A SYSTEMATIC REVIEW OF TAGGING AS A METHOD TO REDUCE THEFT IN RETAIL ENVIRONMENTS

Review Protocol

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1. ABSTRACT

This document provides the background to and reasons for undertaking a systematic review of the evidence concerning tagging as a method of reducing theft in retail environments. Tagging is taken here to refer to the attachment of a security device (whether magnetic, electronic or ink) to merchandise for the purposes of theft or loss reduction, whether perpetrated by customers or employees. Retail environments are defined as physical spaces that are open to the public where merchandise is sold. The theft or loss of merchandise in the supply chain or from online or Internet retailers will not be included in this review. This protocol outlines the questions that the review hopes to answer and the methods through which relevant studies will be identified, appraised and synthesised. Inspired by EMMIE (Johnson, Tilley and Bowers, 2015) and following recent developments in crime science (Sidebottom *et al.* 2015) and medicine (Kastner *et al.* 2015; Meads *et al.* 2014), our aim is to combine two approaches to systematic review: meta-analysis to assess the evidence on whether tagging has been found to be effective as a method of reducing theft in retail environments; and realist synthesis to explore how, in what form(s), and under what conditions tagging has been found to be effective, ineffective and to produce unintended negative effects. Information on the costs and implementation of tags in retail environments will also be synthesised.

2. THE PROBLEM OF THEFT IN RETAIL ENVIRONMENTS

Pity the plight of the retailer. Competition for market share is fierce and unforgiving. Failure to sell sufficient items at a suitable price is a leading cause of bankruptcy and closure. Competition typically demands efforts to promote items in a bid to attract and retain customers, be that in the form of campaigns, advertisements or product placement. Yet efforts to encourage legitimate customers can likewise encourage those with illegitimate intentions (Cohen and Felson, 1979), as well as create and expand stolen goods markets (Sutton, 1998). Retail theft is thus often a by-product of otherwise sensible attempts to increase customer patronage.

It is easy to see how certain retail environments are criminogenic. The items they stock are often easily accessible and highly desirable. Stores might be designed in a way that is conducive to theft, as when surveillance opportunities are limited. Place management

practices might be poor, as when in-store CCTV footage is seldom monitored. The system by which merchandise is procured, distributed and stored might hinder disappearances from being identified in a timely fashion or offenders detected. And from the offenders' perspective, there is a repertoire of plausible excuses that can be invoked if caught in possession of unpaid for items (i.e. *I forgot to pay for the item*).

Theft in retail environments can include theft by employees and theft by customers (i.e. shoplifting). Although employee theft is 'estimated to account for 40% or more of inventory loss' (Hollinger and Davis 2006: 206), the majority of retailers tend to focus their preventive efforts on theft by customers. Retail items are stolen for different reasons and by different groups of offenders (Clarke and Petrossian, 2012). Items might be taken for personal enjoyment, to sell for profit or to facilitate further crimes (an example of a *crime multiplier*) such as drug abuse (see Smith and Clarke, 2014). As Nelson and Perrone (2000) write, 'The unique aspect differentiating shop theft from other forms of theft is a contextual one: the crime is perpetrated against stores and it occurs during operational hours'.

Retailers often subsume theft under the broader category of 'shrinkage', which denotes products lost due to theft, error or wastage. Loss prevention is core business for retailers. According to the *Global Retail Theft Barometer* (2011), which computes the cost of retail crime in 43 countries, losses attributed to crimes by customers, employees and suppliers was estimated at $119 billion in 2011, an increase of 6.6% since 2010. In the UK alone it was $7.8 billion. Shoplifting was estimated to be responsible for over 40% of those losses. Internationally, spending on security and loss prevention was estimated at $28 billion per year, amounting to 0.3-0.4% of retail sales. Some retailers are clearly better placed than others to deal with the costs of victimization; many even tolerate low levels of shrinkage as an expected cost of doing business (Clarke and Petrossian, 2012). For smaller businesses, however, the costs of theft and associated preventive measures can be crippling. Kuratko *et al.* (2000) estimate that employee theft accounts for nearly a third of all small business failures. Moreover, the effects of theft ultimately fall on the consumer in the form of unavailable products and elevated prices, what Bamfield and Hollinger (1996) refer to as a 'crime tax'.

Accurately estimating the extent of retail theft is challenging. Farrington *et al.* (1993) describe how missing items are usually detected through after-the-event stock audits, at

which point it is difficult to determine the proportion of disappearances attributed to customer theft, staff theft or legitimate reasons such as sales errors or merchandise misplacement. Evaluation studies have similarly noted that where theft reductions are observed, this may be due to successful prevention interventions or because staff are aware that losses are being more closely monitored during that period (such as by extra or even daily stock takes - which may also comprise a protective intervention) so the risk of being caught is much higher (e.g. Farrington *et al*. 1993). For this reason, many evaluation studies of theft reduction schemes in retail environments use the broader term 'loss' to indicate missing merchandise.

Police detection rates are also stubbornly low. Clarke and Petrossian (2012) suggest only one in 150 incidents of shoplifting result in an offender being arrested. Earlier estimates by Buckle and Farrington (1984) put this figure as low as one in 1,000 shoplifters being apprehended. In other studies, interviews have been conducted with active or previous shoplifters to gauge self-reported levels of offending. Acknowledging the possibility of dishonest and inaccurate offender responses (Hayes and Cardone, 2006), one sample of 17 shoplifters admitted to stealing an average of 200 times per year, with four of this sample admitting to never having been caught despite a cumulative 40 years of shoplifting experience (Gill, 2007).

