Title: Situational and Environmental Determinants of ePVM Noticeability in Retail Environments: A Randomized Controlled Trial

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Abstract: Intentional merchandise theft is a pervasive phenomenon, resulting in billions of dollars of lost revenue for retailers each year (Retail Knowledge 2015). As competition for retailers continues to stiffen, and profit margins decrease, retail loss practitioners have turned to situational crime prevention (SCP) techniques to proactively mitigate shoplifting. While repeated studies have demonstrated both the efficacy of Enhanced Public View Monitors (ePVM) for minimizing deviant behavior, and positive return on investment (ROI) for this technology, there has been little research on "dosage," or how situational deployment factors influence the deterrent impact of these technologies. This study examines five situational/environmental deployment or dosing factors that may influence ePVM efficacy in a retail environment. Our results conclude display height and border color were both significant factors influencing noticeability of ePVMs by offenders. Our findings expand the literature on noticeability as a first step to deterrence capacities of theft prevention technologies in micro-environments.

Keywords: Situational Crime Prevention, ePVM, Rational Choice Theory, Randomized Controlled Trial, Perception

Intro

In 2015, the retail sector suffered $60 billion in total merchandise losses (Retail Fraud Survey 2015). As market conditions worsen for brick-and-mortar retailers, the costs of inventory shrinkage are felt more acutely by retailers and shareholders alike. However, the consequences of intentional merchandise theft go far beyond loss, as theft can result also in higher consumer costs and even occasional violence. To mitigate these issues, loss prevention practitioners have increasingly turned to proactive measures to minimize intentional theft (Bamfield and Hollinger, 1996; Hayes, 2003). Empirical studies of effectiveness and return on investment (ROI) for different loss prevention techniques have yielded positive results for law enforcement and loss prevention professionals alike (Cornish and Clarke, 2008; Hayes, Downs, and Blackwood, 2012; Sherman, 2010; Welsh and Farrington, 2000; Welsh and Farrington, 2007). Evidence from randomized controlled trials (RCTs) suggest video surveillance technologies such as closed-circuit televisions (CCTVs) reduce intentional theft in retail environments (Johns et al., 2017; Welsh and Farrington, 2004).

EPVMs are one type of video surveillance technology designed to reduce deviant behavior by displaying an image of any potential offender alongside a statement such as "recording in progress". This disincentivizes potential offenders by alerting them that their actions are being recorded in clear, full color, increasing risk of being seen and/or caught by associates or other customers. While there has been extensive analysis into the effects that video surveillance technologies have on crime prevention (Eck, 2006; Ratcliffe, 2006; Welsh and Farrington, 2009), perception plays an important role in the operation of deterrence (Williams and Hawkins, 1986). While theft-deterrent measure must first be noticed before they can be effective and credible deterrents, there is little literature on what situational and environmental factors influence noticeability of crime and theft prevention technology. This article identifies the effect of situational deployment or dosing factors on the noticeability of ePVMs in micro-environments.

This study uses a specialized RCT to identify how five situational/environmental deployment tactics-- display fixture height, auditory stimuli (beeping sound), visual stimuli (high-contrast bordering), and signage -- affect noticeability of ePVMs by potential offenders.

The project was conducted in Gainesville, Florida in the electronics section of large retail chain outlet. Each participant was accompanied by a trained researcher, and asked to visit four stops along a predetermined, yet randomized route. At each stop, different combinations of public view monitor enhancement treatments were randomly applied to the ePVM or its surrounding area, each participant was asked if they recognized any loss prevention technology, and trained researchers recorded their responses. This study furthers understanding of the influence of environmental situational factors on loss prevention technology efficacy.

