



Final Report

Crime Prevention through Environmental Design (CPTED) for Public Transit Stations: Year 2

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16. Abstract Crime Prevention through Environmental Design (CPTED) uses design principles to engineer safer spaces through the management of both built and natural environmental features. CPTED principles aim to reduce the chances and fear of criminal activity by designing spaces that both deter criminal activity and build community. Notably, public transportation can be an attractor of crime, and safety is cited as one barrier to public transportation. The goal of this work is to identify opportunities to integrate CPTED into transit station design to improve perceptions of safety for riders and increase transit access. To accomplish this goal, the project team catalogued CPTED practices already in use by a local transit agency, even if they were employed outside of an explicit CPTED framework. The team also assessed CPTED features in place at eleven transit stops. A limited rider survey was also conducted. Based on findings to date, the team identifies additional options for applying CPTED in public transit. CPTED principles were also integrated into the semester project of an undergraduate civil engineering course.			
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Abstract

Crime Prevention through Environmental Design (CPTED) uses design principles to engineer safer spaces through the management of both built and natural environmental features. CPTED principles aim to reduce the chances and fear of criminal activity by designing spaces that both deter criminal activity and build community. Notably, public transportation can be an attractor of crime, and safety is cited as one barrier to public transportation. The goal of this work is to identify opportunities to integrate CPTED into transit station design to improve perceptions of safety for riders and increase transit access. To accomplish this goal, the project team catalogued CPTED practices already in use by a local transit agency, even if they were employed outside of an explicit CPTED framework. The team also assessed CPTED features in place at eleven transit stops. A limited rider survey was also conducted. Based on findings to date, the team identifies additional options for applying CPTED in public transit. CPTED principles were also integrated into the semester project of an undergraduate civil engineering course.

Chapter 1: Project Background and Motivation

Crime Prevention through Environmental Design (CPTED) uses design principles to engineer safer spaces through the management of both built and natural environmental features and social management strategies. It is a multi-disciplinary framework that has expanded from an analysis of safe urban spaces to one that encompasses broader assessments of social relations and livability in the built environment. To that end, CPTED principles aim to reduce the chances and fear of criminal activity through the design of spaces that both deter criminal activity and build community. Vacant lots, poor lighting, uncontrolled access, and lack of monitoring can be ameliorated by designing spaces in which people feel—and are—safer.

Transportation access in the United States remains shaped by Eisenhower-era investments in the federal highway system, which cemented car-based development patterns and cultural attitudes in much of the country. According to US Census Bureau data [1, accessed 8/26/25], 69.2% of US workers aged 16 and over drive to work alone, in a car, truck, or van; only 3.5% take public transit. This project is motivated by the possibility that safer public transit could result in more transit use, as safety is often cited as a barrier to public transportation use. CPTED principles offer policymakers a series of tools to improve both safety and safety perceptions among transit users, facilitating greater access to the goods, services, and opportunities that public transportation provides.

The Year 1 report of this project [2] provided a comprehensive overview of the connections between CPTED principals and applications, effective transit services, and access to critical services like food, healthcare, and education. The Year 2 report builds on these findings by examining CPTED practices in place at a transit agency serving Baltimore, MD (hereafter referred to as Transit Agency 3). As part of the project, the team cataloged CPTED practices already in use, even if outside of an explicit CPTED framework. The team also applied the CPTED checklists developed in year 1 of this project at 11 bus stops and transit hubs operated by the agency. Stations were selected in areas chosen through the application of mapping tools and in consultation with transit stakeholders. The work was accomplished through site visits, transit agency staff interviews, and a review of transportation station design standards provided by the transit agency. Based on these findings, the team expands on its list of best practices and priorities for integrating CPTED into transit station design to fill gaps identified through the study. CPTED and public transit were also the focus of a small transit user survey, as well as a semester project in an undergraduate civil engineering course at the University of Delaware.

The remainder of this chapter addresses arguments for and against of CPTED, as well as recent coverage of CPTED in the news media, before providing an overview of the rest of the report.

A. Cases For and Against CPTED

Effectiveness of CPTED

Neighborhoods and schools: While research on the subject of crime can be complex due to the numerous socioeconomic and environmental factors involved, research on the effectiveness of CPTED tends to indicate that implementation of CPTED principles is effective in reducing crime in communities. There is an association between student comfort and safety and CPTED integration in schools, which in turn improves academic performance [3, 4]. It has even been suggested that an increase in CPTED principles in schools can lead to a reduction in verbal and physical abuse [5].

Transit applications: In transit applications, the inclusion of CPTED principles is positive overall, with increased perceptions of safety ultimately encouraging increased ridership and use. Many studies reflect how widespread safety concerns toward public transit stations lead to a decrease in transit use [6]. Principles from CPTED, such as natural surveillance, can improve perceptions of safety and mitigate those concerns [7]. Transparent bus shelter materials, mixed-use buildings nearby, and a sense of guardianship are all factors that have been shown to greatly increase comfort toward transit stations [7]. While CPTED implementation may be limited in its ability to address crime, it is a worthwhile interim step as broader societal and economic issues are addressed [8].

Drawbacks of CPTED

Though some findings related to CPTED implementation are positive, the existing literature on whether CPTED measurably reduces crime is, overall, variable. An Australian study found that while experts in public transportation safety perceived CPTED-designed transit stations to be safer, users did not always agree. The study suggests that social perceptions and stigma of a particular station affect user perceptions of crime more than CPTED design [9]. Additionally, other critics argue that CPTED cannot adequately adapt to behavioral changes in the environment. A study focused on CPTED and bank robberies concluded that CPTED elements in bank design did not necessarily reduce bank robberies, but rather influenced the tactics used by robbers [10]. A separate study argues that lighting and natural surveillance may not fully address vandalism; for example, many graffiti artists intentionally choose visible locations [10]. Other elements of the built environment can further obscure the relationship between CPTED and crime reduction, such as the use of hostile architecture designed to exclude people or instances of poorly executed CPTED implementation. These studies suggest that CPTED may not be easily applied to behaviors that have deep social roots and evolve with the built environment [11].

Quality of life arguments for CPTED

However, other literature suggests that CPTED can increase quality of life when applied correctly, even when it is not directly correlated with crime reduction. Current research on perceived crime finds that the fear of crime may cause people to withdraw from their communities, and is correlated with poorer life satisfaction, physical health, and mental well-being [12]. As such, when a CPTED initiative attempts to reduce the fear of crime by designing a safer perceived environment, there are expected to be some impacts on quality of life. Some, but not all, CPTED elements decrease the fear of crime in a neighborhood and increase the likelihood of residents walking in the neighborhood [13]. Additionally, there appears to be significant conceptual overlap between CPTED principles and livability, where livability is defined as a series of attributes of a community that contribute to well-being [14].