For employee theft in particular, an early large scale mixed methods study from the US found that of over 9,000 employees who responded to an anonymous survey, 7% admitted to stealing merchandise from their company; an additional 3% reported stealing cash. The largest theft activity was the misuse of employee discounts, which 29% of respondents admitted to (Clark and Hollinger, 1981). Previous sweeps of the US *National Retail Security Survey* consistently identify employee theft as the leading cause of reported inventory loss (Hollinger and Davis, 2006), albeit in 2015 estimates of employee theft were overtaken by those for shoplifting as the main source of shrinkage, at 34.5% and 38% respectively (NRSS 2015: 8). Estimates from an online survey by *The Association of Certified Fraud Examiners* (2014) suggests that across all industries, theft (defined therein as asset misappropriation) is the most common form of occupational fraud accounting for 85% of reported cases (other categories were corruption and financial statement fraud). As Hollinger and Davis (2006) report, no matter what data source is consulted, the prevalence of employee theft in the US is estimated by participants to be higher than any other form of larceny-theft.

A recent report based on surveys of UK supermarkets classified 'shrinkage' into four categories: internal crime, external crime, supplier crime and process failures (The Smart Cube, 2014). They estimated shrinkage to account for 0.97 percent of total stock in 2014, a slight reduction from 1.2 percent in 2012, thought to reflect the overall downward trend in theft experienced in many western settings in recent years (see van Dijk, Tseloni and Farrell, 2012). The report found that external theft (shoplifting) accounted for the largest share of shrinkage loss (31 percent) followed by process failures (29 percent); internal crime (employee theft; 20 percent) and finally supplier crime (13 percent).

Research also finds some retail items to be stolen at greater frequencies than others. According to the *Global Retail Theft Barometer*, the most popular items to steal include razor blades, cosmetics, perfumes and alcohol (Bamfield, 2008). The *ECR Europe Top Hot Products* study (ECR Europe, 2010) demonstrated that there is also variation *within* categories in terms of relative risk of theft; spirits go missing with a higher frequency than wine and lager; fresh meat is more likely to go missing than drinks or sandwiches and, interestingly (but not surprisingly), there is a definite preference for named brand products. Gill and Clarke (2012) proposed AT CUT PRICES as a model to make sense of theft choices in retail environments. Like the commonly used CRAVED model (Clarke, 1999), it describes those attributes that make certain fast-moving consumer goods more susceptible to theft, namely items which are Affordable, Transportable, Concealable, Untraceable, Tradeable, Profitable, Reputable, Imperishable, Consumable, Evaluable and Shiftable.

As well as certain items being targeted more frequently than others, evidence suggests that retail theft is unevenly distributed both *between* and *within* stores. In terms of the former, Eck, Clarke and Guerette (2007) found that across 78 stores in Danvers, Connecticut, 85% of all shoplifting reports took place in just 20% of stores (a recurrent crime pattern referred to as the *iron law of troublesome places*, see Wilcox and Eck, 2011). In terms of within store theft variation, offender accounts reveal that 'shoplifters place emphasis on target hardening, guardianship, natural surveillance, and formal surveillance' when making decisions about where and what to steal (Carmel-Gilfilen, 2011:26). Moreover, stores which have 'unattended counters, high, concealing displays, scarce employees, and easily-accessed items' were all reported to be preferred targets for shoplifters (Hayes and Cardone, 2006:318).

Retailers employ a diverse array of measures designed to reduce theft including 'store detectives and guards, active customer service initiatives, secure product handling procedures, locked or otherwise specialized display fixtures, reinforced packaging, staff screening and training, in-store signage, ink or mechanical benefit denial tags, periodic audit/cycle counts, cabling, sales floor design, civil and criminal sanctions, display alarms, and CCTV video domes' (Hayes and Blackwood, 2006:263). Such measures are often used in combination (Lasky, Fisher and Jacques, 2015), with stores keen to employ obvious visual measures to deter hardened shoplifters as well as opportunistic thieves. The types of measures used are dependent on several factors such as the type of store, type of merchandise and ultimately the amount of money the retailer is willing to spend on security. For example, for outlets which stock mainly large goods (such as TVs), mechanical and electrical cables that require staff members to unlock them in order for merchandise to be accessed may be appropriate. However, such measures would not work for smaller, cheaper, more frequently purchased items as they also prevent legitimate customers from easily accessing them, and regularly doing so would take up an inordinate amount of staff time (Hayes and Cardone 2006).

Several scholars suggest reasons for the existence of retail theft. Hayes (1997) focuses on factors associated with the crime event which offenders are presumed to consider before stealing, including: the potential rewards, the perceived level of risk of detection and sanction; and the level of opportunity within a retail setting. Others have focused on more distal factors judged to give rise to the motivation to steal. Schwartz and Wood (1991) created five motivational categories in their typology of shoplifters: entitlement; addictions; peer pressure; stress (including economic pressures); and impulsiveness. More generally, Clarke and Petrossian (2012) note that individuals are often more willing to steal from businesses than they are private individuals. The type of motivating factor(s) may go some way to determining the behaviour and targets of different groups of offenders, as well as pointing towards the best way to deter them. Similarly prospective offenders' perceived level of risk, effort and reward is likely influenced by the retailer's approach to preventing theft, in particular their use of in-store crime prevention measures such as security guards, CCTV and, most relevant here, product tagging.

3. DESCRIPTION OF ANTI-THEFT TAGS USED IN RETAIL ENVIRONMENTS

Tags are a form of situational crime prevention (SCP) (Clarke, 1997). The use of situational measures to minimise shrinkage is a time-honoured and standard practice for retailers. Yet despite the ubiquity of SCP in retail environments, there have been few impact evaluations of its effectiveness. In a review of 206 evaluations of SCP published between 1970 and 2007, Guerette (2009) found 25 (12%) to have taken place in the retail environment.

Perhaps one of the most recognised and common forms of SCP in retail environments is the use of product tagging. 'Tags' is a convenient catch-all term for a variety of article surveillance measures. There are three main forms of tags implemented in retail environments:

- *Ink-dye tags* – these are filled with ink or dye which is expelled when the tag is tampered with, rendering the product damaged and less desirable. These tags are removed by staff at the point of sale.
- *Magnetic tags* – these are often in the form of small magnetic strips attached to products that raise an alarm on exiting the shop if they are not de-magnetised by staff at point of purchase. These electronic article surveillance or EAS tags operate on various parts of the radio wave spectrum from magnetic, to acousto-magnetic, to swept RF depending on the manufacturer. Some tags perform better in specific environments such as very wide exits, or on metallic products.
- *Radio Frequency Identification (RFID) tags* – RFID tags transmit signals to a reader which can identify the tagged product and, when coupled with an RFID reader situated at the entrance and exits of stores, can trigger an alarm if the RFID tag has not been removed.

