ORIGINAL ARTICLE

Exploring and developing crime prevention through environmental design (CPTED) audits: an iterative process

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Abstract

This paper utilizes an ecological perspective to explore the development of a crime prevention through environmental design (CPTED) audit tool through an ongoing iterative process. We draw upon existing examples from criminology and research into auditing the built environment for physical activity and active travel. The purpose of the paper is to present a revised CPTED audit tool and process to assist those managing crime and anti-social behaviour in their streets, neighbourhoods and communities. It may also assist those seeking to use audits as part of the CPTED process set out in the recent International Standards on CPTED: ISO22341 (British Standards 2021). Following Ceccato (Crim Justice Stud 32:165–188, 2019), we briefly reflect on the validity, reliability and generalizability of the CPTED audit tool and consider further possible refinements for future iterations.

Keywords Audits · Crime prevention through environmental design (CPTED) · Design out crime · Fieldwork protocols · Perceptions of crime

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Introduction

In recent years, we have seen the convergence of various disciplines around the ideal of healthy and convivial cities, including public health, urban design, land use and transport planning and environmental criminology. Due to the focus on built environment factors influencing the health and well-being of urban populations, there is an increasing need to effectively evaluate the capacity of factors of the built environment to support healthy lifestyles and activities, to assess the risk of land-use changes and to measure and monitor the impact of design interventions. Indeed, the value of crime prevention through environmental design (CPTED) to a reinvigorated relationship between urban planning and public health has recently been asserted (Cozens, 2015a, b). In 2021, international standards (ISO22341) for a CPTED process were published as 'Security and Resilience—Protective Security: Guidelines for Crime Prevention Through Environmental Design' (British Standards 2021). These have re-established risk assessment as part of the CPTED process, as originally stated by Crowe (1991, 2000) and called for more recently, by several researchers, including Atlas (2008), Cozens (2011, 2016), Cozens and Love (2015) and others.

Environmental audits are one method of evaluation and risk assessment and there is a large body of work on those designed to assist and evaluate public health interventions and urban planning for physical activity (PA) and active travel (AT). There are also those designed to audit the environment for the presence or absence of the principles of CPTED. This paper begins by briefly exploring the history, definitions and use of built environment audits. We then briefly discuss CPTED and explore a range of CPTED audits. We report on an iterative process over several years used to develop and refine a CPTED audit for crime prevention/place-making and community-based projects. Finally, following Ceccato (2019) we briefly reflect on the validity, reliability and generalizability of this audit and posit how the CPTED audit might be improved further.

Built environment audits: a review of theory and application

Built environment audits refer to a range of tools and techniques designed to systematically evaluate places and elements within the built environment against a set of normative conditions or principles of best practice. These tools quantify built environments qualities and functions for the purpose of enhancing our understanding of human and built environment relationships and informing interventions designed to achieve various objectives. Sharing close similarities with other tools such as fieldwork protocols (Ceccato 2019), measurement instruments (Brownson et al. 2009) and systematic social observations (Sampson and Raudenbusch 1999), the term audits is now used widely across a range of built environment disciplines, reflecting the prevalence auditing practices in public administration (Shore and Wright 2015).

The techniques associated with audit practices have been used to measure a variety of human–environment relations. In the field of criminology and

sociology, Sampson and Raudenbush's (1999) used systematic social observations and attempted to rate social cohesion and public disorder across 196 neighbourhoods in Chicago. Ewing et al. (2013) demonstrated that measures of subjective qualities of the urban design of streets can be effective. Recently, research has focused on the influence of the built environment on health due to the prevalence of physical inactivity and rising obesity, seeking to reconnect the fields of urban planning and public health. Studies of the influence of built environment factors on obesogenic environments and associated inactivity have drawn on a suite of auditing tools to evaluate the supportive qualities of built environments for physical activity (Giles-Corti et al. 2005; Jones et al. 2010), walkability and bikeability (Moudon and Lee 2003), and recreation (Reynolds et al. 2007). In research years, there has been widespread use of audits in practical settings and the adaptation of audit instruments for communities to formalize local evaluations of built environment contexts with the purpose of advocating for change (Mahmood et al. 2020). It is also not clear whether audits are used widely in practice, or when they are, whether the knowledge they generate is received and acted on by decision-makers (Babb and Curtis 2015).

