



Suggesting A Stochastic Measurement Tool for Determining Crime and Safety Indexes: Evidence from Turkey

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Highlights

- Suggesting a new measurement tool for crime/safety indexes.
- Application of SMAA-TRI method in the measurement of crime/safety indexes.
- First time using a quantitative decision method except surveys to determine crime/safety indexes.

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Abstract

Crime is a phenomenon that disrupts the welfare and structure of society and has become an important problem in both developed and developing countries. In recent years, in parallel with the increasing rate of urbanization all over the world, there has also been a serious increase in crime rates. With the increase in crime rate, fear of crime has emerged among individual members of society. Fear of crime is the degree of anxiety an individual feels about the deterioration of the social structure. This degree of anxiety is expressed by crime and safety indexes today. In this study, a new measurement tool is proposed in order to eliminate the effects such as emotional preference, decision-making difficulty, etc. For this purpose, the Stochastic Multi-Criteria Acceptability Analysis-TRI (SMAA-TRI) method, in which the measurement can be made with interval and dispersed values, and the probability theory can be reflected as an effect on the decision analysis, has been utilized to measure the crime and safety indexes, determined by online survey up to now, because of the fact that the experts/participants had difficulties in expressing their preferences clearly during their evaluations. It was found that the index values obtained in the study are consistent with the results of the surveys conducted with thousands of people and that the SMAA-TRI method can be effectively used in determining the crime/safety indexes.

1. INTRODUCTION

There are many definitions made at different times regarding the concept of crime, and which of these events and criteria are within the scope of crime, and criteria considered as crimes are discussed in all time. Crime is the result of the behavior of individuals. These behaviors are considered as normal according to what is defined as “normal” in the society where they are imposed or according to rules defined by their governments [1]. Therefore, the crime can be considered as disturbing the welfare and the regulations of the society as well as the order of the country. It is known that this behavior disorder has existed from the past to the present and it is predicted that it will continue to make a profound impact everywhere around the world [2].

To create a more peaceful society structure for its citizens by preventing crimes and providing a safer life is one of the main duties of each government. Therefore, crime is an important issue for all governments. The increase in crime rates in both developed and developing countries has led to the attention of many politicians and scientists from different disciplines. [3].

As a developing country, Turkey is in a state of social, cultural and economical transformation. Turkey, is experiencing a transformation from the agricultural economy to industrial economy, and as a result of this there is a rapid migration from rural to urban areas and urbanization is increasing swiftly. Therefore,

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millions of people with different identities, behaviors and various ethnic background are now living in the cities. This situation both creates an ideal environment for criminals and weakens the control of the government over the individuals. The increase of unemployment has weakened social control and the addition of factors such as widespread poverty, alienation, crime, have caused problems in cities which have to be studied [4].

Another problem that crime creates in a society is the fear of crime. Fear of crime, which has overcome the increasing crime rates itself today, is the level of anxiety of the individual about the deterioration of the social structure. The fear of crime may increase even if the crime rate decreases in a society. Studies made in the beginning to reveal the cause of crime or to explain the reasons for the increase in crime rates have focused on a separate field which is the concept of fear of crime in the beginning from the 1960's [5].

In the past years, survey research without applying any modern quantitative analysis methods has been replaced by quantitative methods. Especially today, heuristic models and multi-criteria decision making (MCDM) methods have been used in order to find the best solution or to offer the closest solution proposals for the problems with incomplete, imprecise, and uncertain information. MCDM methods are techniques that are based on expert opinion and focus on finding the most suitable solution alternative among the alternatives by comparing the criteria in complex situations where it is difficult to make a decision due to the criteria affecting the problem [6].

Today, while dealing with real life crime analysis, there are many conflicting factors, criteria, and constraints that cannot be expressed numerically. It can be said that, this is the main reason of the difficulty of the problem. Therefore, many subjective and objective criteria should be considered together for these problems [7].

Considering the MCDM problems, the quality of the decision is largely dependent on the criterion weights provided by the decision makers/experts and the correct determination of the values of the alternatives according to the criteria. In real life problems, it is often not possible to reach all of these values correctly. Especially in political and public problems, where there are multiple decision makers and the data vary widely, it will be even more difficult to determine the values through questionnaires accurately and clearly. In such problems, there are various criteria with probabilistic, uncertain and imprecise values [8-9].

The Stochastic Multi-Criteria Admissibility Analysis (SMAA) method has been developed for solving discrete MCDM problems where the criterion preferences and weights cannot be obtained from the decision makers precisely, or where they are probabilistic, incomplete or uncertain. Instead of the exact criteria and weight values used in other MCDM methods, SMAA methods allow the values used in problem solving to be intervals and distributions [10].

Due to the subjective nature of the difficulty of obtaining crime/safety indexes, the importance of the subject, and the complexities in making decisions, there was a need to use a new measurement tool with a strong mathematical background that can eliminate the negativity of subjective evaluations. For this purpose, this study aims to propose a new measurement tool to determine crime/safety indexes using the SMAA-TRI method.