B. CPTED in the news

Recent news reports highlight instances of municipal governments explicitly implement—and remove—elements of CPTED from the urban environment. In late 2024, benches were removed at a transit stop in Kansas City, MO. Riders were disappointed, while city officials and the local police department argued that the move would reduce crime and loitering [15]. Despite cases like this, there is a trend of municipalities adopting CPTED principles in cities such as Phoenix, AZ, East Tampa, FL, Titusville, FL, and Kenora, British Columbia [16-19]. Not surprisingly, the rationale behind most of these implementations is to increase overall safety and security. However, some cities, such as Kenora, also cite improvements to perceptions of safety and quality of living as reasons to introduce CPTED principles.

C. Project overview

Project team

The 2024-2025 project team consisted of the PI, Dr. Jennie Saxe, and two undergraduate students, Kiersten Schmitt and Nathan Wolhar, environmental and civil engineering majors, respectively. These students were selected to bring differing viewpoints to this interdisciplinary work. As part of the training for this project, both students completed the National Institute of Crime Prevention (NICP) basic CPTED training course. This 40-hour online course included exams and a field assessment project. The PI previously completed the 3-day virtual Michigan State University Complete Crime Prevention Through Environmental Design (CPTED) Certificate Training in May 2022.

To ensure safe site visits, the team developed a safety plan (Appendix A), which was reviewed by the field safety manager for the Department of Civil, Construction, and Environmental Engineering at the University of Delaware.

Project approach

To investigate the application of CPTED principles at public transit stations and identify opportunities for application of CPTED concepts to enhance rider sense of safety and contribute to enhanced ridership, the project team undertook the following tasks:

- Identification of CPTED practices in use by public transit agencies (Chapter 2)
- Assessment of local public transit stations in underinvested and vulnerable areas for CPTED practices both in-person and through a limited rider survey (Chapter 3)
- Identification of gaps between documented plans and practices in use and opportunities to apply CPTED principles (Chapter 4)
- Engagement of civil engineering students via CPTED integration into coursework (Chapter 5)
- Dissemination of findings (Chapter 6)

Additional project-related documents are found in appendices to this report:

- Appendix A: Project Safety Plan
- Appendix B: CPTED Principles Analysis Form
- Appendix C: CPTED Public Transit Checklist
- Appendix D: CPTED Public Transit Checklist - Bus Stops and Shelters
- Appendix E: Site assessment photos
- Appendix F: CPTED site assessment findings from sites N through X
- Appendix G: CPTED Checklist used for CIEG411 (S2025)

- Appendix H: Rider survey

Chapter 2: CPTED Practices in Use

The Year 1 report of this project [2] describes the development of checklists for reviewing transit agency documents (available in [Appendix B](#)) and for field use (available in [Appendix C](#) and [Appendix D](#)).

The full field checklist ([Appendix C](#)) was used to assess sites Q and T. The streamlined checklist ([Appendix D](#)) was used at locations with only bus stops or bus shelters (sites N-P, R, S, and U-X).

A. Evaluation of documents provided by local transit agencies

The project team contacted staff at Transit Agency 3 to request documents most relevant to safety and station design. The team acknowledges that these documents may not represent a comprehensive compilation of all transit agency documents that address CPTED elements. The team was supplied with the following documents:

Table 2.1: Documentation provided by transit agencies for this study.

Transit Agency	Documentation
Transit agency 3	<ul style="list-style-type: none">● Design Criteria Manual<ul style="list-style-type: none">○ Chapter 11: Architecture, Urban Design, and Landscape Architecture;Chapter 18: Communication Systems; Chapter 22: Fire and Life Safety;Chapter 23: System Safety; Chapter 24: Security● Bus Stop Design Guide

B. Findings from evaluation of transit agency documents

In preliminary interviews with Transit Agency 3, staff were familiar with the principles of CPTED. In some instances, Transit Agency 3 used CPTED terminology to describe their design guidelines, but in other cases, CPTED elements overlapped with good design principles and CPTED-specific terminology was not used. Additionally, the transit agency was limited in their ability to implement CPTED elements as they do not have control over city/jurisdictional design requirements.

Maintenance and natural surveillance principles were covered well by the Transit Agency 3 policies/guidelines/standards reviewed by the team, especially landscaping and vandalism-resistant materials. The documents outlined guidelines to preserve natural sightlines, avoid hidden recesses, and control access to security and maintenance rooms.

Some CPTED principles were not as well covered: natural surveillance and lighting in adjacent facilities such as parking lots and stairs; access control, particularly signage; and activity support. Additionally, the guidelines did not incorporate ways for transit riders to report maintenance and security concerns.

In the team's review of transit agency documents, the team found further support for the connection between CPTED elements and common practices in transit facility design identified in the first year of this project. The presence of some CPTED terminology in Transit Agency 3 documents suggests that CPTED may already be in use in certain transit

facilities, though there are still other CPTED elements that could be expanded upon in design documents and specifications.

Chapter 3: Implementation of CPTED principles at transit stations

Transit Agency 3 is a division of the state’s Department of Transportation. A multi-modal transit system, Transit Agency 3 includes buses, light rail, subway, and regional train service. In addition, Transit Agency 3 includes paratransit, taxi service for certain mobility-designated riders, and supports other local transit agencies across the state.

Using transit maps from Transit Agency 3, the team selected transit stops near public facilities with a high potential for public transit trip generation. These include government buildings, schools, places of worship, and significant route transfers and interchanges. Transit Agency 3 and a local economic development authority were also consulted regarding site selection.

After selection, sites were screened through appropriate, publicly available crime mapping tools to determine crime rates near the transit stops. For Transit Agency 3 sites, the city police department's public crime map was used [20, accessed 7/18/25].

Table 3.1: Details of sites assessed for this report.

Transit agency	Site	Date assessed	Type of stop	Relative crime occurrence
Transit agency 3	N	6/11/25	Signpost bus stop	Low
	O	6/11/25	Signpost bus stop	High
	P	6/11/25	Bus shelter	Medium
	Q	6/11/25	Signpost bus stops and subway entrance	Medium
	R	6/17/25	Signpost bus stop	High
	S	6/17/25	Signpost bus stop	High
	T	6/17/25	Transit hub with bus stops and 2 subway station entrances	Medium
	U	6/17/25	Signpost bus stop	Medium
	V	6/17/25	2 signpost bus stops at one intersection	Low
	W	6/17/25	Bus shelter	Medium
	X	6/17/25	Bus shelter	Low

Site overviews

Sites evaluated included seven bus stops that included only a signpost, three bus stops with shelters, and two transit hubs, which included both bus stops and subway entrances. Sites were chosen using the process depicted in Figure 3.1 with input from local transit and economic development authorities.

Site N. This site is a signpost bus stop serving several bus lines, located just outside of a city park, and near a zoo. The stop is along a divided highway with a grassy median. It is located by a sidewalk near a large intersection with no buildings nearby. The nearby intersection has a traffic light and a crosswalk.

Site O. This site is a signpost bus stop serving one bus line. It is found at an intersection near transition zone separating a residential area from a commercial area. The bus stop is near a church, a community center, and a state Department of Labor building. The stop is connected to the sidewalk network. The two-way road has a park-like median separating the two directions of traffic. There are protected crosswalks at the nearby intersection.

