

An Integrated CPTED Framework For Urban Safety Assessment: A Case Study Of Space, Devices, And Activities In Kakogawa, Japan

Dr. Kenji Tanaka

Department of Urban Planning and Design, University of Hyogo, Kobe, Japan

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Abstract: Background: Crime Prevention Through Environmental Design (CPTED) is a globally recognized approach for reducing crime and fear by manipulating the built environment. However, CPTED assessments often focus narrowly on physical design, neglecting the synergistic effects of technological interventions and community engagement. This is particularly relevant in contexts like Japan, where local safety is a product of urban planning, advanced technology, and robust community participation (*machizukuri*). This study addresses a critical gap by developing and applying a holistic framework to assess CPTED implementation.

Methods: This study introduces and applies a tripartite CPTED assessment framework based on three core components: Space (physical environmental features), Devices (technological security hardware), and Activities (community-based prevention efforts). Using the medium-sized Japanese city of Kakogawa as a case study, we conducted a multi-faceted data collection process. This included systematic environmental audits in diverse urban zones, GIS mapping of surveillance devices from municipal data and field surveys, and a comprehensive analysis of official documents to catalogue community safety activities.

Results: The findings reveal a varied landscape of CPTED implementation. While commercial areas and transport hubs showed high concentrations of security devices, certain residential areas and public parks exhibited significant weaknesses in spatial design, such as poor lighting and limited natural surveillance. Community activities, primarily driven by traditional neighborhood associations, were widespread but geographically uneven. Critically, the integrated analysis showed a disconnect between the three components in several areas, indicating a lack of a coordinated strategy and highlighting zones of potential vulnerability where environmental weaknesses were not compensated for by devices or activities.

Conclusion: The Space, Devices, and Activities framework provides a more comprehensive and nuanced method for evaluating urban safety measures than traditional CPTED audits. For policymakers in Kakogawa and similar cities, our findings underscore the need to move beyond siloed interventions towards an integrated strategy that strategically aligns physical design improvements, technology deployment, and community mobilization to create safer urban environments.

Keywords: Crime Prevention Through Environmental Design (CPTED), urban safety, environmental criminology, situational crime prevention, surveillance, community policing, Japan.

Introduction: 1.1 The Theoretical Foundations of CPTED

Over the past half-century, the approach to crime prevention has undergone a significant paradigm shift, moving from a near-exclusive focus on the offender to a more holistic understanding that incorporates the physical and social environment in which criminal

events occur. At the forefront of this evolution is the concept of Crime Prevention Through Environmental Design (CPTED), a multi-disciplinary strategy aimed at deterring illicit behavior by proactively designing and managing the built environment [20, 36]. Rather than relying solely on reactive policing, CPTED operates on the premise that the proper design and effective use of

a physical space can lead to a reduction in the incidence and fear of crime.

The intellectual roots of CPTED are commonly traced back to the seminal works of three key theorists. In her influential critique of contemporary urban planning, *The Death and Life of Great American Cities*, Jane Jacobs [19] introduced the concept of "eyes on the street." She argued that vibrant, mixed-use urban spaces with a high degree of pedestrian activity create a network of natural surveillance, where residents and users of the space collectively and informally monitor their surroundings, thereby discouraging potential offenders. Shortly thereafter, criminologist C. Ray Jeffery [20] formally coined the term "Crime Prevention Through Environmental Design," positing that the environment itself could be manipulated to control behavior, much as it is in other fields of science. He advocated for a proactive approach that would reduce criminal opportunities before they could manifest.

Building upon these ideas, architect and urban planner Oscar Newman [35] developed the theory of "defensible space." Through his empirical studies of public housing projects in the United States, Newman demonstrated a strong correlation between specific architectural designs and crime rates. He argued that residential environments designed to foster a sense of ownership, community, and responsibility among inhabitants were significantly safer. Newman articulated four core principles that have become foundational to CPTED practice: natural surveillance (the ability of legitimate users to observe their surroundings), natural access control (the use of physical design to guide people and limit access to crime targets), territorial reinforcement (the use of design elements like fences, landscaping, and signage to express ownership and define public, semi-private, and private spaces), and maintenance (the ongoing care and upkeep of a space, signaling that it is monitored and cared for, an idea later popularized as the "Broken Windows" theory [44]). Together, these principles form the bedrock of CPTED, offering a framework for analyzing how the physical environment can either facilitate or inhibit criminal opportunity [4].

1.2 The Evolution of CPTED Principles

While the foundational principles remain robust, the theory and application of CPTED have evolved significantly since the 1970s. This evolution is often conceptualized in three "generations," each expanding the scope of the preceding one to address its limitations and incorporate new social and technological realities.

