

Article

Understanding Police Officers' Usage of High-Visibility Safety Apparel: The Role of Safety Ethics and Professional Appearance

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Abstract: High-visibility safety apparel (HVSA) is personal protective clothing that provides visual conspicuity to reduce police officers' risk of fatality or injury from road traffic accidents. Under the current U.S. Department of Transportation's Federal Highway Administration regulations, police officers on or near Federal-Aid highways are mandated to wear HVSA to enhance their visibility. Although wearing HVSA can significantly prevent traffic-related fatalities among police officers, studies have shown that they do not consistently, or ever, wear it. This study identifies factors influencing HVSA noncompliance among officers by exploring their perceptions of its use and efficiency. Ninety-eight police officers completed a field survey in four cities in Yavapai County, Arizona; their responses were analyzed via predictive decision tree modeling. The results indicated that officers' HVSA-wearing behavior can be predicted by safety ethics, professional appearance, occupation risk, functionality of HVSA, and safety education. Among these predictors, safety ethics and professional appearance were the most important factors in forecasting officers' HVSA-wearing behavior. Our study contributes to enhancing knowledge about the psychological aspects of officers' HVSA-wearing behavior and provides implications for improving their traffic safety policies and compliance in the law enforcement community.

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1. Introduction

Police officers encounter constant work stress from dealing with risky and low-light situations on a daily basis and are often regarded as having one of the most vulnerable human service professions. From 2005 to 2017, 775 officers died in traffic-related incidents (i.e., motor vehicle crashes, motorcycle crashes, and being struck by another vehicle) in the United States, accounting for 37% of all line-of-duty deaths [1]. The most recent report from the National Law Enforcement Officers Memorial Fund (NLEOMF) indicates that while there was a 24% reduction in total officer fatalities between June 2019 and June 2020, the number of traffic-related deaths increased by 4% [1]. Struck-by incidents were the leading cause of traffic-related fatalities in 2019, representing a 21% increase from the previous year [2]. However, it must be noted that these numbers exclude unreported traffic-related incidents and injuries that did not result in death. These statistics are alarming from a risk management perspective, yet there is a lack of scholarly attention to this area of law enforcement that has reassessed the existing safety regulations and policies to reduce these struck-by fatalities.

Struck-by incidents often occur when law enforcement officers are on traffic stops, roadblocks, directing traffic, or assisting motorists at the time [3]. Considering that low visibility is a serious hazard to any individual working near moving vehicles or equipment, being visible in all lighting conditions and environments is critical. To ensure public safety

officers' visibility, several organizations, such as the National Traffic Incident Coalition, International Association of Chiefs of Police, Federal Highway Administration (FHWA), and the International Safety Equipment Association (ISEA), developed the High-Visibility Public Safety Vests Standard in 1999 [4]. High-visibility safety apparel (HVSA), also referred to as a reflective vest, is defined as personal protective clothing that provides conspicuity during both daytime and nighttime usage and meets the American National Standard [5]. The current U.S. Department of Transportation's FHWA regulations have mandated workers on or near Federal-Aid highways wear HVSA to enhance their visibility.

Many previous studies in the field of occupational safety have confirmed that HVSA with American National Standards Institute (ANSI)-compliant fluorescent and retroreflective material can significantly enhance user visibility [6]. However, many police officers do not comply with this federal regulation to wear HVSA as often as they should. Nisenson, Kubu, and Carney [7] found that more than 33% of law enforcement officers across five agencies reported that they never or rarely wear HVSA in the line of duty, while 41.3% reported that they only wear HVSA one to three times per month. Further, no consensus was found regarding several aspects of HVSA usage among all five law enforcement agencies including its regulations and effectiveness during routine patrols or while conducting traffic stops.

While the development of safety gear and technology (e.g., body cameras, body armor, and other types of wearable technology) to protect police officers has become a significant field in research, very little research has evaluated HVSA usage across U.S. law enforcement agencies to enhance police officers' safety. To the best of the authors' knowledge, there is only one study sponsored by the National Institute of Justice that comprehensively examines police officers' attitudes and behavior toward HVSA. To fill this gap, the current study attempts to understand the factors that lead to HVSA noncompliance among police officers by exploring their perceptions related to HVSA use and efficiency.

2. Background of HVSA

The federal requirement that police officers wear HVSA was originally developed in 2005, from the "Safe, Accountable, Flexible, and Efficient Transportation Equity Act: A Legacy for Users" (SAFETEA-LU) that included a small provision "requiring highway workers to wear high visibility garments" [8] (p. 1227). The FHWA first issued regulations governing the use of reflective vests on Federal-Aid highways, which required compliance by November 24, 2008 [9]. Then, the FHWA included this requirement in the Manual on Uniform Traffic Control Devices (MUTCD), which governs the use of traffic control devices on nearly all public roadways [10]. In these proposed regulations, the FHWA stated that law enforcement officers, as well as other first responders, are mandated to follow this regulation because they fall into the category of "workers" that perform most of their duties within the right-of-way of a roadway.