Site P. This site includes a bus shelter; the stop serves one bus line on a street in a neighborhood with residences and some shuttered small businesses. There is an art installation across the street welcoming visitors to the neighborhood. New construction was underway across the street at the time of the site visit. The shelter was a new style, but the older wooden benches remained. This new-style shelter had an integrated light (functionality and adequacy were not assessed during the daytime site visit) and is marked with a maintenance tag.

Site Q. This site is a transit hub near a major medical center. Two signpost bus stops (one in each direction) are separated by a park-like median that includes the entrance to the subway. The median is planted with shrubbery and trees. Signage is available to indicate the transit stops, and a system map is available for the subway. There is a bike rack present. There is elevator access to the subway. There was signage indicating that one bus stop had been recently discontinued. The subway entrance and elevator access incorporated durable metal and transparent materials.

Site R. This is a signpost bus stop found along the sidewalk of a neighborhood with residential and small commercial establishments. It serves one bus line. The stop is served by a dedicated bus/right-hand-turn lane and is at a signalized intersection with a crosswalk. The establishment immediately behind the stop is shuttered, and there is a vacant lot across the street. There is a trash can at the stop, but no other amenities. There is little in the area, and the sidewalk is not well-maintained. This stop, and the two that follow, are located in the area covered by one of the above-mentioned local economic development agencies.

Site S. This is a signpost bus stop on a sidewalk between a residential area and a college campus. The stop serves two bus lines. There is an open-slat metal fence separating the sidewalk from nearby college buildings.

Site T. This is a very busy transit hub that provides access to multiple bus lines and a subway line. There are transit facilities on all four corners of the intersection. The northwest and southeast portions of the intersection include signpost bus stops with benches and trash cans. The southeast stop also includes partial system signage. The southwest corner includes a bus stop with benches integrated into the subway entrance building. There is one access point to the building, and the non-accessible areas around the building have been fenced off. There is also a mural on the building adjacent to this subway entrance. The northeast corner of the intersection has an identical subway entrance building as well as multiple transparent bus shelters and a “next-to-arrive” board for approaching buses. The area is covered by CCTV cameras. The transit hub intersection has crosswalks (though the crossing signals were not functional), one ticket kiosk,

and subway system maps. Some buildings nearby are prepared for demolition. There is a pharmacy adjacent to the northeast subway entrance and numerous mixed-use buildings in the area.

Site U. This site is a signpost bus stop that serves multiple bus lines. It is located mid-block on a one-way street with residences and small businesses. The bus stop backs up to an informal pedestrian path to a grocery store parking lot; the stop and the parking lot are separated by an open-slat metal fence. The street is lined with trees and has on-street parking. There is graffiti in the immediate area. A streetlight is present at the stop, but the adequacy of the lighting was not assessed.

Site V. This intersection has two signpost bus stops that each serve one bus line. The stops are near a medical center, multiple houses of worship, and rowhome residences, some of which are boarded up. Both stops have trash cans. One of the two stops has a nearby streetlight.

Site W. This is a bus stop with a new shelter on a 2-lane street across from a park. The park occupies a city block and has numerous benches, walkways, and a comfort station for visitors. The bus stop is located in front of a high school for students studying for careers in medical professions. The neighborhood has residences and small businesses. This new-style shelter has an integrated light (functionality/adequacy not assessed during the daytime site visit) and is marked with a maintenance tag.

Site X. This is a sheltered bus stop that serves two bus lines. The older-style shelter has a bench and a trash can. The bus stop is connected to the sidewalk network in a commercial area near a busy intersection with gas stations, small businesses, a budget grocery store, and a Ronald McDonald House. The stop backs up to a senior housing complex. There is an open-slat metal fence between the bus stop and the senior housing complex. The bus stop also features a plastic curb extension that fills a space that appears to have previously been a bus pull-off area near the bus stop, possibly added for safety/anti-ramming purposes. The sign for the bus stop is about a half-block past the actual bus stop/shelter. Riders waiting for the bus noted two shootings at this location in the past year.

Site assessment checklist

As described in Chapter 2, section B, a field site assessment checklist was developed for use in evaluating CPTED features present at transit stations. The full field checklist (Appendix C) was used to assess sites Q and T. The streamlined bus stop/bus shelter checklist is provided in (Appendix D). The streamlined checklist was used to assess sites N-P, R, S, and U-X .

Photographs were taken to document site features. Select photographs are included in Appendix E to this report.

CPTED features at each location were identified as present (P), absent (A), not applicable (N), or unable to assess (U). Rarely, a feature present to some extent was identified as present to some extent (S).

Summary of site assessment findings

Tables of all CPTED element findings are included in Appendix F. Table 3.2 summarizes findings related to CPTED elements in each of the 5 categories present at applicable sites.

Table 3.2: Percent of sites where applicable elements related to maintenance, natural surveillance, access control, activity support, and territoriality were observed.

CPTED Category	On average, sites exhibited this percentage of elements in the given CPTED category
Natural surveillance	71.9%
Activity support	61.5%
Maintenance	56.5%
Access control	48.9%
Territoriality	46.4%

Across all sites in the Transit Agency 3 service area, natural surveillance elements were most likely to be observed, while territoriality elements were least likely to be observed. The section below addresses each of the five CPTED elements across the sites assessed in more detail.

Natural surveillance (entrances): With one exception, entrances to bus shelters and subway stations were well-identified and visible, and subway station entrances included CCTV coverage. The exception is the southwest corner of site T, where the entrance to the subway was near the back of the building and partially obscured by a brick wall. Steps were taken to improve the safety of this configuration, including the presence of CCTV and the restriction of pedestrian access to two sides of the subway entrance building. Transparent materials were used in all locations to preserve lines of sight.

Natural surveillance (parking areas): None of the sites visited included transit-stop-associated parking.

Natural surveillance (inside and around stations): Although the team made notes on the presence of lighting in and around stations, lighting was not assessed because site visits were conducted during the daytime. Additionally, station communication systems were not assessed. All sites were connected to the sidewalk network; none were connected to other trails.

- *Physical structures*: Open-slat, durable metal fencing was very common, though some fences included solid brick pillars that somewhat reduced visibility. In most cases, trees and grass were trimmed to allow visibility. Trees and light poles were generally not placed to allow climbing onto transit stop structures; however, the light poles at sites O and P could be climbed. The exterior of the subway entrances at the site T transit hub could also be climbed.
- *Hidden recesses and alcoves*: Though stations and stops were not designed with hidden recesses or alcoves, there were some features that did block sight lines around stations. In some cases (sites R, S, U, and X), obstructions like brick walls and electrical equipment were on nearby private properties. Notably, the street-level elevator structure at site Q included a recess that could serve as a potential hiding location. This situation is somewhat ameliorated by the use of transparent materials for the elevator. No curved/domed mirrors were found at any sites; these could be used to improve visibility in these locations.

