendations for dutyholder responsibilities. Dutyholders have long-term responsibility to maintain their digital record data, and this is managed within their systems rather than external registers. Manufacturers ceasing to trade remains an issue with this model, but the body responsible for maintaining the national product database could continue to provide a mechanism for raising recall alerts.

6. Discussion and Conclusions

The importance of an effective systems of product recall in the construction industry is identified in the Hackitt Review and reinforced by analysis of the published construction product recall notices (Hackitt, 2018) (OECD, 2019). Despite the evident risks that unsafe construction products raise, the current system is not optimised and relies on an ad-hoc mixture of technical bulletins and posting alerts on several product recall websites, many of which are aimed at consumers rather than trade or professional users. Studies have demonstrated the ineffectiveness of broadcast alert systems (Crumbly & Carter, 2015) in terms of response rates, accuracy, speed and cost. More effective recall systems such as for vehicles (Driver and Vehicle Standards Agency, 2018) employ mechanisms that record a link between the product and the registered keeper.

The researchers explored how such links could be created and maintained for construction products in order to support and optimise product recall systems. Through workshops with industry and academic experts, two models evolved. Both approaches rely on establishing an effective system of unique IDs for construction products, and locations (including spaces and buildings). The first model considered a series of registers for products, spaces, buildings and stakeholders linked via the UID system to support 'push' notifications of recall information. The second model was based around the development of a National Product Database that could be 'polled' by dutyholders' systems for information periodically or at specific events to check for recalls. Either system would be a substantial undertaking for the

construction industry and require agreement on a set of standards to include UID system and corresponding digital and physical identifiers (i.e. bar codes or RFID), product classification and the mandatory attribute data to be stored. However, existing technologies and research have strong potential to form the basis of such a system. The UID system could be based on the GS1 Global Trade Item Number (GTIN) (GS1, 2019) or research into unique product identifiers (UK Research and Innovation, 2015) and the construction industry has a comprehensive classification scheme, Uniclass 2015 (NBS, 2019a). Mandatory product attribute data could draw on the COBie standard (British Standards Institute, 2014), the product data templates within the NBS BIM toolkit (NBS, 2019b) and CE marking data.

With a NPD the need to trace ownership through supply, construction and in-use chains is reduced as long as the digital record systems employed by each dutyholder are linked to the NPD via UIDs to request updates/alerts. The responsibility for awareness of product safety is altered and becomes one stakeholder checking (via automated mechanisms) rather than the current ad hoc broadcast mechanisms. A NPD can support notification of a product issue to any linked system, thus supporting alerts to all dutyholders and at all stages of a project lifecycle. For example, a designer could check the products within a BIM model against the NPD alerts at key stages in the design process. Compliance checking could also include processes to check products against the recall information in the NDP.

Workshop delegates favoured the pull-alert approach as providing clear lines of responsibility, aligning responsibility for data maintenance of the digital record with asset ownership and controlling access to the digital record for security and privacy purposes.

Other benefits for a central NPD are also identified including: the ability to update (pull) other information (new operating or maintenance instructions for example) from the NPD, potential benefit to the supply chain of common product-type information improving communication effectiveness; reducing unauthorised product substitution and use of counterfeit products as noted in a New Zealand feasibility study (Dowdell, Page, & Curtis, 2017).

Further research will review NPD in other sectors and explore the feasibility and wider benefits of this approach in more detail. The proposals for product recall systems identified in this study will be evaluated against the other use-cases identified for the digital record and traceability, in order to establish whether they provide support for wider requirements beyond product recall.

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