Major contributions and novelty of this study can be highlighted as follows: (1) We proposed a new measurement tool for crime/safety indexes, that had been determined for many years by online surveys for many years in the past, with the risk of having incomplete data, emotional preference, and decision-making difficulties. (2) SMAA-TRI method, in which the measurement can be conducted with interval and dispersed values where the probability theory can be reflected as an effect on the decision analysis, has been utilized to measure the crime and safety indexes. (3) Throughout the literature research, no other study could be found in which a quantitative decision method was used to determine the crime/safety indexes, except for introducing the descriptive statistics of the questionnaires. (4) In addition, no other study has been identified in which the SMAA-TRI method was used for crime analyzes. (5) It has been concluded

that the SMAA-TRI method can be utilized effectively for determining the crime/safety indexes. (6) Thus, this paper fills in this gap and suggests a new measurement tool.

In the second section of the study, the related literature was referred, the utilized method was briefly introduced in the third section, the SMAA-TRI method was applied to the problem in the fourth section and the study was completed with the conclusion part containing suggestions for future studies.

2. RELATED LITERATURE

A limited number of studies have been determined through the literature on crime index and the crime/safety relationship. It has been determined that the conducted studies have focused on the relationship between crime and safety from different perspectives, categorizing them according to different crime types, and making associations, focusing mainly on a particular pilot region and handling descriptive or inferential statistics based on surveys [11-13].

The importance of crime and safety in low-income neighborhoods was studied by Mason et al. [11]. The authors emphasized the importance of conducting similar studies with high participation in low-income neighborhoods where it is difficult to get answers to the questionnaires, since the individuals surveyed are mostly elderly and women. In the study, the psychological and social feelings of the residents of the neighborhood according to the factors such as age, employment, education, location of the house and garden-entrance floor/high floor etc., were collected through a questionnaire. The problems that are considered serious regarding the neighborhood are listed under the headings such as vandalism-attack on property/vehicles, snatching, insult/disturbing on the street, attack/harassment due to skin color and ethnicity, and discomfort caused by individuals using drugs. The crime situations discussed were evaluated by dividing them into 4 different categories, and the answers given to the questionnaires were tested at a confidence level of 95% and the situation of walking safely in the neighborhood was tried to be explained.

In another study on crime research, it was tried to reveal the crime levels and safety status that changed with the growth and development of cities. In the study, it has been investigated whether the changes that have occurred in the last ten years in the region affect the crime levels. It was also reported that the cities with larger populations in the region have experienced large crime rates while small cities with a growing population over the past decade have experienced a decline in crime rates, and small city residents feel more secure. In addition, it was emphasized that more crime was committed in cities with high income inequality, racial and ethnic heterogeneity. In terms of public safety, it has been determined that the relationship between inequalities and crime levels that will occur at the city level over time, regardless of small or large cities, is very high and this situation has increased linearly since the 1970s [12].

Another study on the causes of crime focused on the relationship between migration and crime. In the study, the relationship between immigration and crime from 1994 to 2014 was discussed in the macro-social context. Research on crimes has been moved from a qualitative level to a more quantitative level using statistical data. After examining the theoretical studies on the migration-crime relationship in the literature, firstly, the effect of migration on crime rates in the literature was determined, and then the findings of the analysis in this study were emphasized. As a result, an evaluation has been made on the points that the studies on the immigration-crime connection have come to and the work that can be done [13].

Due to the inadequacy of analyzing crime via descriptive statistics utilizing past crime data and surveys, these methods have been replaced by more analytical studies. Based on this idea, the reliability of 106 countries was tried to be estimated by using the crime index, by artificial neural network method (ANN), logistic regression and MOORA method, which is one of the MCDM methods. The superiority of the ANN method in the predictions made with the help of the crime index is highlighted [14].

The relationship between crime and safety have been quantitatively examined in very few studies. Studies on the subject of crime are only affected by the change in analysis methods, and they also provide the opportunity to examine visually instead of only mathematical expressions with technological developments. As an example, a study was conducted on the state of harmony between the crimes

committed in cities and the perception of safety. In the study, utilizing Google Maps application, the safety perception score was aimed to be calculated for various parts of the city of Houston, which was selected as the pilot region. While determining the safety scores, various features such as unemployment rate, ethnic status, and the number of day and night visitors of the regions were taken into account. It has been revealed that the resident population in the region and the active population with day-night circulation are very different. This situation showed that there is no local frequency of crime events, but more qualified studies should be done considering the businesses operating at late hours. It has been mentioned that the increase in population density, especially at night, has a negative effect on the perception of safety of the residents living in the region [15].

In recent studies, it is observed that both quantitative analyzes using crime index data and visually spatial analyzes are conducted. With the help of these analyzes, risk index and crime data were examined between 2005 and 2016 in Wroclaw city, Poland. Areas with high crime rates and high potential for committing crimes are defined probabilistically in the region [16].

It has also been observed that current studies have evolved into more objective analyses by examining crime studies with the help of crime index and analytical methods. However, as tried to be explained in aforementioned studies, crime index and crime-safety relationship studies are in the nature of utilizing past crime data and statistical analysis of survey studies. In this study, it is aimed to add a new perspective to the literature by using the proposed stochastic method.

