

## Social Vulnerability Measurement Tool

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### ABSTRACT

The construct of the Social Vulnerability measuring instrument aims to measure the domain of social weakness or threats in an area. The danger of vulnerability measured is related to three leading indicators, social identity causing social marginality, economic problems caused by extreme events, and monetary property conditions. The SV measuring instrument consists of 11 statement items (SOV11) divided into three sub-dimensions, namely Demographic Characteristics (DC) three statements, Socio-Economic Status (SES) five view and Public Resources Provision (PRP) three opinions with a total measuring instrument is eleven points positive statement. Based on trials on 94 residents of the Koja area, North Jakarta, the reliability coefficient value was 0.848. From the results obtained, this social vulnerability measurement tool (SOV11) can be used to examine the population living in urban coastal areas, especially the city of North Jakarta. This measuring tool was developed from the social vulnerability theory of Fatemi, Ardalan, Aguirre, Mansouri, & Mohammadfam [13].

**Keywords:** coastal, communities, social, urban, vulnerability



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## 1. Introduction

Social vulnerability has become a crucial concept in disaster studies and urban development research because it explains why certain communities are disproportionately affected by environmental and socio-economic disturbances. Communities with limited access to economic, physical, and psychological resources tend to experience greater difficulty in coping with external shocks, which may eventually lead to prolonged poverty and structural inequality [1]. Vulnerability is not merely exposure to hazards; rather, it reflects the susceptibility of a social or natural system to potential damage resulting from environmental change [2]. Therefore, assessing vulnerability levels within a region is essential for decision-makers seeking to design appropriate disaster risk reduction and resilience strategies.

The vulnerability of a community is shaped by intertwined social, economic, and environmental factors [3]. When disturbances exceed a system's adaptive threshold, the resulting imbalance increases the risk of adverse outcomes. In conceptual terms, vulnerability can be interpreted as a function of exposure and sensitivity that influences the capacity to respond to threats [4]. Previous studies highlight several determinants of social vulnerability, including limited access to information and technology, restricted political representation, weak social capital, cultural norms, deteriorating housing conditions, demographic fragility, and inadequate

infrastructure [5][6]. These elements interact dynamically and determine how effectively individuals and communities anticipate, manage, and recover from crisis situations.

Earlier frameworks have attempted to quantify population vulnerability by integrating demographic, social, economic, and environmental indicators through grading and weighting systems [7][8]. Such approaches have been widely used to map vulnerable regions and inform planning processes [9]. However, standardized vulnerability indices often require contextual adaptation, especially in densely populated coastal cities like Jakarta, where environmental risks are compounded by urban density, economic disparities, and infrastructural challenges. In these settings, vulnerability is closely linked to the quality of human resources, socioeconomic characteristics, and demographic composition, as well as the strength of social networks within communities [9]. Developing a localized measurement instrument is therefore necessary to capture context-specific vulnerability patterns and to support evidence-based policymaking.

Social vulnerability can be defined as an internal characteristic of individuals or systems that determines their propensity to suffer damage when exposed to hazards [10][11]. It encompasses physical, economic, political, and social dimensions that influence the degree of harm experienced during natural or human-induced disasters. Structural inequalities such as poverty, marginalization, occupational instability, ethnic minority status, and social exclusion further intensify vulnerability, particularly in urban environments [12]. Certain groups—including low-income households, marginalized ethnic communities, and residents of hazard-prone settlements—often face disproportionate impacts during disasters [13].

From a broader perspective, vulnerability describes the capacity of individuals or groups to anticipate, cope with, withstand, and recover from hazard-related impacts [14]. Social determinants play a central role in shaping this capacity. Limited access to information, social services, political participation, and economic capital increases susceptibility, while poor housing conditions and dense living environments may exacerbate disaster impacts [15][16][17]. Moreover, vulnerability operates across multiple levels: at the household level (personal attributes and resources), the community level (social interaction and support networks), the geographic level (spatial accessibility to essential services), and the institutional level (governance and disaster mitigation mechanisms) [18]. A comprehensive assessment model should therefore consider these interconnected dimensions.

The present study develops a Social Vulnerability Measurement Tool adapted from established hazard and vulnerability theories [14]. While earlier models identified five domains—gender, demographic attributes, socioeconomic status, public resources, and disability [19]—this research concentrates on three principal constructs considered most relevant to the coastal urban context: demographic characteristics, socioeconomic status, and public resource provision. This refinement is supported by previous theoretical discussions emphasizing the significance of demographic composition, economic stability, and environmental infrastructure in shaping vulnerability outcomes [7][15][16][17].