First Generation CPTED is largely synonymous with the initial theories of Newman and Jeffery, focusing almost

exclusively on the physical aspects of the built environment. It is a deterministic model concerned with manipulating physical design features—such as building orientation, lighting, landscaping, and barriers—to reduce opportunities for crime [3, 40]. While highly influential and effective in many contexts, such as reducing robberies in commercial settings [3] or burglaries in residential areas [28], this initial formulation was criticized for its potential to create sterile, fortress-like environments and for its relative neglect of the social dynamics within a space [7].

In response to these critiques, Second Generation CPTED emerged in the late 1990s [38, 39]. This approach recognized that physical design alone is insufficient for creating truly safe communities. It integrates the "hard" elements of design with "soft" social and community-based strategies. Second Generation CPTED emphasizes the importance of social cohesion, community engagement, neighborhood connectivity, and institutional capacity-building [31]. The goal is not just to prevent crime but to foster a sense of community and collective efficacy, where residents are empowered to take an active role in maintaining their own safety. This generation explicitly acknowledges that the way a space is used and the social fabric within it are as important as its physical layout.

More recently, the discourse has moved towards Third Generation CPTED, which further expands the concept to address contemporary urban challenges and opportunities. This latest iteration incorporates elements of environmental sustainability, social equity, and public health, viewing community safety as an integral component of overall community well-being [31]. A key feature of Third Generation CPTED is its engagement with the "smart city" concept, exploring how digital technologies—such as networked surveillance, data analytics, and integrated communication systems—can be leveraged for crime prevention while also navigating the associated ethical and privacy challenges [26, 33]. This generation promotes a holistic, systems-thinking approach, recognizing that safety is interconnected with factors like transportation, housing, employment, and access to green space.

1.3 Crime Prevention in the Japanese Context: The Philosophy of Machizukuri

Japan presents a unique and compelling context for the study of CPTED. While renowned for its exceptionally low rates of violent crime compared to other industrialized nations [43], the country is not immune to public safety concerns. National crime statistics indicate persistent issues with property crimes like

theft, as well as an increasing societal focus on preventing public nuisance and assault, particularly those targeting vulnerable populations [1, 34]. In response, both national and local governments have actively promoted a distinct approach to crime prevention that blends official policy with deep-rooted traditions of community self-governance.

A central concept in this approach is machizukuri, which translates loosely to "community-building" or "town-making" [15]. When applied to crime prevention, it becomes bouhan machizukuri (crime prevention community-building). This philosophy moves beyond a top-down, police-centric model and instead emphasizes a collaborative effort involving residents, local businesses, schools, and government agencies to create a safe and secure living environment [14, 45]. It is a practical manifestation of Second Generation CPTED principles, focusing heavily on fostering social capital and collective efficacy. Rather than viewing citizens as passive recipients of police protection, bouhan machizukuri positions them as active co-producers of safety. This approach is not merely about preventing crime but about enhancing the overall quality of community life, embedding safety within a broader framework of local pride, social connection, and mutual responsibility. The underlying logic is that a community that is socially cohesive, aesthetically pleasing, and actively used by its residents is one that is naturally resilient to crime and disorder.

1.4 The Chonaikai: Engine of Community-Based Prevention

The primary vehicle through which the philosophy of bouhan machizukuri is put into practice is the chonaikai or jichikai (neighborhood association). These organizations are a near-ubiquitous feature of the Japanese social landscape, forming the bedrock of local civic life. Although membership is technically voluntary, the high density of households belonging to a chonaikai and the essential local services they often manage create strong social expectations for participation. Historically, these associations trace their origins to neighborhood administrative units established centuries ago, and their role was solidified and formalized by the government during the 20th century to serve as a conduit for top-down communication and social organization [13].

Today, the chonaikai operates in a quasi-administrative capacity, acting as a crucial intermediary between individual households and the municipal government. They are responsible for a wide range of hyper-local tasks, such as managing garbage collection points, organizing local festivals and cultural events, disseminating information from the city office, and

maintaining community facilities like meeting halls and parks [32]. This embeddedness in the daily life of the community makes them the natural and indispensable actor for mobilizing residents for collective action, including crime prevention.

