WHAT WORKS CRIME REDUCTION SYSTEMATIC REVIEW SERIES

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

Aiden Sidebottom, Amy Thornton, Lisa Tompson, Jyoti Belur, Nick Tilley and Kate Bowers

UCL Department of Security and Crime Science

Corresponding author:

Aiden Sidebottom
UCL Department of Security and Crime Science
35 Tavistock Square
London
WC1H 9EZ
a.sidebottom@ucl.ac.uk

March 2017

1

COPYRIGHT

CONTENTS

LIST OF TABLES

Table 1: Characteristics of studies with quantitative outcome measures included in Effect section

Table 2: Risk of bias assessment for studies included in Effect section

LIST OF FIGURES

Figure 1: Flowchart of study selection

Figure 2: Illustrative logic model of how EAS tags might produce their effects

ACKNOWLEDGEMENTS

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

ABSTRACT

Retailers routinely use security tags as a form of situational measure to reduce theft. Guided by the acronym EMMIE, this paper set out to 1) examine the evidence that tags are **E**ffective at reducing theft, 2) identify the **M**echanisms through which tags are expected to reduce theft and the conditions that **M**oderate tag effectiveness, and 3) summarise information relevant to the **I**mplementation and **E**conomic costs of tagging. Following a systematic search of the published and unpublished literature, and through consultation with four retailers, we identified fifty studies that met our inclusion criteria. Eight studies reporting quantitative data were assessed in relation to the effectiveness of tags, but heterogeneity in the type of tag and the reported outcome measures precluded a meta-analysis. Based on the available evidence it is difficult to determine the effectiveness of tags as a theft reduction measure, albeit there is suggestive evidence that more visible tags outperform less visible tags. The three identified mechanisms through which tags might plausibly reduce theft – increase the risks, reduce the rewards, increase the effort – were found to vary by tag type, and their activation dependent on five broad categories of moderator: retail store and staff, customers (including shoplifters), tag type, product type, and the involvement of the police and wider criminal justice system. Implementation challenges related to staffing issues and tagging strategy. Finally, although estimates are available on the costs of product tagging, our literature searches identified no high-quality published economic evaluations of tagging. The implications of our findings and suggestions for future research are discussed.

Keywords: EMMIE, loss prevention, retail, shrinkage, situational crime prevention, tags, theft

BACKGROUND

Shoplifting is a persistent problem for many retailers. It is a major source of 'shrinkage', the umbrella term used to denote losses attributed to theft, fraud, error, damage or wastage. According to estimates from the *Global Retail Theft Barometer* (2015), the cost of retail crime globally exceeded $214 billion in 2014-15[i]. Beyond obvious financial losses to retailers, the effects of retail crime can be far reaching. In extreme cases, chronic crime levels can force businesses to close thereby limiting employment opportunities and the availability of goods and services (Hopkins and Gill, 2017). Moreover, high crime levels ultimately fall on the consumer through elevated prices, comprising what Bamfield and Hollinger (1996) call a 'crime tax'.

Loss prevention is thus a key concern for many retailers (Hayes, 1997). It is also big business: global expenditure on security and loss prevention is estimated to be around 0.65% of total sales (Global Retail Theft Barometer, 2015). Diverse measures are implemented to reduce theft in retail environments. These include "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 …. periodic audit/cycle counts, cabling, sales floor design, civil and criminal sanctions, display alarms, and CCTV video domes" (Hayes and Blackwood, 2006, p. 263). Despite the preponderance of security measures used by retailers, evaluations of their effectiveness remain scarce (Hopkins and Gill, 2017). Those evaluations that are available have also been criticised for, amongst other things, insufficient time periods over which to assess the impact of interventions and failure to identify the causal mechanism(s) through which security devices produce their effects (Hopkins and Gill, 2017).

This review is concerned with the effectiveness of security tags in retail environments. Tags are widely used in retail settings (DiLonardo, 2015; Hayes, 2007; Beck and Palmer, 2010; Global Retail Theft Barometer survey, 2015). They are often favoured over other loss prevention methods because tagged products remain on display and are accessible to staff and prospective buyers. Despite the popularity of tagging, to date there has been no attempt to systematically review the evidence on whether they are effective at reducing theft.

Informed by EMMIE – an acronym denoting five categories of evidence considered relevant to crime prevention decisions makers (see Johnson, Tilley and Bowers, 2015) – in this review we summarise the available evidence to: 1) determine whether tags are **E**ffective at reducing theft; 2) articulate the **M**echanisms through which tags are expected to reduce theft and the conditions that **M**oderate tag effectiveness; and 3) identify the **I**mplementation considerations and **E**conomic costs of tagging.

The remainder of this review is organised as follows. First, we briefly chart the history and development of tagging in retail environments, and describe the main types of tags available. Next, we outline the acronym EMMIE and how it informed this review. Third, we report our methods and search strategy. The results then follow, organised according to EMMIE. We finish by discussing our findings and their implications.

ON THE DESIGN AND DEVELOPMENT OF ANTI-THEFT TAGS

Tagging is a form of situational crime prevention (Clarke, 1997; Clarke and Bowers, 2017) intended to reduce opportunities for theft. 'Tags' is a convenient umbrella term for a diverse range of security products including bottle caps, spider wraps and anti-tamper seals (see Beck, 2016b). This review focusses on two specific categories of tag:

- *Ink tags* – these refer to reusable 'hard tags' that contain glass phials of indelible ink or dye that is expelled when the tag is tampered with, thereby rendering the product damaged and less desirable (DiLonardo and Clarke, 1996). Ink tags are non-electronic. They are typically used by apparel manufacturers and tend to be removed by cashiers at point of sale.

- *Electronic Article Surveillance* (EAS) tags – these can take several forms, from "hard" plastic tags to "soft" self-adhesive paper tags (DiLonardo, 2008; 2015; Hayes, 2007). EAS systems generally consist of three components: the electronic tag, detector gates with built-in radio antennae (typically located at store exits) and a control unit (Bamfield, 1994). EAS tags sound an alarm if they pass the detector gates without being removed or de-activated. EAS tags operate on various parts of the radio wave spectrum from electro-magnetic (EM) to acousto-magnetic (AM) or radio frequency (RF), depending on the manufacturer (DiLonardo, 2015).

Ink tags originated in Sweden in the 1980s. Usage was initially patchy: tags were often large and bulky and application and removal was challenging (DiLonardo, 2008). Progressive refinements to the design of ink tags resulted in a greater penetration rate, particularly in the USA. Recent generations of ink tags are more sophisticated still, often including an electronic component and associated alarm system (see http://www.concepttag.com/).

EAS tags have likewise undergone considerable technological innovation over the past 50 years since their inception. Whilst EAS tags were originally designed for apparel retailers, in response to widespread thefts they have since been applied to a much wider range of goods, including groceries and music products. The first commercial tags deployed in the 1960s were hard, round and plastic, affixable by pins, using RF, EM and microwave technologies (DiLonardo, 2015). The 1980s saw the advent of smaller magnetic "soft" EAS tags which were disposable, attached with adhesive backs, and could be deactivated at point of sale. The 1990s produced tags which could be sewn into or heat-sealed onto clothing at the point of manufacture (DiLonardo, 2015). This process of *source tagging* has become increasingly popular over the past decade, particularly among retailers since it ensures better consistency in tag application and it removes the requirement of retailers to train and resource staff to tag items in store (Beck and Palmer, 2010). More recently, retailers have experimented with the use of RFID EAS tags albeit primarily as a way of monitoring stock levels as opposed to controlling theft (see Jones et al. 2005). EAS tags are arguably the most commonly used contemporary article surveillance measure, boosted by ever-cheaper RF technology. Seventy-three per cent of respondents to the *Global Retail Theft Barometer* survey (2015) reported using EAS tags[ii].

EMMIE AND OUR APPROACH TO SYSTEMATIC REVIEW

The goal of this review is to equip retailers and crime prevention professionals with information to help make evidence-informed decisions concerning the appropriateness of tagging as a theft prevention measure, for different products, in varying retail settings and under a range of circumstances. To this aim, we selected EMMIE as a guiding framework for our review (Johnson et al. 2015; Tilley, 2016; Bowers and Johnson, 2017). EMMIE does not mandate a preferred method of undertaking a systematic review. Johnson et al. (2015) do, however, suggest that evidence that reliably speaks to the five dimensions of EMMIE might best be captured through a mixed methods design. This can be seen in the EMMIE-informed

review of alley gating by Sidebottom and colleagues (2017). In their review, questions concerning the effectiveness of alley gating – what works? – were examined using meta-analytic methods, whereby quantitative data from primary evaluation studies were pooled to produce on overall effect size. By contrast, questions on *how* alley gates are expected to reduce crime (mechanisms) and under what conditions (moderators) were examined using a qualitative approach inspired by realist review methods (see Pawson, 2006). This involved a wider range of primary studies, including but not limited to those evaluative studies that were eligible for meta-analyses, being read, coded and discussed with the aim of formulating working theories on the causal processes through and conditions under which alley gates may produce their observed effects. In this review, consistent with Johnson et al. (2015) and Sidebottom et al. (2017), we adopt a mixed-methods approach.

METHODS

Criteria for considering studies for this review

We used the following criteria in selecting studies for this review:

a) *The study must report an explicit goal of reducing the theft, shrinkage or loss of items through the use of security tags*. Theft could refer to offences committed by customers or employees, although in many cases we expect the offender will be unknown. 'Tag' can refer to any type of article surveillance measure including ink tags, electronic tags or more recent hybrid tags. Studies were included irrespective of who funded or implemented the tags (such as tag vendors, police, retailers), or whether they were implemented in isolation or as part of a wider package of loss prevention measures.

b) *The study must relate specifically to retail environments, defined here as physical spaces open to the public where merchandise is sold*. This is distinguished from tags implemented in non-retail environments (such as the workplace or prisons) or the retail supply chain, both of which were excluded from this review. Studies in which items were tagged at source (by the manufacturer) or in-store (by the retailer) were included.

As mentioned previously, consistent with other reviews that have drawn on the EMMIE framework (see Sidebottom et al. 2017), we used a mixed-methods approach when synthesising evidence according to the five categories of EMMIE. To determine the effectiveness of tags as a theft reduction measure – the **E**ffect section of EMMIE – we selected studies that satisfied points a) and b) above and met the following two criteria:

c) *The study must report at least one quantitative theft, shrinkage and/or loss outcome measure*. It is widely recognised that retailers differ in how they measure loss or shrinkage (see Beck, 2006; 2016a). For this reason, we accepted a range of outcome measures that relate to the effectiveness of tags including but not limited to police recorded crime data or store product inventories.

d) *The study must report original research findings.* Quantitative findings for any study were incorporated only once, even if reported in multiple publications. Where this might be the case, the study reporting the most detailed information was included or, where necessary, any dependency in the data dealt with appropriately.

Based on an initial scan of the literature, we anticipated a small number of impact evaluations. Consequently, in this review we considered various research designs (including simple before and after designs). However, as will become clear, in the event all but one of the identified evaluations of tagging in retail environments used some form of comparison group.

Items c) and d) were not part of the inclusion criteria for selecting studies that may provide evidence concerning the **M**echanisms, **M**oderators, **I**mplementation or **E**conomics of tags. For these elements of EMMIE, we undertook a realist-review approach and therefore considered a broader range of research studies. To be included in this branch of our review, studies had to satisfy points a) and b) above - report an explicit goal of reducing theft, shrinkage or loss in retail environments through the use of tags - and report substantive information relating to at least *one* of the items below:

e) Theft-related causal mechanisms activated by tags in retail environments;
f) The conditions judged to influence the activation of theft-related causal mechanisms in retail environments;
g) The implementation of tags in retail environments; or

h) The costs of tags in retail environments.

Realist reviews are increasingly practiced in the health sciences to better understand 'what works for whom, how and in what circumstances' (see, for example, Berwick 2008; Davidoff 2009; Meads et al. 2015; Best et al. 2012; Kastner et al. 2015). Examples in criminology are rare, but those which are available converge on the finding that few primary studies report data concerning how an intervention is assumed to work (mechanism) and under what conditions (moderators) (van der Knaap et al. 2008; Sidebottom et al. 2017). Consequently, for this branch of our review we used a generous inclusion criteria and considered studies to be eligible if they "reported" information relevant to Mechanisms, Moderators, Implementation and Economics; eligibility was not contingent on studies providing *empirical evidence* pertaining to these elements. Insisting on this more stringent threshold was felt to be too restrictive and would likely result in the exclusion of potentially informative studies.

Identifying studies: databases and information sources

Eligible studies were sought using five methods: 1) A keyword search of electronic databases including retail journals, grey literature and dissertation databases (see Appendices 1, 2 and 3)[iii]; 2) a hand search of relevant journals that are not included in the databases we examined[iv]; 3) a keyword search of publications by relevant government, research and professional agencies (see Appendices 4 and 5); 4) forward and backward citation searches of evaluation studies included in the Effect section[v]; and 5) consultation with retailers and loss prevention managers (see *Consulting Retailers* below). We considered the latter search tactic to be important for this review because we expected a substantial grey literature on the effectiveness of tags produced for specific businesses but treated as commercially sensitive at the time of production.