Literature

Law enforcement professionals have turned to Situational Crime Prevention (SCP) to proactively mitigate shrink issues in micro environments. SCP as applied to loss prevention operates on a few key assumptions. First, SCP theory conceptualizes individuals often perform as rational actors, and therefore, suggests their behavior can be altered by application of targeted treatments that make crime less beneficial, overly difficult, or riskier (Carroll and Weaver, 1986; Clarke, 2009). Second, shoplifters make context-specific decisions, and update their decision-making process as they acquire new information and are presented with new stimuli. Therefore, altering situational context to more clearly present potential offenders with a perceived opportunity structure that either increases risk and/or effort, or limits reward may limit the possibility of criminal activity (Cornish and Clarke, 2008). Third, most crime occurs during daily routine activity, and thus the most effective means to limiting the benefit/increasing risk are interventions at the site of the crime itself (Cohen and Felson, 1979; Nagin and Paternoster, 1993). These insights have been applied to prevention techniques for a wide range of deviant activities, (Gilmour, 2016), including organized crime (Bullock et al., 2010), terrorism (Clarke, 2009), and fraud (Smith et al., 2011).

While practitioners have successfully used SCP to minimize acquisitive crimes such as shoplifting, critics suggest SCP, and by extension Rational Choice Theory, has not sufficiently engaged with sociological and psychological contextual factors that limit rational action (Hayward, 2007). The Rational Choice Theory of decision-making presupposes not only that individuals have complete information about possible choices, but they understand that information and how it relates to the action they are undertaking, an understanding of the risk associated with incomplete information, and the cognitive processing ability to maximize personal utility (Pickett and Roche 2016; Pogarsky, Roche and Pickett 2017, 86; Elster 1986, 5).

However, there are cognitive and psychological limitations to individuals' rationality, especially under real-world conditions. Factors such as situational complexity and incomplete information about alternatives affect the decision-making process (Pograsky, Roche and Pickett 2017; Yamagishi et al. 2014; Simon 1972). Limited cognitive capacities as well as psychological biases often influence decision-making in ways that diverge from rationality in a predictable way (Kahneman 2011; Loughran, Paternoster, Piquero, 2012; Tversky, 1972). Moreover, while rational action is predicated on a fixed utility function, potential offenders often update this utility function through inclusion of perceived situational factors that may influence probability of sanction for any individual criminal opportunity (Nagin, Solow and Lum 2015, 81).

Multiple strands of research have identified ways in which individual decision-making diverges from rationality in predictable ways. Exposing individuals to stimuli related to, or reminiscent of, an activity (priming) can activate certain latent knowledge or redirect individuals to certain goals (Dollan, Halsworth, Halpern, King and Vlaev, 2010; Kendrick, Neuberg and

Cialdini, 2005; Cameron, Brown-Iannuzzi and Payne, 2012; Wentura and Degner, 2010). One study found objects perceived as threats were judged to be spatially closer to the individual perceiving them than non-threats (Vagnoni, Lourenco and Longo, 2012). Furthermore, individuals with specific purposes or motivations will perceive their surroundings differently, focusing on elements of their surroundings that relate to the action or purpose by which their mind is occupied (Balcetis, 2006).

SCP recognizes that crime prevention is contextual in nature, and that incentives for potential offenders to commit crimes must be locally targeted and crime-specific (Clarke and Cornish, 1985; Cornish and Clarke, 1987; Miro, 2014; Cohen and Felson, 1979). RCTs demonstrate that deviance may be mitigated by clear communication of elevated risk of punishment to potential offenders (Nagin and Pogarsky, 2003; Weisburd, Eint, and Kowalski, 2008). While situational factors can convey threat to a potential offender, if practitioners "get the situational factors wrong" this may result in missing, or a systematic misperception of, presence of threat for individuals, which compromises the deterrent effect of any theft prevention tactic or technology.

It is incumbent upon both theorists and practitioners to not only understand whether theft prevention technologies work, but also to understand how they operate in actual micro environments, the mechanisms by which they operate, and the situational factors that will increase noticeability, "recognizability," and credibility as a first step to conveying threat of sanction, or other dynamics sufficient to deter or disrupt and offender. Before a potential offender can formulate a decision regarding whether an individual theft prevention technology poses a threat, they must first notice, recognize and be concerned ("see, get, fear") about that technology. While ePVMs and other CCTV interventions have been identified as effective means to limit theft losses (Hayes and Downs, 2011; Johns et al. 2017; Welsh and Farrington 2004), there has been little research into the situational and environmental dosing or deployment factors that influence noticeability of these technologies to potential offenders.