Audits have been used to empirically inform a range of theoretical frameworks. Multi-disciplinary studies in public health and urban planning draw on socio-ecological models, where measures of built environment variables are required to explore the relationship of a range of factors at different levels of influence (Giles-Corti et al. 2005). Socio-ecological models arrange potential health and well-being determinants into domains at the individual, social, organizational, proximal (neighbourhood and community) and policy behavioural settings (Sallis et al. 2008). To support the wider adoption of auditing techniques in research, policy and community activities, the methodological integrity of audits has been the focus of research. Inter-rater reliability tests are used widely to compare the ratings of different auditors and identify consistent and ambiguous measures and scales within audit tools (Brownson et al. 2009). New ways of facilitating audit practices through advances in spatial technologies, such as Google Street View and remote sensing, have drawn attention to the reliability and validity of online audit tools (Brookfield and Tilley 2016). The integration of effective training programs prior, during and post auditing process may improve the reliability of audits (Hoehner et al. 2006).

The impact of auditing practices on social and institutional systems and their implications for the distribution of their benefits has been another important consideration. Lewis (2008) argues that the design and administration of audit instruments reflect moral positions regarding the distribution of access to resources or public goods. These moral arrangements are embedded within the structure and assumptions of audit frameworks. According to Lewis (2008), audits can be categorized as audits of satisfactions; audit of opportunities; and the audit of capabilities. Lewis considers audits of satisfactions, which are derived from people's preferences with existing conditions unreflective of the full potential of built environment resources and opportunities, which may be present by not necessity utilized. Instead, he supports audits of capabilities approach, which measures current and potential access to build environment resources.

Auditing for CPTED: developing a research agenda

The origins and detailed discussions and critique of CPTED are outside of the scope of this paper and have been highlighted elsewhere (e.g. see Taylor 2002; Cozens et al. 2019; Atlas 2008; Armitage 2016; Cozens 2016; Cozens and Love 2015). According to Crowe (2000, p 46), CPTED is defined as 'the proper design and effective use of the built environment [which] can lead to a reduction in the fear and incidence of crime, and an improvement in the quality of life'. In the UK and parts of Europe, the term Designing Out Crime has also been adopted. This paper specifically focuses on audits of the physical and built form and what is known as 1st Generation CPTED, rather than any other iterations of the theory (e.g. 2nd Generation and 3rd Generation CPTED). There is evidence that auditing or site assessments are an important part of current CPTED practices (Ramsay 2013) and have been used by police, the fire service, community organizations and local planners in Christchurch, New Zealand. Although there are different interpretations of CPTED, seven principles are commonly associated with modern ideas of CPTED and include territoriality, surveillance, image management, access control, activity support, target hardening and geographical juxtaposition (the wider environment). Figure 1 provides a diagram to highlight these concepts, which are briefly described below.

Territoriality uses design and signage to clearly designate spaces as private, semi-private, semi-public or public and defines the intended use of space to encourage ownership and appropriate use. Surveillance is about the design and use of space and how it can promote opportunities for visibility and 'eyes on the street' (Jacobs
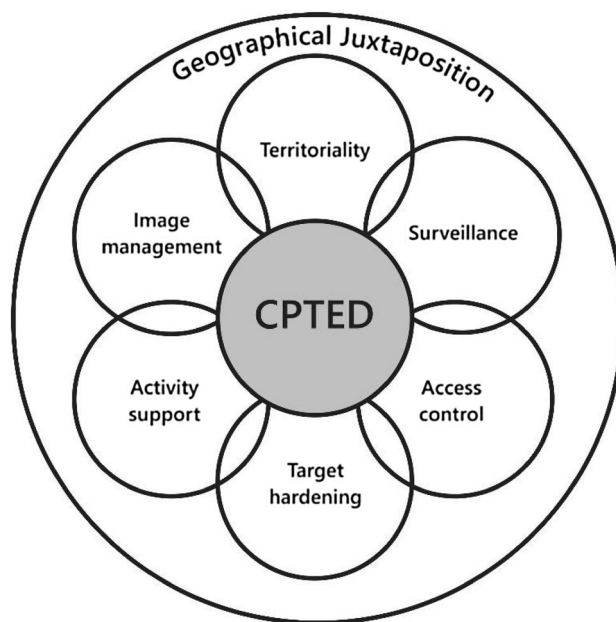

Fig. 1 The Seven Principles of CPTED (adapted from Cozens et al. (2019), pp. 328–356)

1961). 'Mechanical' surveillance strategies include lighting and CCTV. Access control uses design, 'real' barriers (e.g. boom gates and bollards) and 'symbolic' barriers (e.g. signage and changes in texture/colour) to limit access to specific spaces, rooms, buildings or locations. Image management/order maintenance is about signalling to users that a space is cared for, valued and overseen by the community. This may help discourage criminal and anti-social behaviour. Essentially, it is about keeping spaces clean, well maintained and free of graffiti and vandalism. Activity support encourages legitimate land uses, activities and users to foster and promote 'eyes on the street' and natural surveillance. Target hardening makes targets of crime more difficult for criminals to access by adopting more effective and efficient locks on doors and windows, security screens and alarms. Finally, geographical juxtaposition is essentially the potential influence of the wider environment. An understanding of the surrounding environment is important because different land uses are commonly associated with different types and levels of crime. This wider context can affect how all the other CPTED concepts function in any given situation or space.