Throughout the literature, it is seen that the stochastic MCDM methods, SMAA in general and SMAA-TRI in particular, utilized in this study, are used in many field-specific studies such as energy [17], environment [18], banking [19], water resource management [20], maritime transportation [21], automotive [22], construction [23], education [24], urban management [25], transportation [26], and supply chain management [27]. A summary of recent studies, used SMAA and SMAA-TRI methods, is presented in Table 1.

Table 1. Summary of Current Studies with SMAA and SMAA-TRI Methods

Year	Author	Method	Working Area	Year	Author	Method	Working Area
2011	Morais, Almeida and Figueira [28]	SMAA-TRI	Supply Chain	2020	Zhu et al. [45]	SMAA-FOM	Energy
2013	Kadziński and Tervonen [29]	SMAA	Democracy Regime	2020	García-Cáceres [46]	SMAA	Supply Chain
2014	Corrente, Figueira and Greco [30]	SMAA-Promethee	Automotive	2020	Mi and Liao [47]	SMAA-CoCoSo	Energy
2015	Kizilkaya Aydogan ve Ozmen [31]	SMAA	Health	2020	Yang et al. [48]	SMAA-GCA-TOPSIS	Energy
2016	Kurtulmuşoğlu, Can and Tolon [32]	SMAA	Aviation	2020	Durmaz and Gencer [49]	JSMAA	Aviation
2017	Ari et al. [33]	SMAA-2	Environment	2020	Yang and Wang [50]	SMAA-GCA-TOPSIS	Water Resources Management
2017	Zhang, Ju and Gomes [34]	SMAA-TODIM	Environment	2020	Wang and Lahdelma [51]	SMAA	Energy
2018	Zhu, Zhong and Sun [35]	SMAA-TOPSIS	Environment	2020	Guo et al. [52]	SMAA	Marketing
2018	Jasiński et al. [36]	SMAA-TRI	Supply Chain	2021	Eroglu and Gencer [53]	SMAA-2	Energy
2018	Yang and Wang [37]	SMAA	Electric Vehicles	2021	Pelissari et al. [54]	SMAA	R&D Projects

2019	Liu, Yin and Yan [38]	Fuzzy AHP, SMAA, BWM	Energy	2021	Fu, Lai and Yu [55]	SMAA	Economy, Energy Architecture
2019	Song, Yang and Xia [39]	SMAA	Portfolio Management	2021	Corrente et al. [56]	MCHP-Ch-SMAA	Economics of Innovation
2019	Zhu et al. [40]	SMAA-GRA	Water Resources Management	2021	Liao, Liao and Lev [57]	SMAA-CO	Paper Industry
2019	Dias and Vetschera [41]	SMAA	Education	2021	Mouhib and Frini [58]	TSMAA-TRI	Sustainable Forest Management
2019	Pelissari et al. [42]	FFS-SMAA	Supply Chain	2022	Zhao et al. [59]	SMAA-TWD	Information Systems
2019	Lagravinese, Liberati and Resce [43]	SMAA	Healt	2022	Pelissari and Duarte [60]	SMAA-Choquet-FlowSort	Supplier Evaluation
2019	Govindan et al. [44]	ELECTRE, SMAA	Supply Chain	2022	Menou, Lahdelma and Salminen [61]	SMAA	Renewable Power

By examining these studies, it has been determined that SMAA and SMAA-TRI methods are utilized individually or in combination with other methods such as AHP, TOPSIS for the ranking/sorting problems, in general, compatible with stochastic processes, fuzzy set theory and gray relations are used instead of working with deterministic data. In the literature research, no other study have been determined in which a quantitative decision method was utilized for computing the crime/safety indexes, except that the survey values have been presented as percentages. Besides, to the best our knowledge, it is the only study in which the SMAA-TRI method has been used for crime analysis. In addition, unlike the general crime literature, the crime and safety indexes were measured separately for day and night according to the expert/participant evaluations.

3. METHODS

In this section, the SMAA and the SMAA-TRI methods utilized in this study are briefly introduced.

3.1. Stochastic Multi-criteria Acceptability Analysis (SMAA)

SMAA was proposed for determining the stochastic discrete group decisions of problems with uncertain and/or imprecise information of the criteria weights or the evaluations of alternatives according to the decision criteria. The basic assumption of the method is to use Monte Carlo simulation for exploring the weight space for decision maker/expert evaluations [62].

SMAA is compatible with the real-world decision problems and has been utilized effectively for the reasons listed below; (i) it enables computing with missing information using inverse weight space analysis by expressing the expert evaluations as weight intervals or weight distributions, where the evaluations (preference) of experts could not provide, (ii) contrary to many other MCDM methods, SMAA enables flexible modelling with uncertain and inaccurate expert evaluations through stochastic distributions, (iii) mathematical methods can be utilized effectively for calculating steps [63].

Since its development, various SMAA methods have been proposed for ranking (SMAA-3 [64], SMAA-2 [65], SMAA-O [66], Ref-SMAA [67]) and sorting (SMAA-TRI [10]) problems.

Some participants of a crime questionnaire might leave some questions blank, some of them might not be able to clearly express their preferences for some questions, and they may hesitated for some questions due to the subjective nature of the problem as well as anxiety for answering the questions about the crime. In

such cases, the results of the survey will not be able to provide sufficient descriptive statistical information to solve the problem. But the stochastic structure of the SMAA method can handle such problems by allowing the values to be considered as intervals and distributions.

