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RESEARCH ARTICLE

A Static Machine Learning Based Evaluation Method for Usability and Security Analysis in E-Commerce Website

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ABSTRACT Measurement of e-commerce usability based on static quantities variable is state-of-the-art because of the adoption of sequential tracing of the next phase in the categorical data. The global COVID-19 outbreak has completely disrupted society and drastically altered daily life. The concept refers to an electronic commerce network that appears with thorough, understandable conviction, demand, and rapid confirmation as a replacement for the economical market's ''brick-and-mortar'' model, which replaces how we do everything, including business strategy, and provides a better understanding with the interpretation of e-commerce features. This study was supervised to analyze usability assessments using statistical methods and security assessments using online e-commerce security scanner tools to investigate e-business standards that consider the caliber of e-services in e-commerce websites across Asian nations. The method was developed to optimize complex systems based on multiple criteria. The initial (supplied) weights are used to determine the compromise ranking list and compromise solution. This paper examines the usability of e-commerce in rural areas using a new data set from the Jharkhand region. On the e-commerce websites of Jharkhand, India, usability is commonly considered in conjunction with learnability, memorability, effectiveness, engagement, efficiency, and completeness. Using a user-oriented questionnaire testing method, this survey attempts to close the gaps mentioned above. Then, across each column, divide each value by the column-wise sum that is created using their corresponding value, whichever produces a new matrix B. Finally, determine the row-wise sum of matrix B representing the (3×1) matrix. Using model trees and bagging, this study addresses classification-related issues. This regression technique is useful for problems involving classification. The model is trained using secondary data from the MBTI 16 personality factors affecting personality category.

INDEX TERMS Machine learning, usability, security, E-commerce, data analysis, statistics.

I. INTRODUCTION

E-commerce is the use of the Internet and computer network infrastructure to perform tasks such as selling and acquiring products, transferring and exchanging services, and sharing information. E-business has grown at a rapid pace since 1994 [1], [2]. All traditional commercial enterprises are expected to be converted to e-commerce by 2050 [3]. Although numerous studies on e-commerce websites concerning usability and security have been conducted over the

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last few decades, there is still a need for further evaluation of their qualities and aspects. Currently, the coronavirus known as SARS-CoV-2 is spreading throughout India. The virus's increasing outbreak significantly impacts purchasers' purchasing decisions. Consumer concern during a COVID-19-induced pandemic, it was claimed, has increased people's interest in online business via e-commerce websites [4]. During the COVID-19 pandemic age, businesses and services provided by e-commerce websites significantly impacted profitability and have also empowered optimistic dominance on imperishable spending. Customers want things instantly in today's digital world, where they are always in a hurry and have abundant options. Modern websites offer more lucrative features to such customers than ever before [5]. Many e-commerce websites struggle to maintain high performance across multiple devices and networks. Users, on the other hand, are more impatient and less patient. Slow websites turn off many customers, causing them dissatisfaction [6]. The user's experience on the website varies from one user to the next, and it plays a vital role in the success of an e-commerce site. Even minor delays irritate customers. At the same time, researchers recommend that the page load and downloading time parameters, which contribute to performance, be included in the usability components [7]. The International Standards Organization (ISO) defines usability as ''the effectiveness, efficiency, and satisfaction with which specified users achieve specified goals in particular environments''. Website usability is defined as the degree of simplification and intuition with which an individual user learns to use a specific website and interacts with it to complete a specific task [8], [9].

The VIKOR method uses multi-criteria decision-making, also known as multi-criteria decision analysis (MCDA). Serafim Opricovic created it to resolve decisions involving conflicting and incomparable (different units) criteria, assuming that the decision-maker wants the best possible result, that compromise is acceptable for resolving conflicts, and that the alternatives are evaluated using all established standards. VIKOR ranks the alternatives to determine which compromise is closest to the ideal [4]. The Analytic Hierarchy Process combines math and psychology to organize and analyze difficult decisions (AHP). It has been improved since Thomas L. Saaty's original design in the 1970s. This includes the primary goal or issue you're attempting to resolve, all viable solutions or alternatives, and the criteria you'll use to evaluate the options. AHP develops a logical framework for a difficult decision by outlining its standards and potential outcomes and connecting those components to the overall goal [5], [6], [7], [8]. TOPSIS (The Technique for Order of Preference by Similarity to the Ideal Solution) is used to compare a set of alternatives. It also normalizes scores for each criterion and calculates the geometric distance between each alternative and the ideal alternative, with the highest score in each criterion. Many people have used the TOPSIS method to solve decision-making problems. This method is based on a comparison of all possible solutions to the problem [10], [11].

The design of human-computer interaction influences usability [10]. This intelligent interface makes it easier to use the programmed than a 'clumsy' interface that requires some guesswork on the user's part [11], [12], [13]. Usability is essential in determining e-commerce website success because it allows users to complete tasks correctly and pleasantly [14], [15].

Secure e-business is a component of the Secured information framework that exclusively registers as a constituent that influences data security, privacy, and another expansive province of the Information Security framework [16]. This industry provides numerous opportunities while increasing awareness of new risks and vulnerabilities, such as security threats and hacking [17]. Consistent technological and commercial progress necessitates a coordinated match with the algorithm and its technical solutions [18]. e-commerce websites play an essential role in the overall growth of the e-commerce business world. Usability indicates and demonstrates whether an e-commerce website is effective, efficient, and simple to use in the eyes of the users. There is a challenge for e-commerce website security, mainly when it requires sensitive data from customers on an e-commerce website, preventing fraud and financial scams and protecting the e-commerce website's prominence.

The objective related to this research work is as follows:

1. Identify the attributes and sub-attributes that are used to assess the usability of e-commerce websites
2. The usability estimation of e-commerce websites by using three MCDM methods used for this research work AHP, VIKOR, and TOPSIS to analyze the usability with its attributes and sub-attributes on three e-commerce websites in Jharkhand, India (www.smplazza.com, www.opsmart.in/store, and www.helloshoppee.com/Jharkhand).
3. A comparison of the rank of the e-commerce websites across the three models
4. Examine the different security elements like privacy, integrity, and safety on the e-commerce websites of Jharkhand, India (www.smplazza.com, www.opsmart.in/store, and www.helloshoppee.com/Jharkhand). By using the free website malware and security scanner tools, like SUCURI, Qualys, Immuniweb, Webpagetest, and Dareboost.

A. PROBLEM STATEMENT

To succeed on the Internet, usability is a necessity. Websites that are hard to use are abandoned. People leave if a company's homepage doesn't make it obvious what it offers and what users can do on the website. If a user gets lost on a website, they will stop using it. Thus, Users-centered designers may create usable products by keeping in mind the five usability traits: effective, efficient, engaging, fault-tolerant, and easy to learn.

B. NOVEL SCIENTIFIC CONTRIBUTION

Every day, a large number of e-commerce sites are launched by numerous people. Websites for e-commerce are used to

conduct business, and to conduct business, and they must benefit the customer. So, an e-commerce website needs to win the trust of its users. To put it another way, it is essential to conduct business with a reputable e-commerce site. This article offers recommendations on how to boost trust to improve a website's usability, as well as a study on the usability of websites. Here is a list of the various factors that affect the caliber of an e-commerce site. These variables are used in Matlab to assess an e-commerce site's reliability. This research will examine his psychology to better comprehend it, translate it into a statistical format, and determine whether there is an appropriate technology framework for analyzing his purchase behavior [2], [3], [4]. Understanding topics like these may help businesses and organizations enhance their marketing efforts.

I. Consumer psychology refers to how a consumer feels, thinks, and decides.
II. How does a client feel their environment influences them?
III. Purchases and other marketing-related decisions made by consumers.
IV. How can management tweak their marketing strategies and plans to reach consumers more effectively?

C. RESEARCH GAP FULFILLED WITH CURRENT RESEARCH

The study recommended particular web metrics that are helpful for quickly identifying both specific pages on an e-commerce site with usability issues and general usability problem areas. In-depth information about specific issues that might be present on a page, however, is something they are unable to do. Usability and security are being given more and more importance in modern computer software design. But numerous combinatorial approaches have been used in studies on these subjects. This relationship still has room for improvement in terms of adequately incorporating these features in software applications. In this essay, we suggest a rule to discuss potential compromises between usability and security during the software development process.

- The tradeoff between usability and security can be resolved by A lot of work that has been done almost everywhere in the areas of usability and security. There are several broad categories, including the usability of network interfaces, handheld devices, application interfaces, web interfaces, and other interactive hardware-based interfaces. If we look at all these recognized classes in their respective domains, we can see that certain specific issues have been discussed in their respective spheres of influence. Usability and security don't fundamentally conflict with one another. On the other hand, a more usable system reduces confusion and is more likely to be secure. A more secure system is more reliable, controllable, and thus more usable. Both security and usability concerns want the computer to carry out the user's requested tasks correctly. No fundamental conflict exists between usability and security. But a system that is easier to use will be less confusing and more secure. Being more secure makes a system more dependable, controllable, and thus more useful. The computer must correctly perform the user's requested tasks for the sake of both security and usability concerns.
- The effective and easily understood AHP (Analytic Hierarchy Process) method can combine objective and subjective factors in the decision-making process that is frequently employed to resolve complex problems. This strategy is appropriate for decision-makers who want to avoid risk-related decision-making procedures. VIKOR When the criteria conflict, this method is used to choose between alternatives while putting the focus on sorting the alternatives. The VIKOR method's primary element is the closeness of the ideal solution.
- This research uses three websites for analysis because People will visit another website if they don't like the first one they visit because there are so many similar websites to choose from. Also, three different websites give different variables of statistics data.

D. ORGANIZATION OF PAPER

This research article is formulated as mentioned: Section II considers the transient reviewed literature about the taxonomy of usability and security assessment methodologies and the strengths and weaknesses of various e-commerce strategies. The research work's aims are described in Section III. The sketch of the various methodologies used for evaluating both usability and security is expanded in Section IV. Section V shows the results and findings from several MCDM models used to test usability based on the questionnaire and the security of e-commerce websites using various online website security scanner tools. The thoughts and suggestions for the suggested model based on the results are presented in Section 6. The study piece ends with Section 7.

II. LITERATURE REVIEW

The sites connected with internet business continuously make trials to fulfill clients' fundamental needs and additionally update and attempt to roll out such improvements that assist them with making new clients [19]. The policyholders [20] of web-based business sites are attempting to find a methodology that helps them standpoint their websites. This system adds security and ease of use factors, too. For upgrading the convenience of online business sites, they tend toward the clients' thoughts all the more these days. The clients' inclination assists them with glimpsing inside the reasoning of clients in a combinational manner, like their demeanor and feelings towards the connection point and practical plan of online business sites [21], [22]. These impacts influence clients' choices and behavior towards web-based business sites. On the off chance that the web-based business site considers the client's inclination towards their site, then, at that point, there is a lot more prominent possibility that they work on their fulfillment and make clients much more steadfast towards themselves. One more method for prevailing upon clients is to give or guarantee that their information

is protected and that they didn't use it for any off-base reason. They also protect their information from information robbery, deception, or spillage. They do this by giving different safety efforts and continually changing the IT online market. These variables increase the number of online business clients overall [23]. To deal with this developing trade and client numbers, any organization needs appropriate administration to accomplish the work successfully and productively. The research was done earlier, examining the convenience and security of the Technology Acceptance Model (TAM) on online business sites. Many scientists have adopted a comprehensive probability (TAM) exploration model for convenience and security highlights in web-based business sites [24] [25]. Hat measures and afterward explores the handiness and ease of use of a connection point.

It observes that security and usability concerns deter users from using e-commerce websites. Consequently, only 42% of users transform their online exploration into shopping. Users understand that the principle underlying the design and implementation of an e-commerce website is to implement usability and security parameters systematically. To grasp the advantages of usability, including its attributes like efficiency, effectiveness, fulfillment, memorability, etc., for achieving the target, and security, which explores privacy, integrity, and safety. Ratnasarim et al. [26] provided one way to exclaim the e-satisfaction methodology; the goal of developing this model is to determine the contentment of customers of e-commerce websites. The model evaluates the impact of information on a product; the ease of products, services, and websites; the financial aspects and security of users; product marketing and the offer that comes with it; and the website's interface for user happiness. They discovered that the ease of the product, service, and other factors, as well as the security of the financial components, have the most significant impact on consumer happiness. These two components impact the other three elements.