No date restrictions were applied to our searches. Studies did, however, have to be available in English. Our list of candidate studies was checked by recognised experts on retail crime (see Appendix 6).

Consulting retailers

Retailers were approached in two ways. Firstly, via the UK *Metropolitan Police Service (MPS) Business Crime Hub*, which coordinates and provides crime prevention advice to many large retailers in London. Twenty-three retailers were sent an e-letter (see Appendix 7) by the MPS outlining the purpose of our review and requesting that they participate in the study, specifically through the sharing of information gleaned from any trials of the effectiveness of tagging which they had been involved in. A copy of the review protocol was also attached to the email. Secondly, meetings were held with senior police officers who at the time of writing held the positions of national and deputy lead for retail crime in England and Wales. Both were told of this review and asked to circulate a copy of the aforementioned email to relevant retailers requesting their participation.

Data extraction and management

For those studies eligible for inclusion, two researchers independently extracted relevant information (AS and AT). This information related both to the characteristics of the study (author, date, setting) as well as the different elements of EMMIE (see Appendix 8). Any disagreements were resolved through discussion with the research team.

Assessment of bias in eligible studies included in our Effect section

In an attempt to quantify methodological probity, all studies that made causal claims about the effectiveness of tags (i.e. those included in the Effect section) underwent evidence appraisal, conducted independently by two authors (AS and LT). Four potential sources of bias were assessed: 1) Selection bias (whether action and control groups were comparable at baseline, where appropriate), 2) measurement bias (the extent to which the data analysed were a reliable measure of theft, as opposed to loss, shrinkage and so on), 3) regression to the mean (whether the installation of tags followed a sudden increase (or decrease) in theft, shrinkage and/or loss) and 4) contamination effects (the extent to which study authors identified and/or discounted factors that might plausibly explain the outcomes observed). Each domain was scored as low risk, medium risk or high risk. High risk of bias is taken here to mean no mention of relevant issues and/or how they might affect the reliability of the findings. Medium risk denotes mention of relevant issues but no attempt to discount them.

Low risk of bias denotes mention of relevant issues and statistical efforts to discount them. Any disagreements were resolved through discussion with the research team. We recognise that our assessment of any bias that may be present may relate more to the descriptive validity of studies (what is reported) rather than their internal validity (Farrington, 2003).

Realist review

As part of our realist review, four researchers (AS, JB, AT and NT) read and independently coded those articles judged relevant to tagging. A code set was created to extract information on Mechanisms, Moderators, Implementation and Economics (MMIE), and was used to develop working theories as to how tags operate as a theft reduction method. These theories were then scrutinised and refined through regular group discussions. Consultation with retailers and loss prevention managers provided supplementary information and provided a means of receiving feedback on the emerging theories.

RESULTS

Search results and screening

Our search strategy returned over 1,000 potentially eligible records (once duplicates were removed). The title and abstract of identified studies were screened by three review authors (LT, JB and AT) to determine eligibility based on our inclusion criteria. Tests of inter-rater reliability were carried out to ensure the accuracy of this process with 92% agreement on inclusion and exclusion. Our approach at this stage erred on the side of inclusivity, with studies being retained if the title and abstract made any reference to tagging in retail environments. The full text of 152 studies was then examined by the same three review authors using our inclusion criteria. Disagreements were resolved by discussion and, where necessary, through the involvement of additional authors.

The number of, and reasons for, exclusions at each stage of the sifting process are shown in Figure 1. In sum, fifty studies were judged relevant to tagging, all of which were analysed as part of our realist synthesis (see Appendix 9 for a list of these studies). Of these fifty studies, eight made claims about the effectiveness of tags and were therefore deemed eligible for quantitative synthesis (the Effect section).

It is noteworthy that our consultation with retailers produced four reports on tagging trials carried out by two retailers. In Figure 1 these reports are included in 'other sources'. Moreover, four retailers agreed to participate in semi-structured interviews on the use of tags and one retailer agreed to show members of the review team around a central London store to demonstrate how tags are applied in practice. All participating retailers asked that their identities remain anonymous and that the aforementioned industry reports not be shared.
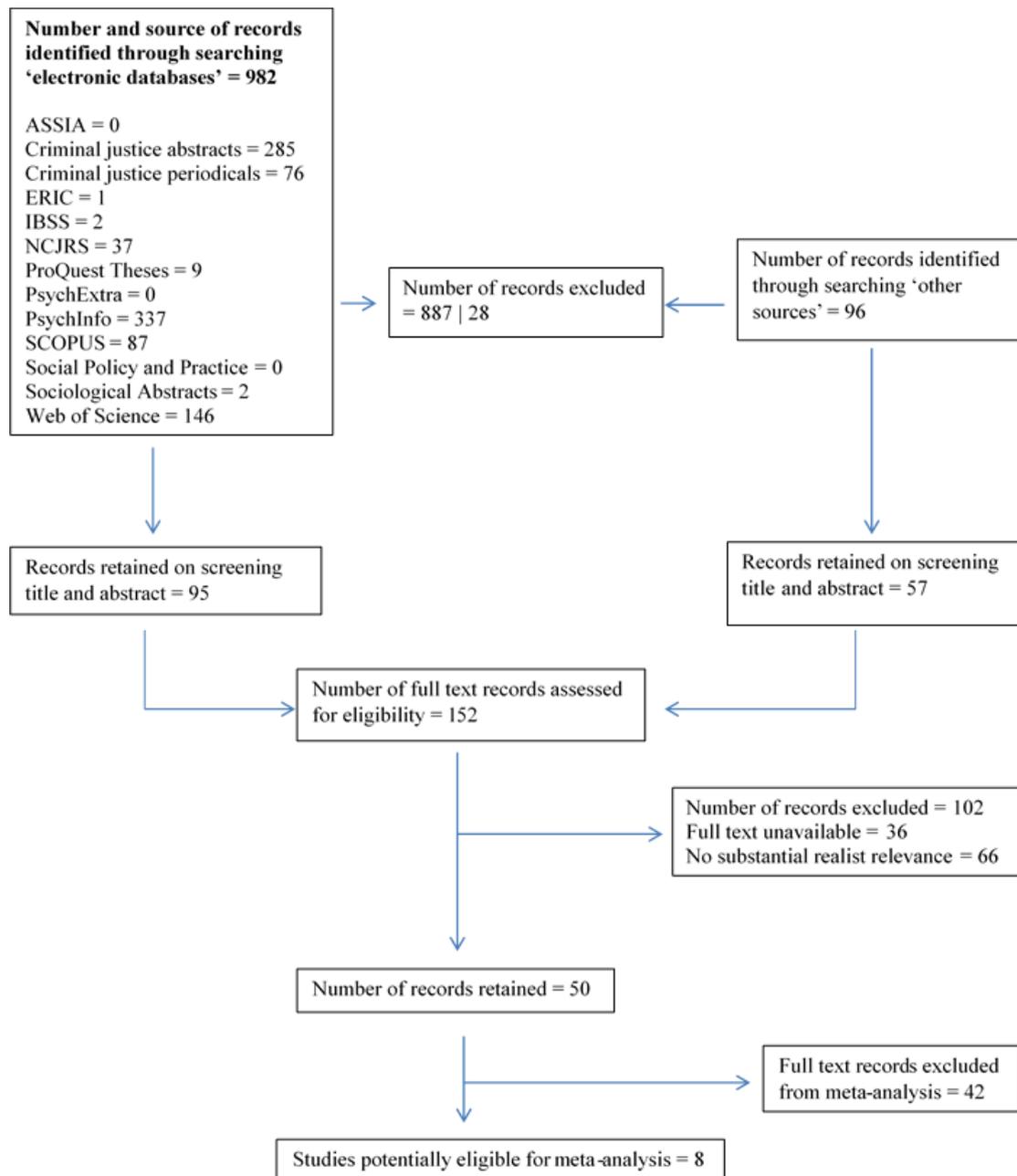
Figure 1 Flowchart of study selection

EFFECT

We identified eight studies that made causal inferences about the effectiveness of tags in retail environments. Characteristics of these studies are summarised in Table 1 and a narrative review is provided in Appendix 10. As shown in Table 1, five studies appeared in the scientific literature (journals or book chapters) and three studies were industry reports, two of which were conducted by a single retailer. Study dates ranged from 1993 to 2016. Seven studies examined the effectiveness of EAS tags and DiLonardo and Clarke (1996) was the only evaluation of the impact of ink tags. We identified no impact evaluation studies for other types of tag. All studies took place in either the U.S. (n = 4) or U.K. (n = 4), in supermarkets (n = 2), large retail stores (n = 3), predominately clothing stockists (n =2) and a large electronics store (n = 1).

Seven of the eight studies used some form of comparison group. This ranged from making comparisons between 1) similar but untagged products in the same store (Retailer B, 2015), 2) different stores in which the specific tags under evaluation were not installed (Farrington et al. 1993; Bamfield, 1994; Hayes and Blackwood, 2006; Beck and Palmer, 2010; Downs, Hayes and Tallman, 2011), and 3) the store chain average more generally (DiLonardo and Clarke, 1997). The trial reported in Retailer A (2015) did use a comparison group but only in relation to changes in sales and availability. The impact of tags on shrinkage was assessed using a before and after design. As shown in Table 1, there was considerable variation in the number of sites included in each study. For example, Farrington et al. (1993) reported on the effectiveness of EAS tags that were implemented in two stores compared to one store that was redesigned with security in mind, one store which received security guards and a 'control' store that received no additional security measures. Likewise, Bamfield (1994) examined a comparatively small sample of four action sites against one control site. The largest study was by Beck and Palmer (2010) which used data from a multibillion dollar US clothing retailer to examine the effects of switching from hard tags to source-tagged soft tags. Retailer B (2015) adopted a different approach to the other studies whereby shrinkage levels for select lines of tagged meat products were compared to that of similar non-tagged items in the same store.

Although these eight studies all made causal inferences about the effectiveness of tags, on closer inspection we observed considerable heterogeneity across studies, particularly in terms

of study outcome measures (discussed below). This was compounded by the different types of tags being evaluated (hard vs. soft EAS tags, visible vs. concealed tags) which, as we shall see, might plausibly give rise to different preventive mechanisms. We felt that these studies were too dissimilar to warrant a meaningful meta-analysis (see Petticrew and Roberts, 2006, chapter 6). The sections that follow discuss the heterogeneity across these studies, looking first at study outcome measures and then at the findings of our risk of bias assessment. The third section draws some tentative conclusions about the effectiveness of tags from reviewing these studies.

Heterogeneity in outcome measures

Table 1 shows that shrinkage/shortage was the most common outcome measure across the eight studies (n = 6). Commentators have long-observed variation in how shrinkage is conceived and measured by retailers (see Beck, 2006; 2016a). Our findings support that conclusion. Bamfield (1994, p. 162) measured shrinkage as "the difference between actual sales + net stock compared with the previous period, and the book level of sales + stock". Downs et al. (2011) likewise measured shrinkage as "actual in-stock – expected in-stock/expected in-stock). DiLonardo and Clarke (1996) and Beck and Palmer (2010) both used store inventory statistics. Finally, Retailer A (2015) and Retailer B (2015) did not provide a clear definition of how shrinkage was measured, possibly for reasons of commercial sensitivity. It should be clear that although each of these studies used some form of shrinkage, it is difficult to determine the comparability of these shrinkage estimates.

Our interviews with retailers revealed that the accuracy of the inventory counting processes that generate shrinkage estimates may vary both by business and product: fledgling businesses with less sophisticated delivery and tracking procedures may suffer a higher proportion of non-theft losses than more mature businesses with highly stringent, well-established systems in place; the delivery and tracking processes for high value items also tend to be more sophisticated than low value items. Moreover, from the perspective of *theft reduction*, an additional limitation is the inability to isolate the degree to which theft is a *source* of shrinkage, as opposed to error, wastage and so on. It is also likely to be unclear who perpetrated the theft – customers or employees (for a related discussion see Beck, 2016a). It is worth mentioning that in some cases it appeared that the researchers had little influence over the data that were available to them. For example, Beck and Palmer (2010, p.