3.2. SMAA-TRI Method

The SMAA-TRI, the extended version of the ELECTRE-TRI, enables computing with inaccurate, uncertain and/or missing information through parameter stability analysis [68].

The main parameters of SMAA-TRI method can be described as [69]; the lambda cutting level, symbolized by a stochastic variable λ with a density function $f_L(\lambda)$ identified within the range $[0.5,1]$, can be described with a stochastic value which used to express the minimum weighted sum of the decision criteria and convert the fuzzy outranking relation into a crisp one.

As aforementioned, criteria weights and the evaluations of alternatives according to the decision criteria can be defined with exact, interval, and some probability distributions. The weights are symbolized by a weight distribution with a joint density function $f_W(w)$ in the feasible weight space W as in Equation (1). The

$$W = \left\{ w \in R^n : w \geq 0 \text{ ve } \sum_{j=1}^n w_j = 1 \right\} \quad (1)$$

other parameters, utilized through the computational steps of the method, are demonstrated by the set $T = \{M, B, q, p, v\}$, where M symbolizes the criteria evaluation matrix which contains the evaluations of each alternative according to the decision criteria, B symbolizes the set of profiles which define the upper and lower limits of predefined categories. q , p , and v symbolize the indifference, preference, and veto thresholds, respectively which are utilized to build the outranking relationships by describing preferences according to a unique criterion. q designates the difference within a criterion which assessed unimportant. p refers to the minimum difference that would cause the expert's evaluation to alter. q should be less than p , where the difference between them indicates hesitation. v defines the minimum difference that entirely invalidate the outranking relation.

SMAA-TRI reveals a set of category acceptability indexes (CAI) (π_i^h) , defines the split of probable parameter values, allocate alternatives (a_i) to each predefined category (C_h) . The computational steps of the SMAA-TRI are presented below [10,70-71,6];

A categorization function, assesses which of the a_i alternatives will be allocated to the h category index, as defined in Equation (2).

$$h = K(i, \lambda, w, T) \quad (2)$$

and a category membership function, a multidimensional integral over finite parameter spaces that's utilized to calculate the CAI mathematically as defined in Equation (3)

$$m_i^h(\lambda, w, T) = \begin{cases} 1, & \text{if } K(i, \lambda, w, T) = h \\ 0, & \text{otherwise} \end{cases} \quad (3)$$

CAI, a possibility for membership in the category that measures the stability of the allocation, computed by Equation (4) with using multiple integrals

$$\pi_i^h = \int_0^1 f_L(\lambda) \int_{w \in W} f_W(w) m_i^h(\lambda, w, T) dw d\lambda \quad (4)$$

CAI are possible values in range $[0,1]$, with "0" referring that an alternative can't be allocated to the category and "1" referring that it will be allocated to the category. For each alternatives, the acceptabilities for all categories sum to "1".

The calculations of the computational steps may be compelling, especially for large-sized problems. Thus, the JSMAA software, an open-source platform for the modeling and solving the SMAA-2 and SMAA-TRI problems, widely used [71]. The adapted version of the SMAA-TRI decision support process flowchart proposed by Tervonen [71] is presented in Figure 1.