Demographic characteristics encompass social identity elements such as age, ethnicity, minority status, and cultural norms, all of which influence exposure and adaptive capacity [19][20]. In disaster contexts, belief systems and social cohesion may also shape coping strategies and recovery processes [21]. Socioeconomic status refers to income security, employment stability, and ownership of material assets, which directly determine economic resilience. Prolonged unemployment and income instability may push households closer to the poverty threshold, increasing their susceptibility to crisis impacts. Public resource provision includes access to healthcare facilities, sanitation systems, transportation, education, and emergency services. Adequate healthcare accessibility reduces health-related vulnerability [22], while deficiencies in infrastructure and public services are frequently associated with lower socioeconomic conditions and increased disaster risk [23].

By integrating these three dimensions into a concise and empirically tested instrument, this study seeks to provide a valid and reliable tool for measuring social vulnerability in urban coastal communities. The development of such a context-sensitive measurement model contributes to improved vulnerability mapping and supports targeted policy interventions aimed at strengthening resilience in North Jakarta.

## 2. Method

This study applied a quantitative research design aimed at developing and validating the Social Vulnerability Measurement Tool (SOV11). The instrument was constructed as a self-report personal inventory administered to adult respondents aged above 20 years to ensure sufficient social and economic maturity in evaluating vulnerability conditions. A total of 94 respondents residing in the Greater Jakarta area participated in the study. Participants were classified into two categories based on predefined socioeconomic criteria: a high-vulnerability group and a low-vulnerability group. The high-vulnerability group consisted of 35 residents from the coastal area of Koja, North Jakarta, characterized by economic instability indicators. The low-vulnerability group comprised 59 respondents whose monthly income exceeded the Jakarta Provincial Minimum Wage (Rp. 4,416,186) and who were employed in relatively stable occupations.

The gender composition of respondents is presented in Table 1. The high-vulnerability group included 15 men (42.9%) and 20 women (57.1%), while the low-vulnerability group consisted of 22 men (37.3%) and 37 women (62.7%). Overall, the sample was composed of 39.4% male and 60.6% female participants. Employment characteristics, summarized in Table 2, indicate that 42.9% of individuals in the high-vulnerability group worked as casual laborers without permanent contracts, reflecting job insecurity. In contrast, respondents in the low-vulnerability group were primarily private office employees (72.9%) and government officers (16.9%), suggesting greater occupational stability. Income distribution is shown in Table 3. All respondents in the high-vulnerability category reported earnings below the provincial minimum wage, with 74% earning less than Rp. 1.5 million per month. Conversely, 89.8% of respondents in the low-vulnerability group earned above Rp. 4.3 million. Housing status further differentiated the two groups, as presented in Table 4. Only 2.9% of high-vulnerability respondents owned their homes, while 60% resided in parent-owned houses and 31.4% rented. In comparison, 47.5% of respondents in the low-vulnerability group reported home ownership. These socioeconomic indicators supported the categorization of vulnerability levels used in the study.

**Table 1.** Participant gender data overview.

Participants		Man	Woman
High vulnerability	N=35	15 Org (42.9%)	20 Org (57.1%)
Low vulnerability	N=59	22 Org (37.3%)	37 Org (62.7%)
Total	N= 94		

**Table 2.** Participant job status data overview

Participants		Privt Offc	Gov Offc	Laborer	Trader	Professional
High vulnerability	N=35	25.7 %	NA	42.9 %	28.6 %	2.9 %
Low vulnerability	N=59	72.9 %	16.9 %	NA	10.2 %	NA
Total	N= 94					

**Table 3.** Participant income data overview

Participants		Rp. <1.5jt	<Rp3jt	<Rp.4.3jt	>Rp.4.3jt
High vulnerability	N=35	74 %	25 %	NA	NA
Low vulnerability	N=59	NA	1.7 %	8.5 %	89.8%
Total	N= 94	100 %			

**Table 4.** Overview of participants' residence status

Participants		Owner	Family-owned	Parent Owned	Rent
High vulnerability	N=35	2.9 %	5.7 %	60 %	31.4 %
Low vulnerability	N=59	47.5 %	16.9 %	27.1 %	8.5 %
Total	N= 94	100 %			