Ehikioya and Guillemot [27] attempt to broaden the TAM model by including more elements or aspects of the TAM model. The Thaïs model attempts to gauge the genuine acknowledgment of clients for web-based business exchanges and how they construct trust in e-merchants and dealers. They add client factors, site variables, and e-dealer factors. There is model assistance to handle the trust structure client-to-e-merchant and the sites. Hamid et al. [28] find that conventional online business models like TAM and others are not exceptionally reasonable for M-Internet/trade, which is developing quickly, so they propose another model called VAM (Value Added Modeling). The VAM incorporates the principal qualities of M-web. In this model, they add more portable explicit components, and they find the idea of M-web and universality-related values influence the most clients. Safa and Isami [29] find that web-based business associations forget their customers effectively in the present mechanical and impacting world. They also find that acquiring the steadfastness of any client takes time and cash. They track down a safe connection between innovation that online business utilizes, e-fulfillment, and the association's gathering factors. Ali and others' [30] research into the nature of administration and consumer loyalty reveals that every one of the six components of administrative quality influences the client, and their impact on clients is positive and massive.

A. Di Crosta et al., [31] find usability never stops its effect on users; it significantly impacts user satisfaction. They find that neglecting customers' demands can lead to significant losses and that many e-commerce websites obtain average usability scores. They aim to investigate the significance of usability in websites related to e-commerce for the user's satisfaction and to provide insights on website development for improvement. They focus on five categories of usability for customer satisfaction. They are content, ease of use, publicity and promotion, personalized services, and emotions. According to Damaševičius, [32], a limited number of studies have been done to develop features for e-commerce websites. They also find that a few researchers have done some work on the e-commerce model, but this research only provides very few e-commerce insights, and they do not include usability and security. They find that usability and security have a lot of dimensions, and for better usability and security in e-commerce, they need to co-relate effectively. Most e-commerce models include a few dimensions of it. Researchers have overlooked security and privacy. Therefore, these factors need to be researched more to reduce the gap between usability and security.

Peighambari et al. [33] proposed that information security issues are the most manageable part of the progression of web-based business web applications. The most pressing issues are also the UI and language. Knowing the client-driven point means a lot for planning the site. Most web-based businesses center around the trading of significant-worth final results. The initial step to fabricating a site is generally inventive and significant. The undeniable level plan and the nitty-gritty plan are the pieces of online business web architecture. Over the long haul, the sites will become increasingly unique. The new variation is vital for online business organizations since internet businesses change every once in a while. Presently, web-based business is a lot greater and more mind-boggling when compared with the past, and adding another component to it likewise builds the intricacy of online business. Zhang et al. [34] find that in non-industrial nations, web-based businesses develop quickly. The client's web experience and an investigation of their behavior as it relates to the sites will aid in determining the convenience and nature of the sites. Presently, clients are becoming less lenient towards things they would rather not pause. Slow sites can't make decent articulations to the clients. Convenience is everything about how the substance is introduced on the site. Those sites that have a quick load speed have more clients. The client also requires both high-quality and low-cost items and services. Subsequently, web-based business sites should offer both support and plans to their clients.

TABLE 1. Taxonomic of usability and security evaluation methods.

Authors	Various attributes measured usability as well as security
Szymanski and Hise (2000)	Creations, product information, item and its benefits provided, security, web-consulting
Dwairi and Kamala (2009)	Online experience, demographics, satisfaction, design, security, privacy, content, risk
Chong et al, (2012)	Satisfaction, information's quality, intention to repeat use, service provided by the system, perceived value
Safa and Ismai (2013)	Information as well as system quality, effectiveness, use of convenience
Ali et al., (2018)	The system as well as the quality of service, acceptability, security, privacy
Min Shi and Hong Yuan (2018)	User satisfaction, usability, personalized services, emotional state, customers' demands. Ease of use, publicity, and promotions
NurAzimahbtMohd, ZarualFitriZaaba (2019)	Usability and security dimensions, evaluation model, exchange of service, satisfaction, efficiency, memorability, learnability, error, individual quality.
Sylvanus A. Ehikioya and Eric Guillemot (2020)	Security and networking problems, user interface and language service, design, high-level design, detail level design, real-time behavior, e-commerce transaction, scrum, dynamic website
Daljit Kaur and Harpreet Kaur (2020)	Web experiences, usability, quality of a website, performance of website, users' preferences and behaviors, page load and download time
Soomaiya Hamid, NarmeenZakariaBawany and KanwalZahoor (2020)	User friendly, satisfaction level of customer, usability and accessibility, effectiveness, design, the user interacts, accessibility testing, quality of e-commerce websites, system usability scale
Ina Ratbasari, SalimSiregar and AsepMaulana (2021)	Trust, satisfaction, purchaser's behavior, online shopping, quality, and security of e-services

Micu et al. [35] find that user interface is also significant for any e-commerce website because if the website is good looking or user-friendly, then the customer will also come to those websites and think that they are also good. For making a good website, the company should know the satisfaction level of the customers towards websites [37], [38]. They find that usability and accessibility are essential for any website. They also observe that most e-commerce websites do not follow essential usability principles and do not focus on Web Content Accessibility Guidelines (WCAG). These concepts help us ensure the system's efficacy and containment towards users [39]. The design of an e-commerce website is so simple that anyone can use it. Website accessibility is an essential factor in determining the quality of an e-commerce website shown in table 1.

Strengths and weakness of various-commerce approaches on usability as well as security [36], Surveyed based on the attributes considered by the different methods in the account of different dimensions of usability and security features which provides a recapitulation related to the strengths and weaknesses of different methods. It narrates whether the currently available methods used in e-commerce may apprehend

TABLE 2. Strengths and shortcomings of existing e-commerce methods on usability and security.

Approaches	Measured Usability Attributes							Elements of Security		
	Learnability	Efficiency	Memorability	Error	Satisfaction	Effectiveness	Engagement	Privacy	Integrity	Safety
Szymanski and Hise [26]	✓				✓			✓		
Dwairi and Kamala [27]	✓				✓			✓		✓
Chong et al., [28]	✓	✓	✓		✓					
Safa and Ismai [29]	✓	✓			✓					
Ali et al., [30]	✓	✓	✓							
Min Shi and Hong Yuan [31]	✓	✓			✓		✓	✓		✓
NurAzimah, FitriZaaba [32]				✓	✓		✓			✓
Sylvanus A. et al. [33]				✓		✓	✓		✓	✓
Daljit Kaur and Harpreet Kaur [34]		✓			✓		✓			
Somaya et [35]	✓			✓	✓	✓	✓			
Ina Ratbasari, et al. [36]				✓	✓			✓		✓

the entire measurements related to usability and security in a single method. Depending upon the survey, Table 2 introduces an assessment of the different methods for recognition, which could express every dimension's concern to usability and security.

Most of the approaches encountered at least learnability and satisfaction for each way listed above. There were no methodologies used in the production of all areas of usability and security. Learnability, efficiency, and satisfaction were tested by [26], [27], [28], [29], [30], [31], [32], [33], [34], [35], and [36] is recommended as method's process in Figure 1.

III. METHODOLOGY

A. USABILITY EVALUATION

Based on the above objective, usability evaluation is a prime concern for evaluating efficiency in e-commerce websites((www.smplazza.com, www.opsmart.in/store, and www.helloshoppee.com/ Jharkhand) based on their user's satisfaction.

B. IDENTIFICATION OF THE ATTRIBUTES ALONG WITH SUB-ATTRIBUTES OF USABILITY

Usability must be treated comprehensively by including attributes like effectiveness, engagement, website error rate, efficiency, completeness, and satisfaction with learnability, and where effectiveness is measured based on its sub-attributes: proper organization, enabling self-service, and preferred communication channel of the website. Learnability is measured by completion, response, and learning a sense of websites. Efficiency can be evaluated based on home page design, links to fetch information, and the retention rate of the websites. Memorability encounters are based on correct and

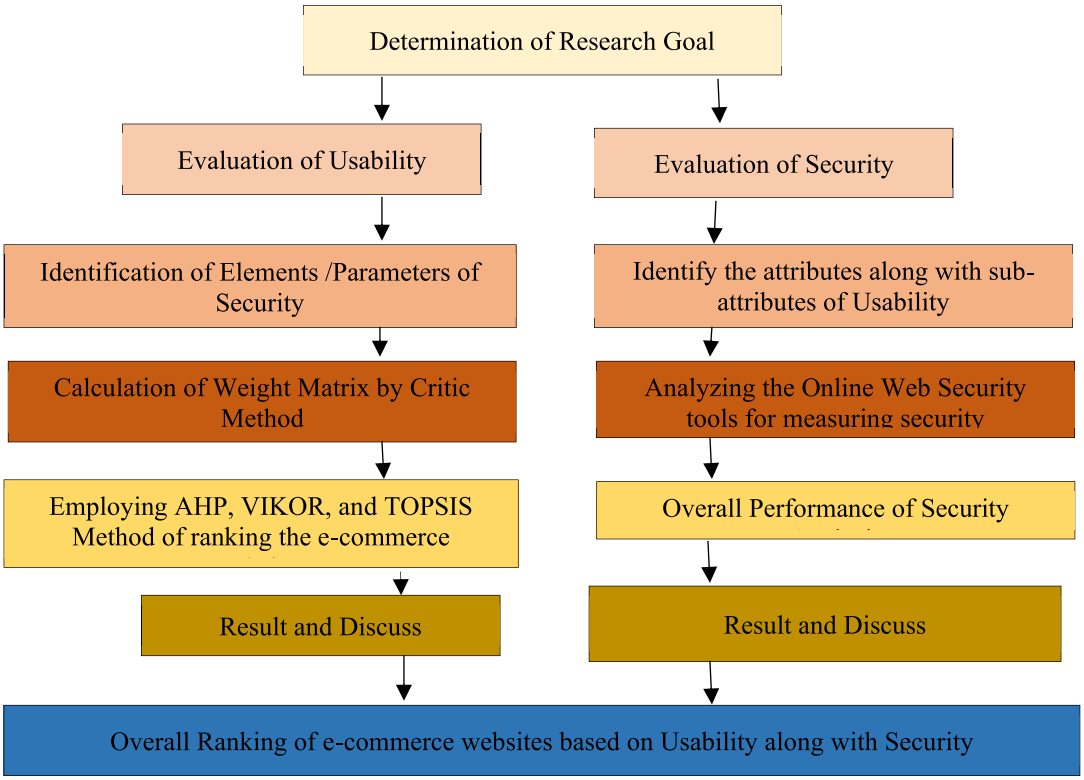


FIGURE 1. Flow of the proposed work.

relevant information that is regularly updated. The error rate can be measured by overall accuracy, error percentage, and average latency. Website satisfaction can be judged based on customer feedback analysis and emphasis on personalization. Website engagement signifies well-formatted content and effective navigation. The website layout includes information architecture and an informative planned layout, which is shown in Figure 2.

C. SOCIO-ECONOMIC DEMOGRAPHIC DATA FACTOR CHARACTERISTICS OF THESE PARTICIPANTS

A quantitative form of raw data is accumulated as a result of data collection. Then a statistical analysis is performed after a summary of the data. Data were statistically analyzed using the SPSS scoring method, which was adopted as a standard. The frequency distribution mean is the main component of the statistical design. Only 3.8% of respondents are under the age of 20, compared to 31.6 % who are in their twenties, 32.8% who are in their twenties, 23.9% who claim to be in their twenties, few who are in their twenties and older, and only a tiny fraction who claim to be in their twenties. Because all of the respondents were studying social work as a postgraduate degree, it is clear that they were between the ages of 22 and 24. The bulk of the conclusions from earlier research applied to this study as well. A nearly equal number of men and women (53.9% and 30%, respectively) made up the remaining respondents. Most respondents (66.2%) identify as Hindus, followed by Christians (28.1%) and Muslims (5.6%), who make up a relatively small minority of respondents. Just 15.9% of respondents fall into the other caste or general group, while 40.1% of respondents are from a backward caste, and an equal number (22.5%) are from a very backward caste. For 41.7% of the respondents, the family income was less than Rs. 10,000, for 31.1% of the respondents, it was between Rs. 10,000 and Rs. 20,000, and for the remaining 43.5%, it was beyond Rs.20,000. A person's ability to pursue an education and find work is impacted by a variety of variables, including the financial stability of their family. This study attempts to analyze the various asset kinds and their valuations because nearly a third of them (35%) only have immovable properties. The response may vary from the respondent'scharacteristics.

D. AHP METHOD

The Analytic Hierarchy Process is based on the capacity to make decisions in a complex scenario, including many variables or benchmarks for prioritizing and selection. Following that, all comparisons and the evaluation of relative weights between criteria and the numerical likelihood of each alternative are carried out. The weights assigned to each component allow for evaluating each element within the given hierarchy. The key contribution of this approach is the process of transforming empirical data into appropriate mathematical models.