- *Materials:* At the site Q transit hub and at all bus shelters, transparent materials were used for roofs, though the roof of the shelter at site X was not as transparent as at the newer shelters at sites P and W.
- *Technology:* Though CCTV was common inside and around stations, the presence of call boxes was less common, only associated with sites Q (inside subway entrance) and T (located outside of the northeast subway entrance). There was a callbox in the vicinity of site S, but it was not associated with the transit stop. Audio enunciators were not present at bus shelters or inside the street level of the subway stations, but were present on some arriving buses. Visual “next-to-arrive” boards were present inside subway entrances at both transit hub locations (sites Q and T) as well as the bus stop on the northeast corner of site T. Station communication systems were not assessed.

Activity support: Of the 4 elements in this category, one (related to multi-level station design and visibility) was not applicable, as no stations were designed in this manner. Both transit hubs had nearby amenities, though they were not associated with the stop or the transit agency. Notably, food trucks were present at site Q. The average score for this category was also raised by the fact that storage lockers were not present at either of the 2 applicable sites (sites Q and T). Seating was present at all bus shelters; in many instances, where bus stops had a newer shelter, the older wooden slat benches remained for additional seating. Open space, though not transit-agency controlled, was present near 64% of the sites. Both transit hubs had “no loitering” signage posted.

Maintenance: Where buildings were present at stops, all were well-maintained. Long-wearing materials were generally present, though specific material types (e.g., tempered glass, laminated glass) were not determined. A few old-style wooden-slat/concrete benches remained, but they were often accompanied by newer-style bus shelters. Where benches (but not shelters) were present at bus stops for seating, they were all wrought-iron and often bolted to the sidewalk. 73% of sites included a waste receptacle. At each site, these were for trash only, with no paired recycling bin. At site X, a waste bin was present, but there was a significant amount of litter at the stop, and a newspaper box was being misused as a trash receptacle. Notably, no sites had a way for riders to report maintenance needs.

Access control: Signage at all transit stops was new, clear, and consistent, using the transit agency’s recognizable colorway. Two specific “circulator” bus lines used distinct, but recognizable signage that was consistent for those bus lines. Maps were uncommon, present at only 18% of stops assessed, and at site Q, the maps were located approximately a half-block from the bus stops and subway entrance. Site T had the most complete map coverage, with system and local maps present at both subway entrances (northeast and southwest corners of the intersection) and a partial system map present at the bus stop at the southeast corner. Site T also had a sign at the southwest corner of the intersection alerting to the use of CCTV in the area. Only the site Q transit hub had multiple entrances to the subway, but transparent materials provided visibility despite riders entering from multiple directions. No sites included parking or vehicle access, so these elements were not assessed.

Territoriality:

- *Signage:* The standard transit agency signage for bus stops includes a note that the area is for transit vehicles only; however, “no trespassing” signage was uncommon. Only the transit hubs (sites Q and T) included “no loitering” signage, though it was defaced with paint at site T. All entrances were clearly marked, and transit hub “transition zones” were denoted with standard signage.
- *Structures:* Where structures were present, they were set back from the road as much as practicable. In some locations (site Q subway entrance, site X sheltered bus stop), bollards or similar structures were present to prevent

ramming. Site X was unique in that what appears to be a former bus pull-off area has been filled with a plastic curb extension. It is unclear whether this was to facilitate bus boarding or to reduce vehicular traffic at the bus stop.

Comparing policies and design guidelines with site assessment findings

The following table compares CPTED elements covered well in transit agency documents with site assessment findings.

Table 3.3: Comparison of CPTED elements covered well in transit agency documents and site assessment findings related to those CPTED elements.

Transit agency	CPTED elements (<i>and specifics</i>) covered well in documents provided to the project team	Site assessment findings related to CPTED elements covered in agency documents
Transit Agency 3 (sites N-X)	Maintenance <i>landscaping, vandalism-resistant materials</i>	<p>Most locations were well maintained (6 sites exhibited at least 50% of the checklist maintenance elements); sites with buildings were well-maintained; notably, 2 of the newer style bus shelters (sites P and W) had maintenance tags</p> <p>Landscaping was well-maintained at 67% of applicable sites, with most shortfalls related to overgrown weeds and street trees blocking bus stop signs</p> <p>Wear- and vandalism-resistant materials were present in 57% of applicable locations; some sites had surfaces susceptible to graffiti, but were not defaced; other sites had graffiti nearby, but not at the transit stop itself; where older wooden/concrete benches were present, they were paired with newer wrought-iron benches and/or newer bus shelters</p>
	Natural surveillance <i>preserve natural sightlines, avoid hidden recesses, control access to security and maintenance rooms</i>	<p>High levels of natural surveillance were present across transit sites visited, with only 1 site not meeting at least 50% of the checklist natural surveillance elements</p> <p>Open fences and CCTV were ubiquitous</p> <p>Some trees needed to be trimmed, and some locations had weeds exceeding 2' in height (Sites N, P, and U)</p> <p>No sites included hidden recesses, alcoves, blind corners, or similar features, and transparent materials were widely used; bus shelters did not feature advertising that could block visibility</p> <p>Access to security and maintenance rooms was generally not assessed; however, it was noted that the emergency egress hatches for the subway stops were not accessible from street level</p>

For sites served by Transit Agency 3, most sites were well-maintained, as would be expected from coverage of maintenance issues in the agency’s documents. Routine weed and tree trimming in key areas would address maintenance issues further. In addition, steps could be taken to deter graffiti. For example, at site V, the westbound bus stop was next to a large expanse of brick wall. That wall could be further covered with a mural or with a vegetative screen. In no locations was seating limited to the wooden/concrete benches susceptible to wear; bus shelters or more durable benches were present, as well.

Natural surveillance elements were widely implemented as described in the transit agency documents provided. The impact of these measures was seen in the materials and design of stations as well as in the responses to the rider survey (see section D).

The table below compares site assessment findings to CPTED elements found to be unaddressed—or not well-addressed—in transit agency documents.

Table 3.4: Comparison of CPTED elements not covered well in transit agency documents and site assessment findings related to those CPTED elements.

Transit agency	CPTED elements (<i>and specifics</i>) <u>not</u> covered in documents provided to the project team	Site assessment findings related to CPTED elements omitted in agency documents
Transit Agency 3 (sites N-X)	Natural surveillance <i>lighting in adjacent facilities, such as parking lots and stairs</i>	As noted in Table 3.3, natural surveillance elements were very common Lighting was not assessed in these site visits No facilities had transit-associated parking lots
	Access control <i>signage, reporting security concerns</i>	Only 1 site exhibited more than 75% of applicable access control elements, and 7 sites exhibited less than 50% of these elements Though signage was standard and consistent, signs included language to deter non-transit vehicles from the area, and CCTV was ubiquitous, riders did not have instructions on how to report security concerns Maps were uncommon
	Activity support	Only 1 site (site U) exhibited less than 50% of applicable activity support elements, and 2 sites (T and W) exhibited all applicable elements The site Q transit hub had no street-level seating for waiting riders; only one non-shelter bus stop included a bench for waiting riders
	Maintenance <i>reporting maintenance needs</i>	Though sites were generally maintained (see Table 3.3), notably, no sites included a method for riders to report maintenance needs

In the provided Transit Agency 3 documents, the lack of coverage of reporting maintenance needs was also seen in the field: no sites included signage directing riders on how to report maintenance needs. Riders agreed in surveys (section D) that they did not know how to make maintenance reports, nor did they know how to report security concerns. Few sites had location or system maps. Despite this, transit stop signage was generally clear and consistent, though it was not covered well in the documents reviewed.