However, these principles are not sufficient on their own (Crowe 1991, 2000; Atlas 2008; Cozens 2011, 2016) and decisions about CPTED need to be based upon sound judgements about crime (and other) risks in and around the local context. Indeed, Crowe (2000, p 6) argued CPTED 'is a process and not a belief system'. Crime risk assessments (CRAs) are an important part of the CPTED process, as originally articulated by Crowe (1991, 2000) and restated by others since (e.g. Atlas 2008; Cozens 2016). This can involve the analysis of crime and demographic data along with architectural drawings and diagrams for new developments. However, some have argued the quality and integrity of these types of CRA is highly questionable (e.g. Clancey 2010; Clancey et al. 2015, 2016). Another type of CRA involves the assessment of existing environmental settings using CPTED audits conducted during site visits. This is the specific focus of this paper. The analysis of crime and demographic data in each of the locations where the CPTED audits were carried out, was an important part of the process. However, this is outside of the scope of this investigation and will not be explored or reported on, in this paper.

Literature review: an overview of CPTED audits

There have been many attempts to create audits to measure indicators for CPTED. Indeed, Atlas (2008, p 511) observes 'there are more versions of security surveys and checklists than there are alligators in the Everglades. The challenge is to determine which methodology to use'. Moreover, few studies have evaluated the utility or effectiveness of any CPTED audit, let alone their validity, reliability or generalizability. We highlight a range of approaches before discussing the CPTED audit we have developed as a result of an iterative process over several years. Following Ceccato (2019), we also briefly reflect on the validity, reliability and generalizability of our audit and how it could be improved as part of an ongoing iterative process.

The use of formalized observational studies of the built environment accompanied the emergence of CPTED as a theory and practice. Linking to the observational

approached of Jacobs (1961) and Whyte (1980), Newman's (1973) work on Defensible Space, which underpins CPTED, was partly based on early observations of the Pruitt Igoe public housing projects near his office at Washington University in St Louis (Newman 1996). Following the publication of *Crime Prevention Through Environmental Design* (*CPTED*) (Jeffery, 1971) and *Defensible Space* (Newman 1973), many researchers have created a range of tools and audits to try to measure the presence or absence of CPTED. Below, we summarize the numerous attempts to create CPTED audits. Within the text, we also provide a brief narrative which describes the key landmarks in the development of audit tools.

One of the first audits was provided by Winchester and Jackson (1982). This was specifically designed to assess the risk of residential burglary and used binary yes/no responses to fourteen statements largely concerning access and surveillance. This was known as Burgess Checklist and is significant, since it was one of the first—and was subsequently adopted and modified by Armitage (2006) in various assessments of the UK's Secured by Design scheme (SBD). This is a police-endorsed initiative where housing is specifically designed to reduce opportunities for crime using a wide range of CPTED features. Through ongoing adaptation of these earlier iterations, the methodological basis of CPTED auditing began to develop and be refined.

Early CPTED audits/checklists focused on residential burglary and commonly used binary, yes/no responses to a range of CPTED-related statements. These usually audited individual properties for residential burglary or later, comparing several properties. Studies from the 1990s onwards often included more statements and the use of ratings of 1–3 and 1–5, rather than the binary yes / no option.

From 2000 onwards, audits began focusing on specific micro environments such as bus stops (Loukaitou-Sideris et al. 1999; Ligget et al. 2001), railway stations (Cozens 2015a, b). There were also concerns about inter-ratability—and some researchers responded by using more raters and more 'trained' raters. Following the 911 terrorist attacks in 2001, research began developing audits focused on reducing terrorism (e.g. Saville 2004; Atlas 2008).

In terms of landmarks, 2009 saw the beginning of audits using statements about local/proximal land uses—attempting to extend the CPTED statements of the audit, to include Newman's forgotten dimension—geographical juxtaposition. Later audits included statements about the presence or absence of proximal land uses (e.g. Cozens and van der Linde 2015; Cozens 2016; Cozens and Tarca 2016; Cozens and Babb 2018). Indeed, it has recently been demonstrated that few studies on CPTED have included GJ in their analysis, despite it being one of Newman's (1973) four Defensible Space concepts, which underpin CPTED (Cozens et al. 2019). However, given research using crime data (e.g. Anderson et al. 2013; Bowers 2014) and perception data (Boehme 2020) suggesting local land uses can influence perceptions of personal safety, indicators for geographical juxtaposition are therefore important to include in a CPTED audit.