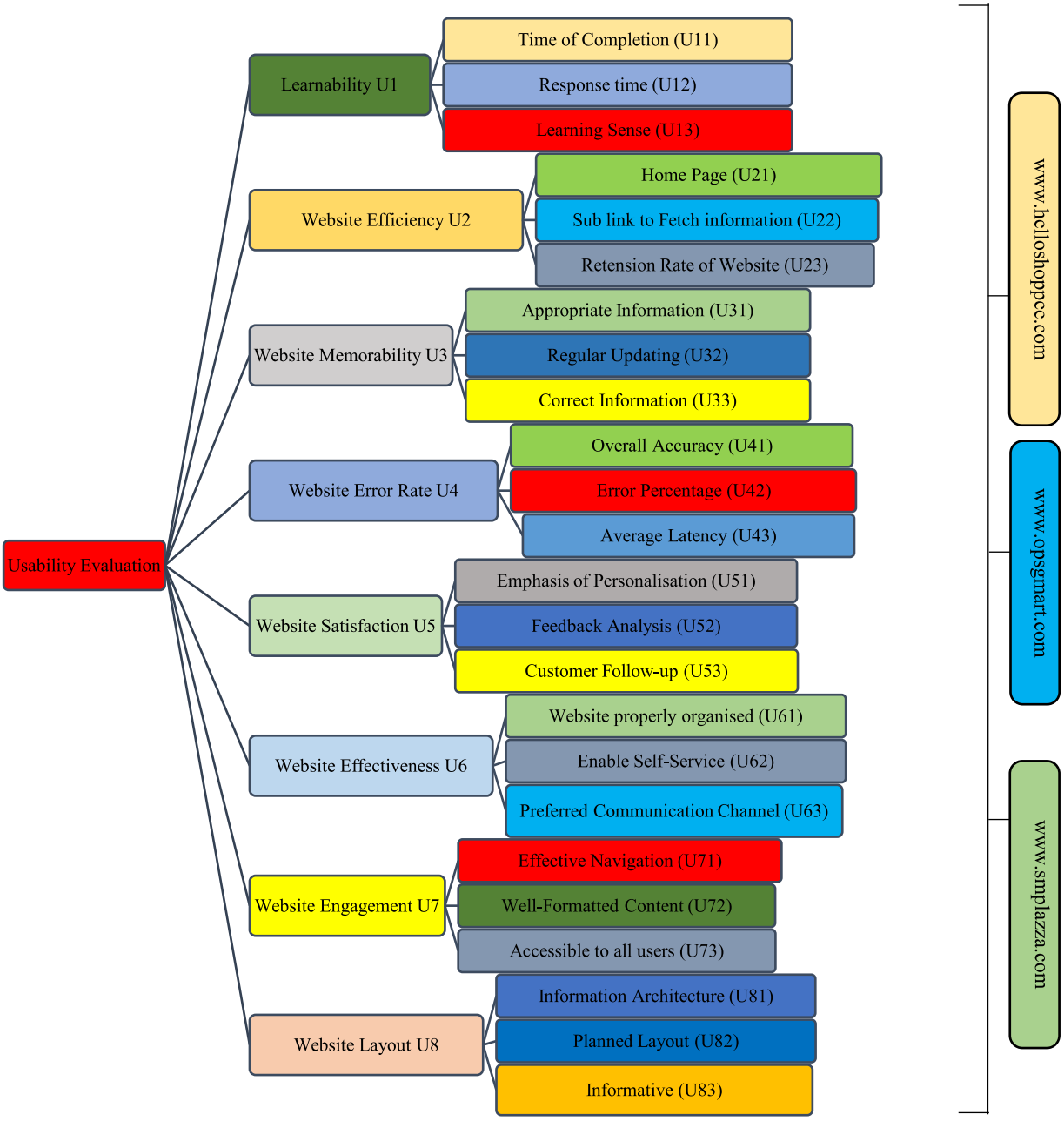


FIGURE 2. Identification of various attributes along with its sub-attributes of e-commerce websites.

The scale of comparison: The following scale varies between (1-9) and regulates the alternative relative importance although correlated with other alternatives shown in Figure 3. And the AHP flow chart process is demonstrated in Figure 4.

Pairwise Comparison: In the AHP methodology, pairwise comparison is one of the fundamentals. Firstly, they establish priorities for their main criteria by judging them in pairs of their relative importance, generating a pairwise matrix. The fundamental scale, i.e., the comparison scale, is used to make the comparison or the judgments represented in numbers. The scale of comparison (Fig.3) has been explained above. The number of judgments needed for a particular matrix of order n, the number of elements being compared, is $n(1\text{-}1)/2$ because it is reciprocal, and the diagonal elements are equal to unity. The next step is to compare the sub-criteria that belong to each of the main criteria, thereby constructing three more pairwise comparison matrices. Then the three alternatives are compared concerning each of the sub-criteria, leading to a nine-pairwise comparison matrix.

Generating weight matrix: The final step is synthesizing or weighing the results to obtain the final priorities.

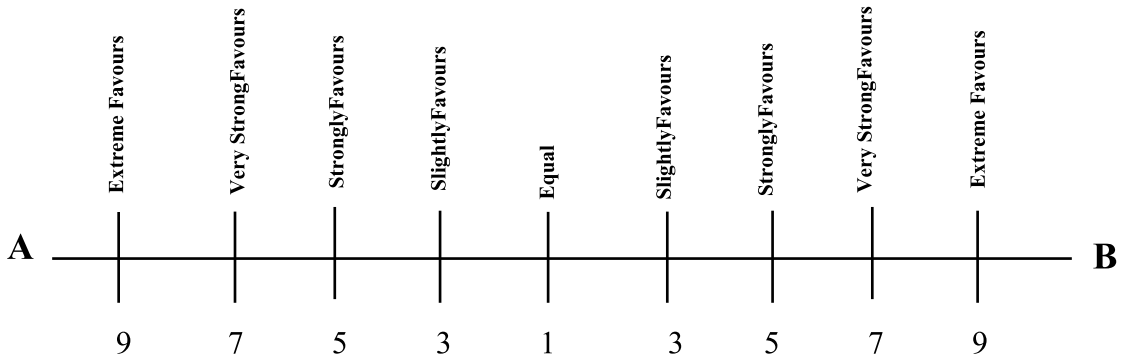


FIGURE 3. Scale of Comparisons.

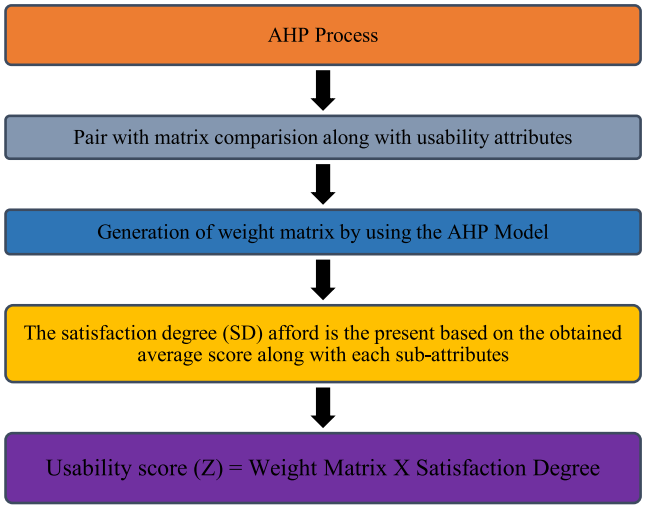


FIGURE 4. AHP flow chart process.

Steps involved in finding the weight matrix:

Step i. Find the summation based on each column of matrix A.

Step ii. Across the column segregate each value the column-wise based on their corresponding sum whichever results in anew matrix B.

Step iii. Find the summation of matrix B row-wise, that delivers (3 × 1) matrix.

Step iv. The respective will divide the matrix to obtain the weight matrix (w).

Step v. Resultant weight matrix is acquired.

The weight matrix for the attributes is calculated from the summation based on each column of matrix A.

Afterward, across the column, separate each value over the column-wise constructed on their corresponding sum whichever results in a new matrix B. Then, Find the summation of matrix B row-wise, which conveys (3 × 1) matrix. The matrix will be divided by the respective to obtain the weight matrix. Subsequently, the resultant weight matrix is obtained.

1) SATISFACTION DEGREE

The satisfaction degree (SD) afford is the present based on the obtained average score along with each sub-attribute. The satisfaction degree is marked based on satisfaction ratings which are mentioned below:

a. Very satisfied denoted as VS as top rating
b. Satisfied denoted as S where (S < VS)
c. Average denoted as A where (A < S < VS)
d. Unsatisfied is denoted as US where (US < A < S < VS)
e. Very Unsatisfied denoted as VUS where (VUS < US < A < S < VS)

The degree of Satisfaction of jth criteria which is denoted by D(Cj) is evaluated by mathematically:

$$\boldsymbol{D(Cj)} = \frac{\boldsymbol{y1 * T(X1) + y2 * T(X2) + \cdots\cdots + y12 * T(X12)}}{\boldsymbol{y1 + y2 + \cdots + y12}} \tag{1}$$

where, D(Cj) = degree of satisfaction

y_i = degree of membership value for each satisfaction level, $y_i \epsilon$ [0,1] for i = 1, 2 . . . .12.

Usability score: Usability score is denoted by Z, which is a resultant product ofWeight Matrix and Satisfaction Degree.

Usability score (Z) = Weight Matrix ∗ Satisfaction Degree Mathematically.

Or,

$$Z = Uij^{*}D(Cj) \tag{2}$$

where, Z = Usability Score.

Uij = weight matrix of the attributes corresponding to the sub-attributes.

D(Cj) = Satisfaction Degree of the attributes.

Hence, the satisfaction degree is calculated by AHP methodology and the overall ratings are performed based on this satisfaction degree.

E. VIKOR METHOD

The VIKOR method is an essential multi-criteria decision-making technique. It helps to evaluate the rank-based listing by initial weights. The method is based on ranking

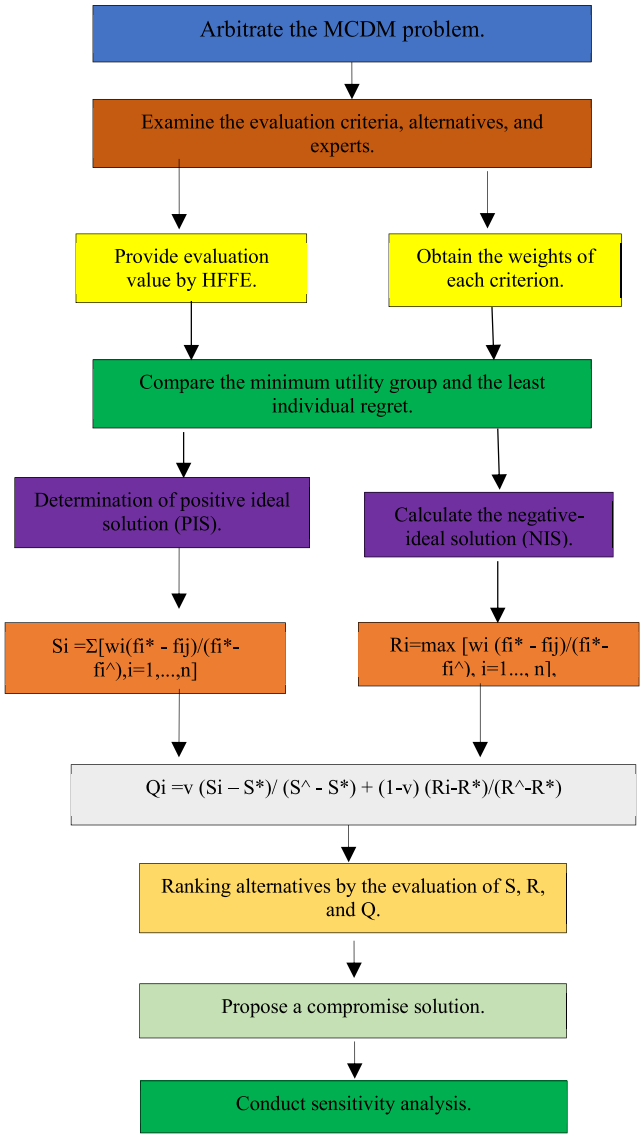


FIGURE 5. The flow chart process of the VIKOR method.

and regulating the compromise solution, which assists in decision-making to attain the ultimate result. The philosophy of this methodology is to find the optimal ranking by analyzing the fitting substitute. Recently, the convention of the VIKOR methodology has potentially impacted the ranking of e-commerce websites. The flow chart process of the VIKOR method is explained in Figure 5.