Activity support was not well covered in the transit agency documents provided. The checklist only includes 5 elements in this category, with many not applicable at most locations. Therefore, less emphasis should be placed on the findings in this category except for seating. Seating was only present at one non-sheltered bus stop and was absent from the site Q transit hub; it is possible that this missing amenity contributed to rider survey feedback (section D).

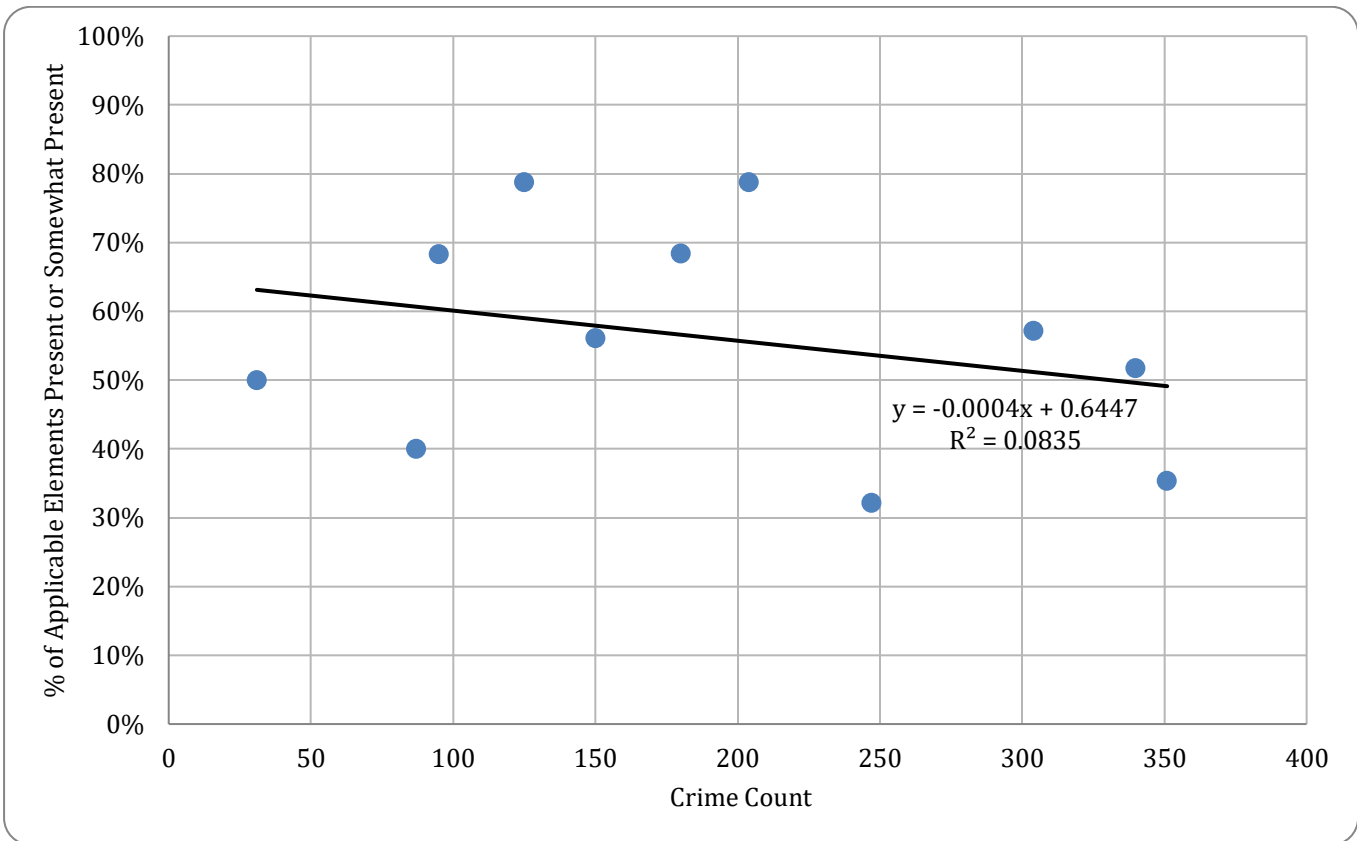
Again, lighting was not assessed in these site visits, so a comparison of site conditions with documentation was not possible.

Applying CPTED in areas of high and low crime reporting

The team used the city police department's public crime map to determine the number of reported crimes in the previous 365-day period. The 11 sites in this study were in neighborhoods that experienced between 31 and 351 reported crimes during this timeframe (mean = 192.2, SD 107.5). The site with the highest number of reported crimes (site R) also had the lowest percentage of maintenance, natural surveillance, and territoriality elements identified as “present” or “somewhat present”. The site with the lowest number of reported crimes (site V) was not among the highest or lowest number of elements observed in any of the CPTED categories. Sites Q and T had the highest overall percentage of CPTED elements observed, yet possessed relatively moderate levels of crime, with 125 and 204 reported crimes, respectively.

These findings and the weak correlation between the number of crimes reported and the proportion of applicable CPTED elements present (Figure 3.2) support the conclusion that the presence of more CPTED elements does not guarantee safer conditions. However, the lack of many CPTED elements across the majority of categories at the site with the highest number of reported crimes (site R) does warrant further investigation of the relationship between crime and the physical environment.

Figure 3.2: Percent of applicable elements present/somewhat present vs. count of crimes at sites in the study.



The team did not find a clear correlation between the lack of CPTED elements and higher rates of reported crime. The Pew Research Center notes that violent and property crimes are likely underreported [21]. Unreported offenses contribute to the “dark figures” of crime; unreported crimes cannot be investigated, resolved, or studied. Though exploration of crime reporting rates is beyond the scope of this work, it is important to note that gender, socioeconomic status, varying perspectives on and experiences with law enforcement, an individual’s group identification, whether the victim knows the offender, the seriousness of the crime, the cost and benefit of reporting, and additional factors combine to paint a complex picture of willingness to report crimes [22 23].

A. Rider surveys

In addition to site assessments, the team developed a survey instrument to gauge rider perceptions of safety and the presence of CPTED elements. Appendix H includes a sample flyer distributed to riders as well as the survey questions. This survey was determined to be exempt by the University of Delaware Institutional Review Board ([2320823-1] Rider Perceptions of Safety: Crime Prevention through Environmental Design at Public Transit Stations, letter dated May 27, 2025). Survey flyers were distributed at stops where riders were present. Only 4 responses were submitted by riders providing feedback on 2 transit stops (sites Q and X). None of the respondents indicated that they knew how to report maintenance needs or safety concerns at the two stops; this aligns with the team’s observations that there was no signage to this effect posted at transit stops visited.