Over the years, the number of statements in the audits has expanded significantly at times (e.g. Crowe 2000; Atlas 2008; 2013; Center for Disease Control and Prevention; 2017) to include many more variables. However, these tend to have reduced applicability and ease of use. Others have increased the 1–5 Likert

scale to scores out of 10. Increases in the number of audits taken in a location are also a key landmark change, with more recent audits using multiple audit points in a street—rather than the more traditional use of a single CPTED to 'get a feel' for the area. (e.g. Raham et al. 2015; Cozens 2016).

More recent audits have introduced the idea of weighting specific CPTED concepts (e.g. McCamley 2002) and the use of categories to signify statements which cannot be measured (e.g. Centres for Disease Control and Prevention 2017) such as does not exists (DNE) and unable to observe (UTO).

After dark, as a specific point in time to conduct CPTED audits has also been highlighted as being important. Indeed, the audit presented later in this paper attempted to audit the after-dark environment as well as during the day.

An appropriate and effective audit therefore needs to strike a balance between complexity and usability. The scores also need to be easily and quickly analysed and interpreted.

Table 1 (below) briefly summarizes a range of CPTED audits developed from the 1980s–2010 and comments on their significance. Table 2 does the same for CPTED audits developed from 2011 onwards.

Ceccato (2019) refers to CPTED audits as fieldwork protocols (FPs) noting their popularity as a tool for data collection. FPs have been defined as 'a pre-designed form used to record information collected during an observation or interview'. Creswell 2013, p.168). However, Ceccato (2019) asserts that despite the extensive use of FPs in criminology and beyond, there is a lack of research which seeks to assess their potential or efficacy to collect data.

Research has demonstrated that FPs can capture important environmental indicators which help explain why crime and the fear of crime occurs at particular locations and times (e.g. Phipps and Horrobin 2014; Raham et al. 2015; Iqbal and Ceccato 2016; Ceccato et al. 2018). Ceccato (2019) asks what we should expect from an FP designed to measure personal safety and/or the presence or absence of CPTED features in the built environment. She opines firstly that FPs can be effective and collect unbiased data. Secondly, they should provide measurements which are stable across all the items in the protocol. Thirdly, although FPs can be developed in a uniform way, they can still be flexible and adapted for different locations, types of places and contexts. Table 3 highlights the basic conditions of FPs for CPTED audits.

Ceccato (2019) then reflects on the validity, reliability and generalizability of each FP. The FP used for the subway station more closely resembles the type of CPTED audit we are focusing on in this paper, and it was scored as 'high' for content validity, 'medium' for criterion validity, high/medium for time reliability, 'high' for internal reliability, 'high' for observer reliability and 'high/medium' for generalizability. Ceccato (2019) concludes there is evidence that FPs (including CPTED audits) can be useful.

It has long been recognized that there can be difficulties in maintaining high levels of inter-observer reliability. However, Ceccato (2019) suggests this can be made less problematic when observers are well-trained and briefed on all the visual cues in the audit before they begin any fieldwork data collection. Ceccato (2019) summarized over ten years of research in Sweden and Lithuania, using

Table 1 CPTED Audits: 1980—2010

Author(s) & date of CPTED Audit	Brief summary and significance of the audit
Winchester & Jackson (1982)	Used a binary yes/no risk index for residential burglary to measure occupancy and security devices/behaviour, based on fourteen variables for access and surveillance
Vander Voordt and Van Wegen (1990, 1993)	Used a binary yes/no approach for recording the presence or absence of design criteria associated with crime on four locations in the Netherlands. Factors included target vulnerability, surveillance, accessibility and escape routes
Crowe (1991, 2000)	Provides very detailed CPTED matrices where CPTED criteria are assessed as 'satisfactory', 'unsatisfactory' or 'NA' (not applicable). Detailed audits for schools, convenience stores and gas stops, rail, transit, and terminals, malls and shopping centres are too complex and do not provide any framework for scoring any of the CPTED variables. Not very practical
Perkins et al. (1992, 1993)	Used trained raters to audit physical elements of 576 homes to measure physical signs of disorder, territoriality and the built environment. They report the method has been demonstrated to possess strong predictive validity and inter-rater reliability
Loukaitou-Sideris et al. (2001)	Measured crime and environmental attributes in and around 60 bus stops in Los Angeles. Those near alleys, multifamily housing, liquor stores and check-cashing establishments, vacant buildings, and graffiti and litter exhibited higher crime rates. Lower crime rates linked to good visibility
Liggett et al. (2001)	Measured a range of physical indicators around high crime bus stops in Chicago. These included land use, visibility, bus shelters, lighting, street and sidewalk width, parking, levels of traffic and the presence or absence of bars and liquor stores
McCamley (2002)	Used 45 raters to assess the presence or absence of 139 physical elements associated with crime. However, these indicators and how they were measured were not explicitly outlined
Cozens et al., (2003a; 2003b)	A Situational Station Security Index (SSSI) measured CPTED qualities, such as surveillance, access control and territoriality in and around railway stations in South Wales. One audit was conducted once at each of the 15 stations and used a binary yes/no approach
Saville (2004)	The CPTED risk audit for anti-terrorism infrastructure protection, use a binary yes/no approach. A total of 24 questions assessed CPTED concepts such as territoriality, surveillance, access control, image and maintenance, increasing effort and risks and reducing rewards
Minnery and Lim (2005)	Constructed a CPTED audit for housing in Australia measuring territoriality, access control, surveillance, activity support, motivation reinforcement, legibility/permeability, security, robustness and land-use mix on a scale of one to five. Crime data supported their framework