In VIKOR method, firstly, identify the beneficial and non-beneficial criteria. Beneficial criteria are those criteria whose higher value is desired, whereas non-beneficial criteria are those criteria whose lower value is desired. The next step, Finding the best value i.e. (xij)max for beneficial criteria and (xij)min for non-beneficial criteria and also finding the worst value i.e. (mij)min for beneficial criteria and (mij)max for non- beneficial criteria.

Next calculate the unity measure denoted by Si.

Mathematically,

$$Si = \Sigma_{j=1}^{m}(W_j * \frac{X_i^+ - X_{ij}}{X_j^+ - X_i^-}) \tag{3}$$

where, Si = Sum of all the values in the row for each criterion.

Wj = weight of the criteria or the attributes.

X_i^+ = Best value for the criteria.

X_i^- = Worst value for the criteria.

X_{ij} = Value in the cell.

Now, calculating the Individual regret known as Ri.

Mathematically,

$$Ri = max_j(W_j * \frac{X_i^+ - X_{ij}}{X_j^+ - X_i^-}) \tag{4}$$

where, Ri = Maximum value in the row of each criterion.

X_i^+ = Best value for the criteria.

X_i^- = Worst value for the criteria

X_{ij} = Value in the cell

Next calculate the S∗, S−, R*, R−

Where, S* = minimum value in Si

S− = maximum value in Si

R* = minimum value in Ri

R− = maximum value in Ri

After calculating the S*, S−, R*, R− values, calculate the Qi

$$Q_i = \mu + \frac{S_i - S^*}{S^- - S^*} + (1-\mu) * \frac{R_i - R^*}{R^- - R^*} \tag{5}$$

where,

μ = Weight for the strategy of maximum group utility take $\mu = 0.5$.

Then, based on the Qi value the ranking of the alternative can be given. Rank 1 will be given to the alternative with minimum Qi value. A decision maker can select the best alternative based on these rankings.

In the VIKOR method, a compromised solution is proposed for which check two conditions that are given below:

C1 = Acceptable advantage

$$Q(A2) - Q(A1) \tag{6}$$

where DQ = 1/j-1

j is the number of alternatives

Q (A1) = rank 1 value

Q (A2) = rank 2 value

C2 = Acceptable stability in decision making.

Alternative A1 must also be the best ranked by S or/and R.

If one of the conditions is not satisfied, then a set of compromise solutions is proposed, which consist of:

- Alternatives a1 and a2 if only condition C2 is not satisfied, or
- Alternatives a1, a2 . . . .a(M) if condition C1 is not satisfied; and a(M)is determined by the relation

$$Q(a(M)) - Q(a1) < DQ \tag{7}$$

for maximum M (the positions of these alternatives are ''in closeness'').

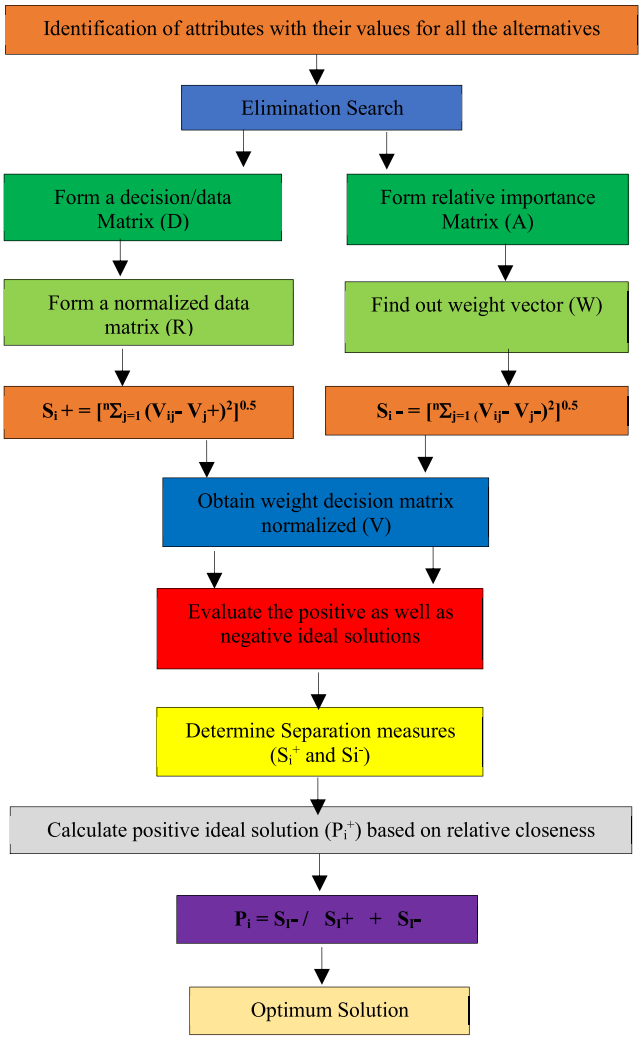


FIGURE 6. Process of the TOPSIS method.

From the above methodology, VIKOR proposes a compromise solution that conducts sensitivity analysis.

F. TOPSIS METHOD

This MCDM approach compares different sets using an analytical judgment over the acquired dataset, depending on a defined criterion. The optimum approach for determining a new frame of reference that adheres to the optimization base and order performance Figure 6 illustrates the TOPSIS method's flow chart approach.

In TOPSIS method, firstly, working on identifying the attributes with their values for all the alternatives. Afterward, the vector normalization is calculated.

Mathematically,

$$\mathbf{X'ij} = \frac{X_{ij}}{\sqrt{\sum_{j=1}^{n} X_{ij}^{2}}} \tag{8}$$

where,

X_{ij} = Performance value in each cell.

From the above operation, we reach the normalized decision matrix. The value in each cell is known as the normalized performance value.

Now, multiply the weights of each criterion by the normalized performance value of each cell. Then calculate the ideal best and ideal worst values for both beneficial and non-beneficial criteria that are mentioned below:

V_j^+ = indicated the ideal (best) value.

V_j^- = indicated the ideal (worst) value.

Now, calculate the Euclidean distance from ideal best and worst.

- Euclidean distance from ideal best
  Mathematically,

$$S_i^+ = \left[\sum_{j=1}^{n} \left(V_{ij} - V_j^-\right) \wedge 2\right] 0.5 \tag{9}$$

- Euclidean distance from ideal worst
  Mathematically,

$$S_i^- = \left[\sum_{j=1}^{n} \left(V_{ij} - V_j^-\right) \wedge 2\right] 0.5 \tag{10}$$

Now, we calculatethe performance score.

Mathematically,

$$\boldsymbol{P_i} = \frac{\boldsymbol{S_i^-}}{\boldsymbol{S_i^+ + S_i^-}} \tag{11}$$

Thus, based on the performance score we rank the alternatives. Maximum the Pi value, higher is the rank.

G. SECURITY EVALUATION

There is a prediction that by the year 2050, all businesses through traditional commerce will be transformed into e-commerce. This statistic is excellent news for the industry and even better news for cybercriminals.

H. IDENTIFICATION OF ELEMENTS AND ATTRIBUTES OF SECURITY

Security is measured comprehensively by including attributes like privacy, safety, and integrity. e-commerce websites. Privacy signifies protecting customers' personal and often sensitive information gathered through their interaction with websites. Safety is a state in which hazards and conditions leading to harm to e-commerce websites are controlled to preserve the customer's trust. Integrity interpolates the ability for insurance of the information actuality display on a website do not admit any alteration by an unapproved party.

I. WEBSITE SECURITY SCANNER TOOLS

Online website security scanner tools assist in identifying, categorizing, and monitoring various security benchmarks in various e-commerce websites. Cross-site scripting, browser sink attack, weak authentication, source code disclosure, malicious file upload, sensitive information disclosure, system exposure, SQL injection.

For free website security scanning, is preferred. It performs rapid analysis for malware, ostracises status, and impregnates SPAM.

Qualys: It is essential to essential examine e-commerce websites for vulnerabilities and SSL/TLS disarrangement, and it maintains a comprehensive investigation of the websites for e-commerce.

ImmuniWeb: Here it investigates e-commerce websites contrary to GDPR compliancy, HTTP security headers, malware tests, and Drupal sites.

Dareboost: This is a synthetic monitoring tool to oversee the front-end performance of our core pages. Strong features of Dareboost are granular testing frequency and customizable network conditions.

Webpagetest: It enriches the existing website performance tests with further visibility into security details, such as HTTP security headers and vulnerable JavaScript libraries found on a website.

IV. RESULTS AND DISCUSSION

A. USABILITY EVALUATION OF E-COMMERCE WEBSITES

This survey attempts to use a user-oriented questionnaire testing method to find the gaps discussed above as usability is looked upon by and large in conjunction with learnability, memorability, effectiveness, engagement, efficiency, completeness, and satisfaction on the e-commerce websites of Jharkhand, India(www.smplazza.com, www.opsmart.in/store, and www.helloshoppee.com/Jharkhand).

In this survey, questionnaires were prepared with attributes and related sub-attributes on a scale of 1 to 5 with unsatisfactory being indexed just as 1, and the same very satisfactory indexed 5. Questionnaires were prepared and distributed to 25 users. 22 users have participated, and out of those, 19 valid experimental data were submitted for the evaluation of the e-commerce websites of Jharkhand, India (www.smplazza.com, www.opsmart.in/store, and www.helloshoppee.com/Jharkhand). The sample rate was 94% effective. The selected users must ensure a strong internet experience background, with at least five years of participation in using e-commerce websites. In this survey, we considered two different tasks to be performed on all three e-commerce websites. Task-1 is for a customer to give you feedback about their shopping experience, and Task-2 is the search process for a particular product.

B. WEIGHT MATRIX

The Analytic Hierarchy Process (AHP) method plays a vital role in decision-making based on complex scenarios.

Steps involved in finding the weight matrix:

i. Step i. Find the summation based on each column of matrix A.
ii. Step ii. Across the column segregate each value the column-wise based on their corresponding sum
   a. whichever results in anew matrix B.
iii. Step iii. Find the summation of matrix B row-wise, that delivers (3 × 1) matrix.
iv. Step iv. The respective will divide the matrix to obtain the weight matrix (w).

TABLE 3. Comparison matrix for the corresponding attributes.

Comparison Matrix of Attributes Ui	Usability Sub-attributes Uij	Ui1	Ui2	Ui3
	U11	1	4	4
U1	U12	1/4	1	1/2
	U13	1/4	2	1
	U21	1	1	1/3
U2	U22	1	1	1/3
	U23	3	3	1
	U31	1	3	3
U3	U32	1/3	1	1
	U33	1/3	1	1
	U41	1	1	1
U4	U42	1	1	1
	U43	1	1	1
	U51	1	1/3	1/3
U5	U52	3	1	1/3
	U53	3	3	1
	U61	1	1/3	1/3
U6	U62	3	1	1
	U63	3	1	1
	U71	1	1/3	1
U7	U72	3	1	3
	U73	1	1/3	1
	U81	1	1/3	1/3
U8	U82	3	1	1
	U83	3	1	1

v. Step v. Resultant weight matrix is acquired.

Pair-wise Comparison Matrix for the corresponding attributes based On the AHP comparison scale is calculated in Table 3.

This table analyses and demonstrates the comparison matrix for the corresponding attributes of the respective three e-commerce websites i.e. www.helloshoppe.com, www.opsgmart.com, and www.samplazza.com. The comparison matrix is deliberated through wielding the Scale of comparison: The scale varies between (1-9) which regulates the alternative relative importance although correlated with other alternatives. Also associating with the matrix comparison along with the usability attributes.

The obtained weight matrix based on the comparison matrix is for attributes in Table 4. **Here, the** weight matrix for the attributes is calculated from the summation based on each column of matrix A. Afterwards, across the column, separate each value over the column-wise constructed on their corresponding sum, whichever results in a new matrix B. Then, finding the summation of matrix B row-wise conveys the (3 × 1) matrix. The matrix will be divided by the respective weights to obtain the weight matrix. Subsequently, the resultant weight matrix is obtained.

Analysis of the satisfaction degree score by using the AHP Method: Based on the calculated weight matrix, the e-commerce website *helloshoppe.com*, table 6 for opsgmart.com, and table 7 for samplazzza.com.Satisfaction Level Based on www.helloshoppe.com (HE) Attributes in Table 5 The satisfaction degree of all the attributes of the e-commerce website *www.helloshoppe.com* is calculated based on the obtained average score along with each sub-attribute

TABLE 4. Weight matrix.