What tag to use is partly influenced by the item to which it will be secured. Ink-dye tags, for example, are best suited for products whose desirability would be reduced if the ink were released (termed benefit denial), such as clothing. This type of tag contrasts with magnetic or RFID tags that are designed to deter offenders by increasing perceived risk of detection of theft of protected items.

There is much variation *within* tags. These include whether the tag is clearly visible or not (including being put inside the packaging or on the product itself, as in tape measures or electric tools) or whether it activates an audible or inaudible alarm (where only a guard for example may be notified). When a tag is attached to the product can also vary. Items can either be tagged by a supplier or wholesaler at source or by the retailer in distribution centres or even in-store.

Of the two options, source tagging is estimated to be used for 20% of products tagged (Global Retail Theft Barometer, 2011). More generally, one reason why retailers favour tags over other loss prevention methods, such as secure casings, locking display fixtures, or putting items behind the counter, is that products remain on the shop floor and therefore are more accessible to prospective buyers.

EAS tags are arguably the most commonly used article surveillance measure by retailers, boosted by ever-cheaper RFID technology. Macy's and a handful of other apparel retailers are using RFID tagging for inventory tracking with more to come. But it is very expensive to tag and place tag readers throughout distribution centres, trucks, and stores.

Some newer tags incorporate a capability for tracking inside a store with readers placed in key locations. Other tags, can be satellite-tracked. These are placed into cash packs, pharmaceuticals, iPhone packaging, very expensive handbags, etc. with a view to helping police catch robbery suspects, commercial burglars or professional shoplifters.

Newly emerging RFID tags can be "passive", where simple microchips that have limited memory capacity and no power source are used. Passive tags are activated by an appropriate RFID reader, which provides the energy source necessary for the tag to communicate. RFID tags can also be "active". These tags are typically larger in size and are battery powered, with the potential to broadcast a signal over much longer distances. The wider infrastructure necessary to realise the crime reductive benefits of RFID tags can also vary. By infrastructure we refer to RFID-readers, back-end systems to store data and the training of staff in the placement and/or removal of tags (Piramuthu, Wochner and Grunow, 2014).

It should be noted that tags are not solely used for the purposes of theft reduction. They are also being implemented for the purposes of product authentication (to detect counterfeit

items) and as a means of assisting supply chain management. Nor is their use limited to retail environments. RFID and EAS tags are used in airports to track the movement of baggage (Mishra and Mishra, 2010) and can even be found in hospitals to track new-borns and certain elderly patients, as well as certain prisons to monitor inmates (Hickman *et al.* 2010).

As mentioned previously, in keeping with scientific realism,, one aim of this review is to investigate the process by which tags can reduce theft (Johns, et al., in press; Pawson and Tilley, 1997). Pre-review, we can hypothesise several mechanisms through which tags might reduce theft from retail environments. Potential mechanisms include:

- The presence of visible real or 'dummy' tags, EAS warning signage, point of sale tag deactivators, and exit detection systems (as well as associated publicity) acts as a deterrent to prospective thieves (*increase perceived risk of detection/apprehension and if publicised increased uncertainty over whether the risk is high or low*)
- Obvious intentional in-store movements and removal noises by offenders in an effort to circumvent tagging in store (such as attempting to remove the tag from the product) raises the suspicion of motivated guardians – shop staff, shoppers – and prompts response (*increase perceived risk of actual detection/apprehension/incapacitation*)
- An audible alarm sounds on exiting a store with tagged items thereby alerting security personal and others (*increase perceived risk of detection/apprehension*)
- Inaudible alarm sounds on exiting store with tagged item thereby conspicuously alerting security personal (*increase actual risk of arrest and incapacitation*)
- Unauthorized removal of a tag impairs the value/quality/structural integrity of tagged items thereby reducing individual *enjoyability and disposability* (*reduce rewards and deny benefits*)
- Post-theft removal of tags is difficult thereby reducing *enjoyability* and *disposability* (*reduce rewards and deny benefits)*

Mechanisms are rarely activated unconditionally, however. We may also hypothesise as to why tags might not work to reduce theft in retail environments:

- Exit EAS detection pedestals fail to detect a tag due to antenna field "holes," or offenders masking tag signals with foil.

- "alarm apathy": the sounding of alarms in retail environments is so common that it provokes little reaction from store staff and patrons thereby undermining its effectiveness as a theft prevention measure. Several studies find very high false alarm rates (see Handford, 1994). A similar explanation has been put forward for the counterintuitive finding that household alarms in England and Wales are no longer found to reduce risk of burglary (they in fact appear to *increase* it, see Tilley *et al.* 2015). Alarm apathy is amplified by what is referred to as "tag pollution", which refers to incidences where non-deactivated tags present on customers' own items sound alarms. This can cause negative reactions from legitimate consumers and may lead them to stop visiting such stores particularly if a false alarm has caused them personal embarrassment (Dawson, 1993).
- No/slow/ineffective response to the sounding alarm, discrediting it in the eyes of prospective thieves.
- Widespread availability of cheap methods to remove tags without damaging tagged items. Advice is readily available on the internet - including short, instructive videos.
- Implementation problems, such as tags being insufficiently oriented to trigger alarms, tags insufficiently attached to items and therefore being easily removable, etc.
- Offender adaptation and countermoves (see Lasky, Fisher and Jacques, 2015; for a general discussion see Ekblom, 1999), advice on which is again readily available on the internet:
    - Foil-lined booster bags to shield tag signals
    - Jamming the tagging system
    - Coins used to shield tags
    - Distracting staff so offenders can escape un-noticed
    - Passing tagged items above or below the tag detectors

In order to work most effectively, it is hypothesised that retailers must ensure offenders are made aware of tagging in their stores, including the use of overt tags on items; highly visible gates at the front of stores that are difficult to circumvent; audible alarms being activated if a stolen item is detected; in-store notices alerting customers to the use of tags; empowered and motivated staff quick to respond to alarm activation (Beck, 2006). This review will explore evidence for these potential mechanisms in more depth.