Table 1 (continued)

Author(s) & date of CPTED Audit	Brief summary and significance of the audit
Armitage (2006)	Refined Winchester and Jackson's (1982) audit, extending it to 33 design variables using a mean score from two audits of statements on territoriality, surveillance, image management, access control and target hardening
Atlas (2008)	Provides a very detailed, but very complex CPTED audit. It includes yes/no binary responses which focus on CPTED features of the development and site, the building and interior space Atlas (2008) adopts the Anti-terror Risk Infrastructure Protection Model (ATRiM model)
Cozens and Love (2009)	Produced a CPTED audit for Pedestrian Access Ways (PAWs). Fourteen CPTED measures, e.g. visibility, lighting, entrapment spots, maintenance, access control, width of pathways, proximity to vacant spaces/properties, proximity to alcohol suppliers, schools and ATMs, phone boxes or public toilets. This is one of the first CPTED audits to consider proximal land uses
Office of Crime Prevention n.d	The WA State Graffiti Taskforce has developed CPTED audits (Office of Crime Prevention n.d) using a checklist of 76 CPTED measures in a binary satisfactory/non-satisfactory approach on measures for wayfinding, surveillance and visibility, landscaping, lighting, territorial definition, image, planning, management, building materials, access/egress control and activity uses

different observers but similar FPs. These protocols were employed differently in the field and were applied in different contexts. For Ceccato (2019, p19), 'future research should devote time to improving inter-observer reliability of the data collected using the FPs' and observers should possess 'minimum agreeable knowledge' of theoretical concepts and CPTED indicators before beginning any fieldwork'.

The CPTED audit: an iterative process

Ceccato (2019) reported reflections on the use and CPTED audits over a ten year period. Given the earlier work on CPTED audits discussed in the literature mentioned previously, and research conducted by one/both of the authors (e.g. Cozens 2015a, b; Cozens 2016; Cozens and Babb 2018), we reflect on our journey and experiences using and adapting CPTED audits as 'notes from the field'.

The first project was conducted in 2015–2017 in Maylands (a suburb north east of Perth, Western Australia) and partners included the City of Bayswater, Maylands Business Association, Western Australian Police, Focused Solutions and Central 55 (a homeless charity). Twenty-seven local business completed crime and fear of crime surveys. Essentially these probed crimes they had experienced and/or were worried about and security measures they had adopted. The audit divided

Table 2 CPTED audits since 2010

Author(s) and date of CPTED audit	Brief summary and significance of the audit
Hedayati Marzbali et al. (2012a, b)	Developed a CPTED audit for residential settings in Malaysia, using several indicators for natural surveillance, access control, territoriality and exterior maintenance. A total of 164 dwellings were audited
Phipps and Horrobin (2014)	Trained 83 residents to audit their local streets for their perceptions of safety relating to the presence or absence of 36 exterior CPTED attributes of territoriality, natural surveillance, activity support and access control. They used a five-point Likert scale (very unsafe, unsafe, neutral, safe or very safe) in daylight and scores of 6–10 in darkness
Cozens and van der Linde (2015)	Surveyed 100 rail users comparing perceptions of crime and CPTED features at two railway stations in Perth (WA). They used a binary yes/no CPTED audit to measure the presence or absence of visibility at the station, surveillance from passers-by, surrounding land uses, CCTV, security guards, exit points, perceptions of the image of the stations
Raham et al. (2015)	Developed a CPTED audit of four suburban railway stations in Melbourne, Australia. Indicators for surveillance, motivationsupport/access control, maintenance and territoriality/activity support were scored between 0 and 10 and audited specific locations, including platforms, ticketing area, entrance and exit point of the station, entrance and exit point of the platform, waiting areas and car parks. It is unclear how the weightings used were selected and justified
Cozens and Tarca (2016)	Used a CPTED audit of 20 yes/no statements to explore dereliction and perceptions of crime in Perth (WA) associated with two photographic images of the same house (one shows the house in a derelict state in 2008 the other, in a more recent refurbished state in 2014). Indicators included surveillance, territoriality, image management and access control/target hardening
Kowalczyk (2016)	Developed a CPTED checklist with a total of 42, largely binary (yes/no, good/bad, easy/hard) measures for general impressions, lighting, signage, sightlines, isolation, movement predictors, entrapment spots, escape routes, activity uses, maintenance and territorial definition
Cozens (2016)	The Designing Out Crime Risk Assessment (DOCRA) measured the presence or absence of a total of 36 binary (yes/no) measures for territoriality (9), surveillance (10), image and maintenance (8) and environment (9). This extended existing models to include variables for geographical juxtaposition (GJ) not commonly included in CPTED audits previously