Weight Matrix WUi of Attribute Ui	Ui1	Ui2	Ui3
U1	O.66	0.13	0.21
U2	0.20	0.20	0.60
U3	0.60	0.20	0.20
U4	0.33	0.33	0.33
U5	0.14	0.29	0.57
U6	0.14	0.43	0.43
U7	0.20	0.60	0.20
U8	0.14	0.43	0.43

TABLE 5. Satisfaction degree (HE).

Satisfaction Degree of Attributes Ui	Sub-attributes Uij	VS	S	A	US	VUS
	U11	0.38	0.30	0.25	0.04	0.03
U1	U12	0.52	0.36	0.06	0.04	0.02
	U13	0.40	0.35	0.09	0.11	0.05
	U21	0.35	0.29	0.30	0.02	0.04
U2	U22	0.40	0.26	0.16	0.14	0.06
	U23	0.36	0.33	0.20	0.06	0.05
	U31	0.34	0.29	0.26	0.04	0.06
U3	U32	0.36	0.31	0.22	0.05	0.06
	U33	0.38	0.33	0.19	0.05	0.04
	U41	+0.40	0.26	0.24	0.08	0.02
U4	U42	0.39	0.26	0.26	0.06	0.05
	U43	0.33	0.24	0.22	0.15	0.06
	U51	0.30	0.31	0.29	0.04	0.06
U5	U52	0.38	0.25	0.20	0.10	0.07
	U53	0.33	0.28	0.21	0.13	0.05
	U61	0.35	0.28	0.12	0.19	0.06
U6	U62	0.40	0.21	0.26	0.09	0.04
	U63	0.31	0.21	0.22	0.17	0.09
	U71	0.30	0.26	0.24	0.15	0.05
U7	U72	0.40	0.36	0.10	0.09	0.05
	U73	0.30	0.29	0.24	0.12	0.05
	U81	0.24	0.24	0.21	0.18	0.13
U8	U82	0.39	0.22	0.19	0.14	0.06
	U83	0.30	0.26	0.30	0.04	0.10

(ii) Satisfaction Degree based on the Attributes of www.opsgmart.com (OP) is in Table 6. The satisfaction degree of all the attributes of the e-commerce website www.opsgmart.com are calculated based on the obtained average score and each sub-attribute.

(iii) The Satisfaction Degree based on the Attributes of *www.samplazzza.com* (SM) is in Table 7. The satisfaction degree of all the attributes of the e-commerce website *www.samplazzza.com* is calculated based on the obtained average score along with each sub-attribute. This table analyses and demonstrates the satisfaction degree of all the attributes along with each sub-attribute based on the user interface quality, information quality, perceived security, and perceived privacy, stability, and economic effect.

(i) Usability Score obtained for all the attributes of www.helloshoppe.com is demonstrated in Table 8. This table analyzes and demonstrates the usability score of the

TABLE 6. Satisfaction degree (OP).

Satisfaction Degree of Attributes Ui	Sub-attributes Uij	VS	S	A	US	VUS
	U11	0.35	0.26	0.26	0.08	0.05
U1	U12	0.26	0.24	0.27	0.13	0.10
	U13	0.30	0.29	0.28	0.05	0.08
	U21	0.28	0.24	0.22	0.18	0.12
U2	U22	0.35	0.26	0.30	0.04	0.05
	U23	0.25	0.27	0.28	0.13	0.07
	U31	0.30	0.24	0.22	0.16	0.08
U3	U32	0.35	0.33	0.23	0.04	0.04
	U33	0.26	0.24	0.21	0.15	0.14
	U41	0.26	0.28	0.22	0.18	0.06
U4	U42	0.35	0.27	0.26	0.07	0.05
	U43	0.28	0.24	0.25	0.14	0.09
	U51	0.28	0.25	0.30	0.11	0.06
U5	U52	0.30	0.31	0.25	0.10	0.04
	U53	0.26	0.30	0.22	0.14	0.08
	U61	0.28	0.27	0.25	0.14	0.06
U6	U62	0.26	0.30	0.26	0.12	0.06
	U63	0.29	0.19	0.10	0.17	0.15
	U71	0.29	0.24	0.25	0.18	0.04
U7	U72	0.30	0.23	0.24	0.13	0.10
	U73	0.28	0.26	0.32	0.08	0.08
	U81	0.32	0.30	0.24	0.08	0.06
U8	U82	0.30	0.24	0.30	0.10	0.06
	U83	0.35	0.29	0.19	0.10	0.07

e-commerce website helloshoppe.com about the System Usability Scale, which includes questions that users of the concerned website will answer. The usability score has been calculated by using the formula which has been described below. i.e., Usability score (Z) = Weight Matrix × Satisfaction Degree

(ii) Usability Score obtained for all the attributes of www.opsgmart.com demonstrated in Table 9. This table analyses and demonstrates the usability score of the e-commerce website opsgmart.com about the System Usability Scale, which includes questions that users of the concerned website will answer. The usability score has been calculated by using the formula which has been described below. i.e., Usability score (Z) = Weight Matrix × Satisfaction Degree

(iii) Usability Score obtained for all the attributes of www.samplazza.com demonstrated in Table 10. This table analyzes and demonstrates the usability score of the e-commerce website samplazza.com with reference to the System Usability Scale, which includes questions that users of the concerned website will answer. The usability score has been calculated using the formula described below. i.e., Usability score (Z) = Weight Matrix × Satisfaction Degree

TABLE 7. Satisfaction degree (Sm).

Satisfaction Degree of Attributes Ui	Sub-attributes Uij	VS	S	A	US	VUS
	U11	0.21	0.28	0.24	0.17	0.10
U1	U12	0.24	0.30	0.28	0.08	0.10
	U13	0.26	0.29	0.30	0.10	0.05
	U21	0.28	0.32	0.30	0.07	0.03
U2	U22	0.24	0.34	0.19	0.16	0.07
	U23	0.28	0.30	0.22	0.09	0.11
	U31	0.40	0.28	0.19	0.08	0.05
U3	U32	0.41	0.28	0.18	0.07	0.06
	U33	0.35	0.30	0.17	0.11	0.07
	U41	0.29	0.32	0.26	0.09	0.04
U4	U42	0.28	0.32	0.29	0.03	0.08
	U43	0.27	0.30	0.32	0.06	0.05
	U51	0.18	0.24	0.20	0.28	0.10
U5	U52	0.28	0.18	0.14	0.22	0.18
	U53	0.24	0.20	0.23	0.21	0.12
	U61	0.38	0.30	0.12	0.13	0.07
U6	U62	0.35	0.31	0.21	0.09	0.04
	U63	0.28	0.34	0.19	0.12	0.07
	U71	0.29	0.25	0.23	0.12	0.11
U7	U72	0.28	0.22	0.33	0.09	0.08
	U73	0.29	0.23	0.19	0.20	0.09
	U81	0.30	0.31	0.23	0.09	0.07
U8	U82	0.32	0.33	0.22	0.10	0.03
	U83	0.29	0.17	0.18	0.20	0.16

TABLE 8. Usability score (He).

Usability Score of Attribute Ui	VS	S	A	US	VUS
U1	0.40	0.31	0.19	0.05	0.03
U2	0.36	0.30	0.21	0.06	0.05
U3	0.35	0.30	0.23	0.04	0.05
U4	0.36	0.25	0.23	0.09	0.04
U5	0.34	0.27	0.21	0.10	0.05
U6	0.35	0.21	0.22	0.13	0.06
U7	0.29	0.23	0.25	0.13	0.08
U8	0.32	0.26	0.24	0.09	0.06

TABLE 9. Usability score (Op).

Usability Score of Attribute Ui	VS	S	A	US	VUS
U1	0.32	0.26	0.26	0.08	0.06
U2	0.27	0.26	0.27	0.12	0.07
U3	0.30	0.25	0.22	0.13	0.08
U4	0.29	0.26	0.24	0.12	0.06
U5	0.27	0.29	0.23	0.12	0.06
U6	0.27	0.24	0.18	0.14	0.09
U7	0.29	0.23	0.25	0.13	0.08
U8	0.32	0.26	0.24	0.09	0.06

1) OVERALL USABILITY SCORE OF AHP METHOD

Figure 7 shows the overall usability scores of three respective e-commerce websites from the AHP method have been calculated and illustrated. The website www.helloshoppe.com has a usability score of 7.99 with Rank of 1 also www.samplazza.com has a usability score 7.97 with a Rank of 2 and www.opsgmart.com has a usability score 7.95 with a Rank of 3 are pictorially represented in an organized manner.

TABLE 10. Usability score (Sm).

Usability Score of Attribute Ui	VS	S	A	US	VUS
U1	0.22	0.28	0.25	0.14	0.08
U2	0.27	0.31	0.23	0.1	0.08
U3	0.39	0.28	0.18	0.08	0.05
U4	0.27	0.31	0.28	0.05	0.05
U5	0.24	0.19	0.19	0.22	0.13
U6	0.32	0.32	00.18	0.10	0.05
U7	0.28	0.22	0.28	0.11	0.08
U8	0.30	0.25	0.20	0.14	0.09

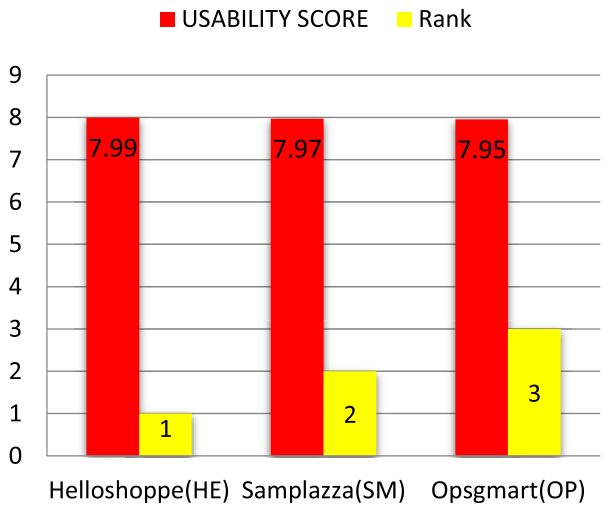


FIGURE 7. Usability score obtained from AHP Method.

C. WEIGHT MATRIX

CRITIC methodology is the main concern for the determination related to the weight matrix. Steps involved in using the critic method.

Step i: The process of Normalization will be performed on the decision matrix.

Step ii: Evaluate the standard derivation based on each criterion.

Step iii: The distance correlation is based on pair-wise criteria.

Step iv: Evaluate the information content.

Step v: Determination of the objective weights.

Weight matrix obtained for the corresponding attributes through CRITIC method is demonstrated in the Table 11. This method includes the potency of the dissimilitude and the dispute in constructing the decision-making problem.

TABLE 11. Analysis of weight matrix.

Analysis of Weight	Usability Attributes	Usability Sub-attributes	Weight
Weight Matrix WU1 of Attribute U1	U1	U11	0.5
		U12	0.25
		U13	0.25
Weight Matrix WU2 of Attribute U2	U2	U21	0.5
		U22	0.25
		U23	0.25
Weight Matrix WU3 of Attribute U3	U3	U31	0.25
		U32	0.5
		U33	0.25
Weight Matrix WU4 of Attribute U4	U4	U41	0.09
		U42	0.18
		U43	0.72
Weight Matrix WU5 of Attribute U5	U5	U51	0.05
		U52	0.37
		U53	0.12
Weight Matrix WU6 of Attribute U6	U6	U61	0.12
		U62	0.06
		U63	0.81
Weight Matrix WU7 of Attribute U7	U7	U71	0.26
		U72	0.50
		U73	0.22
Weight Matrix WU8 of Attribute U8	U8	U81	0.25
		U82	0.5
		U83	0.25

D. ANALYSIS OF RANKING OF THE USABILITY ATTRIBUTES BY USING VIKOR METHOD

Based on the weight obtained from the VIKOR method demonstrated in table 12. In this method, comparing the minimum utility group and the least individual regret by determining the positive ideal solution (PIS) through the formula Si = Σ[wi(fi∗-fij)/(fi∗-fi^), i = 1, . . . , n]. Also calculating the negative-ideal solution (NIS) through the formula Ri = max [wi(fi∗-fij)/(fi∗-fi^), i = 1 . . . , n]. Afterwards calculating the Qi value with the formula Qi = v(Si − S∗)/(S^− S∗) + (1-v)(Ri-R∗)/(R^− R∗). Now, Ranking the alternatives by evaluating S, R and Q. Finally proposing a compromise solution by conducting a sensitivity analysis.