Additional survey responses are summarized in Table 3.5.

Table 3.5: Responses to rider survey (SA = strongly agree, A = agree, N = neither agree nor disagree, D = disagree, SD = strongly disagree)

	Site Q <i>Transit hub</i>					Site X <i>Bus stop with shelter</i>				
	SA	A	N	D	SD	SA	A	N	D	SD
This transit stop is well maintained.		2							1	1
It is clear that transit passengers are the intended users of this space.	1	1						1		1
If present, signage at this stop is clear and helpful.	1	1							1	1
During the day, I have a clear view of the areas around me.		2				1	1			
At night, I have a clear view of the areas around me.			2				1	1		
This stop is used for transit purposes only.		1	1							2
I have the amenities (benches, waste bins, etc.) I need at this transit stop to be comfortable as a transit user.		1			1		1		1	

Though the sample size is very small, some interesting findings can be drawn by comparing survey results and site assessment findings.

Maintenance

Riders and the site assessment align on site maintenance for site Q. Site Q was determined to have 83.3% of applicable maintenance elements present or somewhat present. For site X, 80% of applicable maintenance elements were present. The unfavorable rider opinion may stem from the litter observed at the site; this was also noted by the assessment team.

Sightlines and lighting

Riders reported a sense that during the daytime they had a clear view of areas around them, but had that feeling to a lesser extent at night. Site assessments concluded that site Q and site X exhibited 76.5% and 77.8% of applicable natural surveillance, respectively. Though the site team did not assess the sites at night, it is reasonable that rider sight lines would be perceived as less effective at night.

Signage and intended users

The more favorable feedback on signage for site Q tracks with the findings of the site assessment. Site Q exhibited 71.4% of applicable access control elements, while site X exhibited 44.4%. For site X, survey responses tended toward disagree or strongly disagree in terms of the stop being used only by intended transit users.

Stop amenities

Site Q exhibited 75% of applicable activity support elements, yet responses did not indicate that level of satisfaction with amenities. Notably, site Q did not have seating, and “no loitering” signage indicated that even the low brick wall present around the subway entrance building should not be used for seating. On the other hand, site X only exhibited 50% of applicable activity support elements, but the responses did not indicate strong dissatisfaction. Satisfaction with benches, waste bins, and other amenities may be related to individual user preferences and other experiences with transit infrastructure.

Chapter 4: Gaps in CPTED implementation and opportunities to apply CPTED principles

The findings presented in this chapter should be considered preliminary. An assessment of findings from years 1 and 2 of this work will be completed and submitted for publication, adding to the body of knowledge in this area.

A. Opportunities to further implement CPTED principles in public transit infrastructure

Opportunities to further implement the five CPTED elements identified in this report are presented in this section. The team understands there are likely financial considerations, local architectural standards, and other logistical considerations that would influence further CPTED implementation. In addition, the team anticipates varying ease of implementation where transit infrastructure and related elements are on public property as compared to private property. Though the team did not investigate these areas, there may also be conflicts between CPTED best practices and traffic safety standards.

These assessments were conducted as part of this SMARTER Center US DOT UTC project. The information contained herein is based on guidelines set by the research group and documents the observations of the individuals conducting the assessments. This work is intended to assist in improving the overall level of security only. It is not intended to imply that the existing security measures or proposed security measures are absolute or perfect.

Maintenance

At no stop were there instructions on how riders should report maintenance needs. This could be accomplished by a QR code on bus stop signage or on bus shelters, where present. Also, no stops provided infrastructure for recycling. The city provides single-stream recycling services. Paired recycling and waste bins could reduce litter. To assist with routine site maintenance (e.g., weed control), partnering with community or neighborhood groups may be a viable strategy. The site O bus stop signage included an additional sign that the stop had been “adopted” through the transit agency’s Adopt-A-Stop program.

Access control

Maps continue to be extremely uncommon at bus stops. Partial system maps, like the one at site T, or strategic deployment of maps in locations where ridership growth is desired, could be considered. QR code links to system maps are a low-cost way to make transit information easily accessible. In addition, transit agencies may want to provide a clear method for riders to report unauthorized activity. This could also be incorporated via QR codes instead of new signage.

Natural surveillance

In locations where desirable lines of sight are obstructed, the use of domed mirrors may improve visibility. As some obstructions are present on private property, private property owners would need to be willing to (or incentivized to) install these mirrors. The installation of emergency callboxes could provide a greater sense of comfort for riders. With limited resources, these installations might be prioritized where supporting infrastructure exists and/or in high-crime areas. As a reminder, lighting and communication systems were not assessed, so recommendations in these areas are not provided.

Territoriality

In some locations, bus stop signage was obscured by trees. Trimming trees to 8 feet above ground level would enhance visibility of bus stop signage, thereby supporting territoriality and natural surveillance. Other creative methods to support territoriality—like sidewalk or other art at bus stops—could also be explored.

Activity support

Notably, the site Q transit hub did not include seating for waiting riders, and “no loitering” signage was posted, creating an unwelcoming environment for transit riders. Leaning benches/bars for riders may be a compromise should the provision of bench seating be undesirable. Employees and patients of the nearby hospital may be more likely to use transit with additional stop amenities. Additional scooter parking may be needed at site T in response to the observation of improperly parked electric scooters.

B. CPTED implementation and crime reporting

The data gathered for the 11 sites in this study did not show a significant relationship between levels of reported crime in neighborhoods around the assessed transit infrastructure and the number of CPTED features present. However, transit agencies may wish to investigate crime reporting data further in conjunction with local or transit agency police to prioritize additional CPTED elements in areas with higher levels of reported crime. Rider surveys completed by the transit agency may also be valuable in gathering information on rider perception of safety to shed additional light on the “dark figures” of crime.

Chapter 5: Engaging civil engineering students in public transit equity via CPTED integration into coursework

A. Course overview

CIEG411 (Communicating with Stakeholders in Engineering) has been a required part of the University of Delaware undergraduate civil engineering curriculum since Spring 2021. This course, typically taken by second-year undergraduate civil engineering students, follows two other technical communication courses: COMM212 (Public Speaking & Professional Presentation) and ENGL410 (Technical Writing).

By the end of CIEG411, students will be able to:

1. Explain the importance of meaningful communication in civil and environmental engineering
2. Demonstrate a working knowledge of different tools and methods of oral and written communication used by practicing civil and environmental engineers
3. Assess engineering projects to identify stakeholders and appropriate methods of communication
4. Create a variety of communication products to support projects, engage stakeholders, and generally support sound decision-making

The course topics include stakeholder identification, public engagement in civil engineering projects, communicating about risk, crisis communication, and more. Additional background is available on the components and motivation for developing and offering this course [24, 25]. As part of the course, students complete a semester project that requires students, in small groups of 4-5 students, to assemble a communication plan for a simple civil engineering project. The communication plan includes a stakeholder analysis, message maps, a communication schedule, outreach materials, and a plan to evaluate communication effectiveness. Students also present their project in a mock public meeting at the end of the semester.