However, law enforcement agencies expressed concern over the FHWA regulations. Notably, the law enforcement community commented that wearing HVSA while performing duties on roadways can place police officers in an adversarial or confrontational role such as when apprehending suspects, stolen vehicles, felonious drugs, or any vehicle occupant who is armed and dangerous [11]. Thus, because of this aspect of policing, the agencies wanted more flexibility for law enforcement to determine when it is appropriate to use HVSA. Consequently, the FHWA modified the definition of "workers" so that the HVSA requirement would include law enforcement personnel only "when directing traffic, investigating crashes, and handling lane closures, obstructed roadways, and disasters within the right-of-way of a Federal-Aid highway" [10]. The regulations and revised MUTCD also included requirements for HVSA to meet specific visibility standards set by the ANSI.

The ANSI first established the ANSI 107 standard for reflective vests generally used by highway workers in 1999. The ANSI 107 standard classifies HVSA according to type and class depending on the occupation or industry served, and provides regulations

and guidelines for design, performance, and materials for high-visibility personal protective equipment (PPE). Performance requirements include color, retroreflection, and recommended configuration of the materials [12]. The retroreflective materials of vests are designed to directly reflect incident light back toward the driver while providing an enhanced contrast, as they capitalize on the illumination from approaching headlights [13]. The ANSI/ISEA 107-2020 is the latest revision of this standard to design, test, and label garments to provide enhanced visibility for workers [14].

3. Law Enforcement Officers' Attitudes toward HVSA

3.1. Safety Attitudes

3.1.1. Safety Ethics

Safety attitude refers to an employee's predisposition to respond toward a safety and security goal, procedure, and prevention measure [15]. Further, there is an ethical component in the practice of safety. Safety ethics means that a person values safety by preventing risky behaviors and accepting responsibility for safety [16]. Although people have safety ethics that they have developed throughout their lives and usually demonstrate within the workplace, their safety ethics can be further influenced by organizational safety culture shared in the workplace that influences all employers and employees' attitudes concerning risks [17]. The idea that organizational culture influences an individual's safety performance assumes that people strive to adhere to their environment. If an organization has a safety climate, employees seek to become productive members of that organization by complying with the knowledge and skills that they learn from organizational safety management practices. For instance, Montana's Department of Transportation reported that a law enforcement officer's prioritization of traffic safety was largely associated with their perception of how others (e.g., other officers and their immediate supervisor in their department) prioritize traffic safety [18]. Notably, extensive research has proposed that an organizational safety climate is a good predictor of safety compliance among employees [19–23]. This implies that officers' safety ethics could influence the degree of HVSA compliance.

3.1.2. Safety Education

Although people naturally act in a manner that is consistent with their beliefs, attitudes, and values, their behaviors will change as their beliefs or perceptions change. Safety education refers to the theoretical orientation and transfer of safety knowledge to an employee, which can further shape their safety attitudes. Safety education prepares an employee to make the right decisions when faced with workplace hazards. Vinodkumar and Bhasi [23] conducted a survey to explore employees' safety compliance and found that safety education was the most critical safety management practice that results in safety knowledge and compliance. When it comes to road safety, Alonso, Esteban, Useche, and Colomer [24] found that road safety education (i.e., age, observed road misbehaviors in parents and peers) is positively associated with self-reported road misbehaviors, emphasizing the fact that road safety education is a process that needs to be maintained throughout one's entire life. Therefore, the current study posits that safety education plays an essential role in determining employees' behaviors toward safety compliance.

3.2. Negative Preconceptions

3.2.1. Occupational Risk Perception

According to Cox and Tait [25], risk perception is the acknowledgement of a potential harm or loss. Thus, an individual's perception of risk plays a key role in occupational safety and health. People take precautions when they are aware of the potential hazards associated with their performance. Thus, it is assumed that people are more likely to consider using PPE when their risk perception regarding their performance is high. Previous studies have found various elements associated with risk perception. For example, DiLillo et al. [26] suggested that the more experience people have with a particular hazard, the less risky

they will perceive the hazard to be, as they may become accustomed to a risk and thus be less sensitive to the true measures of the risk. Similarly, Sandman [27] found that the level of perceived risk is reduced when employees are cognizant of potential work hazards, familiar with the work, and when occupation risks are controllable.

Other studies have indicated that individual prior experience influences the degree of risk perception. When Shults et al. [28] assessed attitudes and personal behaviors regarding seat belt usage, they found that greater seat belt usage is likely to occur among those who have received a traffic violation in the past 12 months and those who have been injured while driving. Tiesman and Heick [29] surveyed 1466 officers from 60 law enforcement agencies to examine their motor vehicle risk perception and found that prior on-duty motor vehicle crashes, roadside accidents, or knowledge of other officers' motor vehicle accidents significantly increased their motor vehicle risk perception.

Individual traits and personalities have also been found to influence risk perception. Previous research investigating risky water-related behavior has suggested that a person's overestimation of their capabilities and skills and underestimation of risk are regarded as significant factor in drowning fatalities [30,31]. Studies have also described how the typical male traits of sensation-seeking riding and confidence in skills may lower risk perception [32,33]. Considering that law enforcement in the U.S. remains a male-dominated profession, officers' lower risk perception may be a significant barrier to HVSA usage.