4. PREVIOUS RESEARCH ON TAGGING IN RETAIL ENVIRONMENTS

A number of primary evaluations of the effectiveness of tagging in retail environments have been conducted, generally showing positive results. Bamfield (1994) found a 28-32% reduction in shop theft when using EAS, while DiLonardo (1996) found an 80% reduction. In a study of 9 stores using different kinds of shoplifting prevention measures, Farrington et al (1993) found that the use of tags was associated with a 76-93% reduction in thefts. They also found that tags performed better than security guards (which showed no reduction) and store redesign (which showed a 50-80% temporary reduction).

A more recent study by Hayes and Blackwood (2006) found less impressive results; total unit losses in stores that implemented EAS tags were *higher* than in stores without EAS tagging. This may be a statistical anomaly as both sets of stores saw decreases in the post intervention period, but control stores saw larger decreases. It may also be due to the implementation of the tags, since they were not highly visible and may therefore not have deterred thieves. Beck and Palmer (2011) also found an increase in shrinkage of 250% when soft tags added at source by manufacturers replaced hard tags added in store. They hypothesised that the lack of visibility of these tags meant that they no longer acted as a sufficient deterrent to shoplifters.

Fewer studies have evaluated the effectiveness of ink tags in retail environments. An exception is DiLonardo and Clarke (1996) who report on two for which reductions in theft were associated with the use of tags. The first study, comparing 14 new stores to a nationwide store chain average, saw a 14% reduction in theft, while a second study using a before and after design across four new stores, witnessed a 47% reduction in theft.

Although not evaluation studies, research has also examined retailers' and shoplifters' perspectives on tagging as a theft reduction measure. For example, a survey of retail managers in Scandinavia by Lindblom and Kajalo (2011) found that most items reportedly stolen from stores were electronically tagged, and that managers believed security guards in uniform to be a more effective method of theft prevention than tagging. In an ingenious recent study, Lasky, Fisher and Jacques (2015) fitted eye-tracking devices to a sample of shoplifters and investigated their perceptions of available security measures (including tagging) in two national retail stores in the US. Although several offenders reported that they would not attempt to steal tagged items, others suggested ways in which tags could be

circumvented, such as 1) opting for cheaper items that are less likely to be tagged (an example of target displacement), 2) removing items from their packaging on the assumption that tags are ordinarily attached to packaging rather than products and 3) attempting to sneak around the security tag detectors thereby not sounding the alarm. Other offenders were little deterred, reporting that alarms are activated so frequently (and often mistakenly) that many store staff typically ignore them.

To date there has been no attempt to systematically review the evidence on whether tags, in all their forms, are effective at reducing theft in retail environments. As this section has shown, evidence regarding the effectiveness of tagging to prevent theft in the retail environment is mixed, as are offender accounts on the deterrent effect of product tagging. With theft-related losses borne by retailers reaching billions of pounds per year, it is important to determine the (cost) effectiveness of tagging as a method of theft reduction in retail environments, as well as gain a better understanding of the mechanism(s) through which they are expected to effect positive change and the conditions under which this is most likely.

5. OBJECTIVES OF THE SYSTEMATIC REVIEW

This systematic review has three objectives. The first is to assess whether product tags (broadly defined) have been found to be effective as a method of reducing theft in retail environments. The second is to assess how, in what form(s) and under what conditions tags have been found to be effective, ineffective and to produce unintended negative effects in retail environments. The third is to review information on the costs and implementation of tags.

6. APPROACH TO SYSTEMATIC REVIEW

The approach taken here is consistent with that reported in Sidebottom *et al.* (2015). Briefly, using EMMIE (Johnson *et al.* 2015) as a guiding framework for the types of evidence necessary to inform improved decision-making, we combine two distinct approaches to systematic review: statistical meta-analysis and realist synthesis. Each approach is directed toward a different yet complementary set of review questions. Our meta-analysis is primarily concerned with systematically appraising the evidence to determine 1) whether tags 'worked'

to reduce theft in retail environments, 2) what factors were found to moderate effectiveness and 3) whether tagging was a cost-beneficial theft prevention measure. Our realist synthesis is primarily concerned with systematically appraising the evidence to uncover 1) how tags might work to reduce theft in retail environments (what realists call the 'mechanisms'), 2) the conditions necessary for tags to activate mechanisms that reduce theft in retail environments (what realists call the 'context') and 3) the outcome patterns observed if tags operate as expected. These two approaches to review should not be considered independent, however. It is our hope that the findings of each branch of our review can inform and be informed by the other. For example, emerging context-mechanism-outcome conjectures generated by the realist review can be empirically tested with the data available for meta-analysis, if the evidence collected in the primary studies is adequate. It is our contention that pursuing evidence that speaks to the range of review questions raised by EMMIE will maximise the value and usefulness of the outcomes of this review for industry, researchers, practitioners and policy makers.

Figure 1, adapted from Sidebottom *et al.* (2015) in their review of the effectiveness of alley gating, shows how these two approaches are to be integrated. It is noteworthy that Sidebottom and colleagues (2015) found that limitations in the data collected in the primary studies they reviewed meant that promising realist theories relating to alley gating could not be empirically tested. Put differently, primary evaluation studies appraised in the course of that review did not provide the information necessary to empirically examine the context-mechanism-outcome conjectures produced by the realist review of the alley gating literature. It is acknowledged that this may also be the case with the studies identified that relate to tagging in retail environments.