The Social Vulnerability Measurement Tool was developed based on established theoretical frameworks of social vulnerability [14][19]. The initial instrument consisted of 30 items distributed across three theoretical constructs: demographic characteristics, socioeconomic status, and public resource provision. Items were designed to capture indicators such as income instability, employment insecurity, social marginalization, housing conditions, and access to public infrastructure. The instrument employed a four-point Likert scale ranging from 1 (Strongly Disagree) to 4 (Strongly Agree). Both favorable and unfavorable statements were initially included, and reverse scoring procedures were applied where appropriate in accordance with standard psychometric principles [25][26]. Following data collection, item-total correlation analysis was conducted to evaluate item performance. Items that did not meet acceptable correlation thresholds were removed, resulting in a final validated instrument consisting of 11 positive statements (SOV11), divided into three dimensions: Demographic Characteristics (3 items), Socioeconomic Status (5 items), and Public Resource Provision (3 items).

The research process began with problem identification and a comprehensive review of literature concerning social vulnerability in densely populated urban environments. Variables were operationalized based on established theoretical constructs [14][19]. Sampling was conducted using a combination of snowball and purposive techniques [24], beginning with community contacts in North Jakarta and extending to participants who met the predefined criteria. Prior to completing the questionnaire, respondents were informed about the purpose of the study and provided consent to participate. The questionnaire was administered in paper format, and participants were given approximately one to two hours to complete the instrument.

Data analysis was performed using JASP statistical software (Version 0.14.1) [24]. The analytical procedure included descriptive statistical analysis to summarize participant characteristics, item analysis to assess internal consistency, Exploratory Factor Analysis (EFA) to examine underlying factor structures, and Confirmatory Factor Analysis (CFA) to evaluate model fit. Reliability was assessed using Cronbach's alpha and McDonald's omega coefficients, while construct validity was evaluated through factor loadings and goodness-of-fit indices, following established psychometric standards [25][26].

### 3. Result and Discussion

The psychometric evaluation of the Social Vulnerability Measurement Tool (SOV11) was conducted through a series of statistical analyses, including normality testing, reliability assessment, and confirmatory factor analysis (CFA). The objective was to determine whether the instrument demonstrates acceptable validity and reliability for measuring social vulnerability in urban coastal communities, consistent with theoretical constructs proposed in previous studies [13][14]. Data normality was examined using the Shapiro–Wilk test. The results for each dimension—Demographic Characteristics (TotDemoChart), Socioeconomic Status (TotSocEco), and Public Resource Provision (TotPubReso)—are presented in Table 5. The Shapiro–Wilk statistics indicate p-values of 0.002, 0.010, and <0.001 respectively. Since these values are below the 0.05 threshold, the assumption of normal distribution is not fully supported for the three dimensions. However, considering the relatively moderate skewness values (0.201, -0.358, and 0.054), the distribution can be considered acceptable for CFA analysis with robust estimation methods.

**Table 5.** Overview of normality of social vulnerability variables

	<i>TotDemoChart</i>	<i>TotSocEco</i>	<i>TotPubReso</i>
Valid	94	94	94
Skewness	0.201	-0.358	0.054
Shapiro-Wilk	0.954	0.963	0.948
P-value of Shapiro-Wilk	0.002	0.010	< .001

The overall Shapiro–Wilk statistic for the 11-item instrument yielded a value of 0.989 with a p-value of 0.633, suggesting that the aggregate score approximates normal distribution. The total sample (N = 94) produced a standard deviation of 5.523, indicating moderate dispersion of responses around the mean. These findings suggest that the data structure is suitable for further factor analysis. Internal consistency reliability was evaluated using both Cronbach’s alpha and McDonald’s omega coefficients, in accordance with psychometric standards [26]. For the high-vulnerability group, McDonald’s omega was 0.711, indicating acceptable reliability. In contrast, the low-vulnerability group produced an omega coefficient of 0.419, suggesting weaker internal consistency within that subgroup. This difference may reflect variation in perceived vulnerability exposure, as individuals directly experiencing socioeconomic marginalization may respond more consistently to vulnerability-related items, consistent with prior discussions on marginalization and risk perception [12], [16], [17].

The overall reliability coefficient for the final 11-item instrument was 0.848, indicating strong internal consistency. As shown in Table 6, item-rest correlation values ranged from 0.232 to 0.753. Although Item 1 demonstrated a lower correlation (0.232), the majority of items exceeded the recommended threshold of 0.30, supporting their contribution to the construct. Reliability, defined as the consistency of scores obtained across similar measurement conditions [26], is therefore considered satisfactory for the SOV11 instrument.