ePVM Mode and Mechanisms of Action Leading to Efficacy

SCP suggests ePVMs are effective in limiting asset theft via shoplifters because they signal increased risk to the potential shoplifter in two ways. First, ePVM systems improves formal surveillance by use of cameras fixed on high-value or high-theft items or areas of the retail outlet. Formal surveillance increases the perceived possibility that shoplifters will be caught. Second, the success of shoplifting is predicated on anonymity of the perpetrator. ePVMs limit anonymity by acting to increase surveillance via traditional means (e.g. camera feed to a centralized location) as well as making the actions of a potential shoplifter visible to other customers or store associates. However, possible offenders must not only visually identify ePVMs to be deterred, they must also understand their function. It is possible, for example, that potential shoplifters may identify ePVMs as a customer safety or service device as opposed to a surveillance or anti-theft technology.

While prior research demonstrates the efficacy of ePVMs for deterring potential offenders, adjusting situational variables may increase the possibility that potential offenders visually identify (see), understand the purpose of such devices (get), and recognize these devices as a credible deterrent (fear) in a micro environments. Several factors may influence their efficacy along these dimensions.

First, height level is an influential variable in visual recognition (Dreze, Hock, and Perk 1994). Adjusting height level may make ePVMs more or less obvious to potential offenders.

Optimal vertical positioning increases the possibility the potential offender will pick up and identify the ePVM, but will may also affect how a potential offender's image is displayed. However, offenders may not visually identify ePVMs. Second, potential offenders may be alerted to the presence of an ePVM by a beeping sound, activated by an individual's proximity to the ePVM. Third, a person's judgment regarding an object is influenced by constructs that are activated in earlier tasks (Mandel and Johnson 2002; Herr 1989). This is referred to as "priming". In this study, signage depicting a black background with a drawing of a human eye, with the phrase "Attention: monitoring in progress" was used. It is expected that, not only did this alert potential offenders to the existence of the ePVM, but also added to their understanding of the ePVM as a surveillance technology.

Fourth, color is an important element of object recognition (Singh 2006; Schindler 1986). Current store formats are very visually "busy." Adjusting the colored border surrounding the ePVM to contrast it with the surrounding background may influence whether possible offenders visually spot and identify the ePVM. Finally, a flashing light, activated by an individual's proximity, may make the ePVM more readily visible by potential offenders, as well as make it appear a more credible threat to their crime attempt.

H_0: Situational and environmental factors have no effect on ePVM noticeability by possible offenders.

H_1: Placing ePVM closer to eye level (4' to 5') increases ePVM noticeability by possible offenders.

H_2: A sound alert emitted when an individual is within a certain range of the ePVM increases noticeability of ePVM by possible offenders.

H_3: Signage alerting possible offenders to the purpose of the ePVM increases ePVM noticeability by possible offenders.

H_4: A high-contrast colored border increases ePVM noticeability by possible offenders.

H_5: A flashing light, activated by an individual's proximity, increases noticeability of ePVM by possible offenders.

Research Design

This study employs an RCT fractional factorial design. The benefit of RCTs is that confounding factors are adjusted for by randomly assigning treatments to participants within a single group (Farrington 2003; Weisburd 2000). A resolution 4 fractional factorial experimental design was used for this study (Box, Hunter and Hunter 1978). This design requires 16 distinct treatment combinations to create a main effects model that will allow us to identify which individual factors may increase/decrease the likelihood that an offender will notice or see an ePVM. To capture each combination efficiently, researchers tested four factors at a time. The 16 combinations of treatments are shown below:

Table 1 Treatment Combination Matrix for ePVM Noticeability for Randomized Controlled Trial