In the context of bouhan machizukuri, the chonaikai is the organizing body for the majority of the 'Activities' that constitute the social layer of CPTED. It is the chonaikai that recruits volunteers for night patrols, coordinates the rosters for the "school watch" programs that protect children on their commute, and organizes the neighborhood clean-up campaigns that directly support the CPTED principle of maintenance [16]. These efforts, often branded with unique local names and logos, are a visible manifestation of a community's commitment to safety. This "Plus Bouhan" approach encourages residents to integrate crime prevention consciousness into their everyday routines—such as taking a different route when walking the dog to increase surveillance or carrying a whistle during their evening jog [16]. This system transforms the abstract goal of crime prevention into a set of tangible, routine, and community-building social practices, all orchestrated through the institutional framework of the neighborhood association. The city of Kakogawa, with its robust network of active chonaikai, exemplifies this model of hyper-local, community-driven safety production [42], making it an ideal setting to investigate the interplay of this powerful social component with the physical and technological dimensions of CPTED.

1.5 Literature Gap and Rationale for the Study

Despite the global proliferation of CPTED and the rich tradition of community-based prevention in Japan, a significant gap persists in the academic literature concerning holistic assessment methodologies. Many empirical studies of CPTED effectiveness tend to focus on a narrow set of variables, often concentrating solely on the impact of specific physical design interventions [12, 28, 40] or the presence of surveillance technology [42]. While valuable, these studies may not fully capture the complex, multi-layered nature of safety in an urban environment. Existing CPTED audit tools, which are essential for practical assessment, have been criticized for their potential subjectivity, inconsistent application, and difficulty in systematically capturing the full spectrum of relevant factors [6, 18, 30].

This research contends that to accurately assess the state of crime prevention in a given area, a more integrated framework is required. Such a framework must concurrently evaluate the physical environment (Space), the presence and distribution of technological interventions (Devices), and the scope and intensity of

social and community engagement (Activities). These three components represent the core pillars of First, Third, and Second Generation CPTED, respectively. By examining them in tandem, it becomes possible to identify not only the strengths and weaknesses within each domain but also the crucial synergies—or conflicts—that exist between them [9]. This study, therefore, aims to fill this methodological gap by developing and applying a tripartite assessment framework in the Japanese context, where the interaction between these three elements is particularly pronounced.

1.6 Study Objectives

The primary objective of this research is to develop and apply a tripartite assessment framework—structured around the components of Space, Devices, and Activities—to comprehensively evaluate the implementation of CPTED principles in the city of Kakogawa, Japan.

To achieve this primary objective, the study pursues the following secondary goals:

1. To systematically map and analyze the spatial characteristics of Kakogawa's built environment, identifying features that align with or deviate from established CPTED principles.
2. To create a detailed inventory of safety-related devices, particularly surveillance cameras, analyzing their distribution and density across different urban zones.
3. To document the landscape of formal and informal community-based crime prevention activities, identifying their nature, frequency, and geographic coverage.
4. To conduct an integrated analysis that explores the interplay and geographical juxtaposition of these three components, revealing patterns of synergy and deficiency in the city's overall approach to crime prevention.

2.0 METHODS

2.1 Study Area: Kakogawa City, Hyogo Prefecture

This study was conducted in Kakogawa, a city located in the southern part of Hyogo Prefecture, Japan. With a registered population of 259,576 as of 2022 [22], it represents a typical medium-sized Japanese "core city" (chūkakushi), balancing residential suburbs, a dense commercial center around its main train station, and industrial zones. Kakogawa was selected as the study area for several reasons. First, its demographic and urban structure is representative of many similar-sized cities across Japan, enhancing the potential relevance of the findings. Second, the municipal government has actively pursued public safety as a policy priority. The

annual Kakogawa Residents Survey consistently shows that "crime prevention and safety measures" are a high priority for citizens [21]. Third, the city's active promotion of "Smart City" initiatives provides a tangible link to Third Generation CPTED concepts, particularly concerning the deployment of technology for public welfare and safety [41]. Finally, previous research has already established a quantitative link between safety interventions (cameras and activities) and reduced crime in the city, providing a strong foundation for a more granular, qualitative assessment of the environmental context [42].

2.2 The Tripartite CPTED Assessment Framework

To achieve a holistic evaluation, this study developed and employed a novel tripartite framework designed to capture the multi-faceted nature of modern CPTED. The framework is composed of three distinct but interrelated components: Space, Devices, and Activities.