**Table 6.** CFA social vulnerability fit index results

<b>Item</b>	<b>Cronbach's <math>\alpha</math></b>	<b>Item-rest correlation</b>
Item 1	0.855	0.232
Item 3	0.845	0.382
Item 11	0.840	0.476
Item 14	0.830	0.595
Item 15	0.828	0.612
Item 16	0.826	0.640
Item 17	0.827	0.629
Item 18	0.817	0.753
Item 28	0.822	0.673
Item 29	0.846	0.392
Item 30	0.843	0.426

Initially, the instrument consisted of 30 items, including both favorable and unfavorable statements scored using a four-point Likert scale. Reverse scoring procedures were applied in accordance with standard measurement guidelines [25]. Following item analysis and reliability testing, 19 items were removed due to insufficient psychometric performance, resulting in 11 positive items retained for the final model. The retained items and their dimensional classification are described in Table 7, which outlines the three factors: Demographic Characteristics (3 items), Socioeconomic Status (5 items), and Public Resource Provision (3 items).

**Table 7.** Description of statements of social vulnerability measurement tool (sov)

Kode konstruk	Dimensi	+/-	Pernyataan
SOV 1	DC.1	+	Tetangga sekitar saya cuek ketika saya sedang susah.
SOV 2	DC.3	+	Pergaulan dilingkungan saya berdasarkan suku
SOV 3	DC.11	+	Tenaga saya terbatas
SOV 4	SE.14	+	Di masa pandemi ini, pekerjaan saya rawan PHK.
SOV 5	SE.15	+	Penghasilan saya semakin tidak menentu di masa pandemi.
SOV 6	SE.16	+	Kondisi pandemi membuat saya bermasalah dalam kehidupan keluarga
SOV 7	SE.17	+	Saya khawatir dengan kondisi ekonomi saya di masa pandemi yang terjadi.
SOV 8	SE.18	+	Saya cemas dengan kondisi keuangan saya
SOV 9	PR.28	+	Saya terganggu dengan bau got yang ada dilingkungan
SOV 10	PR.29	+	Saya khawatir banjir datang ketika musim hujan
SOV 11	PR.30	+	Saya cemas jika terjadi kebakaran

Description: DC= Demographic characteristics, SE=Socio-economic status, PR= Public resource provision.

Confirmatory Factor Analysis was conducted to evaluate the structural validity of the three-factor model derived from theoretical foundations of social vulnerability [13], [14]. The model comparison results are shown in Table 8. The baseline model produced  $\chi^2 = 459.212$  (df = 55), whereas the proposed factor model yielded  $\chi^2 = 47.192$  (df = 39) with  $p = 0.173$ . Because the p-value exceeds 0.05, there is no significant difference between the observed covariance matrix and the hypothesized model, indicating acceptable model fit. Further model fit indices are presented in Table 9. The Comparative Fit Index (CFI) of 0.980 and Tucker–Lewis Index (TLI) of 0.971 both exceed the recommended threshold of 0.90, indicating excellent model fit. Additional indices, including the Incremental Fit Index (IFI = 0.981) and Relative Noncentrality Index (RNI = 0.980), further confirm structural adequacy.

**Table 8.** CFA social vulnerability fit index results

Model	X <sup>2</sup>	df	p
Baseline model	459.212	55	
Factor model	47.192	39	0.173

**Table 9.** CFA social vulnerability fit index results

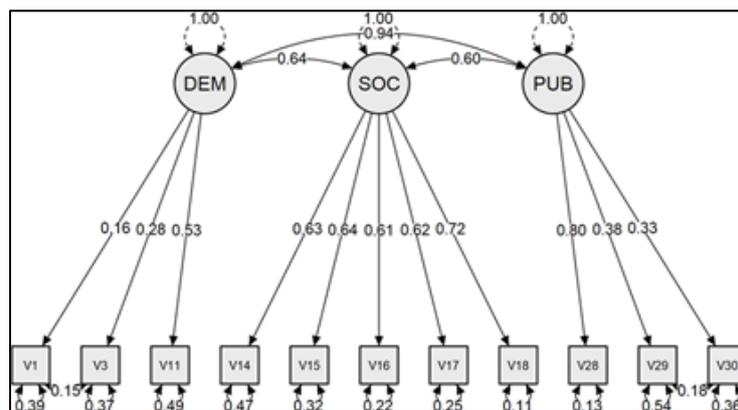
Index	Value
Comparative Fit Index (CFI)	0.980
Tucker-Lewis Index (TLI)	0.971
Bentler-Bonett Non-normed Fit Index (NNFI)	0.971
Bentler-Bonett Normed Fit Index (NFI)	0.897
Parsimony Normed Fit Index (PNFI)	0.636
Bollen's Relative Fit Index (RFI)	0.855
Bollen's Incremental Fit Index (IFI)	0.981
Relative Noncentrality Index (RNI)	0.980