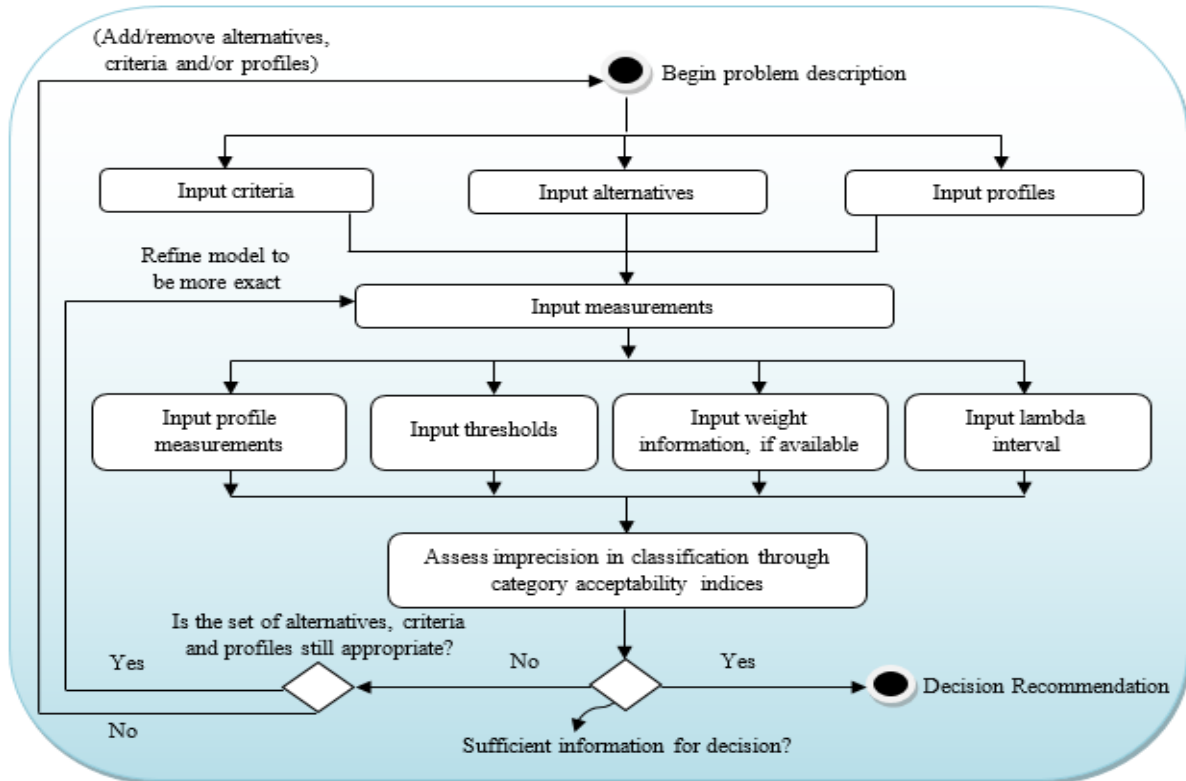


Figure 1. The Adapted Version of the SMAA-TRI Decision Support Process Flowchart [71]

4. DETERMINATION OF CRIME AND SAFETY INDEXES

4.1. The Preliminaries

The crime index can be directly calculated by dividing the number of crimes processed in a region by the total population. Records of murder, rape, robbery, serious injury, theft, motor vehicle theft, and arson are considered when calculating this index. Because of their severity and frequency, these eight crime types are considered common indicators of the criminal experience of a region under consideration [72]. However, direct calculation is insufficient to exactly explain people's perception of crime and safety as in the calculation of life and tourism indexes. Besides, the safety index provides a comprehensive evaluation of the overall security in a region. This index considers fundamental indicators of a place's safety which includes the resident's reviews as well as violence and property crime rates to measure the safety and security of an area [73]. The calculation of the indexes is done with its help [1- crime index rate]. It can be said that crime and safety indexes are opposite of each other from this point of view.

A study has been conducted to examine at what times and at what levels violent crime is committed according to the age level of the offender in the Book of Statistical Briefings by the Juvenile Division of the U.S. Department of Justice and the Bureau of Crime Prevention. In this study, an answer was searched to the question of what time intervals are very likely for adults and youth to commit violent crimes against children. In general, the number of violent crimes committed by adults increased from 06:00 to the evening hours and peaked at 21:00. The number of crimes continued to decrease from 21.00 to 06.00. More than a quarter (28%) of all violent crimes committed by juvenile offenders under the age of 18 were reported to consist between 15.00 and 19.00. By comparison, 24% of all crimes committed by adults occurred between

8 PM and midnight. 24% of all crimes committed by adults occurred between 8.00 PM and midnight when compared with juvenile offenders as seen in Figure 2. It has been stated that crimes committed at night have decreased in both adult and youth categories [74].

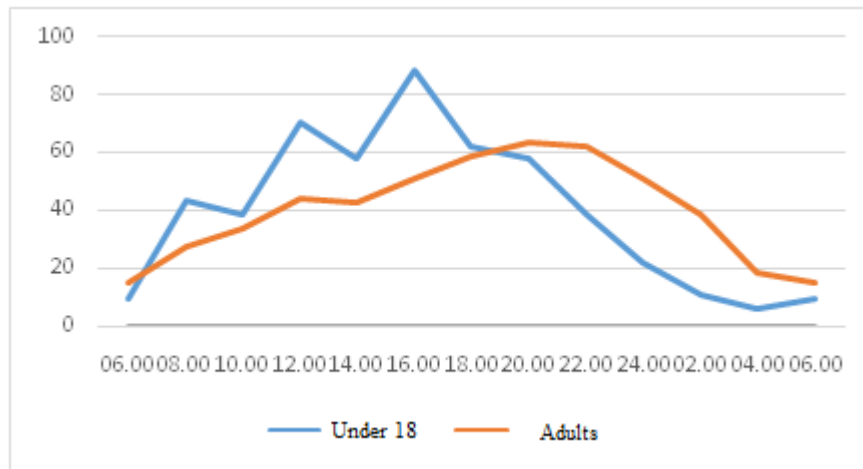
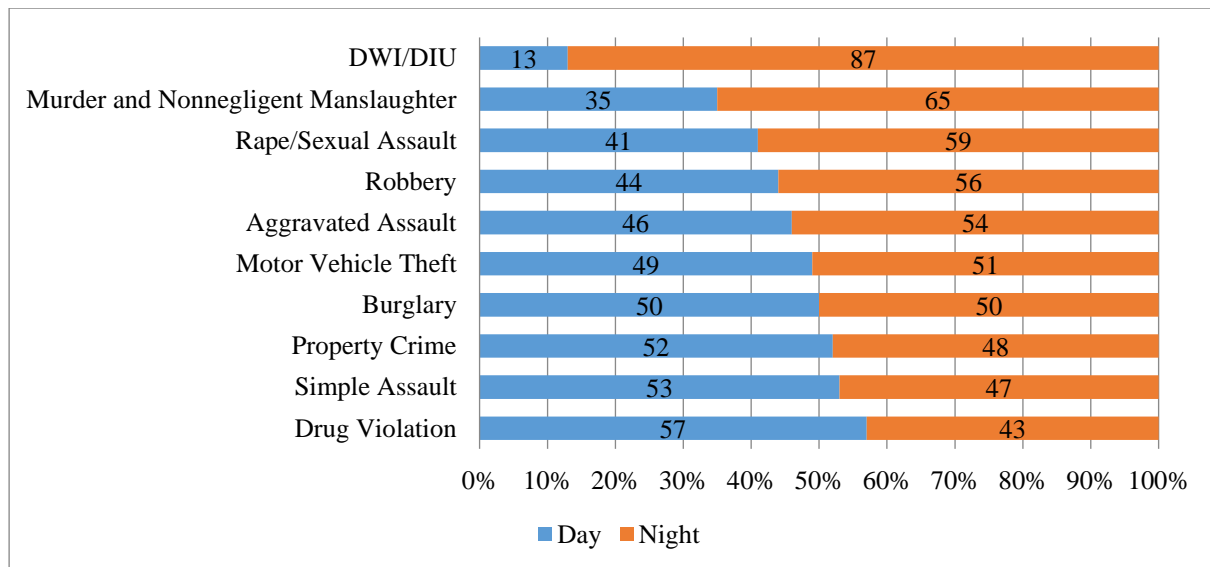