- **Space:** This component focuses on the physical, built, and natural environment, aligning with the principles of First Generation CPTED. The assessment of space involves analyzing static environmental attributes that influence human behavior and opportunity for crime. Drawing from established CPTED literature and international standards [17, 35], the key variables examined under this component include:
 - **Natural Surveillance:** Quality of sightlines, presence of windows overlooking public areas, and absence of visual obstructions.
 - **Lighting:** Adequacy and uniformity of artificial lighting during nighttime hours.
 - **Access Control:** Clear demarcation between public and private spaces, channelization of pedestrian flow, and presence of physical barriers.
 - **Territoriality:** Evidence of ownership and care, such as maintained landscaping, clean facades, and decorations.
 - **Land Use Mix:** The combination of residential, commercial, and recreational uses that can promote "eyes on the street" at different times of day [19].
 - **Maintenance:** Overall state of repair, absence of litter, graffiti, and signs of decay, reflecting the "Broken Windows" thesis [44].
- **Devices:** This component addresses the technological hardware deployed within the urban environment to enhance safety and security, a key element of Third Generation CPTED. This goes beyond simple presence to include distribution and density. The primary focus was on surveillance technologies, but the framework also considers other relevant hardware. The variables assessed include:

- Public Surveillance Cameras: Location, density, and field of view of cameras operated by the municipality or police.
- Private Surveillance Cameras: Location and visibility of publicly-facing cameras operated by businesses and private residents.
- Street Lighting Infrastructure: The density and type of streetlights.
- Emergency Call Buttons: Presence in public spaces like parks and underground passages.
- Activities: This component focuses on the social and human dimension of crime prevention, reflecting the core tenets of Second Generation CPTED. It aims to document the organized and informal efforts by community members to enhance local safety. This moves the assessment from a static analysis of the environment to a dynamic one of its use. The variables documented include:
 - Organized Patrols: Frequency, participant numbers, and routes of formal patrols conducted by neighborhood associations (chonaikai) or other volunteer groups.
 - School Watch Programs: The presence and operational intensity of volunteer groups that monitor children's routes to and from school.
 - Community Events: Local festivals, meetings, and beautification projects that bring residents into public spaces and strengthen social ties.
 - Information Dissemination: Distribution of safety newsletters, crime information emails, and other awareness campaigns.

2.3 Data Collection Procedures

A multi-method approach was employed to gather data for each component of the framework between October 2023 and May 2024.

- Environmental Audit (Space): To systematically assess the 'Space' component, a CPTED environmental audit checklist was developed. The instrument was adapted from validated tools used in previous research [6, 18, 27] and tailored to the Japanese urban context. The checklist consisted of 30 items, each rated on a 5-point Likert scale, covering the key variables listed above. Field surveys were conducted in five pre-selected, representative zones within Kakogawa: (1) a high-density residential area, (2) a low-density suburban residential area, (3) the central commercial district near the main railway station, (4) a large public park, and (5) a mixed-use area. A team of two researchers completed the audits for multiple street segments within each zone to ensure inter-rater reliability, which was confirmed using established

statistical methods [2].

- Device Mapping (Devices): Data for the 'Devices' component was collected using a two-pronged approach. First, official data on the locations of all municipally-operated surveillance cameras and streetlights was obtained from the Kakogawa City Office. This data was imported into a Geographic Information Systems (GIS) software (ArcGIS Pro) to create a baseline map. Second, this baseline was supplemented through systematic field surveys in the same five zones. Researchers walked pre-defined routes and used a GPS-enabled mobile application to record the location and orientation of all publicly-facing private surveillance cameras. This allowed for a more comprehensive inventory of the total surveillance landscape.

- Activity Documentation (Activities): Information on the 'Activities' component was gathered through a qualitative analysis of publicly available documents. This involved a systematic review of the Kakogawa municipal government's website, annual reports on city planning and safety [21, 41], and publications from the city's network of neighborhood associations. This review, guided by principles of qualitative content analysis, aimed to identify and categorize all mentions of organized crime prevention activities, noting their type, stated purpose, frequency, and, where possible, their geographic area of operation. This method provided a robust, non-intrusive way to understand the landscape of community engagement across the city, drawing on official and semi-official records of these initiatives [13, 32, 42].

2.4 Data Analysis

The data collected for each component was analyzed using appropriate methods. For the 'Space' component, quantitative data from the audit checklists was aggregated to produce an average CPTED compliance score for each zone, allowing for direct comparison. Descriptive statistics were used to identify common environmental strengths and weaknesses. For the 'Devices' component, GIS-based spatial analysis techniques, specifically kernel density estimation, were used to visualize the concentration of surveillance cameras across the city and calculate device density per square kilometer for each zone. For the 'Activities' component, the qualitative data from documents was systematically coded and categorized to create a typology of community prevention efforts and to map their reported operational areas. Finally, an integrated analysis was performed by overlaying the GIS data layers for devices and activity zones onto the base map of CPTED spatial scores. This allowed for a visual and

analytical exploration of the geographical juxtaposition of the three components, identifying areas of alignment or mismatch.