Table 2 (continued)

Author(s) and date of CPTED audit	Brief summary and significance of the audit
Centers for Disease Control and Prevention (2017)	The Crime Prevention Through Environmental Design (CPTED) School Assessment (Centers for Disease Control and Prevention 2017) looked at statements for nine areas; initial impressions (3), the grounds (83), the buildings (73) the interiors (175), global impressions (4), additional observations (a statement), surrounding land uses (general review and statements), surrounding land-use condition (13) and assessment day information (weather, date and time). It used 1–5 ratings and provided a description and examples of how this should be done, to assist auditors. If all the audit measures are used a total of 351 statements need to responding to—regarding level of agreement with each statement. This audit also include the capacity to record categories such as 'Does Not Exist' (DNE) and 'Unable To Observe' (UTO). This very comprehensive and detailed audit, however, does not provide any process or mechanism for making sense of the data or quantifying it in any way
Cozens and Babb (2018)	Used 1–5 scaling for each of the measures for CPTED of territoriality, surveillance, order maintenance and environment. Modified to include 'Does Not Exist' (DNE) and 'Unable to Observe'. Used 'trained auditors and analysed the audit data alongside fear of crime data and showed that the areas that score poorly by the audit correlated with those that respondents perceived were unsafe
Ceccato (2019)	Compared three different environments (a public park, a railway station (underground) and a retail setting) exploring these in relation to crime and perceived safety data. Looked at different parts of the station and measured variables including; visibility, illumination conditions, the presence of dark corners at platforms, hiding places at platform; sunlight illumination, visibility to other areas and possibility of surveillance by others

the precinct into five areas where three to five survey spots were chosen at regular intervals for the audit points. A total of 24 sites in the area were each audited once. Two members of staff were assisted by seven students who were briefed beforehand. The factors affecting crime and safety at each audit site were noted and integrated into the results for each street within the four CPTED elements of image, land use, surveillance and territoriality. Each of these categories was measured using several questions requiring binary responses (yes/ no). The data gathered during the audits was used to leverage funding for crime prevention improvements in the area.

As part of the iterative process, this initial CPTED audit was critically inspected and reviewed for content and ease of use based on the experiences of those who conducted the audits. Further insights were gained from the most recent research on audits (e.g. Centre for Disease Control and Prevention 2017) and further modifications were made based on new literature. Essentially, conducting 24 individual audits at 24 sites was seen as a weakness which could affect reliability. In addition, using binary yes/no responses was regarded as lacking detail and precision. Auditors also reported issues where measures were not present or they could not be observed.

Table 3 Basic conditions of fieldwork protocols (adapted from Ceccato, 2019)

Fieldwork protocol—fundamental elements	Characterization of fieldwork protocols for research
Validity How successful was the FP and did it achieve what it was set out to do?	*Content validity* If the FP is created to measure the presence of four CPTED principles in an area—then these should be the backbone of the FP *Criterion validity* Refers to the extent to which records collected correlate with other data, as hypothesized
Reliability Refers to the consistency of a measure in the FP over time, internally and across auditors. It depends on the measurability of the hypotheses and relationships	*Reliability over time* Is the extent to which data collected are consistent over time (e.g. data collected at rush hour compared to data collected at the same time of day) *Internal consistency* Dependent on the stability of the measurements across items in the protocol (e.g. a measure based on the correlation between different items on the same test *Inter-observer reliability* Different observers should show a capacity to show the 'same reality' or similar evidence when assessing CPTED concepts in a space
Generalizability Whether the FP or findings can apply to other research contexts or situations	Possible causal links between crime and types of environment (obtained by the FP) should be tested and applied to other environments of the same type, to other contexts and to other types of events in similar environments

