A Study on TOPSIS MCDM Techniques and Its Application

M. Amudha, M. Ramachandran, Vimala Saravanan, P. Anusuya, R. Gayathri
REST Labs, Kveripattinam, Krishnagiri, TamilNadu, India.
Email: vimala@restlabs.in

Abstract
Optional selection technique similar to The Ideal Solution (TOPSIS) is a multi-criterion decision Is the method of analysis. This was originally Sing-Lai Hwang Created in 1981 by and Yoon, and Yoon and Yoon in 1987. In 1993Further improved by Hwang, Lai and Liu. Became TOPSIS Narrow geometric Distance from selected alternative positive optical solution (PIS) and negative ideal Based on the idea that the solution must have a very long geometric distance (NIS) Consists of. Identify Weights for each criterion, each Every alternative and best alternative to the criteria Normalizing the marks and geometric distance between Compensation is a method of comparing the set of alternatives by calculation. The assumption of TOPSIS is The criteria increase uniformly or Decrease. Many because of parameters or Criteria scale problems often have Normalization of inappropriate dimensions is common needed. Compensation systems such as TOPSIS Trade between criteria Allow exchanges where bad results on one scale are good results on another scale May be denied by. It offers So much more than unpaid methods Realistic modeling form, in which Alternative solutions are included or excluded In terms of tough cut-offs. Its in nuclear power plants an example of application given.

Introduction
For the Ideal Solution (TOPSIS) Series 1981 by Hwang et al Multi-scale created by Yoon Decision-making approach. The best alternative is short geometry the notion of having to have distance Based on. A positive best from (PIS) The solution is the best solution for geometric distances and negatives (NIS). To make this definition easier, you buy a mobile phone suppose you like, you go to a store and find 5 mobile phones with RAM, memory, display size, battery and price basically analyze. Finally, you are confused after looking at several factors, and more Not sure how to decide which mobile phone you should buy. TOPSIS is a way of assigning rankings based on the weights and impact of a given factor. TOPSIS, Optional sequencing technique, similar to the ideal solution, this is a multi-criterion decision analysis method. This is a set of basic alternatives the previously mentioned criteria Compares. This This time in different industries Used in business, each time collected Analytical decision should be made In terms of data. Of tops is Mysterious logic, the chosen alternative and the narrowest geometric distance from the solution, and the longest geometric distance from the bad solution Better to have Based on the notion of want.

Multi criteria decision making
From the Multi-Scale Decision Making (MCDM) format All decision making in engineering up to production Has the potential to improve areas, but it is more than that. this can be very useful for applications in technology marketing sectors. Very small in material performance Gains. Full potential of MCDM systems is complex Material selection is perceived by the Material for Problems, Process and Ability to consider form simultaneously. So the scope of MCDM methods is broad Experience expanding to scale engineering applications and improving product selection Feedback is also required. Effectiveness of practical design issues and data limits to deal with uncertainty and compromise It is important to use MCDM most effectively in handling, product selection and design [1]. Multidimensional decision analysis (MCDA) or multidimensional decision making (MCDM) is a fully developed branch of sub-disciplinary and operational research Yes, it is interested in Subjective evaluation of a finite number Designing supportive math and computational tools results. A Defined by the decision maker Alternatives under performance criteria or team (Ultima, 1999). MCDA / MCDM Mathematics, Behavior Conclusion Theory, Economics, computer technology, software In many fields, including engineering and information systems Uses knowledge from. [2Ideal, one of the known classical MCDM methods For order performance through Solution (TOPSIS) Unity The technique was first introduced by Hwang to solve the MCDM problem. And by Yoon [2]. That is, for many problems like this, the decision maker Many others. MCDM Problem Matrix Can be summarized in the form [3]. Since Belman and Jadeh first introduced ambiguous packages in MCDM, several researchers Are involved in decision making ambiguous contexts. Are interested. The fusion between MCDM and ambiguous synthesis theory is a new one Led to the decision-making As vaguely multi-criterion decision making (FMCDM) today The so-called theory, incomplete and uncertain We have decision models that can handle knowledge and information [4]. One in professional organization and functional research Important Topic Many criteria ambiguous Decision making (FMCDM), which is in various fields Used. Valuable in FMCDM contexts This is to prepare knowledgeable scholars Options and spaces in the title To understand. Many decision-making alternatives and Vague multi-criteria with criteria Decision Making (MCDM) (FMCDM) is an expert organization that specializes in operational research. Important topic. In the selected criteria, MCDM is very much from the set of alternatives Aims to identify the appropriate alternative (s) [5]. The TOPSIS