Figure 2. U.S. Juvenile Crime Categories and Hours of Crime

More than 840,000 public order incidents were examined in 2017 in 10 major American cities in the investigation of crimes that occur during the day and at night by TheSleepJudge (2021) website [75]. Types of crime in major metropolitan areas such as Los Angeles, San Francisco, Boston, Austin, and Fort Lauderdale, their location in each city, the times they occur and the events analyzed and the information is presented in Figure 3. It is also reported that more than half of the police incidents (%55) occurred during the day (07:00 - 18:59).



*DWI: Driving While Intoxicated *DIU: Driving Under the Influence

Figure 3. Rates of Various Crimes in The Night and Day

Robbery, drug abuse violations, simple assault and property crimes were slightly more likely to occur during the day, while more severe crimes such as drink driving, murder, rape/sexual assault and robbery were reported more frequently at night. It was observed that 87% of drunk driving, 65% of murder cases, 59% of rape and sexual assaults and 56% of robberies happened in the evening.

4.2. The Material

There are many statistical data collected with the help of surveys on a research web site named Numbeo. The web site serves statistics about crime and safety indexes. Crime and safety indexes for various countries throughout the world and important cities in these countries exceeding 400 have been followed for many years on the site [76].

Inputs are also provided to data such as life index and tourism index with the help of crime/safety indexes. In this study, the index data was computed with the help of an analytical method as an alternative to the results acquired through the online survey for years. In this way, it is aimed that the crime and safety index data will guide the other index data mentioned in a much more efficient and rapid manner.

The scale questions used in the calculations of the crime and safety indexes have been exactly preserved as shown in Table 2. Alternatively, it is aimed to measure the perception of exposure to the crimes described in the scale during day and night hours. The crime and safety indexes that constitute the problem are presented in Table 2 by designing the model. These indexes are described in the categories section.

Table 2. Model Design and Definition of Variables

Abbreviations	Title
Alternatives	
Day	Perception of exposure to crimes asked on the criterion scale during daytime
Night	Perception of exposure to crimes asked on the criterion scale at night
Categories	
Crime Index	Crime index rate measured by experts/participants according to the perception of exposure to crime
Safety Index	Safety index rate measured by experts/participants according to the perception of exposure to crime
Criteria	
C1	How serious do you feel the crime level is?
C2	How much do you think the crime level has changed in the last three years?
C3	How worried are you of getting robbed or snatched?
C4	How worried are you about your vehicle being stolen?
C5	How worried are you about your belongings being stolen from inside your vehicle?
C6	How worried are you about being physically attacked?
C7	How worried are you about being humiliated or disturbed by anyone on the street or in any other public place?
C8	How concerned are you about being physically attacked because of your skin color, ethnicity, gender or belief?
C9	How worried are you about having problems with anyone who uses or sells drugs?
C10	What level do you think the crimes against property is?
C11	What do you think the level of crimes against life is?
C12	How worried are you about having a corruption or bribery problem?

Face to face interviews have been conducted with five academicians who conducted surveys for crime analysis and perception measurement. Thus, it is aimed to separate the answers given in the headings into crime and safety indexes. The model design and the problem description were also evaluated appropriately by the experts as a result of the interviews. In the determination of the cutting level (λ), it was accepted as a stochastic variable with a normal distribution in the range of [0.65-0.80] as in many other studies [27,28,36] in accordance with the literature.

During the interviews with the experts, it was determined that the use of normal likert scales would not be sufficient for the questions measuring the perception of crime/safety indexes. Instead, it was considered that it would be more appropriate to make an interval choice in accordance with the [0-10] scale to express opinions (0-least perception level, 10-highest perception level). For instance, any expert can point out an evaluation for a criterion intervalely as 3-5. It was concluded that the SMAA-TRI method proposed in the study was suitable for this measurement and the initiated evaluation.

JSMAA software was used for the application of SMAA-TRI method in the study [71]. The categories in which crime and safety indexes are grouped are separated from each other by their category values in accordance with the method. The values of the alternatives according to the criteria are presented in Table 3.