In above figure 8, the overall usability attributes (ranking) of three respective e-commerce websites from the VIKOR method have been calculated and illustrated based on the Qi Score. And from VIKOR method it has been stated that the lower the Qi score, the higher the ranking So, the website www.helloshoppe.com has usability score 3.34 with Rank 1 also www.samplazza.com having a usability score 4.7 with Rank 2, and www.opsgmart.com having usability score 4.94 with Rank 3 are pictorially represented in an organized manner.

E. ANALYSIS OF RANKING OF THE USABILITY ATTRIBUTES BY USING TOPSIS METHOD

Based on the Weight obtained from the Critic method demonstrated in table 13. This table analyzes and demonstrates the ranking based on the performance score of the three e-commerce websites. Firstly, identifying the attributes with their values for all the alternatives and then working on the elimination search, which forms two matrices: the Decision data matrix and the Relative Importance matrix. From the Decision matrix, form a normalized data matrix, and also from the Relative Importance Matrix, find out the weight vector. Then, calculating (Si + = [nΣj = 1 (Vij− Vj+)2]0.5) and (Si− = [nΣj = 1 (Vij− Vj−)2]0.5). Now, obtained weight decision matrix is normalized, evaluating the positive as well as the negative ideal solution and determining Separation measures (Si+ and Si−). Calculate a positive ideal solution (Pi +) based on relative closeness. The formula for

TABLE 12. Ranking to the corresponding attributes.

Analysis of Ranking	Usability Attributes	Usability Sub-attributes	Si	Ri	Qi	Rank
Ranking based on Qi RU1 of Attribute U1	U1	U11	0.25	0.25	0.12	2
		U12	1	0.5	1	3
		U13	0.29	0.16	0.02	1
Ranking based on Qi RU2 of Attribute U2	U2	U21	0.87	0.5	1	3
		U22	0.5	0.25	0	1
		U23	0.5	0.5	0.5	2
Ranking based on Qi RU3 of Attribute U3	U3	U31	0.5	0.5	0.5	2
		U32	0.5	0.25	0	1
		U33	0.87	0.5	1	3
Ranking based on Qi RU4 of Attribute U4	U4	U41	0.45	0.36	0.31	2
		U42	0.9	0.72	1	3
		U43	0.27	0.18	0	1
Ranking based on Qi RU5 of Attribute U5	U5	U51	0.35	0.18	0.61	2
		U52	0.43	0.37	1	3
		U53	0.05	0.05	0	1
Ranking based on Qi RU6 of Attribute U6	U6	U61	0.18	0.12	0	1
		U62	0.87	0.81	1	2
		U63	0.87	0.81	1	3
Ranking based on Qi RU7 of Attribute U7	U7	U71	0.74	0.5	1	3
		U72	0.5	0.5	0.53	2
		U73	0.48	0.26	0	1
Ranking based on Qi RU8 of Attribute U8	U8	U81	1	0.5	1	3
		U82	0.12	0.12	0	1
		U83	0.5	0.5	0.71	2

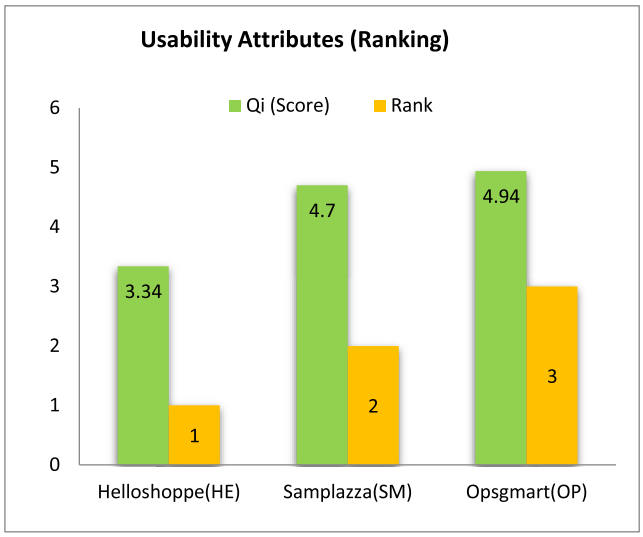


FIGURE 8. Usability attributes (Ranking) obtained from VIKOR method.

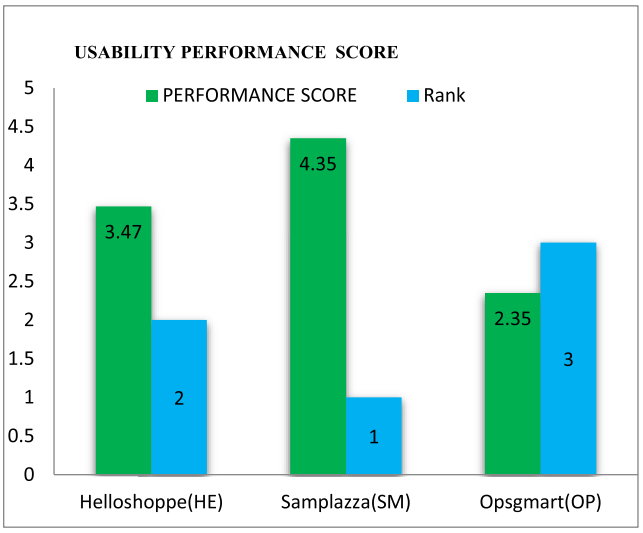


FIGURE 9. Usability performance score obtained from TOPSIS method.

TABLE 13. Ranking based on performance score.

Analysis of Ranking	Usability Attributes	Usability Sub-attributes	Si+	Si-	Pi	RANK
Ranking based on Pi U1 of Attribute U1	U1	U11	0.07	0.20	0.73	1
		U12	0.23	0	0	3
		U13	0.11	0.15	0.57	2
Ranking based on Pi U2 of Attribute U2	U2	U21	0.10	0.04	0.31	3
		U22	0.11	0.06	0.37	2
		U23	0.06	0.11	0.62	1
Ranking based on Pi U3 of Attribute U3	U3	U31	0.12	0.12	0.50	1
		U32	0.12	0.12	0.49	2
		U33	0.16	0.03	0.17	3
Ranking based on Pi U4 of Attribute U4	U4	U41	0.13	0.14	0.50	2
		U42	0.27	0.02	0.09	3
		U43	0.05	0.26	0.83	1
Ranking based on Pi U5 of Attribute U5	U5	U51	0.08	0.06	0.45	2
		U52	0.13	0.02	0.14	3
		U53	0.008	0.14	0.94	1
Ranking based on Pi U6 of Attribute U6	U6	U61	0.03	0.13	0.78	1
		U62	0.13	0.02	0.13	3
		U63	0.13	0.03	0.19	2
Ranking based on Pi U7 of Attribute U7	U7	U71	0.21	0.05	0.20	3
		U72	0.20	0.10	0.35	2
		U73	0.10	0.20	0.64	1
Ranking based on Pi U8 of Attribute U8	U8	U81	0.14	0	0	3
		U82	0.03	0.13	0.78	1
		U83	0.12	0.08	0.39	2

calculating Pi is (Pi = SI−/ SI+ + SI−). Finally optimizing the optimum solution [39].

Figure 9 shows the overall performance scores of three respective e-commerce websites from the TOPSIS method have been calculated and illustrated. The website www.helloshoppe.com has a performance score of 3.47 with a Rank 2 also www.samplazza.com has a performance score of 4.35 with Rank of 1, and www.opsgmart.com having a performance score of 2.35 with Rank of 3 are pictorially represented in an organized manner.

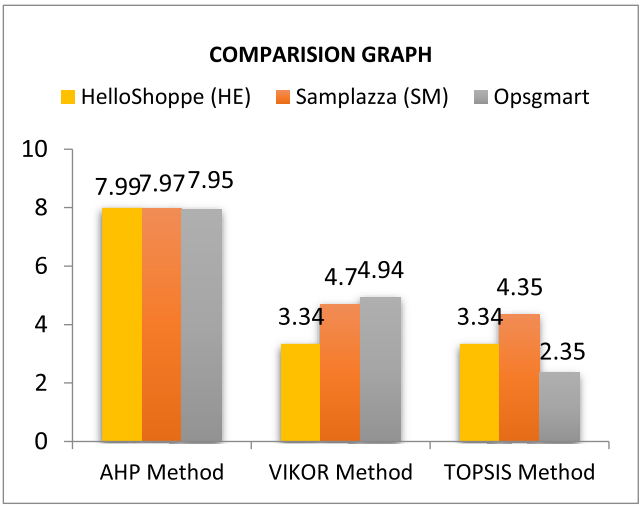


FIGURE 10. Comparisons between AHP Method, VIKOR method, and TOPSIS method.

F. COMPARATIVE ANALYSIS WITH EXISTING WORK

The overall comparative analysis of all three e-commerce websites of Jharkhand, www.smplazza.com, www.opsmart.in /store, www.helloshoppee.com/jharkhandbased on the AHP, VIKOR, And TOPSIS is shown in figure -10 with cumulative score value of all the usability attributes and sub-attributes.

In the above comparison graph (figure 10), the score of the AHP method is shown based on the usability score for the attributes of the three respective e-commerce websites. In the AHP method, *www.helloshoppe.com* holds the highest usability score compared to the other e-commerce websites, i.e., *www.samplazza.com* and www.opsgmart.com. The score of the VIKOR method is shown based on the

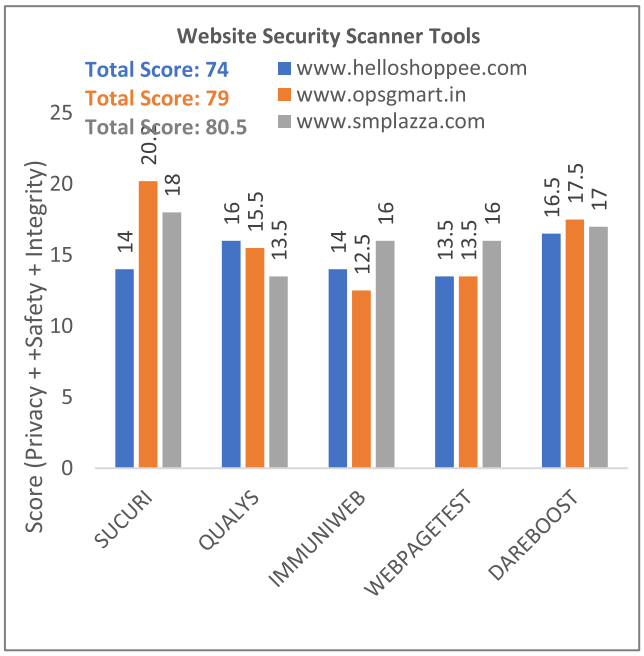


FIGURE 11. Security evaluation indices of three e-commerce websites.

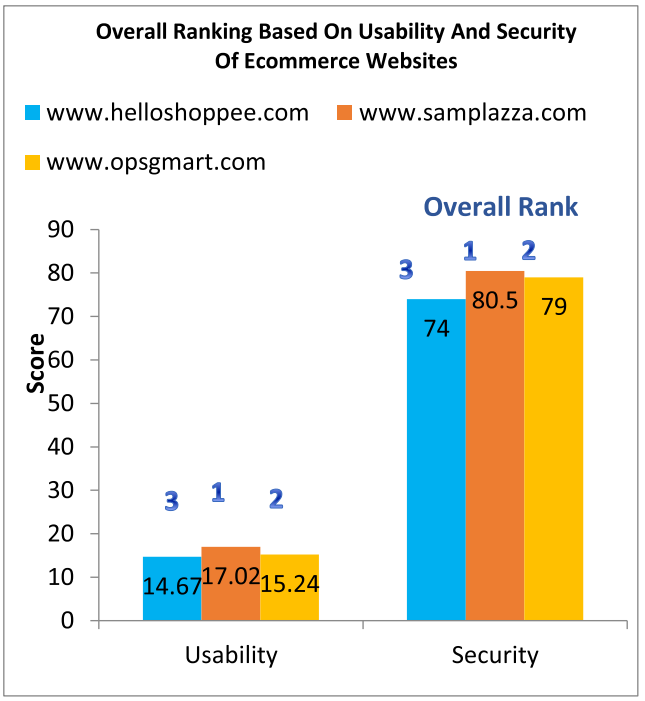


FIGURE 12. Overall ranking on the basis of usability along with the security of e-commerce Websites.