3.2.2. Negative Preconceptions toward High Visibility at a Crime Scene

Another negative preconception regarding high-visibility comes from the idea that a police officer should be as conspicuous as possible yet also as inconspicuous as possible. For example, officers should be conspicuous when managing traffic as a means to enhance their presence, yet there are times when they should avoid being visible, especially when performing surveillance or confronting suspects that may be armed and dangerous [34]. Further, law enforcement agencies and advocacy groups continue to argue that reflective vests make officers easier targets if a situation turns violent, especially in nighttime conditions. Nisenson, Kubu, and Carney [7] also found that many officer respondents believed that wearing a reflective vest would make them a target in situations where they do not wish to be seen. This illustrates that the decision to wear HVSA is mostly dependent on tactical situations or circumstances for law enforcement officers.

3.3. Perceived Benefits of HVSA

3.3.1. Functionality

For optimal protection, safety apparel must be functional enough to serve its purpose. For instance, HVSA must be effective in enhancing officer conspicuity to protect them from potential struck-by accidents. The concept of reflective clothing is that the sooner a worker in or near traffic is seen, the more time a driver has to avoid an accident. As people generally respond to specific colors (e.g., fluorescent orange or yellow), using these colors can result in drivers' instant recognition of traffic workers. In a simulated work zone, the University of Michigan Transportation Research Institute found that a driver was able to detect a person in non-reflective clothing at 125 feet, whereas they detected a person in reflective clothing at 891 feet [35]. Another study explored the safety effect of high-visibility clothing by comparing the number of self-reported accidents between two groups (3402 test cyclists with reflective clothing versus 3391 control cyclists without reflective clothing) and found that the accident rate for personal injury for the test group was 47% lower than that of the control group [36].

In addition to the empirical evidence of HVSA functionality, it is as important for officers to feel confident that wearing reflective vests can protect them against workplace hazards. The wearers often consider the ease of use, the time it takes to put on, and overall convenience when it comes to PPE efficiency [37,38]. If officers believe that the disadvantages of wearing HVSA outweigh the benefits (i.e., the functionality of HVSA), they will

perceive HVSA as ineffective and nonfunctional. Officers' misconceptions regarding how HVSA functions can also contribute to their resistance in wearing it.

3.3.2. Professional Appearance

As appearance is a robust design component that is used to produce an impression, clothing is used as an indicator of social status and personality [39,40]. When it comes to a law enforcement officer's professional appearance, an image that represents authority for public safety and commands presence is desirable. Appearance and clothing influence people's perceptions of others as well as their perceptions of themselves, and uniformity can affect a wearer's cognitive processing and behavior [41,42]. Kwon [42] examined perceptions of the mode of dress (i.e., uniform) between males and females to find that male concepts of clothing are closely linked to social status and hierarchy. Considering that police officers in the U.S. are predominantly male, this suggests that reflective vests should be designed to manifest their professional authority.

However, the color of reflective vests makes it difficult for police officers to maintain professional authority, as it creates a specific impression of the wearer to the perceivers. People tend to perceive lighter colors as more pleasant and less dominant relative to dark colors [43,44]; therefore, the law enforcement community may be concerned that their authoritative image would be skewed if they wore bright, reflective vests. Nisenson, Kubu, and Carney [7] found that surveyed police officers at four out of five agencies disagreed with the statement that wearing a reflective vest enhances their professional appearance as an officer. Based on these notions, it is important to explore how police officers' attitudes toward their self-perception can influence their decision to wear HVSA.

3.3.3. Comfort

While functionality and professional appearance are two critical factors that influence the perceived benefits of HVSA, wearer comfort is another crucial factor that influences officers' HVSA-wearing behavior. There are two dimensions of comfort that affect wearability: aesthetic (e.g., how HVSA looks and feels) and physiological comfort (e.g., thermal insulation, water penetration properties, and air permeability). Aesthetic comfort is associated with the psychological meaning of "comfort." Slater [45] defined comfort as "a pleasant state of physiological, psychological, and physical harmony between a human being and the environment" (p. 4), to stress that it is a multifaceted construct impacted by various elements and is not merely the opposite of "discomfort." For law enforcement officers, the aesthetic comfort of HVSA can be just as significant as its physiological and physical comfort, since maintaining positive self-perception can be vital to their ability to feel comfortable.

The ease of performing task-related movement (mobility) and the physical fit on the wearer are also important wearability characteristics for the physiological and physical comfort of safety apparel. For military clothing, Schutz, Cardello, and Winterhalter [46] argued that the satisfactory fit of a garment is essential for wearers to feel comfortable. The frustration that comes from wearing uniforms that hinder movement—whether as a result of poor design or poor fabric choice for functionality—can lead to job attitude problems [40]. For ballistic vest wearers, research indicates that thicker and bulkier ballistic panels may negatively impact mobility, which could affect officers' comfort and willingness to wear safety apparel [47,48]. By noting that PPE can impede a wearer's comfort, this study assumes that any discomfort caused by HVSA's features may dissuade police officers from wearing HVSA.