Table 3. SMAA-TRI Parameter Values for Perception of Exposure to Crime During the Day and Night

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
Day	1.0-3.0	1.0-3.0	1.0-3.0	2.0-3.0	1.0-3.0	2.0-3.0	1.0-3.0	1.0-3.0	1.0-2.0	1.0-2.0	2.0-3.0	2.0-3.0
Night	1.0-4.0	1.0-2.0	2.0-4.0	2.0-4.0	1.0-4.0	2.0-4.0	1.0-2.0	1.0-2.0	2.0-3.0	1.0-3.0	3.0-4.0	1.0-3.0
Category	1.0-4.0	1.0-3.0	1.0-4.0	2.0-4.0	2.0-3.0	2.0-4.0	1.0-4.0	0.0-2.0	1.0-2.0	1.0-4.0	0.0-3.0	1.0-3.0

A consensus was reached and a single value was entered into the software as a result of the debates made by the experts. For instance, for the question “How serious do you feel the crime level is? (C1)”, it was stated by the experts that a perception of crime was felt at a level between 1.0 and 3.0 on a [0-10] scale. Criterion weight was not used in accordance with the problem structure due to the targeting of perception measurement and the problem being a political and public decision.

4.3. The Results

The category acceptability indexes that emerged as the solution of the proposed model are shown in Figure 4 and the graphical representation of the category acceptability indexes are presented in Figure 5.

Alternative	Crime Index	Safety Index
Day	0,22	0,78
Night	0,42	0,58

Figure 4. Category Acceptability Indexes

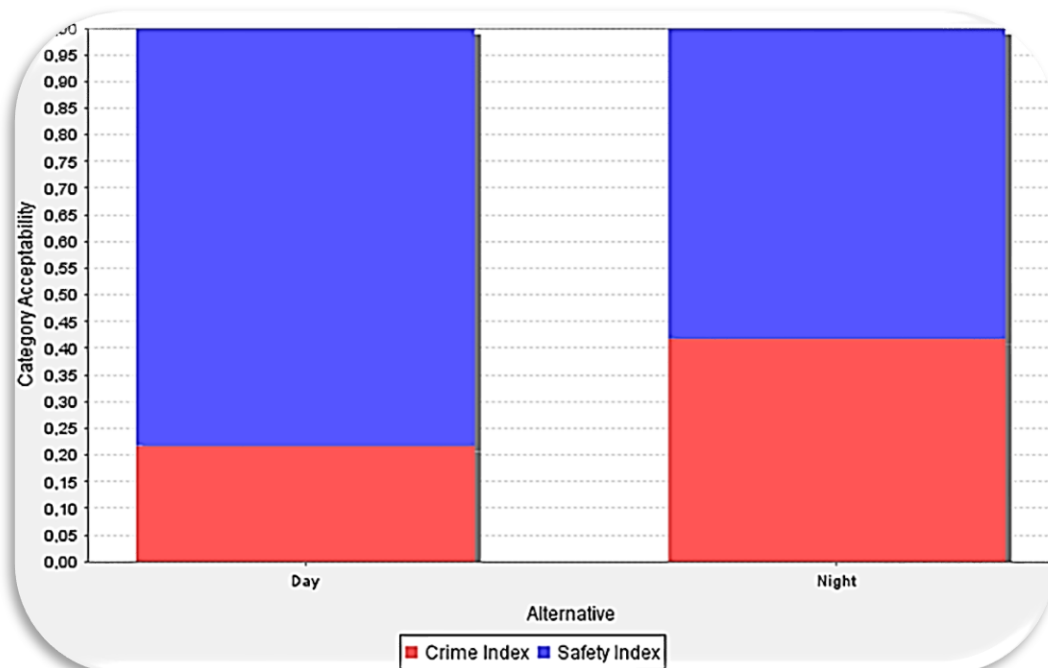


Figure 5. Graphical Display of Category Acceptability Indexes

Category acceptability indexes indicate how well an alternative match that category. Due to the model in the study having two categories, the alternatives will be a member of the group that is most likely.

Under these conditions, the value of category acceptability for daylight hours safety index is 0,78. This value indicates that there is a 78% probability of safety in Turkey during daylight hours without being a victim of any crime. Also, category acceptability indexes value of safety index for night hours is 0,58. This value indicates that there is a 58% perception of safety in Turkey without being a victim of any crime at night. From the reverse perspective, category acceptability index value of crime index for daylight hours is 0.22. This value indicates that there is a 22% perception of crime in Turkey during the daytime that one can be a victim of any crime. The category acceptability index value of crime index for night hours is 0.42. This value indicates that there is a 42% perception of crime in Turkey that one can be a victim of any crime at night.

Crime and safety indexes for Turkey are also investigated in the analyzes made by Numbeo for many years with online surveys. Turkey's general safety index value was measured as 60.45% and crime index as 39.55% as a result of the survey with 2115 people as of November 2021 by Numbeo. The safety index was measured as 75.88% during the daytime hours and 51.11% during the night hours. In this research, Turkey's general safety index value was measured as 68%, crime index as 32%, security index as 78% during daytime hours and 58% during night hours by taking the average of the confidence and crime indexes measured for daytime and nighttime hours. According to the results, a difference of about 3% to 7% was determined in the same direction and the measured values are parallel to each other. The comparative representation of the obtained results is presented in Figure 6.