Qi ranking of the three alternative e-commerce websites. In the VIKOR method, it is clear that the lower the Qi score, the higher the ranking. That's why *www.helloshoppe.com* holds the highest ranking as compared to other e-commerce websites, i.e., www.samplazza.com and www.opsgmart.com. The score of the TOPSIS Method is shown based on the Performance Score of the alternatives of the three respective e-commerce websites. In the TOPSIS method, it's clear that the higher the performance score, the higher the ranking. So, from the above graph, *www.samplazza.com* holds the highest performance score compared to the other e-commerce websites, i.e., *www.helloshoppe.com* and www.opsgmart.com. After the comparative analysis, it is observed that the AHP method shows a better result for e-commerce websites, as www.hellope.com holds a value of 7.99, which is the highest value among other websites. As per the analysis of the VIKOR Method, the Qi rank of www.helloshoppe.com holds the value of 3.34, which is positioned at rank one. In the way we are making the performance analysis of TOPSIS, it is observed that www.samplazza.com holds the highest Pi valuative, at 4.35, which is positioned at rank first.

G. SECURITY EVALUATION OF E-COMMERCE WEBSITES

The Dataset collected on a scale of 10 for all three e-commerce websites in the form of a graph of privacy, integrity, and safety indices of all three e-commerce websites are designed by Python Programming Language shown in figure-11.

The retrieved result focuses on and concludes with figure 11 that:

Privacy of helloshoppee.com should increase.

Safety concern of www.smplazza.com is also not considered in the real security framework.

Sucuriweb scanner tool performs the maximum value of 52 for all three e-commerce websites in concern of privacy, safety, and integrity, webpage test scores the lowest at 42. Out of all the data analysis and the overall privacy, safety, and integrity score with all the website security scanner tools.

The overall security measures of the e-commerce website www.smplazza.com are highest with a score of 80.5, whereas www.helloshoppee.com shows a minimum overall score of 74. The Above graph encourages and motivates the requirement of a proposed model which should incorporate and address all the elements of security to a great extent.

H. OVERALL RANKING OF E-COMMERCE WEBSITES BASED ON USABILITY AND SECURITY

Based on the results obtained from the above section figure 12 explains the overall ranking of all three e-commerce websites based on their usability and security evaluation.

In Figure 12, the overall ranking based on usability and security of e-commerce websites has been calculated and illustrated. The website *www.helloshoppe.com* has a usability score of 14.67 with a rank of 3, while *www.samplazza.com* has a usability score of 17.02 with a rank of 1, and *www.opsgmart.com* has a usability score of 15.24 with a rank of 3. Along with the security score 74 of *www.helloshoppe.com*, ranked 3, the security score 80.5 of *www.samplazza.com*, ranked 1, and the security score 79 of *www.opsgmart.com*, ranked 2, are pictorially represented in an organized manner.

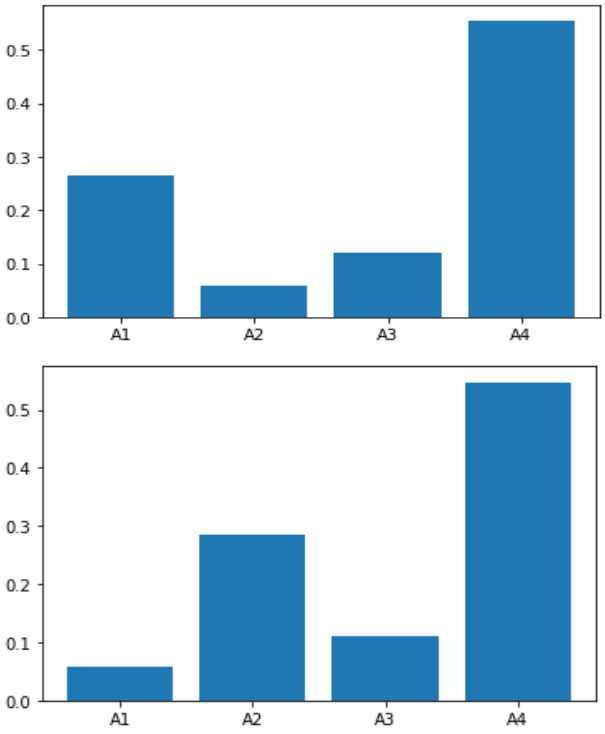


FIGURE 13. consistency mapping and confidence mapping.

I. AHP RESULT VISUALIZATION

In Figure 13, the priority vector [0.0455 0.6394 0.1082 0.2069] consistency index 0.0673, achieves a consistency ratio of 0.0756 after simulating the confidence value as given in the unit.

In the entire analysis, AHP gives more accurate results because the hierarchy's elements can be compared to one another fairly and consistently because each element is assigned a numerical weight or priority, which allows for the comparison of various and frequently incommensurable elements. Because of this capability, the AHP stands out from other decision-making processes. About the question, AHP and TOPSIS are two techniques built on different theories. The weights of the criteria and alternatives in the AHP are determined by pair-wise comparison and DM preferences based on weighted aggregation. The foundation of TOPSIS is distance. There are therefore assumed to be suitable and inappropriate solutions.

J. TESTING OF WEB TOOL

This section discusses the development of an automation-based testing framework that facilitates and makes it easy to implement new tests for web platforms that are similar to e-commerce applications. using the advantages of Java, JUnit, and the TestNG extended libraries, as well as the Page Object Pattern. The developed scripts are automated acceptance, functional, and non-functional tests that are broken up into smaller pieces using the Page Object pattern and then called in a different order depending on the test requirements and business logic. Software testers must distinguish the programming logic of individual modules because even though tests may be numerous, the elements visible in a given functionality are frequently the same.

K. COMPARATIVE ANALYSIS OF MACHINE LEARNING ALGORITHM FOR USABILITY ANALYSIS

Model trees and bagging are used in this study to address classification-related problems. To use this regression method for classification problems, we consider the conditional class probability function and search for an approximate model-tree representation of it. The classification class chosen as the predicted class is the one whose model tree yields the highest approximated probability value based on the MALE and FEMALE response categorical value. When we compared the performance of the proposed technique to that of other well-known ensembles of decision trees on common benchmark datasets, the proposed technique typically outperformed the others. The following model depicted shows an accuracy of 88.9 % with a scatter plot, ROC curve, and confusion matrix shown in Figure 15. The dataset was preprocessed using rescaling, binning, and data-splitting techniques to increase the predictability of the models. The Neural Network-based Trilayered model among all trained classification models had the highest accuracy of 81.19% for predicting usability as shown in Figure 16, specifically for the mild severity score. The dataset was preprocessed using rescaling, binning, and data-splitting techniques to increase the predictability of the models. The Neural Network-based Trilayered model among all trained classification models had the highest accuracy of 81.19% for predicting usability, specifically for mild severity score. It assigns input values to the input layer's nodes. The output values are distributed to each of the output layer's nodes. The hidden layer holds the results of the intermediate steps involved in determining output values from input values. A neural network of this type can recognize and learn any correlation between the input and output values when the hidden layer contains a sufficient number of nodes, according to theoretical analyses of the learning algorithms. However, the quantity of nodes and training cycles required to reach the desired accuracy level is impossible to foresee. However, we do not want to evaluate simulation studies while simulating noise with an artificial neural network [39], [40].

1) PSYCHOMETRICS PARAMETER RESPONSE EVALUATION USING LOGISTIC REGRESSION

The section seeks to define a person's personality using the big 5 models and machine learning techniques. A person's personality has a big impact on both his personal and professional life. A lot of companies are now short listing candidates based on personality traits because doing so increases productivity because workers are more likely to work in their areas of strength than in tasks they are required to complete. The intension to access the statistical

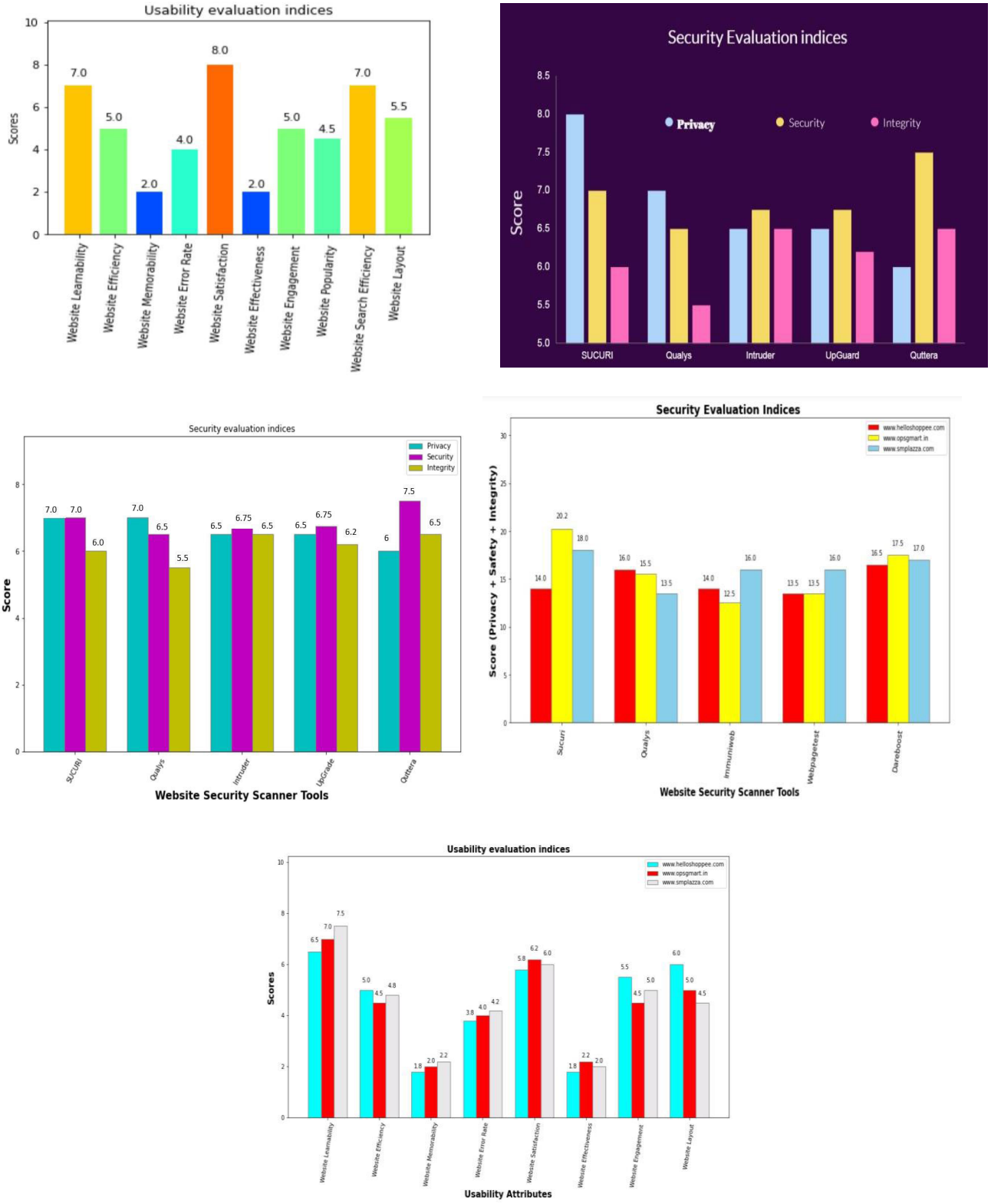
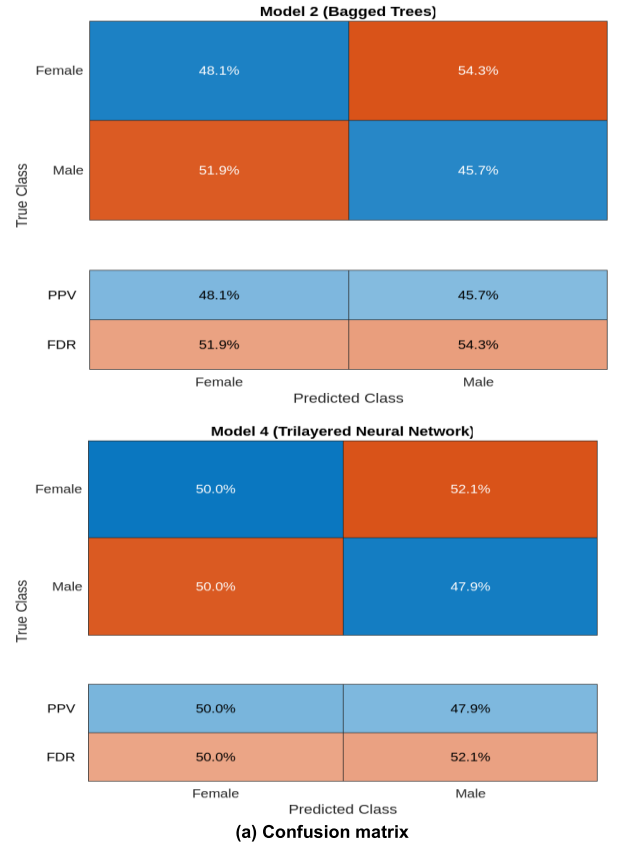
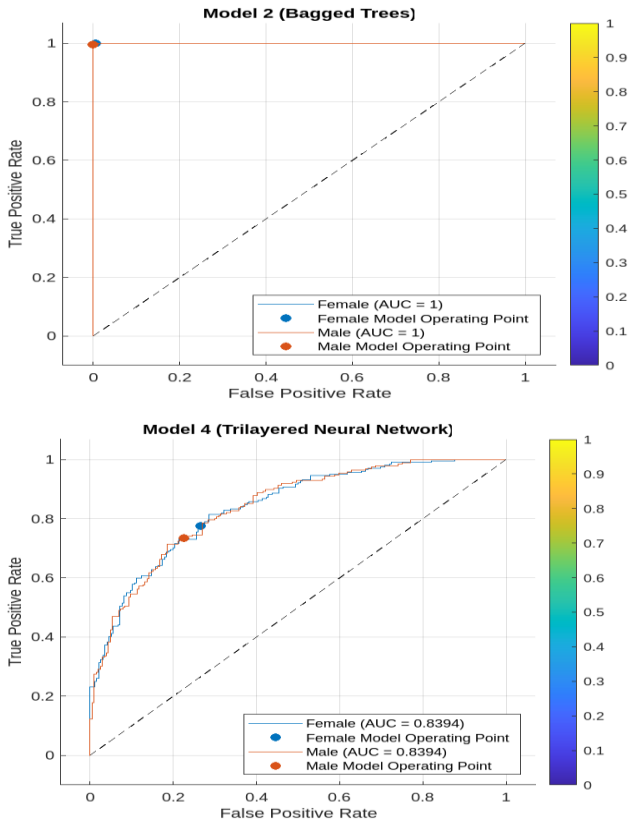