4. Materials and Methods

4.1. Decision Tree Predictive Model

By providing ease of communication and statistical parsimony (i.e., fewer predictors in the classification model), decision tree-structured models have been widely used in health behavior and clinical studies to solve various discrimination problems [49–51]. Among

the variety of predictive modeling techniques such as logistic regression or support vector machines, decision trees have been found to be one of the most efficient predictive models [49,50,52]. In sum, decision tree predictive models can provide decision-makers with better insights to increase the value of their policies [51,52] and can provide organizations with new opportunities for predicting future behavior and the “discovery of relationships” in data [53].

4.2. Conceptual Framework and Research Questions

The conceptual framework of HVSA (Figure 1) consists of three categories of variables: safety attitudes, negative preconceptions, and perceived benefits of HVSA. This framework displays how seven variables within the three categories predict police officers’ HVSA-wearing behavior. Based on this framework, the following four research questions were generated:

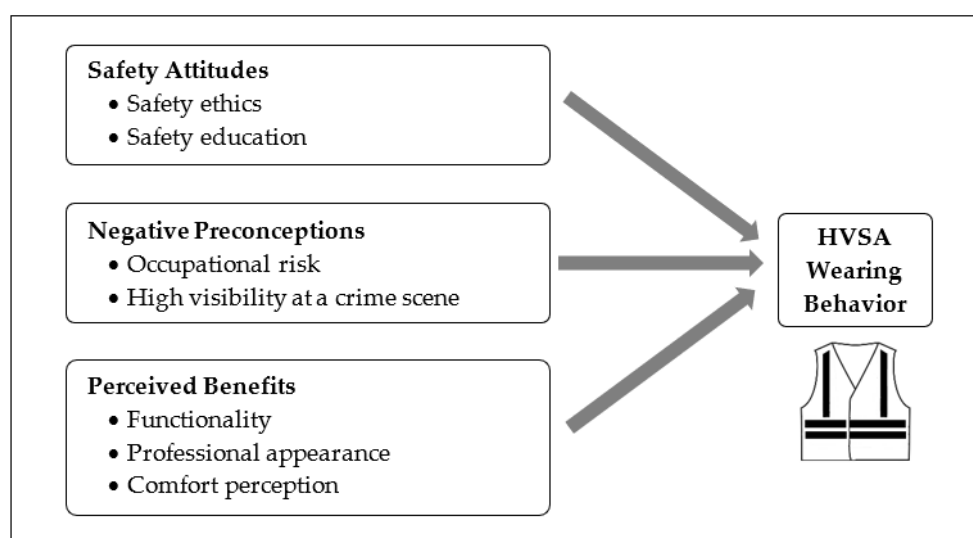


Figure 1. Conceptual framework of high-visibility safety apparel (HVSA).

Research Question 1: Are safety attitudes toward safety ethics (Q1a) and safety education (Q1b) important predictors of police officers’ HVSA-wearing behavior?

Research Question 2: Are negative preconceptions toward occupational risk (Q2a) and high visibility at a crime scene (Q2b) important predictors of police officers’ HVSA-wearing behavior?

Research Question 3: Are perceived benefits of functionality (Q3a), professional appearance (Q3b), and comfort (Q3c) important predictors of police officers’ HVSA-wearing behavior?

Research Question 4: If yes, which factors are the most critical factors to forecast police officers’ HVSA-wearing behavior?

4.3. Participants

Data were collected through a pen-and-paper survey conducted among police officers in four cities of Yavapai County (i.e., Prescott, Prescott-Valley, Chino-Valley, Cottonwood), Arizona. Both male and female police officers who were required to use HVSA were recruited to participate in the survey via face-to-face communication. A formal survey request along with a cover letter was submitted to the police chief or safety manager in each city to obtain approval to administer the survey. All participants provided their informed consent for inclusion before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of Embry–Riddle Aeronautical University (IRB 13-113). There was no separate pilot study. The survey took approximately 20 min to complete. Out of 196 distributed

surveys, 98 completed surveys were returned, yielding a 50% average response rate. No compensation was provided to the participants for completing the survey. Analysis of the respondents' demographic information revealed that their ages ranged from 23 to 61 years, with a mean age of 37.6 (Table 1). The average level of work experience in the law enforcement profession was 10.7 years, ranging from 5 months to 38 years. The majority had performed general patrol or traffic safety duties at least once in their career (96.9%). Approximately 88.8% were in the White/Caucasian ethnic group followed by the Hispanic ethnic group (7.1%). The majority were male police officers (93.9%); only 6.1% were female officers.

Table 1. Demographic Profile of Respondents ($n = 98$).

Variable	%
Gender	
Male	93.9
Female	6.1
Age	Years
Age range	23–61
Mean age	37.6
Median age	36.0
Police work experience	Years
Range	0.4–38.0
Mean	10.74
Median	9.5
Missing value	1.0
Rank	%
Officer, deputy, trooper	57.1
Corporal	8.2
Sergeant	19.4
Captain or above	3.1
Other	11.2
Race	%
White/Caucasian	88.8
Hispanic	7.1
African American	3.1
Asian/Pacific Islander	1.0
Marital status	%
Single, never married	12.2
Married	81.6
Divorced	5.1
Separated, widowed	1.0
Education	%
High school graduate	5.1
Some college or associate degree	61.2
Bachelor's degree	25.5
Some graduate work	5.1
Graduate degree	3.1

4.4. Measures

An instrument was designed to measure safety attitudes toward officers' safety ethics and safety education, negative preconceptions toward occupational risk, and high visibility at a crime scene through use of HVSA alongside the perceived benefits of functionality, professional appearance, and comfort while wearing HVSA. Each of the scale's measurement items was measured on a 10 cm line on the Visual Analog Scale (VAS) and was anchored at each end by 'strongly disagree' and 'strongly agree.' The outcome variable of HVSA-wearing behavior was measured as the duration of HVSA usage (total hours and

minutes each month). Despite operational difficulties and a longer completion time, VAS has been known to provide more accurate information in comparison with Likert-type categorical scales in paper-based surveys [54].