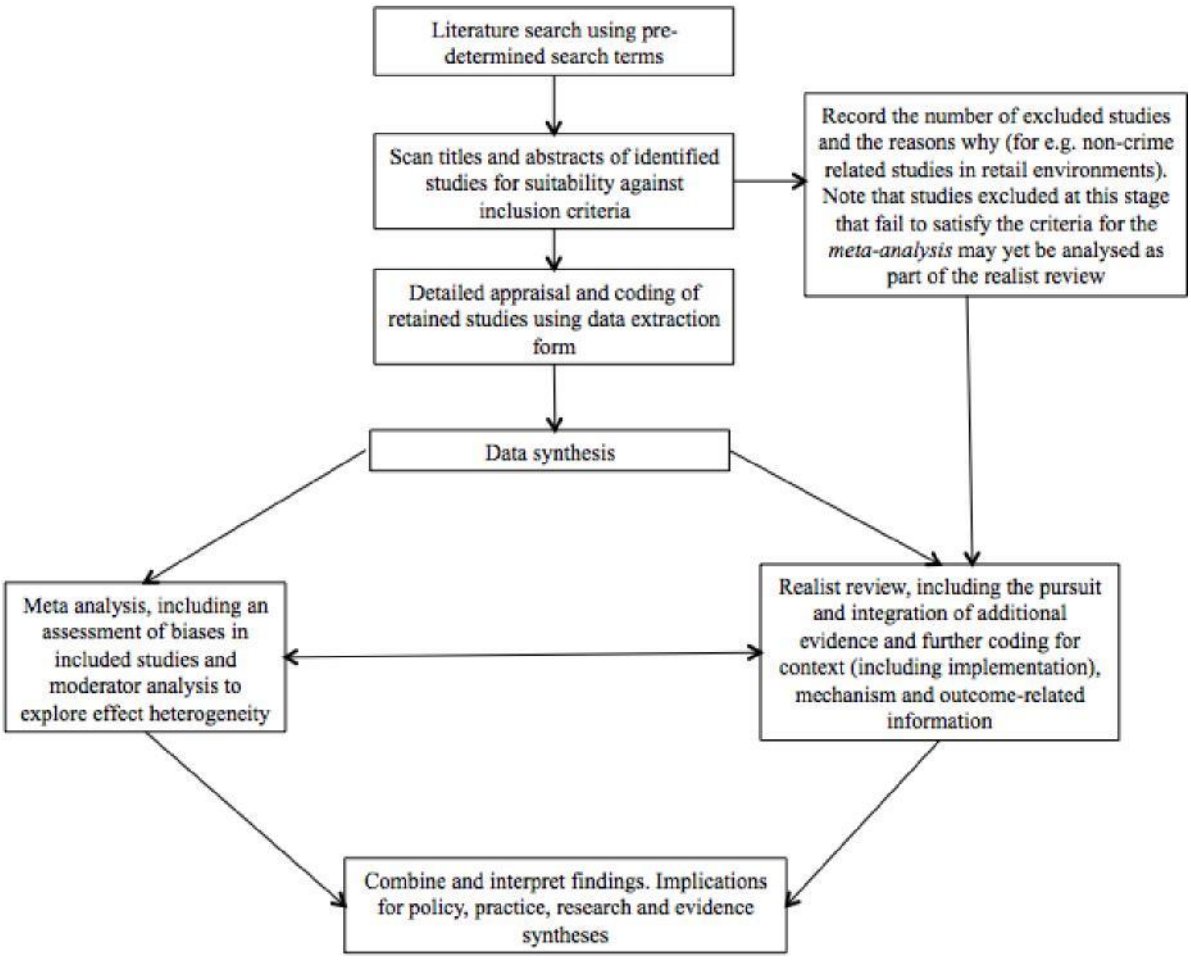

Figure 2: Flowchart of the review process to be followed in assessing the effectiveness of tagging at reducing theft in retail environments (adapted from Sidebottom ***et al.*** 2015)

7. REVIEW METHODS

This section details the methods to be used in this review. It describes our inclusion criteria, strategy for identifying studies, search terms, data extraction and management processes, statistical analyses to be performed as part of the meta-analysis and the realist synthesis process.

Criteria for considering studies for this review

In selecting studies for this review we will use the following criteria:

a) The study must have reported an explicit goal of reducing theft or loss of items through the use of tags (broadly defined). Theft can refer to offences committed by customers *and* employees, and in many studies we expect the offender will be unknown. We will include studies in which tags have been implemented by any stakeholder (such as law enforcement) or retailer. Studies will also be included if tags were implemented in isolation or as part of a wider package of anti-theft/loss reduction measures. We will not exclude studies on the basis of what item is tagged (be it clothes, cosmetics or cabbage).

b) The study must refer to tags intended for use in retail environments, defined here as physical spaces open to the public where merchandise is sold. This is distinguished from anti-theft tags used in 1) non-retail environments (such as the workplace) and 2) supply chain management, which are excluded from this review. Studies in which tags were reportedly implemented at source (by the manufacturer) or in-store (by the retailer) will be included.

To be included in our meta-analysis, a study has to satisfy points a) and b) above and:

c) Report at least one quantitative crime or loss outcome measure. Outcome data can comprise official measures (such as police recorded crime data or store product inventories) or unofficial measures (such as self-reported levels of theft or systematic counting of in-store items). Studies that only report outcome measures that are not directly related to theft or loss (such as changes in customer takings) will not be included.

d) Report original research findings. Systematic reviews are not included. The quantitative findings for any single study will be incorporated only once, even if reported in multiple publications. Where this is the case, the study reporting the most detailed information will be included or, where necessary, any dependency in the data dealt with appropriately.

e) Employ a research design that allows for the computation of a reliable effect size (such as an experimental or quasi-experimental evaluation design with a control group or a suitable single study interrupted time series design).

Items c, d and e do not form part of the inclusion criteria for the realist synthesis. To be included in our realist synthesis, studies have to satisfy points a) and b) above - report an explicit goal of reducing theft or loss in retail environments through the use of tags - and at least one of the items below:

f) Report substantive information relating to theft-related causal mechanisms activated by tags in retail environments
g) Report substantive information relating to the conditions needed for tags to activate theft-related causal mechanisms in retail environments
h) Report substantive theoretical content concerning tags in retail environments and crime-related outcomes
i) Report substantive information about the implementation and operation of tags in retail environments
j) Report substantive information about the costs of tags in retail environments

More generally, the review will consider published and unpublished (grey) studies. No date restrictions are to be applied. Studies do, however, have to be available in English since available resources limit our ability to search and translate non-English studies.