Table 1: Characteristics of studies with quantitative outcome measures studies included in Effect section

Study	Publication type	Location	Store type	Tag type	Item(s) tagged	Action group	Control group	Outcome measure(s)	Results
Farrington et al 1993	Book chapter	UK (country-wide)	Electrical goods stores	EAS tags	Electrical goods	2 stores with tags	1 store control, 1 store redesigned and 1 store with security guards	% of items stolen	Significant long term decrease in number of items stolen in stores where tags were installed
Bamfield 1994	Book chapter	UK (North and Midlands)	Variety chain retailer	EAS hard tags	All except those which cost <£5	4 stores	1 store	Shrinkage	28.3% reduction in shrinkage post intervention
DiLonardo and Clarke 1996	Journal	USA (country-wide)	Women's clothing stores	Ink tags	Clothing	14 stores	None	Shortage	42% reduction in shrinkage where ink tags were installed
Hayes and Blackwood 2006	Journal	USA (several states)	Mass merchant retail chain	EAS tags (concealed and not)	Personal grooming products	13 stores	8 stores	Item loss levels, product availability, sales	No significant difference in loss levels, product availability or sales figures
Beck and Palmer 2010	Journal	USA (country-wide)	Apparel retailer (clothing, fragrances)	EAS hard tags vs EAS soft tags	Clothing	355 stores	540 stores	Shrinkage	250% increase in shrinkage following installation of soft tags
Downs, Hayes and Tallman, 2011	Industry report	USA (location unspecified)	Department store	A3 EAS tag (in red and beige) vs EAS tags	Jeans	3 stores	3 stores	Shrinkage and sales	Overall A3Tags produced a 49% increase in shrinkage and 5% increase in sales; red A3Tags saw a 42% reduction in shrinkage and 18% increase in sales
Retailer A 2015	Industry report	UK (country-wide)	Supermarket	EAS soft tags vs hard cases	CDs	20 stores	60 stores	Shrinkage and sales	134% increase in shrinkage following installation of soft tags; 16.6% increase in sales of tagged items
Retailer B 2015	Industry report	UK (country-wide)	Supermarket	EAS soft tags	Meat products	Number of stores not stated	Similar items in same store	Shrinkage	52.6% reduction in shrinkage following installation of EAS

116) explicitly reported having "no control over the collection of the raw shrinkage data". Similarly Downs et al. (2011, p. 14) add that they "had no control over the accuracy of the data provided by the participating retailer".

It is noteworthy that we identified only two studies that included a *theft* outcome measure. In both cases collecting such data required considerable effort and resources on the part of the research team. Farrington et al. (1993) systematically counted the number of specified items on display each day. Shoplifting was inferred if the absence of a particular item could not be attributed to the item being sold, used, damaged, relocated or given away. It is important to add that this type of theft-specific information could not be gleaned retrospectively using inventory counting systems common to most retailers. Farrington et al. (1993) report that the research team was involved from the outset of the project and worked closely with the participating stores to provide training in and a rationale for this additional data collection procedure.

The second study reporting a theft outcome measure is Hayes and Blackwood (2006), who made use of various data including inventory counts and site observations. A novel feature of their study was the use of CCTV footage from selected stores to determine whether losses could be attributable to customer or employee theft.

Risk of bias assessment

The risk of bias ratings for all eight studies are displayed in Table 2. Selection bias was found to be a key methodological concern in all eight studies. No studies reported the use of inferential statistical tests to ensure equivalence of action and control groups before the installation of tags. Matching was typically based on similar store characteristics (such as size, layout, product range etc) as opposed to outcome measures. Beck and Palmer (2010) display, but do not quantitatively assess, the volume and trajectory of shrinkage in action and control sites before the installation of tags.

How retail stores were selected to receive tags in some studies also raised concerns about their representativeness. In Bamfield's (1994) study, for example, tags were

installed only in those stores that demonstrated a sufficient level of enthusiasm and successfully bid to receive the intervention. It is highly possible that successful store managers who are supportive of tagging are more likely to act in ways that might optimise tag effectiveness through, say, providing adequate training of staff, compared to store managers that were unsuccessful, failed to bid or who are apathetic toward tags. Indeed, this is one of the conclusions of Bamfield's (1994) study, with the largest reductions in shrinkage occurring in those stores that reportedly had the best performing managers. Similar concerns about representativeness are apparent in DiLonardo and Clarke's (1996) study, in which ink tags were installed in 14 newly opened stores and shortage (shrinkage) levels compared to that of the storewide average. The authors acknowledge that although these two groups were considered comparable, a quantitative assessment of their equivalence was not possible given the data available.

Table 2: Risk of bias assessment for eight studies included in Effect section

Study	Selection bias	Measurement bias	Regression to the mean	Contamination effects
Farrington et al. 1993	Medium	Low	High	Medium
Bamfield, 1994	High	Medium	High	Medium
DiLonardo and Clarke, 1996	Medium	Medium	High	Medium
Hayes and Blackwood, 2006	Medium	Low	Low	Medium
Beck and Palmer, 2010	Medium	Medium	Medium	Medium
Downs, Hayes and Tallman, 2011	High	High	High	High
Retailer A, 2015	Medium	High	High	High
Retailer B, 2015	High	High	High	High

Issues concerning potential measurement bias - the extent to which the data analysed were a reliable measure of theft – have already been covered. Farrington et al. (1993) and Hayes and Blackwood (2006) received favourable ratings because their outcome measures spoke more directly to theft. The two retail reports were deemed to be at high risk of bias since it was unclear how shrinkage was measured. Reasons for this are discussed shortly below.

To protect against regression to the mean effects (and confounding variables) studies implementing tagging in high-theft stores needed to be attentive to underlying trends in their data. Hayes and Blackwood (2006) was the only study to attempt to do this through triangulating data from multiple sources, and thus they received a low risk rating. Beck and Palmer (2010) used time series data to provide an indication of trends, but fell short of conducting a rigorous statistical test for seasonality or other patterns in their data, and hence were considered to be at medium risk of bias. In the remaining studies, either regression to the mean had not been taken into consideration or there was not enough information to judge, resulting in high risk of bias. The five studies published in the scientific literature all readily acknowledged various potential confounds that could have affected the observed results (see Moderators and Implementation sections below). Regrettably, and likely owing to a lack of available data, none statistically examined the effect of these possible shortcomings, and hence received a medium risk rating for risk of contamination.

The three industry reports (Retailer A, 2015; Retailer B, 2015; Downs, Hayes and Tallman, 2011) warrant special mention. As seen in Table 2, based on the material presented, each trial received several high-risk ratings. This was largely owing to the lack of information on potential sources of bias or efforts made to discount them. However, to some extent making comparisons between these reports and the aforementioned scientific articles is inappropriate. The reports made available to us were short, pithy, and contained little superfluous information beyond the key priorities of retailers: what was done and what was found in relation to customer and staff reactions and, ultimately, sales. They were written for an internal audience who are likely to be familiar with how security devices are implemented and assessed in that particular store, and were likely presented with supplementary verbal accounts.

They were not produced for external scrutiny on the research methods undertaken, as has occurred here.

Overall findings of eligible studies

What, then, can be said about the effectiveness of tags as a theft reduction measure in retail environments? Mindful of the aforementioned variability in outcome measures, if we assume that reductions in theft, loss, shrinkage and shortage all denote positive outcomes associated with the introduction of tags, then across these eight studies we find mixed results. Considering all types of tags, five studies report positive results (Farrington et al. 1993; Bamfield, 1994; DiLonardo and Clarke, 1996; Downs et al. 2011 (specifically in relation to red A3Tags); Retailer B, 2015) (see Table 1). With the exception of Retailer B (2015), these studies all relate to the effectiveness of *visible* tags. Of these studies, Farrington et al. (1993) is unusual in collecting theft-specific data, finding that electronic tags produced significant and sustained reductions (over at least six weeks) in shoplifting compared to those stores where tags were not fitted. However, there are concerns over the representativeness of these findings considering the small number of stores that received tags (n = 2) and the limited time period over which tag effectiveness was assessed (1 week pre-intervention and up to 6 weeks post intervention).

As shown in Table 2, the methods used by Hayes and Blackwood (2006) are arguably the most robust of the eight evaluation studies we identified. Their quasi-experimental study related specifically to source-tagged *concealed* EAS tags affixed to personal grooming products. They found no significant differences in loss, product availability or sales figures across test and control stores. By contrast, Beck and Palmer (2010) and Retailer A (2015) report an *increase* in shrinkage following the installation of tags. These apparent backfire effects warrant closer scrutiny. Beck and Palmer (2010), for example, assessed changes in shrinkage rates following the switch from more visible hard tags to less visible soft tags; it was not a conventional tag versus no tag evaluation. The resultant 251% increase in shrinkage in the action stores (compared to a 33% increase in control stores) may, therefore, be partly explained by the effectiveness of the previous (more visible) tag regime. As the study authors report, staff where the new tags were installed attributed the observed increase in shrinkage

to "the lack of a visual deterrent to would-be thieves", and as alarm activations increased, "staff members [became] less likely to respond [to sounding alarms] and more likely to simply wave customers through" (Beck and Palmer, 2010, p. 119). Moreover, staff felt that the soft tags, once noticed by offenders, were easier to remove than hard tags, thereby bypassing the alarm system and further contributing to the increases in shrinkage. This hypothesis was based on an apparent increase in the number of discarded tags found in changing rooms. Also on the topic of tag visibility, Downs et al. (2011) showed that the installation of a new type of EAS tag in *red* produced reductions in shrinkage and increases in sales whereas for the beige counterpart, the reverse was true.

The backfire effect reported by Retailer A (2015) also requires elaboration. As indicated in Table 1, this trial examined the impact of replacing secure casings for CDs with soft RF tags. The CD casings were considered too bulky and unattractive and were replaced with what were judged to be less obtrusive security measures. Shrinkage figures for tagged CDs was 134% greater over the eight-week trial period compared to the same time period before the tags were applied. Although clearly a negative result from the perspective of loss prevention, the authors report a corresponding *increase* in the sale of tagged CDs in 20 action stores (24.7%) compared to CDs in 60 comparison stores where tags were not fitted (which saw an increase in sales of 6.3%), producing an overall net profit. Combined with reported improvements in the sale process and staff time (it was considered quicker and easier to deactivate the tags than remove the secure casings), the tag strategy was considered a success. This apparent disconnect between theft reduction and economic profit is a topic we return to in the Discussion.

MECHANISMS

Mechanisms are taken here to refer to the processes through which tagging in retail environments produces the observed effects (Pawson and Tilley, 1997). Determining the causal mechanism(s) responsible for outcome patterns is challenging, for several reasons: 1) there is often confusion over what constitutes a mechanism (Dalkin et al. 2015), 2) the term is rarely used explicitly in primary studies and 3) how a crime

prevention intervention is assumed to work is rarely articulated (van der Knaap et al. 2008; Sidebottom and Tilley, 2012).

It is important to acknowledge from the outset that none of the studies we identified contained a *quantitative assessment* of tag-related mechanisms nor did they report data that would allow for a retrospective analysis. Consequently, what we describe here are the main mechanisms evident from the sources we scrutinised. Each is discussed here in isolation. In reality, however, it should be noted that tags might activate multiple mechanisms, giving rise to varying outcome patterns or working in concert to produce the same patterns jointly.

References to mechanisms in the tagging literature reviewed

We assessed the prevalence of mechanism-related information in the 50 tagging studies we identified using a simple 3-point scale: 1) the study explicitly referred to how tagging is expected to work, 2) the study alluded to how tagging is expected to work and 3) the study made no reference to the mechanisms through which tagging is expected to work. An obvious limitation with this method is that it takes no account of variation in the extent to which studies discuss mechanism-related information.

Of the 50 studies consulted in the realist branch of our review, we judged that 27 (54%) included information regarding tag-related mechanisms (see Appendix 11). Of those 27 studies, eighteen explicitly referred to how tagging is expected to operate. This is a high proportion compared to other realist reviews of crime prevention interventions (see van der Knaap et al. 2008; Sidebottom et al. 2017). To illustrate, a study that we coded as alluding to tag-related mechanisms might refer to tags producing a deterrent effect. Farrington et al. (1993, p. 100), by contrast, *explicitly* made reference to mechanisms when they stated that 'electronic tagging …[was] intended to have a deterrent effect by increasing the subjective probability of detection'.

We limit our focus here to those 27 studies that explicitly or otherwise reported information concerning tag-related mechanisms. What follows is a description of the three main mechanisms that emerged from these studies. As will become clear, certain

mechanisms are associated with particular types of tags, and are assumed to work differently in different settings. The latter will be covered in more detail in the Moderator section.

Increasing the risks

The dominant mechanism through which tagging is expected to work concerns increasing the risk of an offender being detected (referred to in 25 studies (50%), see Appendix 11). Importantly, this mechanism can operate in two ways – either by altering the perception of risk or by influencing the probability of detection. To elaborate, tags might reduce theft because their presence discourages thieves from attempting to steal tagged items since their chance of detection is perceived to be elevated. In this scenario, thieves avoid *attempting* to steal tagged items. By contrast, the presence of tags may go unnoticed by offenders (particularly if the tags are concealed) or be spotted and ignored. In this scenario the offender proceeds to try to remove the item from the store but the tag activates an alarm, which in turn mobilises staff and results in the offender being apprehended, thereby leading to reductions in theft. Hence the former refers to *perceived* risk, whereas the latter refers to *actual* risk of detection.