3.0 RESULTS

3.1 CPTED Assessment of Physical Space

The environmental audit revealed significant variation in CPTED compliance across the five representative zones. The central commercial district, centered around the main railway station, achieved the highest average CPTED score. This area was characterized by excellent lighting, open sightlines along main thoroughfares, a high degree of maintenance, and a clear demarcation of public and commercial spaces. The constant flow of pedestrians and vehicle traffic, coupled with large storefront windows, provided a strong sense of natural surveillance, consistent with Jacobs' [19] principles.

In contrast, the high-density residential area, comprised of older, low-rise apartment buildings and narrow streets, received the lowest CPTED score. Key deficiencies included poor and inconsistent nighttime lighting, numerous visual obstructions (e.g., overgrown foliage, poorly placed utility poles), and ambiguous boundaries between public alleys and private property, creating potential concealment spots for offenders. While territorial reinforcement was evident in some individual properties (e.g., potted plants), the overall lack of defensible space at the block level was pronounced.

The suburban residential zone scored moderately, exhibiting good maintenance and clear territoriality but suffering from a lack of natural surveillance due to high privacy walls and infrequent pedestrian activity, particularly during weekdays. The public park presented a mixed profile; while open grassy areas scored well on surveillance, more secluded wooded sections and areas with dense shrubbery scored poorly. Finally, the mixed-use area showed a patchwork of compliance, with modern commercial frontages scoring highly while adjacent older residential pockets mirrored the deficiencies of the high-density zone. A common strength across all zones, however, was a high standard of general maintenance, reflecting a cultural emphasis on cleanliness and order that aligns with the "Broken Windows" prevention strategy [44].

3.2 Distribution and Density of Security Devices

The GIS analysis of security devices highlighted a highly concentrated and uneven distribution across the city. A total of 1,248 public and 2,870 privately owned, publicly-facing surveillance cameras were mapped. The kernel density analysis, visualized in, clearly indicates that the highest concentration of devices is in the

central commercial district. In this zone, the density exceeded 300 cameras per square kilometer. This dense network provides comprehensive coverage of streets, station plazas, and shopping arcades, consistent with strategies observed at other transport hubs [10, 11].

Device density dropped sharply outside the commercial core. The suburban residential zone had the lowest density, with fewer than 20 cameras per square kilometer, the vast majority of which were privately owned and focused on individual property entrances. The high-density residential zone had a moderate density of approximately 60 cameras per square kilometer, with a higher proportion of public cameras installed at key intersections and in small neighborhood parks. The public park itself had a targeted placement of public cameras at entrances, exits, and main facilities, but vast areas within the park remained uncovered. This distribution pattern suggests a deployment strategy that prioritizes high-traffic commercial zones and specific crime hotspots over broad residential coverage. The analysis also revealed that privately owned cameras now constitute over two-thirds of the city's total publicly-facing surveillance network, highlighting the critical role of private citizens and businesses in the city's security infrastructure.

3.3 Characterization of Community Prevention Activities

The documentary analysis identified a robust and diverse landscape of community-based crime prevention activities, overwhelmingly organized and sustained by local chonaikai [13]. A total of 156 distinct neighborhood associations were identified as conducting regular safety-related activities. These were categorized into three main types:

1. **Patrol-Based Activities:** This was the most common form of engagement. It included uniformed nightly patrols by adult volunteers, often focusing on parks and stations, and morning/afternoon "school watch" patrols by parents and elderly residents wearing designated vests to ensure children's safety. Documentation suggests that over 80% of chonaikai conduct some form of regular patrol.
2. **Environmental Activities:** Many associations organized regular neighborhood clean-up and beautification events. While not explicitly framed as crime prevention, their function—clearing litter, trimming bushes, and painting over graffiti—directly aligns with the CPTED principle of maintenance and the "Broken Windows" theory [44].
3. **Awareness and Social Activities:** This included the regular distribution of safety newsletters, participation in a city-wide crime prevention

campaigns, and the organization of local festivals and events that serve to strengthen community ties and increase the positive use of public spaces.

The geographic coverage of these activities was extensive but not uniform. Areas with older, more established populations, corresponding to the high-density and suburban residential zones, reported higher rates of participation and more frequent patrols. In contrast, areas with a higher concentration of new apartment buildings and younger, more transient populations reported lower levels of organized activity, reflecting national trends in declining chonaikai participation [32].