Factor Combinations	Height	Sound	Light	Color Contrast	Signage
1	4’-5’	No	No	Black	Yes
2	7’ or >	No	No	Black	No
3	4’-5’	Yes	No	Black	No
4	7’ or >	Yes	No	Black	Yes
5	4’-5’	No	Yes	Black	No
6	4’-5’	No	Yes	Black	Yes
7	4’-5’	Yes	Yes	Black	Yes
8	7’ or >	Yes	Yes	Black	Yes
9	4’-5’	No	No	Neon Green	No
10	7’ or >	No	No	Neon Green	Yes
11	4’-5’	No	No	Neon Green	Yes
12	7’ or >	Yes	No	Neon Green	No
13	4’-5’	No	Yes	Neon Green	Yes
14	7’ or >	No	Yes	Neon Green	No
15	4’-5’	Yes	Yes	Neon Green	No
16	7’ or >	Yes	Yes	Neon Green	Yes

Forty offenders were recruited for this project via local advertisements, and vetted for shoplifting experience level accuracy. Each offender was given $25 in compensation for their participation. Each participant was invited to visit a specific retail store specially set up, located in Gainesville, Florida. Participants were escorted to four distinct sections of the electronics department and asked to locate certain products. Each product was located equidistance from an ePVM (approximately six feet away). The starting location was randomized from a central point in the electronics department to address the confounding effects of starting position and maintain independence of observations. Section visits were randomized as well to limit the confounding effects of visit ordering. Finally, participants were randomly assigned to treatment combinations.

This study examined five factors, each with two levels: first, height varied between four to five feet (1), and seven to eight feet (0). Second, the ePVM either did not display a flashing light when approached (0), or did display a flashing light when approached (1). Third, the ePVM either did not make a beeping sound when approached (0), or did make a beeping sound when approached (1). Fourth, the ePVM either had a border with a similar color to the black ePVM device (0), or a neon green border (1). Finally, the ePVM either did not have signage (0), or had signage depicting a drawing of a human eye with the phrase “Attention! Monitoring in Progress” below.

The unit of analysis is an individual offender “stop” at each station. At each stop, level of noticeability was measured by asking participants along each stop if they noticed any loss prevention technology. Participants could respond either “yes” (1) or “no” (0). Each of the 40 participants was brought to each of the four areas and asked whether they noticed any loss prevention technology, for a total of 160 observations. Chi-squared analyses with tau-b measures of association were used to assess each factor’s influence on ePVM noticeability.

Conditional fixed effects logistic regression analyses were performed to identify the independent effect of each factor on ePVM noticeability controlling for other factors. Tests of model fit with only main effects included in the model indicated the presence of a significant interaction term. Specification tests were conducted and revealed that the model including interaction effects represented a statistically significant improvement in model fit.

Results

Table 2 shows the relationship between height and noticeability. Placing the ePVM at eye-level or just below increased noticeability of the ePVM. Over three-fourths (76%) of participants identified the ePVM when it was located at eye level (4' to 5' above the ground), whereas only 53% of participants identified the ePVM when it was at least 7' or above. Differences in noticeability between height levels were statistically significant [χ^2 (1, N = 160) = 9.84, p = 0.02; τ -b = .248].

Factors	Was ePVM noticed?		
EPVM Height	Yes	No	Tests
Eye level (4'-5') (n=80)	76.3%	23.8%	χ^2 (1, N = 160) = 9.84, p = 0.01; τ -b=.248
Above eye level (7' or above) (n=80)	52.5%	47.5%	
Border Color			
Neon Green (n=80)	57.5%	42.5%	χ^2 (1, N = 160) = 3.30, p = 0.069; τ -b= -.144
Black (n=80)	71.3%	28.7%	
Sound			
Sound emitted (n=80)	70%	30%	χ^2 (1, N = 160) = 2.21, p = 0.137; τ -b= -.118
No sound (n=80)	58.8%	41.3%	
Light			
Light (n=80)	60%	40%	χ^2 (1, N = 160) = 1.34, p = 0.248; τ -b= -.094
No light (n=80)	68.8%	31.2%	
Signage			
Signage (n=80)	63.8%	31.2%	χ^2 (1, N = 160) = .0237, p = 0.869; τ -b= -.013
No signage (n=80)	65%	35%	

Table 2 Univariate Analysis of Situational Factors on ePVM Noticeability

Counterintuitively, participants recognized ePVMs with a neon green border less often (52.5%) than those with a black border (71.3%). These results approach statistical significance [χ^2 (1, N = 160) = 3.30, p = 0.07; τ -b = -.144]. While ePVMs were that emitted sound were more likely to be recognized (70%) than those that did not (58.8%), differences were not statistically significant at p<.05 [χ^2 (1, N = 160) = 2.21, p = 0.137; τ -b = -.118].