Both scenarios relate to increases in the risk of detection: the former serves to deter would-be thieves and the latter boosts the probability of an offender being apprehended. The latter is largely reserved for describing the effects of EAS tags. As noted previously, ink tags are not electronic and therefore do not activate an alarm system. For ink tags, any associated increases in risk could only be produced should an offender attempt to remove the ink tag in store and either being spotted by a member of staff or being coated in the indelible ink (Bamfield, 1992).

Reducing the rewards/benefit denial

The second most frequently mentioned mechanism, referred to in six studies (12%) (see Appendix 11) concerns the reductions in rewards or benefits brought about through using tags. In the studies identified, reward reductions were mainly discussed in relation to ink tags[vi]. Simply put, attempts to remove ink tags illegally might cause

the tag to break, thereby releasing the ink and spoiling the sought after item. This in turn would presumably make the item less desirable and harder to sell (Clarke, 1999).

Increasing the effort

Gill, Bilby and Turbin (1999), in their interviews with 38 shop thieves, discuss the topic of removing tags in store. This relates to a third albeit less frequently discussed mechanism through which tags might plausibly reduce theft: through increasing the effort of offenders (mentioned in only two studies). This mechanism might reduce theft in one of two ways. The first concerns the effort required to exit a store with a tagged item without raising suspicions of staff or other onlookers who might intervene. All things being equal, the required effort is likely to be higher for a tagged item than a non-tagged equivalent, most obviously in efforts to circumvent associated alarm systems (for EAS tags). A second way through which tags might increase offender effort relates to the actual removal of the tag, be that in-store or after the event. Again, it is plausible that thieves might be deterred from stealing products that require extensive efforts or tools to remove the tag. Although plausible, it should be noted that the literature we reviewed provided several examples of the methods and ease with which shoplifters were able to remove tags (see for e.g. Bamfield, 1994; Handford, 1994; Farrington et al. 1993; Gill, Bilby and Turbin, 1999), thereby undermining this mechanism.

Mechanisms generating alternative outcome patterns

The three mechanisms described above all relate to theft or loss reduction. The mechanisms activated by tagging might, however, also plausibly give rise to other unintended positive or negative outcomes. These additional outcome measures were identified primarily through our discussions with retailers. Wherever possible, strong crime prevention evaluations should look to account for unexpected effects (see Eck, 2017). These additional measures are therefore discussed here as candidates for inclusion in future tagging evaluations.

A positive effect of tagging concerns increases in sales. Reductions in loss as a consequence of tagging could increase (or at least not reduce) the availability of

tagged items which in turn might boost sales. Here reductions in theft are an *intermediate* outcome measure, leading to increases in sales (a non-crime final outcome measure). A related positive effect of tagging concerns a reduction in erroneous stock-outs. Many retailers employ automatic stock replenishment systems. The accuracy of these systems is often compromised by high levels of theft because stolen items do not register on stock management systems. Over time, such systems may conclude that the sales of frequently stolen products have dwindled and that replenishment is unnecessary, leading to reduced availability of such items on the shelves.

Turning to negative outcomes association with tagging, some customers may interpret widespread and overt product tagging as an indication of a high crime store (and/or high crime area), which in turn might encourage them to shop elsewhere and/or shop less often (see Longmore- Etheridge 1998). Moreover, inconsistent affixation of tags coupled with poor or tricky detachment procedures might increase the time spent at the point of sale, thereby fuelling irritation among customers and staff and decreasing productivity levels. This could plausibly lead to several unwanted outcomes: customers do not buy the item or go elsewhere, or staff search less diligently for tags on products - thereby increasing the number of false alarms and associated customer embarrassment.

MODERATORS

The terms 'moderator' and 'context' are used interchangeably in this section. They refer to the conditions that enable tags to activate potential causal mechanisms. Similar tags may, thus, activate different mechanisms depending on context, leading to variations in outcomes. As will become clear in the following two sections, some moderators are strongly influenced by the decisions and actions of those responsible for the **i**mplementation of tags, and so some of the same themes occur when discussing both moderators and implementation.

Twenty-eight studies (56%) contained information about moderators of tag effectiveness (see Appendix 11). Eleven of these studies clearly stated one or more potential moderators and the other seventeen alluded to such influences. Taken

together, these studies suggest that tagging and shop theft comprise a complex system, made up of interdependent individuals and organisations that adjust and adapt to one another. We identified five key elements that make up this system, all interacting in the causal processes at work in the operation of tags:

1. The shop (and its staff),
2. Customers (including shoplifters),
3. The tag technology (and its providers),
4. The product (and its designers), and
5. The police and criminal justice system.

The literature we identified provides the following evidence relating to contextual variations that shape the mechanisms activated by tags and thereby some of the outcome patterns generated. These can be tied back into the five key elements listed above.

1. *Staff responses and shop setting*

All alarm systems are prey to false alarms, and the way in which staff and customers respond to these alarms is important (see Blackwood and Hayes, 2003). Although on one hand, false alarms can be considered a negative consequence of EAS tagging, on the other hand they can also be viewed as a moderator of tag effectiveness. Regarding the latter, Beck (1996; 2002) finds that high false alarm rates (up to 93% in some cases) can reduce staff and shoplifter confidence in the alarms. For EAS tags, this can undermine the aforementioned risk-elevating mechanisms; both *perceived* risk of detection and, through reduced responses from staff, the *actual* risk of detection. Hayes and Blackwood (2006) report only an 18% response rate to 4,000 alarm activations, and even then staff usually failed to reconcile the items found on people with their till receipts.

False alarms have a range of sources including un-removed tags passing through the store gates, goods bought at other stores, untagged items that nevertheless trigger the alarm, and defects in the alarm system itself (Beck, 2002). Failure to deactivate within store may be a function of either weaknesses in the system making deactivation

problematic or lack of staff vigilance or training (Handford, 1994). False alarms can cause embarrassment or anger to legitimate customers; some expect an apology and may be put off returning to the store in question, while others familiar with tags and their rationale have been found to be more understanding (Dawson, 1993; Blackwood and Hayes, 2006). False arrests resulting from false alarms have historically (and especially in the US) resulted in prosecution and reputational costs for the stores involved (see Bickman et al. 1980). Against the real risk of false alarms, Bamford (nd) suggests that where false alarms are occasional they may function as reminders to potential shoplifters that tags are being used in a store and thereby reinforce their deterrence value (increase risk mechanism).

Busy shopping periods compromise the scope for staff to respond to alarms. There is evidence of clear seasonal patterns to busyness, where greater busyness is associated with higher levels of shrinkage (Global Retail Theft Barometer, 2015), although this shrinkage cannot be conclusively attributed to shoplifting. Physically the shop layout may facilitate or impede the operation of tagging systems. Doors without sensors offer an attractive low risk exit route for thieves with EAS-tagged goods. Moreover the space between gates affects the consistency of alarm activation (Huber, 2006). The layout of the shop may offer greater or fewer opportunities for the shoplifter to remove tags inconspicuously within store and to walk out without triggering an alarm, and hence reduce risk of apprehension. The shop may or may not include signage that reminds customers of tagging (and other security measures) and/or CCTV systems that can be used in conjunction with tags to increase the perceived risk to shoplifters by supplementing the evidence that goods have been stolen (Beck and Palmer, 2010; Capers, 2008).

2.   *Type of shoplifter and customers*

Two types of shoplifter are commonly referred to in the literature, with some empirical support for the distinction: the 'casual', 'amateur', 'novice', 'impulsive', or 'opportunist' and the 'professional', 'hard core' or 'expert' (Gill et al. 1999; Carmel-Gifilen, 2011; Hayes, 1999; Beck, 2002). Professional shoplifters tend to steal frequently, steal large quantities of goods, plan their shoplifting, steal for resale or refund, check out stores for opportunities and risks, test the efficacy of security

measures including tags, and work out ways of circumventing them. These methods of circumvention are clearly then disseminated, sometimes widely as is evident from readily available advice on the internet. Casual shoplifters on the other hand tend not to plan shoplifting, steal for their own use or to give to others, steal for fun, and to take goods where opportunities manifestly present themselves. They may learn about opportunities to circumvent measures. They are less likely to develop them. For casual shoplifters, conspicuous tags with high levels of publicity are deemed effective and to deter thefts that would otherwise occur.

For professional shoplifters, deterrence is short-term and covert tags are deemed to have an effect through their scope to lead to arrests of shoplifters who are unaware of the risks they are taking (see Handford 1994; Capers 2008; Bickman et al. 1980; Lottes 1992 on the different ways in which overt and covert tags work as potential shoplifting prevention measures). As described previously, Beck and Palmer's (2010) observation that when hard, conspicuous tags were replaced with soft inconspicuous ones, losses increased dramatically (by 250%), suggests that the visible deterrence that is of greater relevance to the casual shoplifter had been more effective, which may in turn suggest that casual shoplifters who are more easily deterred in this case were responsible for the bulk of the losses (see also Downs et al. 2011). Likewise, Buckle and Farrington (1984) in an observational study in a store in Peterborough (UK), which involved tracking and observing a random selection of 503 shoppers for an average of 6.9 minutes each found that 1.8% stole something and none was apprehended. In a more recent study from the U.S. using similar methods, Dabney, Hollinger and Dugan (2004) found 8.5% of shoppers were observed shoplifting. These rates of theft suggest that many customers may be tempted occasionally to steal items, as fairly casual shoplifters.

3.   *Tagging strategy and technology*

As mentioned previously, tags vary in their visibility; 'soft' tags tend to be inconspicuous and 'hard' tags conspicuous. The effect of conspicuous hard tags depends less on staff vigilance than soft inconspicuous tags in that they convey to the shoplifter the impression that they face *increased risks* of apprehension if they steal the goods. Soft tags may not be spotted by the shoplifter until the alarm sounds as

they exit the shop and, if they are not stopped, then any potential crime prevention mechanism is undermined. Indeed, the tag may thereby become discredited as a source of increased risk in the eyes of the shoplifter (see Beck and Palmer, 2010). In recent years several tag vendors have added symbols to soft tags in a bid to make them more conspicuous to potential offenders (Beck, personal communication).

Tagging dosage also varies. Of the 12 US-based retailers interviewed by Blackwood and Hayes (2003), seven were unsure of the proportion of merchandise that was (EAS) tagged and across the remaining five retailers the average was 26% of merchandise (ranging from 1% to 65%). In some stores there is a comprehensive tagging strategy. One retailer we visited as part of this study hard tagged all goods (except for shoes where only those for the right foot were on display). The tags used had features of EAS and ink tags, combining efforts in a bid to activate mechanisms associated with increases in perceived risk (EAS) and denying the benefits (ink tag) of shoplifting. This retailer also used an innovative method of attaching the tags to goods, which had (reportedly) yet to be circumvented by any shoplifters. Dramatic drops in shrinkage had been claimed by this retailer in the commercial press. The idea was to create stores that were comprehensively inhospitable to shoplifters.

Other tagging strategies include tagging frequently stolen goods, high value goods, implementing different types of tag (some of which may be decoy tags) and 'fractional tagging' whereby only a proportion of goods is 'protected' by tags in the expectation that diffusion of benefits effects (see Clarke and Wesiburd, 1994) will also reduce the rate at which untagged goods are stolen (Bender 1997; Masuda, 1997; Hayes and Blackwood, 2006). It is important to note that the opposite might occur insofar that there is displacement from the theft of tagged to untagged items (Bamfield, 1994) or from stores with tags to stores without them (Farrington, 1993). No studies we identified revealed information on the difference these variations in tagging strategy had on the overall rate of shrinkage (studies did, however, examine the cost implications of fractional tagging, which we discuss in the Economics section). We return to the topic of displacement and diffusions of benefits in the Discussion.

4.   *Type of merchandise*

The type of merchandise sold in shops clearly shapes the type of tagging that is possible and the costs of doing so. Ink tags, for example, can quite easily be applied to clothes (DiLonardo and Clarke, 1996) but are less relevant to other products. Meat, which is commonly stolen in some grocery stores is not readily open to hard tags (Retailer A, 2015). Some goods are so inexpensive that the costs of tagging would be prohibitive. Hence the potential for tagging and the activation of specific preventive mechanisms depends on a store's product mix. Stores were found to consider the effect of tags on sales as well as theft in decisions about which tag to use and whether to use them at all. Some types of tag for some products make restocking more difficult and time consuming than others. For example, in one trial, conspicuous bottle-top tagging of alcoholic drinks was found to make restocking more difficult than soft tags (Retailer C, 2016). As discussed previously, tags were applied to CDs in one store because they made displaying and restocking more straightforward (than previous secure casing) and hence increased sales, even at the expense of in-retailer research that showed there were more thefts of them (Retailer B, 2015).