B. CPTED incorporated into the semester project

In the spring semester of 2025, all student group projects related to CPTED and public transit. Six bus stops, including stops on university transit and local public transit authority bus routes, around the UD campus were evaluated using an abbreviated CPTED checklist (Appendix F). Modifications and potential CPTED improvements related to lighting, accessibility, maintenance, and natural surveillance were identified for each location. All projects are realistic (but not actually happening) and are referred to in class and in the remainder of this section as “notional” projects. The notional project assignment included impacts on parking and bus routes as these improvements are made. Student groups then developed a communication plan for notional work at one of these bus stops.

The choice of bus stops at locations around campus is purposeful. As a course comprised primarily of second-year students, they have limited engineering course experience. Bus stop infrastructure is easy to understand, and locations are easy to visit for context.

As a precursor to assigning the project, a lecture module on CPTED principles was presented by the two undergraduate students working on this project, who have been trained in CPTED principles. CPTED and safety as a means of expanding the use of public transit were key motivational factors for each of these projects.

C. Locations selected

Figure 5.1, below, represents the locations of the bus stops assessed and included in this class project:

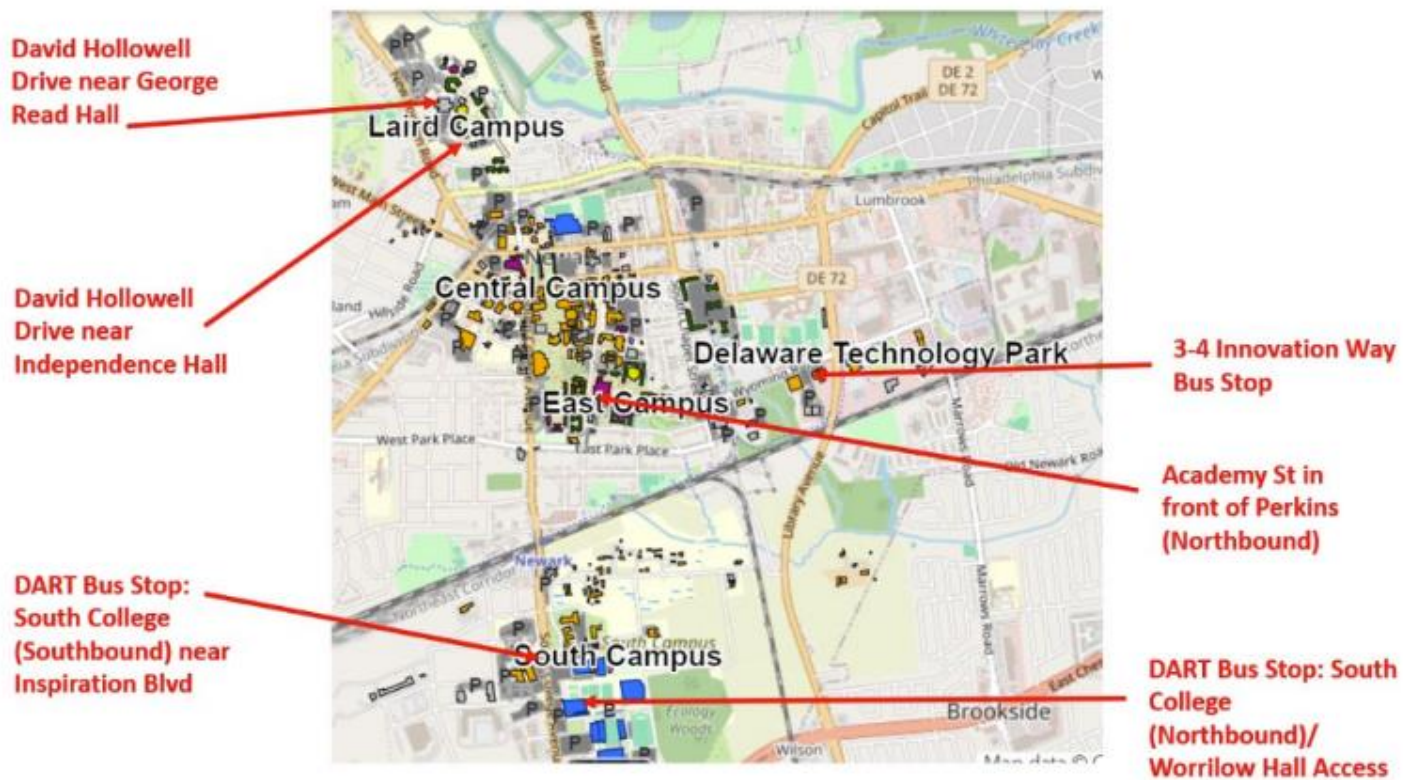


Figure 5.1: Locations used for CIEG411 CPTED communication project.

The following section expands on the proposed CPTED-focused work for each location:

1. Bus stop on Academy Street at Perkins (northbound side)

A preliminary CPTED assessment of the bus stop on Academy Street (northbound) in front of Perkins Student Center was conducted. As a result of the assessment, the bus stop will be renovated to upgrade benches, install a bus shelter, improve lighting, and install a campus map. In addition, a small, converted shipping container will be installed as a collection center for hard-to-recycle items like batteries, unwanted graduation gowns, and electronic waste. During this 3-month project, the bus stop will temporarily relocate 100 yards south of the current bus stop. There will be periodic disruptions to foot traffic due to the project.

2. Bus stop George Read Residence Hall (on David Hollowell Drive)

A preliminary CPTED assessment of the bus stop near George Read Residence Hall on David Hollowell Drive was conducted. As a result of the assessment, the bus stop will be upgraded to install a bus shelter, lighting, and trash and recycling bins. A 30-foot stretch of asphalt walkway will also be removed and replaced with a concrete sidewalk. At the corner, a modern ADA-compliant sidewalk ramp and a map of north campus will be installed. This project will take 3 months during which the bus stop will be moved to side of the residence hall facing Christiana Drive. Biking, walking, and driving along David Hollowell Drive will also be affected during this time.

3. Bus stop at Independence Residence Hall (David Hollowell Drive)

A preliminary CPTED assessment was conducted of the bus stop near Independence Residence Hall on David Hollowell Drive. As a result of the assessment, the stop will be upgraded to install a bus shelter, new lighting, and trash and recycling bins. To facilitate the construction of a ADA-accessible ramp to the residence hall from the bus stop, the building entrance and stairway adjacent to the bus stop will be closed for 3 months. Residents will need to take another path to this bus stop. In addition, a map of north campus will be installed near the bus stop and security mirrors will be installed to assist with visibility around the nearby dumpster enclosure.