This audit was refined in two relatively small community surveys of the town square in the City of Gosnells and of a large revitalization on new land over a previous railway line in Perth, known as the Northbridge City link. The second major project in 2018–2019 involved a section of Beaufort Street, Perth. Partners included community group 'Inglewood on Beaufort' and the City of Stirling. The Beaufort Street CPTED project received $10,000 funding from the State Government's Local Projects Local Jobs initiative. Fifty-seven sites were audited, including 30 along Beaufort Street and 27 in the laneways immediately behind this street. Two staff members and 16 students conducted multiple audits across the 57 sites. Each site was therefore audited, on average up to four times and the average median scores were calculated. This CPTED audit was refined to include 1–5 scaling for each of the measures for CPTED of territoriality, surveillance, order maintenance and environment. It was also modified to include categories for 'Does Not Exist' (DNE) and 'Unable to Observe'. Furthermore, the knowledge and preparation of auditors were significantly improved since they had all previously completed a Special Topics unit called Crime and the Built Environment, where they learned about crime, crime patterns and how to conduct CPTED audits.

Surveys were also carried out with business owners along the Beaufort Street commercial strip and residents who lived in the surrounding residential neighbourhoods. The surveys captured perceptions of safety and allowed respondents to map points in the main street and adjacent neighbourhoods they perceived were safe and unsafe. The findings were cross-analysed with the audit data and showed that the

areas that scored poorly by the audit correlated with those that respondents perceived were unsafe. This community now has data from street audits and surveys, which are being used as an evidence-based process for applying for State and Commonwealth funding to target specific crime and disorder issues. The project has built social capital and energized stakeholders and the community. The methodology used in the research for these projects is an evolving iterative process.

In 2020, due to the COVID-19 epidemic, the audits were conducted virtually using Google Streetview. This approach has been supported in the literature (Vandeviver 2014). The audit was conducted on a section of William Street in Northbridge (WA). Twenty students audited eight sections of this street. There are obvious limitation with this approach, but the continued trialling of this audit did reveal further potential improvements which could be made to the auditing tool. It also emerged as a useful training tool for subsequent students.

One important limitation which emerged from this process was the lack of data collection after dark and particularly, the failure to measure the potential impact of lighting levels in the street. This was partly associated with safety concerns for the auditors. Indeed, many of previous studies highlighted earlier, either did not audit after dark—or did not report that they did. This temporal element of the CPTED audit was developed and inserted into the approach for the next application of this iterative process.

In 2021, the COVID-19 situation had improved in WA, and real-world audits could again be conducted. A total of 136 audits were conducted in and around Bassendean Town Centre. These were carried out by thirty-one students and two members of staff. Given criticisms of previous audits and the literature on the need to conduct audits in the 'after-dark' environment, six audit questions were added to explore lighting levels, visibility and activity after dark. Table 4 shows the statements in the audit tool used in this study. On reflection, the scoring scale of 1–5 was found to be too confusing for auditors so this iteration is restricted to scores of 1–3.

Following Ceccato (2019), each site was audited by at least two auditors, who were all enrolled in the Crime and Built Environment unit. This is a core elective unit called Special Topics, which is part of the Urban and Regional Planning Honours degree at Curtin University, and is accredited by the Planning Institute of Australia (PIA). Students were also instructed on how to use the audit tool in a more thorough and detailed manner. In the class students explored the questions in detail, used Google Street View to experiment with and trialled the tool by assessing the local environment of the University, to familiarize themselves with the concepts and the audit tool.

The spreadsheet also allowed for percentage scores to be generated for each of the CPTED principles; territoriality, surveillance, order maintenance and environment as well as for 'after dark'. This provides a very detailed analysis of each audit point.

One important consideration was to select the sites for auditing. In all the projects previously discussed, specific streets were identified by the stakeholders (predominantly local government and WA Police). Furthermore, all of the audit sites were selected using purposive sampling and were designed to optimize coverage along the street network. Initially, 50-m interval point along streets were audited, but the iterative process revealed a closer-grained analysis was required, and later studies used more audit sites which were also in closer proximity to one another (e.g. 20 or so metres).

Table 4 The Latest CPTED Audit

CPTED measure	Score 1–3

Territoriality

Property boundaries are clearly defined

It is clear whether spaces are public, semi-public or private

The site is located in, or close to spaces with activities

The site is not in, or close to, a secluded or under-used area

The site is located in an area with adequate levels of pedestrian circulation

Entrances to the buildings are clearly defined and visible

The intended use of the site is clear

Surveillance

Building frontages address the street

Building facades are visibly permeable (e.g. windows overlook the street)