5.   *Police and criminal justice system*

Depending upon whether the goal of the retailer is to deter theft or detect and apprehend offenders, the response of criminal justice agencies (responsible for arrest, prosecution, conviction and punishment) is important. This concerns not only the decisions agencies take but also the speed with which they (and in particular the police) react. This in turn feeds back into the tagging strategies adopted. One UK retailer we interviewed remarked that it often took the police over an hour to come to a shop if it reported that a suspected shoplifter had been detained. This created three problems. First, detaining someone, if they are violent, creates risks for store personnel. Second, at least two people are taken off the shop floor whilst the person is held. Third, there could be no certainty that a person who was detained would eventually be charged, prosecuted and convicted. For these reasons, the store elected only to detain someone activating an alarm in extreme circumstances, that is when they had provided a prior warning to the individual, when they had provided a visible presence when that person was within a store (they had a high quality CCTV system),

and when nevertheless the person still carried goods that activated the alarm as they left the shop. This happened infrequently.

IMPLEMENTATION

Problems of implementation are a common feature of crime prevention (Knutsson and Clarke, 2006). In the context of this review, implementation refers to the practical task of installing tags so as to optimise the conditions for them to work effectively. Put differently, those actions that best ensure the *context* is sufficient to activate the sought after preventive mechanisms. Of the 50 studies we identified, 36 mentioned implementation issues and of those 29 contained detailed information on specific aspects of implementation (see Appendix 11). In what follows this information is organised into two main themes: staffing issues and choice of tagging strategy.

1.   Staffing issues

Store staff clearly play an important role in the installation and management of tags. Many of the aforementioned moderators of tag effectiveness relate to the decisions and actions of staff. There were several examples of implementation failures that were attributable to staffing problems. These included failure to correctly attach tags (Farrington et al 1993), double tagging (Handford, 1994; Huber, 2006), or attaching tags so that they cannot be easily removed (Bamfield, 1992; Beck, 2006; Beck and Palmer, 2010). Moreover, studies found that tags were often not deactivated properly (Handford, 1994; Beck, 2002) or that staff failed to react appropriately to activated alarms (Baumer and Rosenbaum, 1984; Blackwood and Hayes, 2003). Maximising the probability that tags are appropriately and consistently attached to items, that they are properly removed or deactivated at point of sale, or that sounding alarms are responded to − moderators of tag effectiveness related to implementation - was generally considered to be influenced by the extent to which staff are adequately trained, monitored and incentivised to participate in a tagging programme.

2. *Tagging strategy*

Decisions about the type of tag(s) to use are obviously dependent on cost (discussed in Economics), store design and the items intended for tagging. In addition, retailers must decide on an appropriate tagging strategy. This can take several forms:

- *Source tagging vs. in-store tagging*: As already mentioned, source tagging involves a tag being incorporated into the label, fabric or packaging of a product at the point of manufacture. Here, specialised staff or processes at point of manufacture can ensure the proper application of tags rather than store staff, who have to be trained and resourced to do so. Source tagging is thus often preferable to retailers since it absolves them of tagging items in store. However, a major difficulty for source tagging is that different manufactures (and retailers) often use different types of tags (for e.g. AM vs. RF EAS tags), each requiring corresponding detection and removal equipment (Beck, 2002). This is a particular problem for stores selling products supplied by different manufacturers and potentially different tagging systems. An alternative approach would require co-operation between producers and retailers (who are often competitors) to incorporate the same kind of tag and technology across all retail outlets of one store or across different stores. Interviews with 12 retailers in the US, who collectively represented over 11,00 individual stores, suggested that the vast majority of tags are implemented in-store as opposed to at source (Blackwood and Hayes, 2003).

- *Universal tagging vs. fractional tagging*: We have already seen in the Moderator section how tag dosage is thought to affect offender perceptions. Yet how tags are applied to products is also a practical decision. Universal tagging is time and resource intensive and can be expensive. However, whether it is preferable to tag fractionally or to tag selectively only some expensive or desirable products depends on the type of merchandise being sold and on the risk of shop theft given the shop's location and type of clientele.

ECONOMICS

Thirty-two of the 50 studies (64%) contained economic information relating to tagging. A narrative summary of relevant economic information is provided here, both in terms of the cost *and* cost effectiveness of tagging. Despite the high prevalence of economic information in these studies, regrettably, this information was not sufficient to conduct a full economic evaluation (such as cost-benefit analysis). We return to this point in the Discussion.

Cost of tagging

The cost of tags was found to vary widely across studies. Disposable RF EAS tags are now available for as little as a penny each (Loebbecke and Palmer, 2006). EAS reusable tags cost around 20-35p (Retailer D, 2015). The most expensive tags (in terms of initial outlay) appear to be ink tags, which are designed to be reusable. However, ink tags typically require less infrastructure and therefore have lower set-up costs than EAS tags since they do not require electronic gates (DiLonardo and Clarke, 1996). It is noteworthy that recent developments in tagging that combine EAS and ink capsules employ both the electronic gates of a traditional EAS system and the tag detachers, thereby making it more expensive than an ink tag system alone. Variations in cost were mostly attributed to the type of tag and their re-usability. As mentioned previously, widespread adoption and technological advancements have significantly reduced the cost of contemporary tagging (Chainlink, 2014).

Information on the costs of the wider EAS tag system (electronic gates at store entrances and exits, de-tagging machinery, tag readers) received less coverage in the studies we identified (n = 15). These studies all alluded to retailers having to account for more than the costs of tags when deciding upon a system. For example, a large retailer must implement the same system across many stores. Conversations with retailers have suggested that £2,000 for a present-day de-tagging device would not be uncommon, and stores will often have multiple de-tagging devices.

A further set of costs relate to employees, whether this is hiring new security guards to monitor electronic gates, training existing staff to handle new tagging systems, or

the hours required to tag and de-tag products in store (if adopting this tagging strategy). Studies from retailers suggest that these costs are keenly observed as part of tagging trials, and form part of the consideration of the economic viability of different tagging systems. Two trials conducted by major retailers, one of soft RF EAS tags on CDs and another of magnetic tags on wallets, measured the amount of time in seconds taken to apply and, in the latter case, remove the tags (Retailer A, 2015; Retailer D, 2015). These figures were then converted into an annual number of staff hours, giving sophisticated monetary estimates which were then considered as part of the overall performance of installed tags.

Economic returns associated with tagging

Considerations over the economic returns associated with tagging relate to the various roles which tags are expected to play in retail environments including but not limited to loss reduction (i.e. stock tracking and management). These wider benefits consequent on tagging create complications when attempting to conduct a cost-benefit analysis. There are numerous ways of calculating costs and benefits (as discussed in more detail by Beck 2008 and Chainlink 2014), but cost-benefit analyses may be even more important for small retailers where even low levels of shrinkage can have significant negative effects on retailers' profit margins (DiLonardo, 1996). Despite the obvious importance of assessing cost-effectiveness, in their interviews with a convenience sample of 12 US retailers, Blackwood and Hayes (2003) found only a quarter reported carrying out routine assessments on the return on investment following the installation of tags.

We have already mentioned the different types of tagging strategy available. The tagging strategy employed by retailers has cost implications. One way in which retailers may reduce their expenditure is to apply tags in their own supply chain (Beck, personal communication). An additional approach is to work with a manufacturer who tags items at source, rather than to apply tags in-store. However, this may lead to the cost of tagging being forced upon manufacturers instead, many of whom may be reluctant to absorb such costs (Chainlink, 2014). There are examples in the literature of manufacturers being persuaded by large retailers to apply tags. Retailers use various methods, including threats no longer to stock the product, promises of

increases in sales and shelf space, and offers to share the costs of tagging. Equally important to note is that, if tags are effective, then if manufacturers agree to apply them at source, a boost in sales should ensue, benefitting manufacturers and retailers alike.

Tagging at source can also assist 'fractional tagging' and the sought-after 'halo effect' (or diffusion of benefits) of tagged items providing protection to non-tagged items. The economic implications of such a 'halo effect' was quantified by one large retailer who saw savings of tens of thousands of pounds in reduced shrinkage amongst similar non-tagged items, which was included in the cost-benefit analysis of the tagging trial (Retailer C, 2015). Another study found this effect moved to unrelated items within the store (Masuda, 1997). This potential diffusion of benefits could be quantified by researchers and used to rank some systems over others, by saving money and increasing margins.

DISCUSSION

Tags are commonly used in retail environments, but their effectiveness as a theft reduction measure has yet to be the subject of a systematic review. In this paper we followed the EMMIE framework (Johnson, Bowers & Tilley, 2015) to review the evidence as it relates to 1) whether tags are effective at reducing theft, 2) the causal mechanisms through which tags are thought to work, 3) the contextual factors that moderate tag effectiveness, 4) how tags are implemented in retail settings and 5) the economics of tagging.

Following a systematic search of the published and unpublished literature, and through consultation with retailers, we identified fifty studies that met our eligibility criteria. Eight studies reported quantitative data and were assessed for information concerning the effectiveness of tagging. On closer scrutiny, substantial variation in the type of tag installed and how tag effectiveness was measured precluded a meta-analysis. Concerns about selection bias were also noted since no study reported any statistical analyses to determine the equivalence of action and control groups before intervention. Drawing firm conclusions about the effectiveness of specific types of tag is therefore challenging. For example, we found only one study on the effectiveness

of ink tags, and that dates back some twenty years (DiLonardo and Clarke, 1996). Likewise with EAS tags, whilst several early studies converge on the finding that tagging is effective (Farrington et al. 1993; Bamfield, 1994), evidence from a larger and more recent study with a stronger research design found tagging to have no noticeable impact (Hayes and Blackwood, 2006). Moreover, studies such as that by Beck and Palmer (2010) speak more to the comparative effectiveness of different forms of EAS tag (hard tags vs. soft tags) as opposed to the effectiveness of tagging per se. Despite this variation, across the eight studies evidence does suggest that more visible tags tend to be associated with greater reductions in shrinkage than less visible tags.

The complexity of tagging was further elucidated through the realist branch of our review, which examined a wider range of studies supplemented with interviews with four retailers. It is clear that different types of tag are expected to produce reductions in theft through different *mechanisms,* which in turn require contrasting conditions for their activation (*moderators*), and which give rise to different *implementation* challenges. EAS tags, for example, are widely assumed to reduce theft through increasing the (perceived or actual) risk that offenders are apprehended. Activation of these risk-enhancing mechanisms is in turn influenced by factors such as tag visibility (did offenders spot the tag?), staff behaviour (did staff respond to the sounding alarm?) and the type of shoplifter thought to operate in store (were offenders deterred by the tagging system?). Ink tags, by contrast, are generally assumed to reduce theft because of the inconvenience associated with removing the tag and the potential release of indelible ink, thereby spoiling the product and making it harder to sell. This variation in how different tags are expected to reduce theft also suggests that pooling information across tag types (in, say, a meta-analysis) to generate an overall conclusion is inappropriate.

It is noteworthy that we identified no high-quality published economic evaluations of tagging (i.e. estimates on the direct and indirect economics costs and benefits of a tagging strategy). Although economic analysis remains infrequent in the crime prevention literature more generally (see Manning et al. 2015), its absence in the context of this review is surprising given the high priority retailers place on cost effectiveness. We suspect this lack of economic evaluation is a product of data

accessibility rather than data *availability*. Consultation with retailers in the UK as part of this review indicated that economic data is available and that trials on the cost effectiveness of tags are routinely undertaken, albeit that the results of such trials are seldom made public for commercially sensitive reasons. However, it is difficult to determine how representative such actions are since evidence from a convenience sample of 12 US-based retailers suggests that robust cost-benefit analysis of tagging remains infrequent (Blackwood and Hayes, 2003). Further research is needed to determine the range of financial costs and outcomes associated with tagging, and how these vary by tag type and product.

The issue of commercially sensitive data speaks to a broader methodological issue encountered in this review, namely our decision to include information that is not publically available. As described in our methods section, in conducting this review we made efforts to involve retailers, some of whom agreed to take part in semi-structured interviews and share internal (confidential) reports of tagging trials. The information gleaned from these sources proved helpful in producing this report and usefully provided a window on the priorities of retail decision makers, but it is unlikely to be made publicly available. On one hand, including evidence that is inaccessible to the research community for reasons of confidentiality goes against the transparency and reproducibility that characterizes the systematic review process. On the other hand, if the purpose of a systematic review is to locate and synthesise relevant evidence so as to arrive at an informed judgment about the effectiveness and appropriateness of, in this case, tagging, it might be considered remiss to exclude information that speaks to that aim.

Implications for practice and research

Much has been written about the use of tags as a theft reduction measure, likely reflecting their widespread use by retailers. We found that this literature helpfully covers a wide range of tag-relevant topics, synthesized here according to the five dimensions of EMMIE. There are, however, several important questions that are yet to be adequately investigated. Addressing these knowledge gaps will most likely be achieved through improved evaluations of tagging in retail environments, building on the small number of evaluation studies we identified in this review.