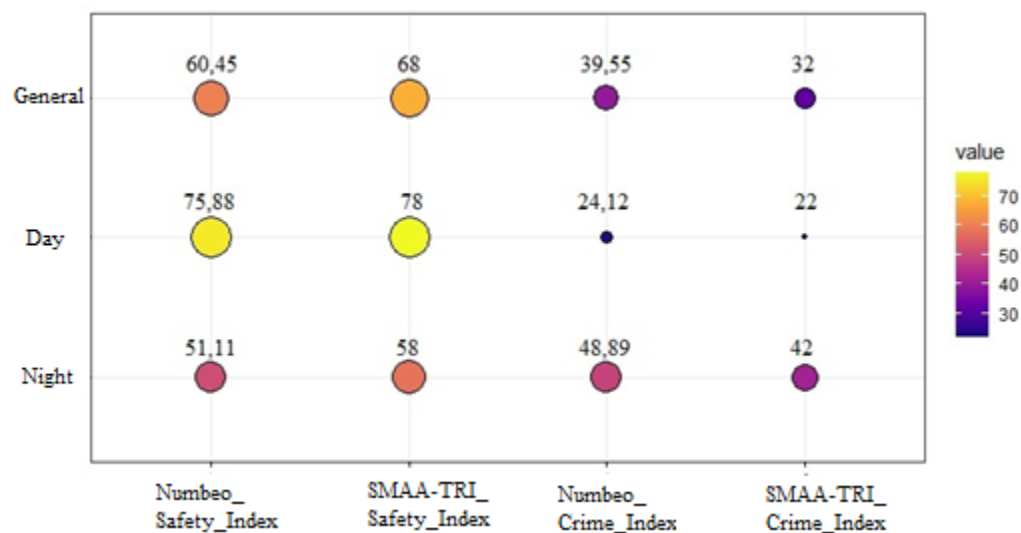


Figure 6. Comparative Representation of The Obtained Results

The safety and crime index values obtained with the SMAA-TRI model is parallel with the measurement results conducted with thousands of people and there are small differences between them. In many studies, the data collected through classical surveys are presented as percentages without any quantitative analysis. Instead, as a result of the study, it has been determined that the SMAA-TRI method, which can be measured even with incomplete and imprecise values and can be used for intermittent data entry, can be used effectively as a powerful tool.

5. CONCLUSION

The increase in the world population has brought about an in-depth investigation of not only the fundamental issues such as economy, health and law, but also the sub-titles affecting these basic issues in order to provide a more livable society to the citizens of the countries. One of the most important fundamental issues is safety. It can be said that the studies that reveal the understanding of safety in the society are mostly obtained by deduction from the situation of in safety. Therefore, countries are working on the crime data that occurs in the society and which creates an in safety. It was seen that both the crimes (murder, theft, verbal-actual harassment, internet, etc.) and the situations that caused the crime (alcohol, substance addiction, etc.) were categorized in the studies. The crime rates analyzed under various headlines

in a region can be revealed with these data. As a result of the surveys conducted with the people living in this region, crime and safety indexes are measured. The results obtained from these indexes not only directly affect the studies related to safety, but also guide the decision makers in some of the most important areas such as education, health, tourism and economy.

While decisions and preferences can be expressed clearly in private sector companies or in daily tactical level decision problems, it is more difficult for governors to make decisions for public related problems where the results will have direct impact on the society. The SMAA method is also a technique developed for such difficult decision problems. This method, does not present the optimal solution but gives a ranking to the alternatives for the decision makers to chose from. The final decision is taken by the decision maker.

In this study, in order to measure crime and safety indexes, a stochastic tool that can be used instead of questionnaires has been proposed and SMAA-TRI method has been utilized. As a result of the study, Turkey's general safety index value has been determined as 68%, while the day and night safety indexes are %32 and %78, respectively. The crime index value has been calculated as 32%, and it has been conducted that the SMAA-TRI method can be used effectively as a tool for measuring the crime and safety indexes. When considering the difficulties of conducting a survey, such as taking a long time, determining the sample size, and the difficulty of applying it in many different cities; it has been evaluated that similar results can be obtained more easily and accurately by using the proposed method. It has also been considered that processing the data, collected from experts, analytically will give more realistic and accurate results when compared to evaluations from questionnaires.

For future studies: (i) A comparative analysis can be handled by using different quantitative analysis methods and comparing the measurement results to the SMAA-TRI method proposed in this study. (ii) The study has been devoted to the scale questions of Numbeo, which has been actively used for many years to measure safety and crime indexes in order to make comparisons. Reliability and validity can be investigated by suggesting different scales and scale questions in order to measure comprehensive indexes such as safety and crime. (iii) Citizens can be asked questions instead of the expert assessments used for measurement in this study. (iv) Long-term negative experiences about crime may cause tendentiousness in perceptions. In order to evaluate this level of tendentiousness in the analysis, the statistical information of the participants can be included in the evaluation simultaneously.

CONFLICTS OF INTEREST

No conflict of interest was declared by the authors.

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