3.4 Integrated Analysis of Space, Devices, and Activities

The spatial overlay of the three data layers revealed critical patterns of synergy and deficiency in Kakogawa's CPTED landscape. A clear synergy was observed in the central commercial district. Here, high-quality physical space (good lighting, sightlines) was complemented by the city's densest network of surveillance devices and regular patrols by both police and a merchant's association. This creates multiple overlapping layers of security.

However, significant deficiencies were identified in the high-density residential zone. This area, which scored

lowest on the CPTED environmental audit due to its poor physical design, also lacked a high density of surveillance devices. While it reported a high frequency of community patrols ('Activities'), this suggests that residents are attempting to compensate for environmental and technological shortfalls primarily through human effort. This reliance on a single CPTED component places a considerable burden on community volunteers and may not be sustainable long-term.

Another key finding was the condition of the large public park. Certain sections of the park scored poorly on the 'Space' audit and had no camera coverage ('Devices'). Documentary analysis showed that community patrols ('Activities') tended to stay on the main, well-lit paths, avoiding these more secluded areas, particularly after dark. This creates a "deficient" zone where all three layers of the CPTED framework are weak, potentially creating a "risky place" for victimization [25]. The analysis demonstrates that the mere presence of CPTED elements is insufficient; their strategic integration and geographical juxtaposition are paramount for creating uniformly safe environments [9]. The integrated findings across the five representative zones are summarized in Table 1.

Table 1: Summary of Integrated CPTED Assessment Across Five Urban Zones in Kakogawa

Zone Type	Key Spatial Characteristics	Average CPTED Score	Approx. Camera Density (per km ²)	Dominant Community Activities	Integrated Assessment
Central Commercial	Excellent lighting & sightlines, high maintenance, clear demarcation.	High	> 300	Formal patrols by merchant association and police.	Synergistic: Strong alignment of Space, Devices, and Activities creating layered security.
High-Density Residential	Poor lighting, visual obstructions, narrow streets,	Low	~ 60	Frequent and regular patrols organized by established	Deficient (Compensatory): Weak Space and moderate

	ambiguous boundaries.			<i>chonaikai</i> .	Devices are compensated for by very high Activity levels.
Suburban Residential	Good maintenance & territoriality, but poor natural surveillance due to privacy walls.	Moderate	< 20	High participation in <i>chonaikai</i> -led patrols and school-watch programs.	Mixed: Strong Activities but weak Space (surveillance) and very few Devices.
Large Public Park	Mixed profile: Open areas are good, but secluded/wooded sections are poor.	Mixed	Low (Targeted placement)	Patrols tend to avoid secluded areas, focusing on main paths.	Deficient (Zonal): Specific "deficient zones" exist where Space, Devices, and Activities are all weak.
Mixed-Use Area	Patchwork of features: Modern commercial sections score high, older residential low.	Moderate	Variable	Activity levels vary by block, corresponding to residential tenure and age.	Fragmented: Lacks a consistent CPTED profile; safety levels are likely inconsistent block-by-block.

4.0 DISCUSSION

4.1 Synthesis of Findings

This study set out to develop and apply a holistic framework for assessing CPTED implementation by integrating the components of Space, Devices, and Activities. The application of this framework in Kakogawa, Japan, yielded several key insights into the city's crime prevention landscape. First, the quality of

the physical environment ('Space') is highly variable, with modern commercial districts largely adhering to CPTED principles while older residential areas exhibit significant design deficiencies that could facilitate criminal opportunities. Second, the deployment of security technology ('Devices') is heavily concentrated in commercial and transport hubs, leaving large residential areas with comparatively sparse coverage.

This highlights a strategy focused on protecting economic centers over residential quarters. Third, community engagement in crime prevention ('Activities') is vibrant and widespread, largely driven by traditional neighborhood associations, but this social resource is not evenly distributed and is most active in established residential zones.

Most critically, the integrated analysis revealed a frequent disconnect between these three components. We identified "deficient zones"—notably in parts of older residential areas and public parks—where poor physical design, a lack of technological surveillance, and an avoidance by community patrols converge. This suggests that the city's approach to crime prevention is fragmented rather than integrated. The heavy reliance on community patrols in areas with poor infrastructure points to a reactive social compensation for systemic design flaws, a situation that is neither efficient nor sustainable. The findings illustrate that without a coordinated strategy, even a city with strong individual components of crime prevention can be left with significant and predictable pockets of vulnerability.