One important topic that is currently understudied concerns crime displacement. Product tagging is a form of situational crime prevention. Historically the main criticism of situational crime prevention has been that any reductions in crime associated with situational measures are undone by offenders shifting their activities to different places and times that fall outside of the range of situational intervention. Evidence to reject the hypothesis that displacement is an inexorable consequence of situational measures is now overwhelming (Guerette and Bowers, 2009); indeed positive diffusion of crime control benefits are repeatedly observed (Guerette and Bowers, 2009; Clarke and Weisburd, 1994). Several studies we identified in this review mentioned but did not empirically assess crime displacement and/or diffusion of benefits associated with tagging (Farrington et al. 1993; Beck and Palmer, 2010). Nor were sufficient data reported for displacement to be analysed retrospectively by the review authors. The closest formal assessment was provided in two retailer reports which sought to quantify the economic impact of "halo effects" on related but non-tagged products (Retailer B, 2015; Retailer C, 2015).

In the context of tagging in retail environments, crime displacement/diffusion of benefits could take several forms: 1) target displacement/ diffusion of benefits *within* stores from tagged to non-tagged items, 2) spatial displacement/ diffusion of benefits to nearby *different* stores and 3) spatial displacement/ diffusion of benefits to stores of the same chain (where applicable) located *elsewhere*. This is an area where future research might usefully be directed, not least because interviews with shoplifters conducted by Giblin et al. (2015) revealed that a small proportion reportedly would shoplift elsewhere when confronted by a credible tagging strategy.

Displacement usually refers to the actions of *individual* offenders in response to situational measures. Adaptation refers to the longer-term process of *populations* of offenders seeking to overcome situational measures (Clarke and Bowers, 2017). When discussing offender adaptation, Ekblom (1999) famously characterises crime prevention as an arms race. Efforts to prevent crime prompt adaptation among those trying to commit it. The literature on retail crime alludes to several such arms races (see, for example, Lasky, Fisher and Jacques, 2015) as offenders seek to circumvent preventive measures. Likewise, the literature we reviewed here contained several references to the many ways in which offenders tried to bypass or override tagging

systems (Handford, 1994; Farrington et al. 1993). Despite this, we identified little evidence on the long-term effectiveness of tags. Addressing this gap is important in light of the adaptive and innovative capacity of shop thieves in combination with the aforementioned challenges of sustaining a tagging strategy where tags might variously be dysfunctional, damaged or disappear. The longest study period of an evaluation study we identified was twelve months post intervention (Beck and Palmer, 2010). Future research might usefully investigate the sustainability of any preventive effects associated with tagging, both to explore the scope for offender adaptation and the practical task of maintaining an effective tag system over time.

Consistent with Sidebottom et al. (2017) in their EMMIE-informed review of alley gating, we found scant *empirical* evidence relating to the mechanisms through which an intervention (here tags) might plausibly reduce crime. Information in the primary studies we identified was only *suggestive* of how tags might produce their effects. Future evaluation studies might usefully collect data related to the expected signatures (i.e. intermediate and ultimate outcome measures) associated with distinctive (and rival) tag mechanisms (for a related discussion see Eck and Madensen, 2009; Weisburd et al. 2015). Doing so would help judge which of the plausible mechanisms are responsible for observed tag effects.

To this aim, Figure 2 presents a simple logic model denoting how EAS tags might reduce theft, developed by the study authors based on the evidence we reviewed here. To be clear, Figure 2 is *indicative* of just some of the ways in which EAS tags are thought to work, it is not supported by empirical evidence. The key point is that logic models such as this can usefully inform future tagging evaluations, signposting potential opportunities for data collection on intermediate outcome measures. In this example, a single tagging strategy is generating the same outcome – reductions in theft – but doing so through different means, each of which produce distinctive signatures which might be amenable to (primary) data collection. For example, if the causal chain shown at the top of Figure 2 were in operation, then we would expect to observe increases in alarm activations and the apprehension of thieves with tagged goods that had not been paid for. Failure to observe these patterns would suggest that some other mechanism is responsible for the observed effects. Take the causal chain at the bottom of Figure 2. Here we see overall reductions in theft without any alarm

systems being activated. In this example, a strong evaluation would collect data on the number of alarm activations – an intermediate outcome measure – following the installation of EAS tags. Logic models such as that of Figure 2 can also help identify the key moderators necessary for a mechanism to bring about the sought after outcome. For example, returning to the causal chain at the top of Figure 2, reductions in theft brought about through this mechanism is contingent on an operational alarm system, a swift staff response, the capacity to apprehend and detain detected thieves, and a police response. If these factors are not in place in a given context then it is less likely that this particular mechanism will produce the desired outcome.

Figure 2: Illustrative logic model of how EAS tags might produce their effects
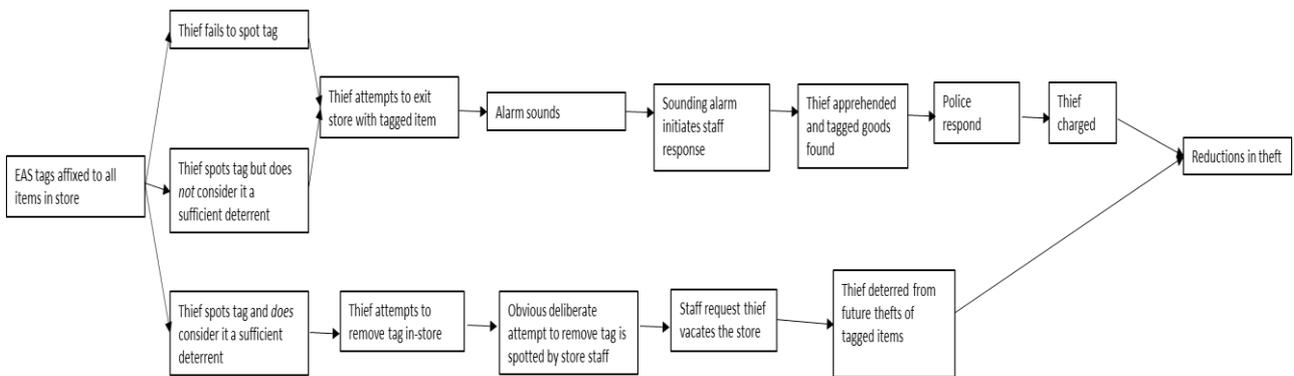
Finally, we reflect on our experience of using EMMIE as a framework for this review. One challenge we encountered related to those topics that spanned numerous elements of EMMIE. The type of tagging strategy is one example. The practical task of putting tags on all or some items (universal vs. fractional) is clearly an implementation issue, and one which is open to the familiar problems of error or mismanagement. Yet the decision over which strategy to employ also has economic implications. Moreover, the type of tagging strategy and the quality of its implementation can also act as moderators that affect whether the causal mechanisms through which tags produce their effects are or are not activated. This may be in combination with other contextual factors such as the type of offender. Our decision to report information according to the five elements of EMMIE has meant that information such as that relevant to tagging strategies appears in multiple sections

CONCLUSION

Retailing is changing, as is the tagging technology available to try to reduce shop theft. Examples include the following:

- The switch to on-line shopping may mean fewer purchases in-store although not necessarily fewer people going to stores.
- Efforts to reduce staff costs in retailing have led to the introduction of self-service checkouts, where the customer is responsible for scanning their own purchases and paying for them, but the unintended consequence is also to create new opportunities for theft.
- Competition between suppliers of tags has incentivised technological developments aiming to improve the performance of tags and persuade stores to introduce them or switch the type of tag they use.

In these circumstances, although the specific findings of the effect sizes of old studies in a different retailing environment using earlier forms of tagging may still have some relevance, current retailers and their advisors need to be attentive to the specific circumstances of the retail crime risks they are addressing. They need to work through the specific ways in which they expect crime and sales to be affected by the tags being contemplated and then to trial innovations in EMMIE terms systematically and honestly, focusing on unintended as well as intended outcomes.

REFERENCES

Bamfield, J. (1994). Electronic article surveillance: Management learning in curbing theft. In M. Gill (Ed.), *Crime at work: Studies in security and crime prevention* (pp. 155-173). Leicester, England: Perpetuity Press.

Bamfield, J. and Hollinger, R.C. (1996). Managing losses in the retail store: a comparison of loss prevention activity in the United States and Great Britain. *Security Journal*, 7:61-70.

Beck, A. (2002). *Automatic product identification & shrinkage: Scoping the potential*. ECR Europe, Brussels.

Beck, A. (2006). Shrinkage and Radio Frequency Identification (RFID): Prospects, Problems and Practicalities', in M. Gill, (eds.) *The Handbook of Security*. Palgrave MacMillan, Houndmills: Hampshire.

Beck, A. (2016a). *Beyond Shrinkage: Introducing Total Retail Loss*. Retail Industry Leaders Association Report.

Beck, A. (2016b). *Amplifying Risk in Retail Stores: The evidence to date on making shop thieves think twice*. ECR Community Shrinkage & On-shelf Availability Group.

Beck, A. and Palmer, W. (2010). The Importance of Visual Situational Cues and Difficulty of Removal in Creating Deterrence: The Limitations of Electronic Article Surveillance Source Tagging in the Retail Environment. *Journal of Applied Security Research*, 6, 110–123.

Berwick, D. (2008). The science of improvement. *Journal of the American Medical Association*, 299, 1182-1184.

Best, A., Greenhalgh, T., Lewis, S., Saul, J., Carroll, S. and Bitz, J. (2012) 'Large system transformation in health care: a realist review'. *The Millbank Quarterly* 90(3): 421-456.

Bickman, L., Rosenbaum, D. P., Baumer, T. L., Kudel, M. R., Christenholz, C., Knight, S. L., & Perkowitz, W. T. (1979). *National evaluation program: Phase I. Assessment of shoplifting and employee theft programs*. Evanston, IL: Westinghouse Evaluation Institute.

Bowers, K. and Johnson, S.D. (2017). Burglary prevention in practice. In: N. Tilley and A. Sidebottom (ed.), *Handbook of Crime Prevention and Community Safety* (2nd edition). Routledge.

Bowers, K., Tompson, L. and Johnson, S.D. (2014) Implementing information science in policing: mapping the evidence base. *Policing*, Volume 8, Number 4, pp. 339–352.

Buckle, A. and Farrington, D. P. (1984). An Observational Study of Shoplifting. *British Journal of Criminology*, 24:1, 63-73.

Capers, C. T. (2008). *Effectiveness of situational crime prevention strategies to deter organized retail theft* (Doctoral dissertation, University of Phoenix).

Carmel-Gilfilen, C. (2011). Advancing Retail Security Design: Uncovering Shoplifter Perceptions of the Physical Environment. *Journal of Interior Design*, 36:2, 21-38.

Clarke, R.V. (1997). Situational Crime Prevention: Successful Case Studies. (2nd ed.). Albany, NY: Harrow and Heston.

Clarke, R.V. (1999). *Hot Products: Understanding, Anticipating and Reducing Demand for Stolen Goods*. Police Research Series, Paper 112. London: Home Office.

Clarke, R. V. and Bowers, K. (2017). Seven misconceptions of situational crime prevention. In: N. Tilley and A. Sidebottom (ed.), *Handbook of Crime Prevention and Community Safety* (2nd edition). Routledge.

Clarke, R.V. and D. Weisburd. (1994). 'Diffusion of Crime Control Benefits: Observations on the Reverse of Displacement' In R.V. Clarke (ed.), *Crime Prevention Studies*, Vol. 2, pp. 165-182. Monsey, N.Y.: Criminal Justice Press.

Dabney, D. A., Hollinger, R. C., & Dugan, L. (2004). Who actually steals? A study of covertly observed shoplifters. *Justice Quarterly*, 21(4), 693-728.

Dalkin, S. M., Greenhalgh, J., Jones, D., Cunningham, B., & Lhussier, M. (2015). What's in a mechanism? Development of a key concept in realist evaluation. *Implementation Science*, 10(1), 1.

Davidoff, F. (2009) 'Heterogeneity is not always noise: lessons from improvement', *Journal of the American Medical Association*, 302(23), 2580-2586.

Dawson, S. (1993). Consumer responses to Electronic Article Surveillance Alarms. *Journal of Retailing*, 69:3, 353-362.

DiLonardo, R. (1996). Defining and Measuring the Economic Benefit of Electronic Article Surveillance. *Security Journal,* 7, 3-9.

DiLonardo, R. (2008). Electronic Article Surveillance, in Sennewald, C. A., & Christman, J. H. (eds). *Retail crime, security, and loss prevention: an encyclopedic reference*. Butterworth-Heinemann.

DiLonardo, R. (2015). Electronic Article Surveillance (EAS) Source Tagging: 20+ Years of Innovation. Accessed online December 9th 2015 at: http://losspreventionmedia.com/insider/loss-prevention-technology/electronic-article-surveillance-eas-source-tagging/

DiLonardo, R. and Clarke, R. (1996). Reducing the Rewards of Shoplifting: An Evaluation of ink tags. *Security Journal*, 7, 11-14.