The measures of this study were modified from existing scales to reflect this study's context. Each measurement scale had a single item. Safety attitudes toward safety ethics and safety education scale items were derived from Donald and Canter [19]; negative preconceptions toward occupational risk and high visibility at a crime scene were derived from Cox, Cox, and Zimet [55]; and perceived benefits of professional appearance were derived from Kwon [42]. Functionality and comfort perception items were developed based on the literature relating to police officers' personal protective clothing [56,57]. Lastly, the item of HVSA-wearing behavior was developed to measure the duration of HVSA usage in hours and minutes per month. Six academic experts in the fields of safety and psychology conducted content analyses of the validity of the survey items. Five reviewers (83.3%) agreed that each survey item measured the research criteria that it was designed to measure. The survey items were evaluated for content validity and revised for clarity and readability. Table 2 presents the descriptions for each scale item.

Table 2. Measurement scale items.

Categories	Construct	Descriptions of Scale Items
Safety attitudes	Safety ethics	Being safe is more important than being comfortable.
	Safety education	Safety education programs induce officers to wear high-visibility vests more frequently.
Negative preconceptions	Occupational risk	I feel worried about my safety during patrol duty.
	High visibility at a crime scene	A high-visibility vest makes me a target in situations that I do not wish to be seen.
Perceived benefits	Functionality	A high-visibility vest prevents officers from getting struck by vehicle accidentally.
	Professional appearance	High-visibility safety vests help enhance officer's professional look and authority.
	Comfort	Overall comfort of high-visibility safety vests is satisfactory.
HVSA usage	HVSA wearing behavior	How many hours and minutes of each month do you actually wear high-visibility vest?

4.5. Data Analysis

To answer the four research questions on whether and how HVSA-wearing behavior can be predicted by the seven variables that were classified into safety attitudes, negative preconceptions, and perceived benefits, a binary classification tree was generated using R statistical software [51,52]. The target variable, HVSA-wearing behavior, was split into a high ($M = 242$, $n = 47$) and low usage group ($M = 44.29$, $n = 51$) based on the median (med. = 90 min) to generate the binary classification tree. To evaluate the performance and accuracy of the final tree model, receiver operating characteristic (ROC) and error matrix analyses were conducted on the full dataset ($n = 98$) [51,52,58]. We used the Rattle package, a Graphical User Interface (GUI), for data mining using R statistical software. The detailed instructions are provided in an article in the R Journal by Williams [59].

5. Results

An optimal classification tree model (Figure 2) was created from the data ($n = 98$) and comprised of six terminal nodes. Three terminal nodes predicted a high HVSA usage group, three predicted a low HVSA usage group. The root node in the decision tree ($n = 98$) was split into two branches according to the primary indicator of safety ethics (≤ 6.1 , > 6.1). Police officers possessing safety ethics greater than 6.1 were predicted as the high HVSA usage group and were denoted as "yes" in the final terminal node ($n = 12$,

12%, prob. = 1.00). Safety ethics exhibited strong predictive power with 100% prediction of certainty. However, when safety ethics were less than or equal to 6.1, the low HVSA usage group (denoted as “no” in the node) was predicted with a 59% prediction of certainty ($n = 86$, 88%, prob. = 0.59).