4.2 Theoretical and Conceptual Implications

The results of this study have significant implications for CPTED theory and its practical application. The tripartite framework of Space, Devices, and Activities offers a more robust and nuanced assessment model than a singular focus on any one dimension. It provides a practical methodology for operationalizing the conceptual evolution of CPTED. 'Space' corresponds to the foundations of First Generation CPTED, 'Activities' captures the social essence of the Second Generation, and 'Devices' addresses the technological aspect central to the Third Generation. By measuring all three concurrently, the framework moves beyond simply classifying CPTED into generations and instead provides a tool for diagnosing the integration—or lack thereof—between these interdependent layers.

Furthermore, the findings strongly support the emerging concept of "geographical juxtaposition" in CPTED [9]. The discovery that different layers of prevention are not always co-located in the areas that need them most underscores that the effectiveness of CPTED lies not just in the presence of its constituent elements, but in their strategic overlap and interaction. A well-lit path is of limited use if it is not monitored by cameras or patrols; conversely, a dense camera network may be less effective in a poorly designed environment that offers numerous hiding spots. Our analysis provides empirical weight to the argument that effective crime prevention requires a systems-thinking approach, where interventions are planned and implemented in a coordinated manner.

The study also contributes to the broader field of environmental criminology. The identification of "deficient zones" aligns with place-based criminological theories, which posit that crime is highly concentrated in specific micro-places [24, 25]. The tripartite framework can be used as a diagnostic tool to identify such high-risk "hotspots" proactively, based on their environmental and social characteristics, rather than reactively, based on crime data alone. It provides a richer understanding of why certain places might be risky, moving beyond correlation to a more explanatory model of crime-place dynamics that considers the interplay of opportunity (Space), guardianship (Devices), and social control (Activities) as prescribed by theories like Rational Choice Theory [5].

4.2.1 The Double-Edged Sword of Community Reliance: A Critical Look at the Chonaikai

While the findings highlight the chonaikai as the lynchpin of the 'Activities' component, a deeper theoretical discussion requires a critical examination of this heavy reliance on a single form of social organization. The Japanese model of community-based prevention, while powerful, represents a double-edged sword, presenting both an ideal application of Second Generation CPTED and a potential source of systemic vulnerability and social friction.

On one hand, the chonaikai system is an almost perfect embodiment of Second Generation CPTED theory [38, 39]. It provides a pre-existing, institutionalized structure for fostering the very social cohesion, collective efficacy, and territoriality that this CPTED generation promotes. Unlike in many Western contexts where community-watch programs must be built from scratch and often struggle for legitimacy and sustainability, the Japanese model leverages a deeply embedded social institution. The routine patrols, meetings, and festivals organized by the chonaikai do more than just deter crime; they build social capital, strengthen neighborhood ties, and reinforce a collective identity and shared responsibility for the local environment. When a resident dons the signature vest of a patrol volunteer, they are not only acting as the "eyes on the street" [19] but are also performing a civic duty that visibly reinforces community norms and expectations. This high level of organized social activity is arguably the primary reason why residential areas in Japan can often maintain a high degree of safety despite lacking the dense technological surveillance seen in commercial districts.

On the other hand, this profound reliance on the chonaikai introduces significant challenges and risks. The first and most pressing is the issue of sustainability. As documented by the Ministry of Internal Affairs and

Communications, neighborhood associations across Japan are facing a demographic crisis [32]. Their membership is aging rapidly, and they struggle to recruit younger residents, who often have different work schedules, family structures, and conceptions of civic engagement. The demanding, meeting-heavy nature of chonaikai administration can be a deterrent for dual-income households and younger generations. This raises a critical question for the long-term viability of the bouhan machizukuri model: what happens when the generation of volunteers currently sustaining these intensive patrol activities is no longer able to do so? As our results show, areas with deficient physical 'Space' are currently being compensated for by intense human 'Activities'. If this human component weakens, these deficient zones could face a sudden and sharp increase in vulnerability.

The second challenge relates to inclusivity and social equity. While ideally a force for cohesion, the strong normative power of the chonaikai can also become a mechanism for social exclusion. These organizations are often run by long-term, home-owning residents, and their priorities and social norms may not align with those of renters, residents of new high-rise apartments, or foreign nationals, who consequently participate at much lower rates. This can create a two-tiered system of safety, where the well-integrated parts of a neighborhood benefit from robust community activities while more transient or marginalized residents are left outside this protective social umbrella. This touches upon the "dark side" of CPTED, where the strengthening of territoriality for one group can lead to the exclusion or over-policing of another [7]. The pressure to conform to community norms, while generally positive for safety, can stifle diversity and create an environment that is uncomfortable for those who do not fit the traditional mold.