Downs, D., Hayes, R. and Tallman, C. (2011). *Product Protection Research Project: A3Tag Testing the Effectiveness of the A3Tag on Sales and Loss*. Report produced by the Loss Prevention Research Council.

Eck, J. E. (2017). Evaluation for lesson learning. In: N. Tilley and A. Sidebottom (ed.), *Handbook of Crime Prevention and Community Safety* (2nd edition). Routledge

Eck, J. E. and Madensen, T. (2009) 'Using signatures of opportunity structures to examine mechanisms in crime prevention evaluations', in J. Knutsson and N. Tilley (eds.) *Evaluating Crime Reduction Initiatives*, Crime Prevention Studies, Vol. 24. Monsey, NY: Criminal Justice Press.

Ekblom, P. (1999). Can we make crime prevention adaptive by learning from other evolutionary struggles? *Studies on Crime and Crime Prevention*, 8, 27-51.

Farrington, D. P. (2003). Methodological quality standards for evaluation research. *The Annals of the American Academy of Political and Social Science*, 587(1), 49–68.

Farrington, D. P., Bowen , S., Buckle, A., Burns-Howell, T., Burrows, J. and Speed, M. (1993). An Experiment on the Prevention of Shoplifting, in R.V. Clarke, R.V. (eds.) *Crime Prevention Studies*. Vol. 1, Monsey, NY: Willow Tree Press.

Gill, M., Bilby, C., & Turbin, V. (1999). Retail security: Understanding what deters shop thieves. *Journal of Security Administration*, 22(1), 29.

Global Retail Theft Barometer (2015). *Global Retail Theft Barometer*. Available online at www.odesus.gr/images/nea/eidhseis/2015/3.Global-Retail-Theft-Barometer-2015/GRTB%25202015_web.pdf+&cd=4&hl=en&ct=clnk&gl=uk&client=firefox-b

Guerette, R. T. and Bowers, K. (2009) 'Assessing the extent of crime displacement and diffusion of benefit: A systematic review of situational crime prevention evaluations', *Criminology*, 47(4) 1331-1368.

Handford, M. (1994). Electronic tagging in action: A case study in retailing, in M. Gill, (eds.), *Crime at work: Studies in security and crime prevention* (pp. 174–184) Leicester, England: Perpetuity Press.

Hayes, R. (1997). Shop Theft: An analysis of apprehended shoplifters. *Security Journal*, 7:1, 11-14.

Hayes, R. (1999). *Retail Theft Trends Report,* Orlando, FL: Loss Prevention Solutions.

Hayes, R. (2007). *Electronic Article Surveillance: Reviewing the Failures and Successes of a Shoplifting Control Process*. Report produced by the Loss Prevention Research Council.

Hayes, R. and Blackwood, R. (2006). Evaluating the Effects of EAS on Product Sales and Loss: Results of a Large-Scale Field Experiment. *Security Journal*, 19, 262-276.

Hickman, L. J., Davis, L. M., & Wells, E. (2010). *Tracking Inmates and Locating Staff with Active Radio-Frequency Identification (RFID): Early Lessons Learned in One U.S. Correctional Facility*. Santa Monica, CA: RAND Corporation.

Hopkins, M. and Gill, M. (2017). Business, crime and crime prevention: emerging debates and future challenges. In: N. Tilley and A. Sidebottom (ed.), *Handbook of Crime Prevention and Community Safety* (2nd edition). Routledge.

Huber, N. (2006). *Minimizing product shrinkage in the supply chain through the use of radio-frequency identification: A case study on a major Australian retailer*.

Johnson, S. D., Tilley, N., & Bowers, K. J. (2015). Introducing EMMIE: an evidence rating scale to encourage mixed-method crime prevention synthesis reviews. *Journal of Experimental Criminology*, 11(3), 459-473.

Jones, P., Clarke-Hill, C., Hillier, D., & Comfort, D. (2005). The benefits, challenges and impacts of radio frequency identification technology (RFID) for retailers in the UK. *Marketing Intelligence & Planning*, 23(4), 395-402.

Kastner, M., Perrier, L., Hamid, J. *et al.* (2015). Effectiveness of knowledge translation tools addressing multiple high-burden chronic diseases affecting older adults: protocol for a systematic review alongside a realist review. *BMJ Open*, 5.

Knutsson, J., & Clarke, R. V. (2006). *Putting theory to work: Implementing situational prevention and problem-oriented policing* (Crime Prevention Studies, Vol. 20). Monsey, NY: Criminal Justice Press.

Lasky, N. V., Fisher, B.S. and Jacques, S. (2015). 'Thinking thief' in the crime prevention arms race: lessons learned from shoplifters. *Security Journal*, advanced access.

Lindblom, A. and Kajalo, S. (2011). The use and effectiveness of formal and informal surveillance in reducing shoplifting: a survey in Sweden, Norway and Finland. *The International Review of Retail, Distribution and Consumer Research*, 21:2, 111-128

Lottes, S. (1992). What's in Store with EAS. *Security Management*, pp:20A.

Manning, M., Johnson, S. D., Tilley, N., Wong, G. T., & Vorsina, M. (2015). *Economic Analysis and Efficiency in Policing, Criminal Justice and Crime Reduction: What Works?*. Palgrave Macmillan.

Meads, C., Nyssen, O.P., Wong, G. *et al.* (2015). Protocol for an HTA report: does therapeutic writing help people with long-term conditions?' Systematic review, realist synthesis and economic modelling. *BMJ Open*, 4.

Mishra, D. and Mishra, A. (2010). Improving Baggage Tracking, Security and Customer Services with RFID in the Airline Industry. *Acta Polytechnica Hungarica*, 139-154.

Pawson, R. (2006). *Evidence-Based Policy. A Realist Perspective*. London: Sage.

Pawson, R. and N. Tilley (1997). *Realistic Evaluation*. London, UK: Sage.

Petticrew, M., & Roberts, H. (2008). *Systematic reviews in the social sciences: A practical guide*. John Wiley & Sons.

Sidebottom, A., Tompson, L., Thornton, A, Bullock, K., Tilley, N., Bowers, K. and Johnson, S. D. (2017). *Gating Alleys to Reduce Crime: A Meta-Analysis and Realist Synthesis*. Justice Quarterly. DOI:10.1080/07418825.2017.1293135

Tilley, N. (2016). EMMIE and engineering: What works as evidence to improve decisions?. *Evaluation*, 22(3), 304-322.

van der Knaap, L. M., Leeuw, F. L., Bogaerts, S. and Nijssen, L. T. J (2008) 'Combining Campbell standards and the Realist Evaluation Approach: The best of two worlds?' *American Journal of Evaluation*, 29(1), 48-57.

Weisburd, D., Hinkle, J. C., Braga, A. A., & Wooditch, A. (2015). Understanding the Mechanisms Underlying Broken Windows Policing The Need for Evaluation Evidence. *Journal of Research in Crime and Delinquency*, 52(4), 589-608.

APPENDICES

Appendix 1. Keyword search terms for electronic databases

We used the following terms when searching the electronic databases. Where necessary, search terms were adapted to suit the requirements of particular databases:

TITLE-ABS-KEY (shoplift* OR ((shop OR store OR retail OR customer OR employee) W/5 (loss* OR shrinkage OR crim* OR theft OR steal OR stolen)) AND (tag* OR eas OR "Electronic theft control system*" OR "Electronic article surveillance" OR "Electronic asset surveillance" OR "Acousto-Magnetic" OR "radio frequency"))

Searches were conducted on 23rd September 2015.

Appendix 2: Electronic and grey literature databases searched in this review

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)

Appendix 3: Retail journals searched in this review

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

Appendix 4: Keyword search terms for 'other sources' searched in this review

We used the following terms when searching the 'other sources' listed below:

1. Anti-theft tags
2. Anti-Theft solution*
3. Source-tagging
4. EAS tags
5. Ink tags
6. Electronic Article Surveillance
7. Radio Tags

Appendix 5: Other sources searched in this review

In collaboration with an information specialist (Phyllis Schultze, Rutgers University) we searched the publications of the following government, research and professional agencies:

1) Center for Problem-Oriented Policing (Tilley 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 also searched:
1) Google
2) Google Scholar
3) Academic Search Premier (EBSC)
4) ProQuest Sociology
5) Rutgers Criminal Justice Grey Literature Database
6) OSCE Polis Digital Library
7) WorldCat

Appendix 6: Experts consulted in this review

Joshua Bamfield, Adrian Beck, Robert DiLonardo, Martin Gill and Read Hayes.

Appendix 7: Copy of e-letter sent to retailers by the *Metropolitan Police Service Business Crime Hub*

Dear Business colleague,

The MPS Business Crime Hub would be grateful for your assistance with a piece of important crime reduction research on behalf of the College of Policing which is being led by Dr Aiden Sidebottom – Department of Security and Crime Science - University College London.

Researchers from University College London (UCL) are conducting a review on the effectiveness of security tagging (broadly defined) as a means of preventing retail theft. The aim is to determine what is known about how and where security tagging can be used effectively to prevent retail theft, findings which clearly will be of relevance to retailers and the police. This research is jointly funded by a major UK Research Council the College of Policing supporting the What Works Centre for Crime Reduction.

The UCL team is currently assembling the available evidence on whether tagging items has been effective as a method of reducing theft. The more evidence they assemble, the greater the confidence that can be placed in the overall findings. To that aim, they are keen to hear from retailers who have undertaken trials to establish the effectiveness of tagging items, mindful that the findings of such trails may not have been published. The hope is that any relevant findings can be incorporated into the overall analysis.

Please be reassured that information received from businesses will be kept in confidence - Names of specific retailers or products will not be mentioned in any outputs of this review and Dr Sidebottom would be happy to sign an agreement to this effect.

The Business Crime Hub strongly supports this research. We therefore ask those who are aware of any trials of the effectiveness of product tags or if you are willing to assist in this research, might kindly contact Dr Aiden Sidebottom at UCL who is leading this review.

For more information please find attached a copy of the review protocol, which sets out in greater detail the aims and methods of the project, or feel free to contact Dr Sidebottom directly.

Appendix 8: Information extracted from included studies

1. Study details (title, year, author(s), publication status, study location(s))
2. Type of tag in study (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. Other interventions implemented over the study period including routine security practices - for example the employment of private security guards.
16. Indirect effects (displacement and/or diffusion of crime control benefits)
17. Information concerning the possible mechanisms through which tags could reduce theft
18. Information concerning the possible moderators that influence tag effectiveness
19. Information concerning the implementation of tags
20. Financial costs and benefits of tags as a theft prevention measure
21. Conclusions of the author(s)

Appendix 9: Studies included in this review

Study author(s)	Study title	Date
Addis, K., Arbetter, L., Murphy, J.	Better red than stolen	1993
Addis, K., Arbetter, L., Harowitz, S., Murphy, J., Wilson, C.	Going to market	1993
Anonymous	Small tags protect big stores	1982
Bamfield, J.	EAS: management learning in curbing theft	1997
Bamfield, J.	Changing Retail, Changing Loss Prevention	c.2012
Bamfield, J.	Beating the Thief: A Retailer's Guide to Electronic Article Surveillance	1992
Barua, A., Mani, D., Whinston, A.	Assessing the Financial impacts of RFID Technologies on the Retail and Healthcare Sectors	2008
Baumer, T. and Rosenbaum, D.	Combating Retail Theft: Programs and Strategies	1984
Beck, A. and Palmer, W.	The Importance of Visual Situational Cues and Difficulty of Removal in Creating Deterrence: The Limitations of Electronic Article Surveillance Source Tagging in the Retail Environment	2010
Beck, A.	Automatic Product Identification & Shrinkage: Scoping the Potential	2002
Beck, A.	The Emperor Has No Clothes: What Future Role for Technology in Reducing Retail Shrinkage?	2007
Beck, A.	Preventing Retail Shrinkage: Measuring the 'Value' of CCTV, EAS and Data Mining Tools	2008
Beck, A.	Shrinkage and RFID: prospects, problems and practicalities	2006
Bender, W.	Playing tag is serious business. Security Management	1997
Bickman, L., Rosenbaum, D., Baumer, T., Kudel, M., Christenholz, C., Knight, S., Perkowitz, W., Everett, M., Smith-Bickman, L.	National Evaluation Program - Phase I Assessment of Shoplifting and Employee Theft Programs - Summary Report	1980
Blackwood, R. and Hayes, R.	EAS Retail Theft Protection Systems: An Issue Update	2003
Blackwood, R. and Hayes, R.	Shoplifting Solutions Survey 2006 RILA Loss Prevention Conference Survey	2006
Capers, C.	Effectiveness of situational crime prevention strategies to deter organized retail theft	2008