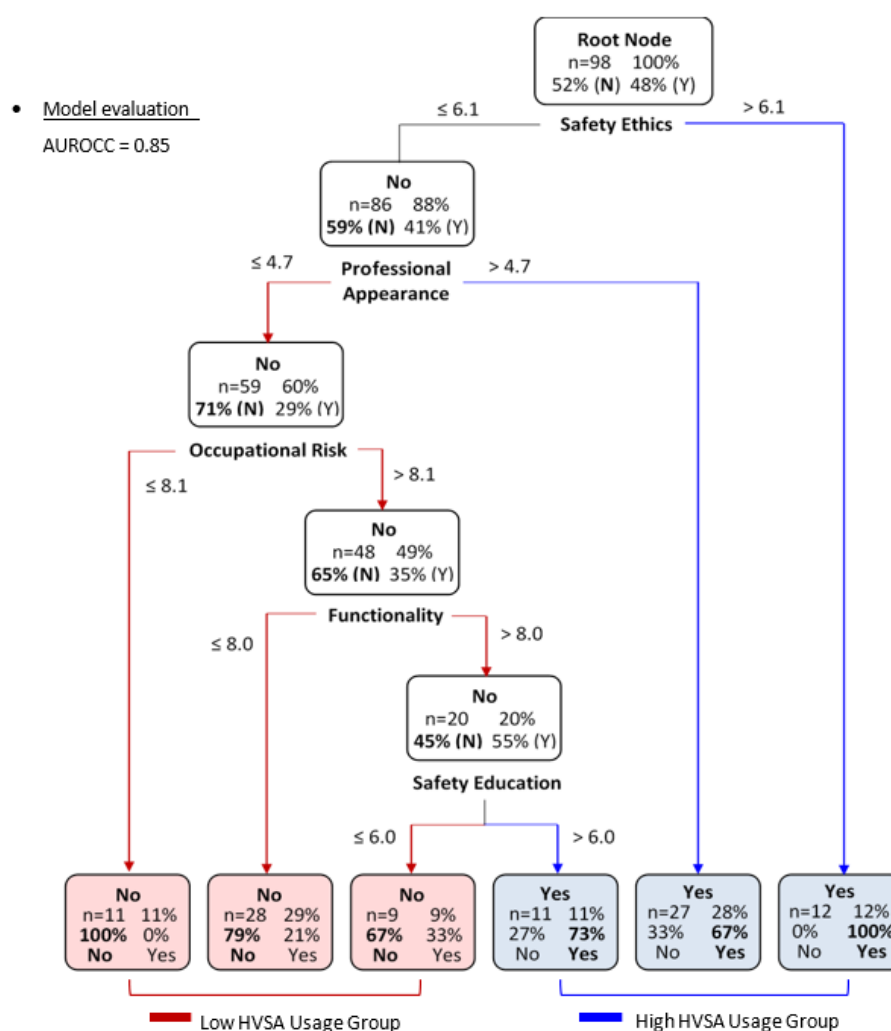


Figure 2. Decision tree model.

Among the respondents, when professional appearance was greater than 4.7, the high HVSA usage group was predicted ($n = 27$, 28%, prob. = 0.67). However, when professional appearance was less than or equal to 4.7, the low HVSA usage group was expected ($n = 59$, 60%, prob. = 0.71). When police officers possessed occupational risk less than or equal to 8.1, the low HVSA usage group was predicted in the final terminal node with a 100% prediction of certainty ($n = 11$, 11%, prob. = 1.00). When police officers possessed occupational risk greater than 8.1, the low HVSA usage group was still predicted ($n = 48$, 49%, prob. = 0.65). Among the respondents, police officers who possessed functionality of less than or equal to 8.0 were identified as the low HVSA usage group in the final terminal node ($n = 28$, 29%, prob. = 0.79). Further, police officers who possessed functionality greater than 8.0 were also identified as the low HVSA usage group ($n = 20$, 20%, prob. = 0.45). The node was then split further by safety education. When safety education was greater than 6.0, the high HVSA usage group was expected in the final terminal node ($n = 11$, 11%, prob. = 0.73). However, when safety education was less than or equal to 6.0, the low HVSA usage group was predicted ($n = 9$, 9%, prob. = 0.67).

These results indicate that high levels of the police officers' safety attitudes, such as safety ethics (Q1a) and safety education (Q1b), and a higher level of perceived benefits of professional appearance (Q3b) predicted the high HVSA usage group. Low levels of safety ethics (Q1a), professional appearance (Q3b), occupational risk (Q2a), functionality (Q3a), and safety education (Q1b) predicted the low HVSA usage group. The first root node was split according to the primary indicator of safety ethics (>6.1 , $n = 12$, 12%, prob. = 1.00) while the second node was split by professional appearance (>4.7 , $n = 27$, 28%, prob. = 0.67), indicating that safety ethics and professional appearance are the most critical factors in predicting high HVSA-wearing behavior, which responded to the fourth research question (Q4). Thus, research questions Q1a, Q1b, Q2a, Q3a, Q3b, and Q4 were explained and supported, while the other research questions were not.

Model Evaluation

To evaluate the model performance and accuracy of the decision tree, ROC analysis was conducted on the full dataset ($n = 98$) by calculating the area under the ROC curve (AUROCC) [51,58]. To evaluate the misclassification rate, error matrix analysis was also conducted on the full dataset ($n = 980$) [51,58]. The results of the ROC and error matrix analyses indicated an AUROCC of 0.85, an overall error rate of 0.21, and a precision rate of 0.81, indicating that the decision tree model was generally accurate and had a low misclassification rate [52,60].

6. Discussion

This study's results offer some critical insights into police officers' perspectives regarding HVSA usage. The study's findings showed that officers' safety attitudes toward safety ethics and safety education and perceived levels of professional appearance, occupation risk, and functionality of HVSA were salient indicators that contributed toward their HVSA usage. Specifically, officers' safety ethics and perceived benefit of professional appearance were the two critical factors in predicting officers' HVSA-wearing behavior. Neither concerns regarding high visibility at a crime scene, or "wanting to remain unseen" in certain situations, nor the comfort of HVSA had predictive power in determining officers' HVSA-wearing behavior.