Other goodness-of-fit measures are summarized in Table 10. The Root Mean Square Error of Approximation (RMSEA) value of 0.047 falls below the acceptable cutoff of 0.08, suggesting close model fit. The Standardized Root Mean Square Residual (SRMR = 0.061) also meets recommended standards. The Goodness of Fit Index (GFI = 0.921) and McDonald Fit Index (MFI = 0.957) both indicate strong model performance. Collectively, these results support the three-dimensional structure of the SOV11 instrument.

**Table 10.** Other fit measures

Metric	Value
Root mean square error of approximation (RMSEA)	0.047
RMSEA 90% CI lower bound	0.000
RMSEA 90% CI upper bound	0.090
RMSEA p-value	0.508
Standardized root mean square residual (SRMR)	0.061
Hoelter's critical N ( $\alpha = .05$ )	109.701
Hoelter's critical N ( $\alpha = .01$ )	125.349
Goodness of fit index (GFI)	0.921
McDonald fit index (MFI)	0.957
Expected cross validation index (ECVI)	1.077

The structural model is visually represented in Figure 1, illustrating the relationship between observed variables and latent constructs. The CFA results confirm that demographic characteristics, socioeconomic status, and public resource provision are empirically distinguishable yet interrelated components of social vulnerability, consistent with theoretical frameworks proposed in previous research [13], [14]. The findings demonstrate that the SOV11 instrument exhibits satisfactory reliability and structural validity for assessing social vulnerability in an urban coastal context. The three-factor structure aligns with established theoretical models that conceptualize vulnerability as a multidimensional construct influenced by demographic composition, economic stability, and access to public resources [14], [19].



**Figure 1.** Model Fit that make up the social vulnerability measurement tool

The relatively higher reliability observed in the high-vulnerability group may reflect stronger experiential coherence among respondents who directly encounter socioeconomic instability. Prior literature suggests that marginalized populations often exhibit heightened awareness of vulnerability-related conditions [12], [16]. This may explain the stronger internal consistency within that subgroup.

The CFA results provide empirical support for simplifying broader vulnerability frameworks into three core dimensions without compromising structural validity. While previous models have included additional

domains such as gender and disability [19], the present findings indicate that demographic attributes, socioeconomic conditions, and public resource provision capture essential aspects of vulnerability within the North Jakarta context. Future research should consider expanding sample size and testing measurement invariance across diverse demographic groups to enhance generalizability. Further cross-regional validation would also strengthen the applicability of the SOV11 instrument beyond the study location.

#### 4. Conclusion

This study developed and validated the Social Vulnerability Measurement Tool (SOV11) to assess vulnerability conditions in urban coastal communities. Based on the results of reliability testing and Confirmatory Factor Analysis (CFA), the instrument demonstrates satisfactory psychometric properties. The overall internal consistency coefficient ( $\alpha = 0.848$ ) indicates strong reliability, while the model fit indices (CFI = 0.980; TLI = 0.971; RMSEA = 0.047) confirm that the three-factor structure is statistically acceptable and theoretically consistent. The final instrument consists of 11 items distributed across three dimensions: Demographic Characteristics (3 items), Socioeconomic Status (5 items), and Public Resource Provision (3 items). These dimensions reflect core components of social vulnerability theory as proposed by Cutter et al. [14] and further elaborated by Fatemi et al. [13]. The empirical findings support the conceptual framework that vulnerability in urban coastal environments is shaped by demographic marginality, economic instability, and limitations in access to public infrastructure and services. The SOV11 instrument provides a concise and context-sensitive tool for measuring social vulnerability in densely populated urban areas, particularly in North Jakarta. Its application may assist policymakers and local governments in identifying vulnerable groups and designing targeted resilience strategies. However, future research is recommended to expand the sample size, examine measurement invariance across demographic groups, and test the instrument in different geographic contexts to enhance generalizability.

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#### 6. Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper. The research was conducted independently without any commercial or financial relationships that could be construed as a potential conflict of interest.

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