Carmel-Gilfilen, C.	Bridging security and good design: Understanding perceptions of expert and novice shoplifters	2013
ChainLink Research	The ROI for RFID in Retail: Use Cases Driving the Current Surge in RFID Adoption	2014
Conrad, A.	'Smart' apparel	1996
Dawson, S.	Consumer responses to electronic article surveillance alarms	1993
Dilonardo, R.	Defining and measuring the economic benefit of electronic article assessment	1996
Dilonardo, R. and Clarke, R.	Reducing the rewards of shoplifting: an evaluation of ink tags	1996
DiLonardo, R.	Electronic article surveillance	2008
Downs, D., Hayes, R. and Tallman, C.	Product Protection Research Project: A3Tag – Testing the Effectivenss of the A3Tag on Sales and Loss	2011
Farrington, D., Bowen, S., Buckle, A., Burns-Howell, T., Burrows, J., Speed, M.	An Experiment on the Prevention of Shoplifting	1993
Giblin, M.B., Grottini, K. and Hayes, R.	Discount Apparel Mix Tag Offender Interview Report	2015
Gill, M., Bilby, C., Turbin, V.	Retail Security: Understanding What Deters Shop Thieves.	1999
Gohil, M. and Trikha, M.	RFID Used for Anti-Theft in Shopping Malls: A Research Survey	2013
Gorshe, M., Rollman, M., Beverly, R.	Item-level RFID: A Competitive Differentiator	2012
Handford, M.	Electronic tagging in action: a case study in retailing	1994
Hayes, R. and Blackwood, R.	Evaluating the Effects of EAS on Product Sales and Loss: Results of a Large-Scale Field Experiment	2006
Hayes, R.	Tailoring Security to Fit the Criminal	1999
Hayes, R.	Retail Crime Control: An Operational Strategy	Unknown
Hayes, R. and Cordone, C.	Shoptheft	2006
Huber, N.	Minimizing product shrinkage in the supply chain through the use of radio-frequency identification: A case study on a major Australian retailer	2006
Jones, P., Clarke-Hill, C., Hillier, D., Comfort, D.	The benefits, challenges and impacts of radio frequency identification technology (RFID) for retailers in the UK	2005
Klein, F.	The World's Largest Cookie Jar	1982

Lindblom, A., Kajalo, S.	The use and effectiveness of formal and informal surveillance in reducing shoplifting: A survey in Sweden, Norway and Finland	2011
Loebbecke, C. and Palmer, J.	A Real-World Pilot of RFID along the Fashion Industry: Kaufhof and Gerry Weber in Germany.	2006
Longmore-Etheridge, A.	The evolution of EAS	1998
Lottes, S.	What's in Store with EAS	1992
Masuda, B	Reduction of Employee Theft in a Retail Environment: Displacement vs Diffusion of Benefits	1997
Patton, J.	RFID as electronic article surveillance: Feasibility assessment	2008
Sensormatic	Electronic Article Surveillance: A Technology Comparison	Unknown
Retailer A, 2015	Soft tagging CDs trial	2015
Retailer B, 2015	Alcohol RF tagging	2015
Retailer C, 2015	Meat, Fish & Poultry RF Tagging	2015
Retailer D, 2015	Wallets trial	2015

Appendix 10: Narrative review of the seven studies included in Effect section

Electronic Article Surveillance: management learning in curbing theft - Bamfield (1994)

Bamfield describes an evaluation of a pilot trial of EAS hard tags in a (predominantly) clothing and textiles chain retailer in the North and Midlands of England. The four treatment stores were selected on the strength of their managers' plan for implementing and monitoring the intervention. The (single) control store was chosen to be similar in location, size and turnover to one of the four treatment stores. Hard tags were implemented for six months, with security guards and detector gates installed at the sole entrance/exit point. 90 per cent of merchandise was tagged with hard tags (with complete coverage for each product line). Merchandise under £5 and 'hard' goods, such as music cassettes, were not tagged. Bamfield presents changes in shrinkage rates alongside qualitative information on levels of in-store aggression and violence over the intervention period, how the EAS tags were perceived by the retailer, whether displacement occurred, and the cost-effectiveness of the tags.

The Importance of Visual Situational Cues and Difficulty of Removal in Creating Deterrence: The Limitations of Electronic Article Surveillance Source Tagging in the Retail Environment - Beck and Palmer (2010)

The experiment reported by Beck and Palmer concerned the effect of a retailer switching from using 'hard' tags applied in store by staff (e.g. EAS) to source-applied 'soft' tags (acousto-magnetic technology). The U.S. retailer sold clothing, fragrance and belts and had a countrywide presence. The study, conducted from January 2006

to September 2007, trialled soft tags being sewn into garments during the manufacturing process in 355 stores of one branded outlet. Two other branded outlets, comprising 540 stores similar in size and location, acted as the control group. Additional staff and CCTV were provided in experimental stores deemed to be most at risk of shrinkage. The proportion of shrinkage was compared across experimental and control stores for six data capture points at four-month intervals. When it became apparent that shrinkage was increasing markedly in the experimental group, the retailer reintroduced hard tags. Beck and Palmer identified that the number of alarm activations rose considerably in experimental stores during the trial, and staff were less likely to respond in the wake of so many alarms being activated. Employee theft was also believed to have increased during the trial period.

Reducing the rewards of shoplifting: An evaluation of ink tags - DiLonardo and Clarke (1996)

The two small case studies presented by DiLonardo and Clarke evaluate the implementation of ink tags in a large chain of women's clothing stores with different branded outlets. The first involved 14 newly-opened, and geographically dispersed, stores whereby ink tags were installed as standard from opening. Physical inventories of stock were undertaken in the first year of opening and compared against the other stores in the chain. The second case study concerned the replacement of EAS with ink tags in four stores with the highest shrinkage rates.

Product Protection Research Project: A3Tag – Testing the Effectivenss of the A3Tag on Sales and Loss – Downs, Hayes and Tallman (2011).

Using data from a large department chain in the US, this study assessed changes in the shrinkage and sales of jeans following the installation of a new type of EAS tag known as the A3Tag. Six studies participated in this study. In two stores, a beige version of the new A3tag was installed. In a third store a red version of the A3tag was installed, and three stores acted as control sites in which existing EAS tags were in place. Downs et al. report that overall there was little difference in shrinkage and sales rates in the treatment stores compared to the control stores (both saw increases in shrinkage). However, when examining the effectiveness of the different type of A3Tag in isolation, it was found that the more visible red tag was associated with reductions in shrinkage and increases in sales compared to the control store (a positive outcome). For the beige A3tag the reverse was true (increases in shrinkage and decreases in sales – a negative outcome, but one that mirrored the trend in control stores, possibly due to a seasonal effect). This difference in effectiveness was mainly attributed to the increased visibility of the red tags. Interviews with a sample of customers and employees indicated that the new type of tag was generally well received.

An experiment on the prevention of shoplifting – Farrington et al. (1996)

Farrington and colleagues describe an experiment to evaluate the effectiveness of EAS tags, store redesign and security guards in a U.K. electrical and electronics retailer, across two branded outlets. A previous study by the authors had measured the shoplifting rates at twenty-nine stores across the U.K. with management trainees

performing the repeated, systematic counting of items on store shelves. The ten stores with the highest shoplifting rates were chosen for the study; but the attrition of one store (due to heavy snow) reduced this number to nine. Comparable stores were assigned into four treatment groups, with three of these groups containing a control store. The other treatment group compared tags with store redesign. Staff were trained in the measurement technique used previously by the authors, with visits post-treatment to check that this was effectively undertaken. Audiotapes, videotapes, films, headphones and small domestic appliances were the product lines under scrutiny, and these were counted for a four-day period both pre- and post-intervention. Items were also counted at a follow-up stage, but the intervening time varied across stores.

Evaluating the Effects of EAS on Product Sales and Loss: Results of a Large-Scale Field Experiment – Hayes and Blackwood (2006)

Hayes and Blackwood studied the effect of concealed source-tagged EAS on personal grooming products in a retailer across several regions of the U.S. A purposeful sample of twenty-one stores with typical shrinkage rates for the company served as the treatment group. Two treatment conditions were tested - the proportion of goods tagged (50 per cent or 100 per cent) and whether there were tag detection gates installed. The outcomes investigated included item losses, shelf availability and store sales and data were collected using multiple methods, for example; weekly item counts; weekly sales; store shipments and store-level adjustments. Over 2,600 hours of CCTV video data were also used to observe the staff and customer response to EAS alarm activation.

Trial of radio-frequency tags on CDs– Retailer A (2015)

This eight-week trial to introduce soft radio-frequency tags was conducted at a national, large U.K. retailer, who had identified that shrinkage for CDs equated to 0.91 per cent of sales. Existing safer-casing CDs (with a large transparent box around the product) were deemed unattractive and time-consuming for staff to remove at the point-of-sale. 20 stores were identified to receive the new 'soft' tags; 60 stores with similar average yearly sales, shrinkage and product ranges were selected as the control stores. A questionnaire was sent to the test stores – of which 14 responded – to collect feedback on the implementation of the new tags.

Trial of radio-frequency tags on meat products – Retailer B (2015)

This trial was conducted at a national, large U.K. retailer, who had identified that shrinkage for meat, fish and poultry products equated to 1.22 per cent of sales. Radio-frequency (RF) source tags were introduced (in a phased manner) in 2015 for 62 specific red meat product lines. A group of similar, but untagged, products acted as the control. Economic data on the costs of tags and the staff time to apply the tags were presented, and the savings to the business were calculated based on projected shrinkage rates.

Study author	Year	Mechanism			Staff/shop	Moderator				Implementation		Economics	
		Risk	Reward	Effort		Offender type	Tagging strategy	Item type	Police & CJS	Staff	Tagging Strategy	Cost of tagging	Economic returns
Addis et al	1993a	X									X		
Addis et al	1993b												
Anon	1982						X				X	X	
Bamfield	1997	X			X					X	X	X	
Bamfield	2012				X	X							
Bamfield	1992	X	X		X		X			X	X	X	
Barua et al.	2008						X					X	
Baumer & Rosenbaum	1984	X								X		X	
Beck & Palmer	2010	X								X	X	X	
Beck	2002	X			X	X				X	X	X	
Beck	2007									X			
Beck	2008	X	X	X								X	X
Beck	2006	X								X	X	X	
Bender	1997	X			X		X		X	X	X	X	X
Bickman et al.	1980	X								X	X	X	
Blackwood, R. and Hayes, R.	2003	X	X		X		X			X	X		X
Blackwood, R. and Hayes, R.	2006				X					X			
Capers, C.	2008					X					X		
Carmel-Gilfilen, C.	2013	X				X							
ChainLink	2014										X	X	X
Conrad, A.	1996										X	X	
Dawson, S.	1993									X		X	
Dilonardo, R.	1996	X										X	X
Dilonardo &	1996		X								X	X	

Author	Year											
Clarke												
DiLonardo, R.	2008	X	X							X			
Downs, D., Hayes, R. and Tallman, C.	2011	X			X							X
Farrington et al	1993	X							X	X	X	
Giblin, M.B., Grottini, K. and Hayes, R.	2015	X				X	X					
Gill, Bilby & Turbin	1999	X	X	X			X			X		
Gohil &Trikha	2013										X	
Gorshe et al	2012											
Handford, M.	1994	X							X		X	
Hayes & Blackwood	2006	X			X	X				X		
Hayes	1999					X						
Hayes	Unknown	X			X			X		X	X	
Hayes & Cordone	2006		X		X							
Huber	2006				X	X				X	X	X
Jones et al	2005				X					X	X	X
Klein	1982									X	X	
Lindblom & Kajalo	2011	X								X		
Loebbecke & Palmer	2006										X	
Longmore-Etheridge	1998	X					X			X	X	
Lottes	1992	X					X			X	X	
Masuda	1997	X						X		X	X	X
Patton,	2008						X					
Sensormatic	Unknown						X			X		
Retailer A	2015									X	X	

Retailer B	2015		X		X	X	
Retailer C	2015					X	X
Retailer D	2015					X	

Appendix 11: Summary of information relevant to Mechanisms, Moderators, Implementation and Economics reported in eligible studies

ENDNOTES

---

[i] This cost included theft by employees and the cost of fraudulent suppliers, as well as shoplifting and the cost of loss prevention systems.

[ii] Tags are not used solely for the purposes of theft reduction, however. They are also 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. EAS tags are used in airports to track the movement of baggage (Mishra and Mishra, 2010), in hospitals to track new-borns and elderly patients and in prisons to monitor inmates (Hickman et al. 2010).

[iii] All retail-related journals were found to be covered by the two multidisciplinary databases (SCOPUS and Web of Knowledge).

[iv] These are *Police Practice and Research: An International Journal* and *Policing: a Journal of Policy and Practice.*

[v] Due to limited resources, we confined our forward and backward citation searches only to these (Effect) studies.

[vi] Bottle tags are also assumed to work through this mechanism. These refer to hard tags that are placed over the neck of bottled products (typically alcoholic beverages). Failure to correctly remove the tag causes the bottle to break.