Identifying studies: databases and information sources

Studies will be identified using the following search methods:

1) A keyword search (see pp. 18) of relevant electronic databases including grey literature and dissertation databases (see pp. 16-17) [1.]
2) A hand search of relevant journals not included in the above databases [2]
3) A keyword search of publications by relevant government, research and professional agencies (see 'other sources' below). This step will be conducted in collaboration

[1] Aware that potentially relevant studies might be published in retail- (and not crime) related journals, we conducted a preliminary search of Google Scholar to identify a number of retail journals and checked whether they appeared in the databases named here (see appendix 1). All retail-related journals were found to be covered by the two multidisciplinary databases (SCOPUS and Web of Knowledge).
[2] These are *Police Practice and Research: An International Journal* and *Policing: a Journal of Policy and Practice.*

with Phyllis Schultz, an information specialist and librarian at Rutgers University (US)

4) Forward and backward citation searches of candidate studies
5) There may be a substantial grey literature produced for specific businesses but treated as commercial in confidence at the time of its production. Efforts will be made to identify and retrieve these studies by consulting experts in the field (see below)

Recognised experts in the field will be approached to check the finalised list of studies. Experts include Joshua Bamfield, Adrian Beck, Ron Clark, Martin Gill, Read Hayes, Richard Hollinger and Matt Hopkins.

Electronic databases to be searched are:

1) ASSIA (Applied Social Sciences Index and Abstracts)
2) Criminal Justice Abstracts
3) Criminal Justice Periodicals
4) ERIC (Education Resources Information Center)
5) IBSS (International Bibliography of Social Sciences)
6) NCJRS (National Criminal Justice Reference Service)
7) ProQuest theses and dissertations
8) PsycINFO
9) PsycEXTRA
10) SCOPUS
11) Social Policy and Practice
12) Sociological Abstracts
13) Web of Science
14) CINCH (Australian Criminology Database)

Government, research and professional agency publications to be searched are:

1) Center for Problem-Oriented Policing (Tilley Award and Goldstein Award entries)
2) Institute for Law and Justice
3) Vera Institute for Justice (crime and victimization publications)
4) Rand Corporation (public safety publications)

5) Police Foundation
6) Police Executive Research Forum
7) The Campbell Collaboration reviews and protocols
8) Urban Institute
9) European Crime Prevention Network
10) Swedish National Council for Crime Prevention
11) UK Home Office
12) UK College of Policing (Polka)
13) Australian Institute of Criminology
14) Swedish Police Service
15) Norwegian Ministry of Justice
16) Canadian Police College
17) Finnish Police (Polsi)
18) Danish National Police (Politi)
19) The Netherlands Police (Politie)
20) New Zealand Police
21) US National Institute of Justice

We will also search:

1) Google
2) Google Scholar
3) Academic Search Premier (EBSC)
4) ProQuest Sociology
5) Rutgers Criminal Justice Gray Literature Database
6) OSCE Polis Digital Library
7) WorldCat

Full text versions of identified studies will be obtained through one of the following means (in order of preference):

a) Electronic copies via University College London (UCL) e-journals service
b) Electronic copies of studies available from elsewhere on the internet

c) Paper copies at UCL

d) Electronic copies at the Gottfredson Library at the Rutgers University School of Criminal Justice (US)

e) Electronic/paper copies requested through UCL's Inter Library Loan (ILL) system, which sources most materials from the British Library;

f) Electronic/paper copies requested from the authors themselves

g) Electronic/paper copies requested from major retailers

h) The UK College of Policing library

Should any of the full text versions of the works collated contain insufficient information to determine their eligibility for inclusion according to our coding strategy (described below), where possible the corresponding author will be contacted in an attempt to retrieve this information.

Search terms

In order to discover relevant items for the systematic review, a number of search terms will be used in the above search engines and electronic databases. These include terms relevant to tagging, retail environments and theft:

shoplift* OR ((shop OR store OR retail OR customer OR employee) AND (loss* OR shrinkage OR crim* OR theft OR steal))

AND tag* OR EAS OR "Electronic theft control system*" OR "Electronic article surveillance" OR "Electronic asset surveillance"

Data extraction and management

As indicated in Figure 1, the first level of screening involves the review team examining the title and abstract of those studies returned following our electronic and bibliographic searches. All references will first be uploaded to the EPPI 4 reviewer software, a web-based program developed by the Social Science Research Unit at the Institute of Education, UCL,

to manage and analyse data generated from systematic reviews (see: http://eppi.ioe.ac.uk/cms/Default.aspx?alias=eppi.ioe.ac.uk/cms/er4). Once uploaded, studies that fail to meet the inclusion criteria for the meta-analysis component of our review will be excluded (with rates of attrition noted). Excluded studies will be flagged in one of two ways: 1) clearly irrelevant (*i.e*. by topic, outcome or study design) or 2) possibly of interest. The latter category refers to those studies that will be revisited in the realist stream of our review (in addition to those that are eligible for meta-analysis). This batch of studies possibly of relevance to the realist synthesis is expected to mainly comprise studies whose title and abstract suggest retail-tagging-relevant research but which do not (appear to) report a crime-relevant quantitative outcome measure, focussing instead on, say, implementation or process-related (intermediate) outcome measures. Should disagreements arise over whether a study should be included or excluded, this will be resolved by discussion between the research team.