Participants recognized ePVMs with blinking lights less often (60%) as opposed to those without blinking lights (68.8%), however differences between groups were not statistically significant at p<.05 [χ^2 (1, N = 160) = 1.34, p = 0.248; τ -b = -.094]. Finally, there was little difference in ePVM noticeability between instances in which there was signage (63.5%) and those in which there was no signage (65%) [χ^2 (1, N = 160) = .0237, p = 0.869; τ -b = -.013].

Table 3- Control tables for interaction between height and sound on ePVM noticeability

	Height at 4' to 5'		
	ePVM Noticed		
Sound Emitted	Yes	No	Test
Yes (n=40)	75%	25%	χ^2 (1, N = 80) = .0690, p = 0.793; τ-b=-.029
No (n=40)	72.5% %	22.5%	
	Height at 7' or above		
	ePVM Noticed		
Sound Emitted	Yes	No	Test
Yes (n=40)	65%	35%	χ^2 (1, N = 80) = 5.01, p = 0.03; τ-b=.250
No (n=40)	40%	60%	

Table 3- Control tables for interaction between height and sound on ePVM noticeability

Further analyses revealed interaction effects between ePVM height and sound's influence on ePVM noticeability. Table 3 shows the differences in the relationship between ePVM noticeability and sound by height level. When the EPVM was positioned above eye level, participants noticed the ePVM more often (65%) when a sound was emitted than when there was no sound emitted (40%). Differences between these groups were statistically significant at p<.05 [(χ^2 (1, N = 80) = 5.03, p = 0.025; tau-b = -.250]. However, when the ePVM was at eye level, there was no difference between noticeability when the ePVM included sound emission (75%) and when it did not (72.5%) [(χ^2 (1, N = 80) = .07, p = 0.793; τ -b = -.029].

Table 4 shows the results of the conditional fixed effects logistic regression, with odds ratios reported [χ^2 (1, N = 160) = 21.46 , p = 0.137]. Diagnostics tests identified a significant interaction effect between ePVM height and sound, and an interaction term was included in the model. The effects of sound on ePVM noticeability was influenced by the height of the ePVM. For ePVMs positioned at 7' and above, ePVMs that emitted a sound were more than 3 times as likely to be noticed than those that didn't. Those positioned at eye level but not emitting a sound were over six times as likely to be noticed than those positioned 7' and above without a sound.

Finally, those positioned at eye level with a sound were five times as likely to be noticed than those positioned 7' or above without sound. In short, for ePVMs that must be positioned above eye-level, sound emission can increase the probability of noticing ePVMs by potential offenders. However, positioning the ePVM at eye-level (for most individuals) increases the possibility of noticeability more than sound alone. As indicated by univariate analysis, border color was a significant predictor of ePVM noticeability. However, the relationship ran counter to our initial hypothesis. ePVMs with neon green borders were almost over 50% less likely to be noticed than those with black borders. Finally, both light and signage did not have a statistically significant effect on ePVM noticeability at p<.05.

	ePVM Noticeability (n=160)		
Predictor	Odds Ratios	Standard Error	*p-value*
7' or above and No Sound	--	--	--
7' or above and Sound	3.090	1.490	0.02
Eye level (4'-5') and No Sound	6.080	3.221	0.00
Eye level (4'-5') and Sound	5.059	2.576	0.00
Neon Green Border	0.496	0.179	0.05
Light	0.644	0.231	0.22
Signage	0.888	0.342	0.76
Note: Odds Ratios reported; [χ^2 (6, N = 160) = 21.46, p = 0.002; Pseudo-R-squared = .115			

Table 4: Conditional logistic regression analysis of situational factors on ePVM noticeability

Conclusions

This study examined the effects of situational factors on noticeability of ePVMs by potential offenders in an actual retail environment. Several important conclusions may be drawn from this analysis. First, situational factors such as placement, color, and sound emission indeed play a role in noticeability of ePVMs by potential offenders. The data suggest treatment deployment height is a key factor in increasing possible noticeability of ePVMS, although sound may be somewhat useful when ePVMs cannot be placed at eye-level.