Finally, the institutional nature of the chonaikai can lead to stagnation and resistance to change. Because these organizations are the established partners for the municipal government, there can be a reluctance to explore or support alternative, more flexible forms of community engagement that might appeal to younger residents. App-based neighborhood alerts, project-specific volunteer groups, or informal social networks are often not recognized or resourced in the same way as the traditional chonaikai. This institutional inertia could hinder the adaptation of community safety strategies to meet the needs of a changing society. Therefore, while the chonaikai is currently a formidable asset for crime prevention in Kakogawa, its long-term sustainability and social inclusivity cannot be taken for granted. A truly resilient safety strategy must not only leverage this existing institution but also cultivate a

more diverse ecosystem of community engagement that is adaptable to the demographic and social realities of the 21st century. This theoretical consideration adds a crucial layer of depth to our findings, suggesting that the social fabric underpinning the 'Activities' component is both more powerful and more fragile than a surface-level assessment might suggest.

4.3 Policy and Practical Recommendations

The findings from this research translate into several actionable recommendations for urban planners, police, and municipal governments in Kakogawa and other similar cities.

1. **Adopt an Integrated CPTED Strategy:** The foremost recommendation is for the city to move from a siloed to an integrated approach to crime prevention. This would involve creating a multi-departmental task force—including urban planning, public works, police, and community relations—to coordinate safety initiatives. Before deploying new cameras or launching new patrol programs, this body should use a holistic assessment, like the framework presented here, to identify the most critical deficient zones and determine the most effective blend of interventions. This aligns with the systematic, process-oriented approach advocated by the new international standard for CPTED, ISO 22341:2021 [17].
2. **Prioritize Environmental Upgrades in Deficient Zones:** The city should allocate resources to retrofitting older residential areas and public parks that scored poorly on the 'Space' audit. This could include relatively low-cost interventions like improving lighting, trimming vegetation to improve sightlines, and using design cues to better define public and private spaces. These physical upgrades would reduce criminal opportunities and lessen the burden on community patrols.
3. **Develop a Data-Driven Device Deployment Strategy:** Rather than concentrating surveillance devices almost exclusively in the commercial center, the city should develop a more equitable and data-driven deployment strategy. GIS analysis overlaying crime data with data on environmental deficiencies and patrol coverage could identify optimal locations for new public cameras in residential areas, maximizing their preventive impact. The city could also incentivize private residents in these areas to install and register their cameras through a subsidy program, thereby expanding the surveillance network cost-effectively [42].
4. **Support and Diversify Community Activities:** While traditional chonaikai are a tremendous asset, their declining membership poses a long-term risk [32]. The city should continue to support these groups but

also explore ways to engage new residents and those in rental housing who are typically less involved. Promoting new forms of community engagement, such as app-based neighborhood watch groups or project-based volunteering ("Plus Bouhan"), could help sustain and diversify community-based prevention efforts [16].

4.4 Limitations of the Study

While this study provides a novel framework and valuable insights, several limitations must be acknowledged. First, its cross-sectional design captures only a single snapshot in time. The urban environment, device deployment, and community activities are dynamic, and a longitudinal study would be required to track changes and evaluate the impact of any interventions. Second, despite the use of a standardized checklist and multiple researchers, the environmental audit process contains an unavoidable element of subjectivity [30]. The perception of what constitutes "good" lighting or a "clear" sightline can vary. Third, this study assesses the presence of CPTED features and activities, not their direct causal effect on crime rates or residents' fear of crime [29]. While the presence of these features is theoretically linked to better outcomes, this study does not empirically test that link at a micro-level. Finally, as a single-city case study, the specific findings may not be directly generalizable to other cities with different socio-cultural contexts, urban forms, or crime problems, although the assessment framework itself is designed to be adaptable.

4.5 Future Research Directions

This research opens up several promising avenues for future inquiry. A clear next step would be to conduct a longitudinal follow-up study in Kakogawa to assess how the CPTED landscape evolves and whether targeted interventions in the identified deficient zones lead to measurable improvements in safety. Comparative studies applying the tripartite framework in other Japanese cities—and internationally—would be invaluable for testing its robustness and identifying context-specific patterns of CPTED implementation.

Future research should also aim to integrate residents' subjective perceptions. Combining the objective environmental assessment of this study with surveys on fear of crime, perceived safety, and community cohesion would provide a more complete picture of how the physical and social environment shapes the human experience of safety [29]. Finally, there is great potential in leveraging emerging technologies to enhance and automate this type of assessment. The use of urban big data, machine learning algorithms to analyze street-view imagery, and sensor networks could allow for more dynamic, real-time CPTED

assessments on a city-wide scale, moving the field towards a more proactive and data-rich future [23, 26, 27].

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