The next stage involves screening the full text of and extracting data from those studies that meet the inclusion criteria for meta-analysis. Entering the information into EPPI 4, reviewers will (where possible) record the following information:

1. Study details (title, year, author(s), publication status, study location(s))
2. Nature (type) of tags put in place (e.g. RFID, ink, magnetic, visible vs. invisible)
3. Total number of tags fitted (intensity)
4. Proportion of merchandise tagged
5. Type of merchandise tagged
6. Where the tags were implemented (at source or in-store?)
7. Type of retail environment (department store; supermarket; warehouse retailers; speciality retailers; convenience retailers; discounter retailer)
8. Details on retail environment (size of store, products sold, location, crime history)
9. Unit of analysis (e.g. store, chain of stores)
10. Research design (RCT, quasi-experimental)
11. Description of comparison group, place or period
12. Sample (size and any notable features)
13. Statistical test(s) used
14. Outcome measure reported and data source

15. Effect sizes (where applicable and/or reported) will initially be coded as they are reported (but see below)
16. Other interventions implemented over the study period including routine security practices- for example the employment of private security guards.
17. Indirect effects (displacement and/or diffusion of crime control benefits)
18. Mention of possible mechanisms through which tags could reduce theft
19. Financial costs and benefits
20. Conclusions of the author(s)

8. STATISTICAL PROCEDURES FOR META-ANALYSIS

We expect studies acquired through our searches to differ in methodological approach. Some will have simple post assessments, some pre and post assessments, and some pre and post assessments with at least one control condition. Control conditions may include other stores or retail environments not using the tagging systems, or comparisons against national averages for theft problems. We predict that only a minimal number of studies will have established some equivalency between comparison and treatment conditions or will have used random assignment to minimize bias. For completeness, those studies that employ research designs that limit confident determinations of impact will be examined prima facie, but they will not be the focus of the meta-analysis.

To account for the varying levels of methodological rigor, studies using different designs will be analysed separately (for example quasi-experimental designs versus RCTs). Estimates of effect size will be computed within groups and comparisons made between them (see below). The statistical element of the quantitative review will focus on studies which at least meet the following conditions: i) they presented raw crime counts or rates of crime, or reported a standard measure of effect size and sampling variance that is suitable for inclusion in a meta-analysis; and ii) the research design used in the evaluation comprised at least two conditions: a treatment and a control. These may use random or non-random assignment (treatment and control), although very few are expected to have used randomization in the design.

It is expected that a range of different data and methods will be used across primary studies. Some of the issues anticipated will be the use of multiple treatment and control conditions (for example a chain of stores in which some receive the tagging intervention and others do

not); the availability of time series data; the use of crime counts and crime incident rates; the use of different methods for calculating effect sizes; and the computation of effect sizes for different crime types (if reported) and differences in the handling of intervention effect sizes. These differences will be identified during the coding stage and dealt with in the statistical analysis (see below).

Calculating effect sizes

To estimate the effectiveness of tagging interventions overall and for relevant sub-groups of studies, we will undertake a statistical meta-analysis. To enable synthesis, the individual effect sizes – which may be reported using different test statistics (*e.g*. odds ratios, mean difference scores, and so on) – will be converted to a common metric. To do this, we will standardise by converting to the type of effect size that is most frequently used across the primary evaluations. Where possible, if the original authors have not calculated an effect size, but it is apparent that this would be possible using the available data, we will endeavour to do so.

Having converted the effect sizes to a common metric, we will undertake a statistical meta-analysis. In line with contemporary research, to deal with any heterogeneity in the effect sizes, we will compute a mean effect size using a random effects model. As is standard practice, when combining effect sizes to compute an overall mean effect, we will weight the individual metrics using inverse variance weights. This will ensure that more reliable effect sizes are given more weight in the calculations. Along with the overall mean effect size, individual effect sizes will be presented, most likely using forest plots showing point estimates and the associated confidence intervals.

Dealing with dependency

It is likely that there will be cases where it is possible to generate more than one effect size from a single primary study. Reasons for this will vary and we would therefore deal with them according to the particular situation, as follows:

1. Data are presented for multiple treatment sites, each with independent matched controls. Where this occurs we will take the mean of the available effect sizes and use this as the overall outcome for the primary study.
2. Treatment sites are compared to more than one control site. In this case, one option is to compute two effect size measures for the study, one showing the worst case scenario and one showing the best. The overall mean effect size (computed across sites) could then be computed using data to show: a) the best case scenarios; and b) the worst case scenarios. Forest plots summarising the effect sizes will be produced for each scenario.
3. Reductions in crime in treatment sites compared to control sites using different pre and post time periods. We will deal with this as in (2) above.

One issue with these approaches is that data are lost or averaged. Therefore, we will also implement a relatively new procedure, which takes a permutation approach (see Moore and McCabe, 2006; Bowers *et al.* 2011; Johnson *et al.*, 2012). The aim of this approach is to use (most or) all of the available data and summarise the distribution for all possible scenarios (not just the best and worst). To do this, where the number of possible permutations is manageable, an overall mean effect size will be computed for each one. Where there is a very large number of possible permutations, a random sample will be selected using a Monte Carlo simulation. This procedure will produce a distribution of standardised mean effect sizes and hence a more complete understanding of the likely overall impact of intervention.

Heterogeneity and sub group analysis

As noted, we expect the effect sizes to vary across studies. To quantify the degree of heterogeneity observed, we will calculate a Q statistic. This statistic is used to determine if any observed variation in effect sizes is likely to be greater than would be expected on the basis of sampling error alone (see Lipsey and Wilson, 2001). A statistically significant Q statistic therefore implies that there are systematic variations in effect sizes that cannot be explained by sampling error. Such differences would include, for example, variation in the contexts in which an intervention has been implemented.