Concerning officers' safety attitudes, those with strong safety ethics and those who perceived safety educational programs as important in inducing HVSA usage showed more frequent usage of reflective vests. All officers with high levels of safety ethics who valued safety over comfort were found in the high HVSA usage group, which implies that officers' prioritization plays an important role when it comes to safety versus other occupational values. These findings suggest that organizational efforts toward establishing a safety culture and safety education programs are crucial. While safety education is a form of learning that develops reasoning and judgment to influence one's attitudes and perceptions, it must be noted that safety training can further provide skill development that improves employees' performance [61,62]. Road safety education, in particular, is known as a reliable factor that contributes to individuals' social behaviors and their long-term road safety outcomes [24]. If police officers are not adequately trained regarding principles behind a safety policy, their participation in safety compliance will only be minimal. Thus, a strategic combination of both education and training is necessary to create a solid foundation for a safety culture within organizations. If more state, county, and municipal law enforcement agencies can establish strategic plans to frame conversations and efforts in enforcing officers to prioritize safety compliance with HVSA, it will increase HVSA-compliance among police officers.

Concerning officers' negative preconceptions (i.e., occupational risk and comfort) associated with HVSA, occupational risk was useful in predicting the frequency of HVSA usage. All officers who were less concerned about their safety during traffic patrol duty were found in the low HVSA usage group. This finding implies that an inaccurate occupational risk perception may limit an employee's ability to engage in appropriate safety behaviors.

As employees become familiarized with their occupational tasks, they tend to underestimate the associated risks [63]. Police officers in the current study had an average of 10 years of work experience in the law enforcement profession; thus, it is possible that these officers may have come to view traffic-related tasks as non-threatening, as they are merely routine. One practical strategy to increase officers' occupational risk perception could be to provide regularly scheduled risk awareness programs that incorporate policies regarding the key functions, goals, and proper usage of HVSA. In addition to mandating police officers to report any injuries, incidents, and hazardous events, agencies can disseminate these written reports and statistics to all employees in an organization. Safety training programs such as "Below 100," which aims to reduce police officer line-of-duty deaths to fewer than 100 per year, can further increase police officers' overall occupational risk perception by making them more aware and knowledgeable of potential work hazards. It is also important for law enforcement agencies to work with other local partners (e.g., American Traffic Safety Services) to launch new educational and training efforts for their employees. Disseminating accurate and timely information (e.g., sending out inter-departmental email or text reminders about routine safety efforts, such as wearing HVSA and seatbelts) could help increase risk perception among police officers.

Concerning the perceived benefits of HVSA, functionality and professional appearance were both significant predictors of officers' HVSA usage. In terms of functionality, this study's findings imply that a lack of perceived functional benefits of HVSA lead officers to refrain from wearing it. Although it is not clear what leads these individuals to believe that HVSA is not functional, it is worth noting some possible explanations. First, it may be related to occupational risk perception. If people do not see serious hazards as being associated with their occupational performance, they will not necessarily consider HVSA as being functional or beneficial. Officers may also overestimate their visibility and fail to appreciate the extent to which their conspicuity depends on wearing reflective vests.

Another potential explanation for the low level of perceived functionality is that officers may genuinely believe that wearing HVSA is ineffective or inefficient for ensuring their safety. If this is the case, further investigation of officers' responses (those who did not view HVSA as beneficial or functional) is needed to understand why they perceive HVSA as being ineffective in providing personal protection. For example, these officers may believe that reflective vests are not necessary during daylight hours. Further, they could view reflective vests as being less useful than the alternative stimuli that are currently available on roadways: they may believe that other visual stimuli such as road signs, officers' instrumentation, or lighting on other vehicles are bright enough for a driver's nighttime vision. As retroreflective markings are often only positioned on vests, officers may perceive that reflective vests only provide modest conspicuity. Identifying the specific reasons behind officers' negative perceptions of HVSA's functionality will be valuable in implementing policies and strategic solutions that support officers' HVSA usage.

Regardless of those potential explanations for the low level of perceived functionality among officers, one practical solution for increasing HVSA among officers is appropriate safety education. Perceived functionality of HVSA is highly associated with officers' risk perception and their knowledge of HVSA's effectiveness, which implies that the perceived functionality of HVSA is closely related to officers' safety ethics. As we emphasized the importance of safety education and training to increase the safety ethics among police officers, local and state law enforcement agencies should put more effort into enhancing the organizational safety climate through increased and comprehensive safety educational programs so that officers will perceive HVSA beneficial and functional. Further, rather than simply relying on statistics to identify and understand the extent of safety problems within the law enforcement agency, sharing anecdotal evidence among officers during safety education and training will better invoke emotions to increase one's motivations to wear HVSA.

Officers who believed that HVSA impedes their professional appearance were less likely to wear HVSA. Accordingly, law enforcement agencies may need to consider devel-

oping newer clothing designs that fulfill both authoritative appearance and conspicuity. Since self-perception plays a significant role in individual behaviors [64], different clothing designs (e.g., color, materials, style, visual appearance) that address officers' concerns regarding their authoritative image will increase their willingness to wear HVSA. To better understand the specific concerns that officers have regarding the appearance of HVSA, a qualitative research approach could help gain information on what particular design features would meet officers' expectations.