Advertising does not obscure the surveillance from overlooking windows

There is passive surveillance from surrounding land uses

There is passive surveillance from passing pedestrians or other users

There is passive surveillance from passing vehicle traffic

There is CCTV in use

Landscape topography (e.g. height/elevation) does not obscure surveillance

Foliage does not obscure surveillance

Order maintenance

There is no evidence of litter/rubbish at or near the site

There is no evidence of graffiti at or near the site

There is no evidence of vandalism at or near the site

The site and buildings are well maintained

There is no evidence of abandoned buildings and/or vehicles

There is evidence of the routine maintenance of properties and structures

There is evidence of the routine maintenance of the natural landscape

Environment

There are no entrapment or ambush spots in or around the site

The site is not adjacent to vacant or derelict land or property

The site is not close to a supplier of alcohol

The site is not linked to other land uses via pedestrian access ways + paths

The site is not close to pawn brokers or cash converters

CPTED Audit after dark

I can recognize someone's face at a distance of 10 m

There are no locations with excessive bright spots (too much 'blinding' light)

There are no locations where there are dark spots and shadows

There are active land uses nearby (e.g. 24 h)

Street lighting is well maintained (e.g. all seem to be working)

Lighting levels allow colours to be easily distinguished

Score 3 for total agreement with the statement and 1 for disagreement. Use 3 for 'there is a lot of this' and 1 for 'there is none of this'. Use N/A (not applicable) if the criteria is not there to measure or you are unable to see the criteria

Conclusions

Our current iteration for a CPTED audit process is still very much a work in progress. However, given the work of Ceccato (2019) and the recent publication of the International Standards on CPTED, (BS-ISO 22341 2021), we felt it was timely to report on the development and status of our ongoing work on CPTED audits. Although we have not provided any empirical analysis, we maintain the iterative process has improved the validity, reliability and generalizability of this CPTED audit.

Overall, the CPTED audit has been refined to be more useable, flexible and relevant to the emerging evidence in the field of environmental criminology and CPTED. It is argued that this CPTED street audit process represents an evolving World 'best practice'. Traditionally, few (often only one) audit is conducted in an area and usually only measures broad variables such as surveillance, territoriality and image maintenance. Few have measured geographical juxtaposition and proximal land uses, fewer still explore the after-dark environment. Our innovative approach uses multiple highly specific measures taken at many more audit points by several (on average four) auditors who have all been trained and briefed. This provides a more detailed micro-scale audit of streets and facilitates a more targeted approach to the specific situation and context of each audit site. For example, where a cluster of audit points all show patterns of low poor visibility after dark, improved lighting could be a suggested improvement. Similarly, for a cluster of audits exhibiting poor scores for image and maintenance, graffiti removal, the repair of vandalized assets and a general clean up might be the most appropriate response.

The highly targeted focus of the CPTED audit potentially makes it useful for a variety of purposes and agencies. Firstly, authorities following the international standards could use the CPTED audit as part of the CRA element to the CPTED process to review and assess the physicality of local environments. Local authorities who may have conducted local perceptions/fear of crime audits could use the CPTED audit to assess 'hot spots' and explore the use of highly targeted CPTED (and other) modifications. Where crime data reveal 'hot spots', again, CPTED audits in these locations could provide another layer of knowledge and information on which to base appropriate crime prevention responses. For those regenerating locations or engaging in place-making improvements, the CPTED audits could be used to complement these approaches. For those seeking to promote public health and physical activity, CPTED audits at appropriate locations could help in improving perceptions of safety and security and in enhancing quality of life. CPTED audits could be used in public spaces (e.g. parks) and for settings/routes where authorities are seeking to encourage walking and cycling.

There are several limitations associated with our CPTED audit process. Firstly, in common with all audits, the CPTED audit is essentially subjective—and the scores generated will be associated with the values and opinions of the auditor. Although the use of 'averaged' scores from several auditors at each audit site is likely to limit extreme scoring, the issue of subjectivity remain. The training of the auditors would

also help in this regard. Secondly, when the audits are conducted is a further limitation, since they will always represent just a 'snap shot' in time—capturing data at a specific time and date. Similarly, the selection of the specific audit sites is another limitation. However, the use of numerous audit sites in a location, for example, provides more detail and data than just one audit for any location.

One further element this iterative process has not yet engaged with is the idea of weighting specific CPTED concepts, as explored by Raham et al. (2015). Indeed, Armitage (2018, p 30) argues that 'consideration should be given to the combination and weighting of each principle; the findings suggest that surveillance clearly plays a major role in influencing decision-making'.

This research essentially presents our 'notes from the field' and does not evaluate or statistically analyse the effectiveness of any of the CPTED audits. Indeed, this could be the focus of further enquiry and exploration. Future research could also explore CPTED experts' ideas and opinions on the current CPTED audit and what weightings might be considered appropriate for each of the CPTED principles within the audit. Further work could also investigate what type of training might be appropriate to potentially improve the efficacy of the CPTED audit. The iterative process continues.

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