FIGURE 14. samples of website security analysis.

Psychometrics is due to the unbiased evaluation of proposed models irrespective of society, background, and region as the proposed model depends upon the categorical features gathered from users and their statically variable dependence. Thus, to ensure that there is no intervention of human perception, the statistics data and their results may vary and



(a) Confusion matrix



(b) Test ROC curve

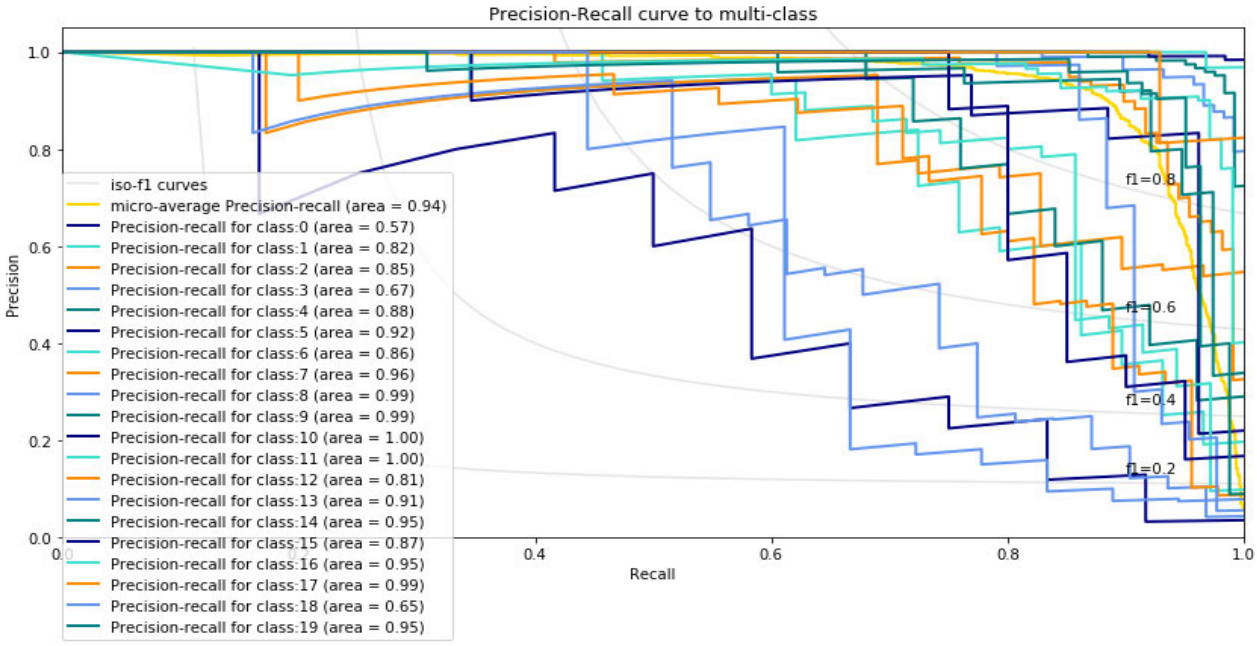
FIGURE 15. Bagged tree and Tri-layered neural network model results.

depend upon numerical value. The model is trained based on secondary data. We have populated the secondary data based on MBTI 16 personality factors affecting personality category and their response. For this, we have manually encoded the MBTI features value using an on-hot encoding technique to train the user's response with personality types such as Conscientiousness, Agreeableness, Neuroticism, and Neuroticism. This study aimed to create a system that could analyze social media conversations to forecast a person's personality. Four BIG5 personality items—Extraversion (EXT), Consciousness (CON), Agreeable (AGR), and Openness to Experiences—were predicted using the MBTI using logistic regression algorithms. Three feature extraction methods have been developed to handle unstructured and unbalanced SM conversations.

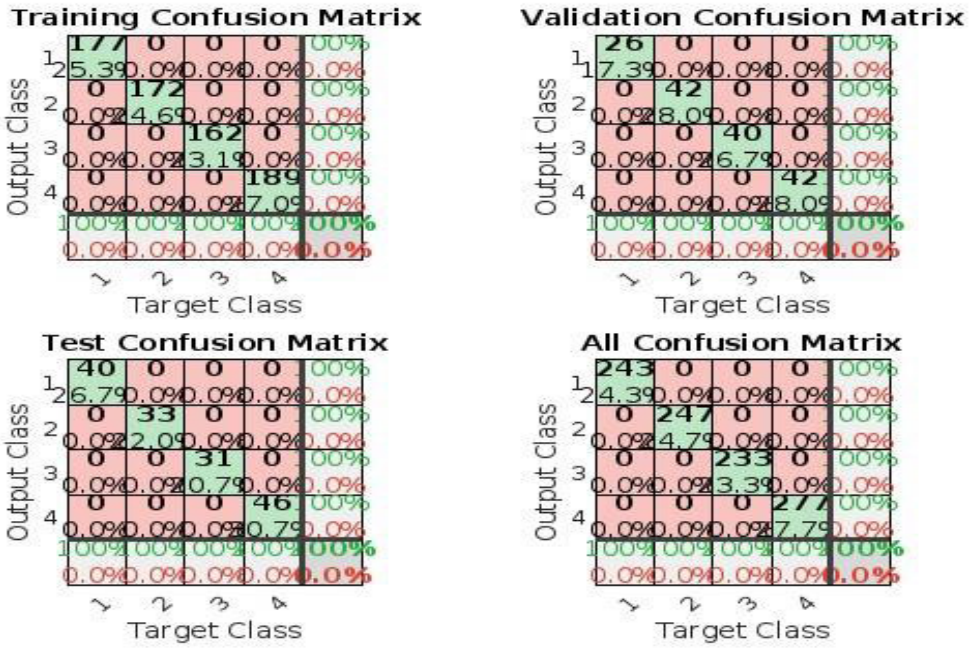
L. DISCUSSIONS

This study takes on and breaks down the strength and importance of web-based businesses. As we draw near, we can undoubtedly observe that there is a lack of one thorough-model which can look at the changed parts of convenience credits and certain components in the business prospect connected with online business sites. Examining the primary positioning measures for all AHP, VIKOR, and TOPSIS with the pertinent three marks of perspective, i.e., balanced, optimistic, and pessimistic the non-appearance of a thorough technique as a system is wasteful because it won't consider total discernment. After that, positioning separate sub-standards and, finally, finishing the positioning of the multitude of individual sub-models utilizing the most pertinent techniques to address the dynamic issues that are AHP, VIKOR, and TOPSIS strategy with the semi-optimistic and semi-skeptical perspectives. Likewise, I tried the ranking in light of the exhibition score and the ease of use score of the relative multitude of qualities. The intensity of the usability and security evaluation is attentive to the areas where improvement is possible so usable secure services must be enhanced to optimize the better solution. The present evaluation approaches do not fulfill the intention of e-commerce websites. This is because the approaches cannot evaluate all the usability components with effectiveness and engagement with the elements of security. Although each method described above made remarkable contributions, they even failed to consolidate into a single model with all usability attributes and security elements. Different methods have different approaches for multi-criteria optimization of complex systems. This research foundation highlights the gap between the mentioned e-commerce evaluation approaches. Accordingly, the upcoming research area will focus on designing a comprehensive, competent model to examine usability attributes with security elements.

Suggestions: As per the discussions above, the comprehensive proposed model should fulfill the following suggestions. This deed serves as an example of the set of standard features



(a) Multi-class curve to show 14 classes of data accuracy from area = 057 to area = 0.95



(b) Confusion matrix for multi-label classification

FIGURE 16. Analysis of Tri-layered neural network model results.

that have been selected, as well as the problems they have and other considerations that different researchers have made. The underlying reasons for the problems will be discussed in this part, along with advice for creating sound design suggestions. These pertinent principles can help draw the fine line between trade-offs in usability and security. The selected qualities from those needs include effectiveness, efficiency, satisfaction, and learnability.

Here we suggest ideas to improve usability, which means making navigation easier and providing the right information when visitors arrive on an e-commerce website. It can be achieved through filters, making tags,

promotional banners, and the use of different categories of products.

This suggests a distinct option set for the consumer to indulge a wider range of customer types and is based on payment and method of delivery.

Enable personalized recommendations: It suggests technology utilization like IoT, deep learning, cloud computation, and artificial intelligence for website visitors to compose recommendations.

Customer-centricity suggests that the decision-making parameters should be improved for the customer, even if it seems that business loses primarily.

Trustworthiness: It tries to secure visitors' trust and clear away their doubts about purchasing, return policy, and misuse of personal data.

Display Security: It recommends that every e-commerce website build specific security systems to protect its users and their data.

It recommends optimizing search engines and also advocates page speed, conversion rates, website speed, domain authority, and website structure.

Promotion and nurture: This section summarizes ways to promote e-commerce websites and products by advertising, conversion rates in software, promoting offers, nurturing visitors who left, etc.

V. CONCLUSION AND FUTURE WORK

According to the findings of this study, there is a significant relationship between usability features and the confidence factors of e-commerce websites. Over the past two decades, eleven different approaches for evaluating and scrutinizing the security and usability requirements of very complex e-commerce websites have been assessed and analyzed (2000–2021). However, some of their flaws include embellishing an insufficient understanding of information and rejecting some usability and security qualities in their approaches. However, the multi-criteria decision-making model combines usability with security. To obtain the overall preferred method of e-commerce websites, a model should be associated and tied in with the qualities of usability and the aspects of online security. Even though we know that the usage of MCDM in e-commerce websites is critical in terms of usability over security, they are the subject of a 26% research piece that has been analyzed over the past 10 years. Furthermore, MCDM (AHP, TOPSIS, Fuzzy, PROMETHEE) assumes ambiguity and imprecision, which fuzzy sets and fuzzy decision-making techniques can constructively manipulate, or it can be a scientific method in conjunction with artificial intelligence, knowledge engineering, soft computing, and neural networks, deep learning, machine learning, and genetic algorithms for making a viaduct that aforementioned the aperture to construct an extensive preferred method which can upgrade website usability and also quality ranking in great scope. The limitation of this study is that we only examine a small number of strategies (eleven in total), and we do not focus on and wrap all of the criteria factors around e-commerce websites. To make progress in the next few days, a plethora of studies, research, investigators, journals, annals, and case studies might be linked to see whether there is a correlation between usability and security criteria in e-commerce platforms.

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