4. Bus stop near 3 and 4 Innovation Way

A preliminary CPTED assessment was conducted for the bus stop near buildings 3 and 4 on Innovation Way in the Delaware Technology Park off of Wyoming Road. As a result of the assessment, an emergency callbox, lighting, and waste receptacles will be added. In addition, the new stop will be made ADA-accessible and wayfinding signage for Delaware Technology Park will be added. The walking path to the pond will be replaced with permeable pavement and picnic tables will be added nearby. The project is expected to take 3 months, during which time, access to parking lots near buildings 3 and 4 will be interrupted.

5. Bus Stop on S. College near Inspiration Boulevard (southbound)

The bus stop on South College Avenue near the Newark Train Station lacks a connection to the surrounding buildings. A 3-month-long project will provide these connections: a safe walking path from this bus stop to the nearby train station parking lot will be installed, interrupting traffic in the parking lot. This path will include bollard lighting to note it as a safe path. A kiosk that includes a map of South/STAR Campus facilities and an emergency call box will also be installed. During the construction, riders will be able to access the bus stop, but will need to take a longer path from the parking lot.

6. Bus stop on S. College near the College of Agriculture and Natural Resources (northbound)

This project is an upgrade to the northbound bus stop on South College Avenue located behind the College of Agriculture and Natural Resources (CANR) Worrilow Hall. The current bus stop is an older style shelter that will be upgraded to match the one across the street (see project 6 photo) with bench seating and USB charging ports. In addition, the path connecting the stop to Worrilow Hall will be temporarily closed to allow for installation of bollard lighting along the path to ensure pedestrian safety. A kiosk that includes a map of South/STAR Campus facilities will be installed near the existing emergency call box. During the 6-month project, riders will need to board at a temporary stop farther north, directly across from the project 6 location.

The following disclaimer was included in the project assignment:

Disclaimer: The preliminary surveys were conducted as part of a SMARTER Center DOT UTC project and is intended for use in CIEG411 projects during the Spring 2025 semester. The information contained herein is based on guidelines set by the research group, as modified for this class assignment, and documents the observations of the individuals conducting the survey. CPTED surveys are intended to assist in improving the overall level of security only and are not intended to imply the existing security measures, or proposed security measures are absolute or perfect.

D. Overview of the project and presentations

The table below summarizes each part of the project. The project was completed in phases throughout the semester and included both group activities and individual assignments.

Table 5.1: CIEG411 CPTED communication project elements and descriptions.

Project element	Description
1. Stakeholder analysis	Groups create a stakeholder analysis to help identify messages for the message map (element 3) and, ultimately, the outreach materials. As part of the stakeholder analysis, students use American Community Survey Data, local media reports, maps, stakeholder interviews, and a site visit.
2. Communication schedule	Groups develop a schedule for delivering written and presentation products related to the project.
3. Message maps	Groups develop message map responsive to organize responses to likely stakeholder questions. Message maps then serve as the foundation for the written and presentation products (elements 4, 5, and 7).
4. Written products: FAQ, Google site, social media posts	Individually, students create one <i>frequently asked questions</i> (FAQ) document, one Google site, and 5 social media posts using messages from the message map, targeted to stakeholders identified in element 1, applying principles of effective communication.
5. Presentation slides & poster for public meeting	Individually, students create a set of slides and a poster for a notional public meeting that are appropriate for expected stakeholders in attendance.
6. Evaluation plan using logic model	Individually, students create a plan to evaluate the effectiveness of communication activities.
7. Group poster presentation	Students give a group poster presentation at a mock public meeting at the end of the semester.

Each element was graded using an “EMRI” mastery-grading rubric, specific to each element of the assignment:

E = Excellent/exceeds expectations

M = Meets expectations

R = Revision needed

I = Significantly incomplete

This project is developed to give students the experience of focusing on communication in engineering projects, with a particular emphasis on stakeholder engagement. By the end of the project, the seven elements come together to create a comprehensive, cohesive project communication plan.

Although not required by the assignment, student group presentations were evaluated for understanding of CPTED as a guiding principle. Of 12 groups, 6 explicitly mentioned CPTED in their presentations, and 7 included it on their posters. However, 11 groups incorporated CPTED elements both orally and visually. This mirrors a common trend among transportation authorities and municipalities: CPTED principles are often applied even when not explicitly acknowledged. While few students named CPTED directly, most demonstrated a clear grasp of its concepts and how said concepts played

a role as the motivation for the project. Table 5.2 summarizes how CPTED was incorporated into group presentations and poster displays.

Table 5.2: CIEG411 representations of CPTED in presentations and posters.

Description of CPTED as part of poster presentations					
<i>CPTED elements refer to safety, visibility, lighting, etc.</i>					
Group #	in verbal presentation		on accompanying poster		Notes
	CPTED elements mentioned	CPTED mentioned explicitly	CPTED elements mentioned	CPTED mentioned explicitly	
1	X		X		"CPTED" is not mentioned as a motivation, though the poster mentions lighting and trash cans as part of the project
2	X				
3	X		X		
4	X		X	X	"rider safety and comfort" is also mentioned on the poster
5	X		X	X	
6	X	X	X	X	"CPTED safety principles" (graphic with 5 CPTED elements) got its own section on the poster
7	X	X	X	X	
8	X	X	X	X	explained CPTED as a motivating factor for the project; possibly the most complete integration of CPTED into the presentation
9	X	X	X	X	CPTED is mentioned but not explicitly as a motivating factor for the work; more a set of standards to be met
10		X	X		"CPTED" mentioned in passing; had to loop back in Q&A to get details, which were provided accurately
11	X	X	X	X	
12	X		X		mentioned safety and wayfinding; making stop "welcoming"

The semester project in this class is intended to give civil engineering undergraduates an intense and immersive communication experience. This project also introduced students to CPTED as a specific way to improve the safety of public transportation. Most presentations included concepts of CPTED and safety in their presentations. This is a contribution to the development of the civil engineering workforce and integration of safety and access concepts into civil engineering coursework.

Chapter 6: Dissemination of findings

As of the date of this report, dissemination of findings has been limited. The table below summarizes outreach efforts to date; additional efforts to engage a broader community will continue.

Date	Brief description of dissemination efforts
Various dates December 2024-March 2025	Meetings with transit agency staff and local economic development authority staff to provide background on CPTED and the project
December 4, 2024	Shared year 1 report post on LinkedIn (as of 8/27/25: 3,367 impressions reaching 2,248 members)
February - May 2025	Engagement of civil engineering undergraduate students on CPTED as part of class project as described in Chapter 5
April 10, 2025	Student poster presentation at SMARTER Symposium
June 18, 2025	Post on LinkedIn about project fieldwork (as of 8/27/25: 1,346 impressions reaching 720 members)
August 11, 2025	Summary of site assessment findings provided to Transit Agency 3 and local economic development agency staff; offered to meet with transit agency staff, managers, and stakeholders
August 11, 2025	LinkedIn post sharing year 1 project explainer video (as of 8/27/25: 762 impressions reaching 481 members)
August 25, 2025	Checklists ready for transit agency use were created and posted to PI website

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