Counterintuitively, ePVMs with black borders were more noticeable than those with neon green borders. There are several possible reasons for this. First, the possible benefit to a more noticeable color may be offset by the familiarity and authentic nature of the ePVMs with black borders. Second, the influential factor in ePVM noticeability may not be the color of the border itself, but rather the contrast with surrounding colors. If ePVMs are in in areas with bright colors (as was the case in our testing), a more muted border color may be more noticeable to potential offenders. Finally, our findings suggest situational deployment factors interact in different ways to influence noticeability of ePVMs in retail settings. This is an important consideration, given that limitations in display of ePVMs due to specific high-risk asset display or storage positioning, marketing considerations, or even legal regulations, may limit the ability of asset protection professionals to position ePVMs in an ideal manner.

This study also represents a contribution to the theoretical literature in both criminology and SCP Theory. Given both that situational crime prevention techniques are predicated upon the assumption of both rational offenders and the importance of altering environmental and situational incentives and hurdles for deviant activity, it is important that certain asset protection technologies are first noticed, understood, and believed to provide a credible deterrent. This study demonstrates that noticeability of theft prevention technologies should not be taken as a given. Further research is necessary to understand under what conditions theft prevention technology is most easily recognized by a spectrum of potential offenders (differential response).

While this study advances understanding of how situational factors' influence ePVM noticeability in a retail environment, there are limitations that may be addressed in future projects. First, the dataset contains a relatively small number of observations (160) given the number of factors (5) addressed in the study. Additional degrees of freedom attendant to multiple factors (and possible interactions between them) necessitate a greater sample size to increase statistical power for multivariate analyses. Thus, there was a greater possibility of Type-1 error. However, the factors found to be statistically significant remained so throughout multiple models. Third, while this study took place in an actual retail environment, to increase external validity additional studies must be conducted in different types of micro-environments. Finally, improvements in noticeability through adjusting situational visibility factors such as height and border color may erode over time as potential offenders adjust tactics (Sherman 1990; Clarke 2009).

By observing the influence of environmental and situational factors on ePVM noticeability, this study advances understanding of factors influencing efficacy of theft prevention technology for practitioners, and improves understanding of offender behavior in general, along several dimensions. First, it provides valuable feedback to theft prevention practitioners regarding which visual or audible elements make ePVMs more noticeable, and thereby more effective for deterring potential offenders. Second, it furthers understanding of which visual or aural stimuli may be dosed to help potential offenders identify threats, and therefore aid in deterring them from illicit activity. Finally, as the effects of border color ran counter to expectation, this prompts additional study on why ePVMs with low-contrast black borders were more readily identified than those with high-contrast green borders. More broadly, this study informs the literature on how to better place security features within any environment where theft or violence may present an issue.

Further routes for research include possible differences in situational factors based on individual-level factors, including age, gender, experience-level of potential offenders (e.g. are different combinations of situational factors necessary to increase noticeability for experienced criminals versus inexperienced criminals), exploration of the relationship between immediate environment (including color schemes, aural landscape) and situational factors in ePVM noticeability. Indeed, noticeability is only one dimension of effectiveness of criminal deterrence and crime prevention technology.

Further research that elucidates the relationship between noticeability and understanding of the function of crime prevention technology, and efficacy of technology as a deterrent, may also be helpful for practitioners and law enforcement alike. Helping to refine theft prevention and crime prevention technology efficacy through adjustment of environmental or situational factors reduce retail loss and potential violence that would adversely affect life safety, reputation, revenues, reduces illicit activity, and reduces cost for customers.

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