If, as expected, significant heterogeneity is observed in the effect sizes, a moderator analysis will be conducted to see if variation in identified factors associated with the reviewed studies

can explain this. As alluded to previously, some of the factors considered will be informed by our realist review of the available evidence, with the aim of ensuring that the analysis is theoretically informed. These are likely to include:

- Type of tag (*e.g.* ink, magnetic-Swept RF EAS, RFID)
- Features associated with the tag (*e.g.* visible vs invisible)
- The proportion of available items that are tagged (retailers tend to use tags only for sufficiently expensive items; blanket coverage is rare. However, Piramuthu and colleagues (2014) questioned this common practice, arguing in favour of (RFID) tagging all items since 'the RFID-tagged expensive items subsidize the RFID-tagging of inexpensive items through the benefits generated from complete item-level visibility of all items at the store (e.g. reduced shrinkage, less spoilage of perishables, ability to guarantee in-store stock)'
- Type of retail environment (*e.g.* supermarket vs speciality retailer)
- Use of tagging in isolation or in combination with other preventive measures (both generic such as CCTV and specific such as tag-related signage)
- Standard security procedures of the retail environment (e.g use of private security guards)
- Country of study

In addition, as is commonly practiced in meta-analyses, if the data are available we will conduct analyses to see if systematic differences in effect sizes are observed according to:

- The type of study design (*e.g.* RCT versus quasi-experimental)
- Publication date (which in the case of tagging may be a proxy measure for technological advancements over time and associated changes in the type of tag implemented, and/or offender adaptation).

As part of the moderator analysis, weighted mean effect sizes will be computed for each of the identified sub-groups. We will also calculate a Q statistic for each subgroup. In the event that the theoretically informed moderator variables explain the observed variation in effect sizes, any remaining variation will be explained by sampling error alone, and the analysis will thus provide insight into (at least some of) the ingredients necessary for successful intervention.

Publication bias

A well-documented issue that can compromise the reliability of the outcome of any meta-analysis is publication bias (*e.g*. Kicinski, 2014). Simply put, if evaluations that suggest positive outcomes of interventions are more likely to be published, there is a risk that any positive effect of intervention will be exaggerated. This is particularly relevant for the current review given our expectation that there may be a large grey literature on the effectiveness of tagging. To determine the extent of a publication bias in our sample our studies, using a moderator analysis, we will first compare the mean effect size observed in published studies with that for unpublished studies. Next, we will produce a funnel plot, showing the effect sizes against their standard error. If no publication bias is present, the individual effect sizes should be more or less symmetric around the overall mean. If, however, there is an overrepresentation of studies that suggest an effect greater (or less) than the overall mean effect, this would suggest that publication bias is a distinct possibility. In this event, we will use the trim and fill method proposed by Duval and Tweedie (2000) to estimate the true effect size of intervention.

Outlier analysis

Outlying individual outcomes can distort the overall mean effect size estimate. Such outliers are particularly serious if they have extreme values and/or come from large studies that have been heavily weighted in the meta-analysis. Analysis will be conducted to check for the existence, and where appropriate, the influence of such outliers. This will be done by visually assessing forest plots for the presence of any extreme values. If it is apparent that potentially problematic outliers exist, mean effect sizes will be calculated both with and without the inclusion of the extreme value(s). This sensitivity analysis will establish whether mean effect sizes are robust and consistent or whether the outlier has a problematic influence over the results found.

Inter-rater reliability

Checks will routinely be made to assess the similarity in information extracted by coders. For a random sample of 5% of studies, two coders will independently code the outcome measures and other findings. These will be compared and the level of agreement calculated. If at any

stage of the process, or for any category inter-rater reliability is low, the two coders and other members of the review team will meet to discuss and seek to resolve any inconsistencies and discrepancies.

9. REALIST SYNTHESIS

The main objective of a realist synthesis is less the unbiased estimation of net effect sizes, but rather an understanding of the conditions in which different outcome patterns are expected. To this aim, proponents of realist synthesis (see Pawson 2006) argue that a wide range of evidence types can legitimately be drawn on: the issue is that of eliciting and refining working theories and assembling the strongest available evidence to test them.

The search tactics mentioned above (and set out in Figure 1) will produce our initial population of studies. To reiterate, the realist element of our review will not be confined to studies that meet the same methodological criteria as our meta-analysis, although it obviously will include them. The realist synthesis will involve three members of the research team reading, rereading and regularly discussing the full text of all identified research articles deemed relevant to tagging to reduce theft in retail environments.

Each article included in the realist component of our review will be coded for references to 1) mechanisms activated, 2) the contexts for their activation, 3) the expected outcome patterns from that mechanism's activation and 4) any evidence speaking to the conjectured context-mechanism-outcome pattern configuration (CMOC). They will also be coded for details of the implementation processes involved in introducing the tags used and in responding to them.

Realist reviews follow an iterative process. In this spirit, individual papers will be returned to repeatedly as CMOC conjectures emerge from our initial reading to determine whether they provide evidence that speaks to these conjectures, whether or not those conjectures are the explicit focus of the papers. This will lead to further coding of the documents. Furthermore, where evidence may be available to assess emergent CMOCs from studies not identified through the systematic search processes used in identifying the initial population of studies, these will be sought on an iterative basis and evidence drawn on best to assess key CMOCs empirically, whilst acknowledging the fallibility of the data used. These studies may, for example, relate to the technical capacity of specific tags, to studies of decision-making by

shop thieves, to police responses to shop theft allegations and to ethnographies of shopping and shoplifting. However, what will be sought cannot be determined in advance of the initial stages of the realist component of the review to identify promising CMOCs.

What will be produced from our realist review is a set of CMOC conjectures with an assessment of the quality of the available evidence that speaks to them and the conclusions that can best be drawn from that evidence. Where possible, as already indicated, some CMOC conjectures may also be open to statistical exploration through the moderator component of our meta-analysis.

10. TIMEFRAME

Stage	**Estimated time period**
Searches for published and unpublished Studies	September/October 2015
Screening articles based on inclusion criteria	October-November 2015
Coding of eligible studies	October-November 2015
Statistical analysis/realist synthesis	November -December 2015
Integration and presentation of results	January-February 2016
Preparation of final report	February-March 2016

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Appendix 1

Retail Journals

International Journal of Retail & Distribution Management

International Review of Retail, Distribution and Consumer Research

Journal of Retail and Leisure Property

Journal of Business and Retail Management Research

European Retail Research

Journal of Applied Security Research

Security Journal

Journal of Retailing

Journal of Retailing and Consumer Services

Retail Security and Loss Prevention

Retailing in Emerging Markets: A Policy and Strategy Perspective