If the goal is to maximize officers' safety by encouraging the proper use of HVSA, officers' HVSA usage should be induced through more effective methods. In addition to stronger organizational policies mandating HVSA usage, one way to motivate and encourage favorable behavioral outcomes is by applying positive reinforcement [65]. Various motivational influences in the workplace can have essential effects on an employee's behavior and will determine whether an employee works safely or unsafely. Most employees desire acceptance and recognition, which indicates that the most effective safety incentive is to motivate, recognize, and reward the right behavior. As positive reinforcement is known to be highly effective in strengthening and increasing behavior, this concept of positive reinforcement can be applied to officers' safety compliance by utilizing both intrinsic (e.g., praise, encouragement, and empowerment) and extrinsic (e.g., salary, bonus, fringes, and benefits) rewards within an organization [66,67]. Therefore, proper rewards to support officers' HVSA usage will make a substantial impact on maximizing officers' safety.

HVSA for law enforcement personnel has been omnipresent throughout Asia and Europe for more than two decades. Unlike in Europe where it is strictly mandated for officers to wear HVSA, MUTCD federal regulations in the U.S. do not require officers to wear HVSA even when directing traffic, handling a lane closure, or investigating a collision. Considering the vague and often situational guidelines for HVSA usage, it is essential to understand the motivations of an officer's decision to wear or not to wear HVSA to develop effective preventive measures. Thus, the current study investigated various factors that may dissuade law enforcement officers from wearing HVSA in order to implement the most effective safety education and training strategies to increase its usage and prevent any avoidable accidents.

Limitations

Several limitations are inherent in this study. First, as it seeks to draw a conclusion from only four cities in Yavapai County, Arizona, as a data source, the generalization of the findings to the respective law enforcement officers' viewpoints regarding their HVSA usage is questionable. Thus, larger samples from various locations across the U.S. are needed to establish a more comprehensive and strategic plan that can increase law enforcement officers' HVSA usage.

Second, it must be noted that these findings are based on officers' self-reports; thus, the results should be interpreted with caution. Several studies have questioned the reliability of self-report data, as respondents answer according to how they believe they should behave rather than how they actually behave (i.e., social desirability bias) and they often have certain tendencies or patterns when responding to questions (i.e., response bias) [68–70]. Nevertheless, self-report methodology is one of the most widely used assessment strategies in behavioral science and has become a typical practice among policymakers. This research method is also commonly observed in law enforcement in the context of environmental and safety regulations [21,71].

Third, we acknowledge that the survey response rate of 50% is considered low. The reasons for the low response rate could be the survey population being distrustful of outside visitors or, a close-knit law enforcement community, the requirement of obtaining approval from multiple supervisors, and, in particular, being busy with daily policing tasks. Accordingly, the methodological approach of analyzing surveys of law enforcement officers is rare, and the majority of law enforcement studies are heavily ethnographic based on observation or interviews [72]. Given the various barriers to surveying law enforcement

officers, a relatively low response rate is a reasonable expectation in a survey of this population [72,73]. Because of a small number of 98 survey participants, we acknowledge that less than 20 participants classified in each terminal node of the decision tree are considered low. A future study could focus on developing ways to collect a larger sample size of law enforcement officers to improve the precision of data analysis results. Further, the majority of the survey participants (93.9%) were male officers (6.1% were female). As law enforcement has been a historically male-dominated profession in the U.S., gender imbalance was unavoidably expected in the survey [73].

Finally, we acknowledge that a pilot study was not conducted before the main data collection. Future work should consider conducting a pilot test or a pre-test trying out of the research instrument to assess the content of the survey items. Although beyond the current study's scope, some key variables that could have improved the interpretation of the current study findings are worth noting. Considering specific personality traits (e.g., conscientiousness, extraversion, agreeableness) or the influence of personal factors (e.g., work experience, time in position, and familiarity with a neighborhood or roadway) may have provided a more in-depth understanding of officers' HVSA-wearing behavior. It is also important to note that law enforcement officers' thoughts and ideas should have the most contributive power in implementing better policies and programs for their safety compliance. Thus, it is recommended for future studies to adopt open-ended questionnaires or qualitative interviews to explore officers' responses in more detail.

7. Conclusions

Similar to not wearing a seatbelt, failing to wear HVSA increases the chance that an officer will be injured or killed in traffic. Our study contributes to understanding the psychological aspects of officers' HVSA-wearing behavior and provides policy implications for improving their traffic safety compliance. This study's results have implications for law enforcement agencies to understand a range of police officers' perceptions and attitudes that are associated with the frequency of their HVSA usage (i.e., HVSA compliance). It is evident that while personal safety ethics (personal safety attitudes toward safety ethics and education) and positive professional appearance increases HVSA-wearing behavior among officers, more efforts are needed by agencies to increase officers' awareness of the occupational risks and positive functionality of HVSA. This emphasizes the importance of safety training and education in addition to considering new HVSA designs and color schemes to help reduce police officers' reluctance to wear it. It is also critical to have more consistent and stronger agency-specific policies encouraging the use of HVSA. Although this study provides directions for future safety prevention interventions that are aimed at changing officers' safety behaviors, more research is needed to comprehensively evaluate and implement effective strategies to increase police officers' HVSA usage. Struck-by vehicle injuries among law enforcement officers are avoidable in most cases and making officers visible on a highway is the most critical solution. Without effective policies or regulations to promote HVSA compliance among police officers, we will continue to lose one of the most valuable assets to our society.

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