method is the second most common of the MCDM approaches is the popular method. Dozens of scholars use TOPSIS in various areas of simple or have extended the TOPSIS system to solve complex problems, modified or customized problems. Development trends of the TOPSIS system and Most of its applications for solving various problems are to solve simple and complex tasks Very clearly rearrange the common developmental trends of all MCDM systems [6]. On the other hand, a boundary profile Under the overview, the financial analyst is between two defined classes will think of a profile that is within range, which may be less intuitive. Consider this with, like the Of the traditional ELECTRE-TRI sorting ELECTRE-TRI-C and ELECTRE-TRI-nC types system Methods for sequencing alternatives using Attribute in the MCDM / A literature Profiles are proposed [7]. In common multidimensional Decision-making (MCDM) approaches, weights of properties Comparative importance in the decision-making process Reflect. The evaluation of the criteria is different Because it includes ideas and meanings, We cannot consider every estimate criteria are equally important (Chen, Zheng, & Ding, 2003). In weighing methods there are two types: subjective methods and objective methods [8]. Marketing strategic decision can be classified as a multidisciplinary Decision Making (MCDM) problem. Large number of marketing strategists when evaluating and selecting marketing strategies Complex factors need to be considered. Important results are indeterminate directly It is recommended that MCDM methods be helpful in achieving this. Basic the principle of MCDM is that of multiple criteria Decisions must be made on a case-by-case basis 2005). So, effectively deal with some issues It is better to use MCDM methods to solve [9]. It is necessary to compare MCDM methods and the importance of the selection problem McCrimmon, 32 MCDM Suggested a taxonomy of Methods. Also, Zavadskas et al.10 MCDM They also pointed to the updated use of methods [10]. There is only one buyer and several suppliers. The winner of the reverse auction (WD) problem both the quality and quantitative characteristics of the benefit and cost categories are considered for resolution. Here, WD The problem (MCDM) is considered a multi-dimensional decision-making problem. Variety in MCDM In shaping the priority value of attributes In order to address the inaccuracies of suppliers or decision makers [11] Multiple criteria decision-making is the presence of many, usually conflicting, decision-making criteria Refers to finding the best idea out of all possible alternatives. Traditional Engineering Economics Models do not notice the intrinsic benefits to operating systems and, therefore, detailed multidimensional decision-making techniques [12]. MCDM is a real-world standard for a variety of quality / quantitative criteria in certain / uncertain / hazardous environments. Appropriate among the many alternatives available, as it is considered a process of assessing circumstances Find action / selection / strategy / policy [13]. Suitable MCDM to solve the problem under consideration Before selecting the method, the situation is relevant It is necessary to develop all the components in detail selection results, analyst and decision makers' problem, possible alternatives, Contradictions between different effects, criteria and data uncertainty Wait until you understand [14]. Alternatively, one or more of the available alternatives depending on several evaluation criteria Many criteria will decide whether to rank or select more COTS products (MCDM) approach is used. MCDM COTS which includes evaluation of several criteria Effective framework for comparing products Provides. For example, various COTS products Whether MCDM can be used effectively for comparison to prove from many dimensions, OTSO (Off-The-Gondio Developed a systematic approach called self-will). [15]. The current TOPSIS system for solving MCDM problems is a benchmark score. Offers only. Conversely, when there is a gap data each depends on each criterion That the value of the alternative may also vary Within a range and different behaviors Considering the fact that may have, different Changing ideals in situations is logically better [16]. Multi-level decision making with ambiguous data we designed TOPSIS for issues, and more We have developed an algorithm to determine the excess desirable choice of all possible alternatives. Converting the result matrix into an ambiguous result matrix and the ambiguous ratings of the decision makers once integrated, we created a weighted ambiguous result matrix. Ambiguous distance value, to obtain and diffuse FPIS and FNIS as crisp values are used. Following the TOPSIS approach, Of each alternative from FPIS and FNIS, respectively We also calculated the similarity [17]. This method also deals with ambiguous MCDM issues Extended. For example, Tsaur, Chang and Yen (2002) first introduced a vague MCDM issue to Android It solves the ambiguous the TOPSIS method MCDM problem using, which converts it into a smoother one with diffusion. Chen and Tcheng (2004) Vague MCDM They transform them into a problem vague using MCDM vague integration. Using Instead of distance, the relative size of each alternative they use gray contact quality to define intimacy. Chu (2002A; 2002b) and chu and lin (2003) Smooth using TOPSIS MCDM solves the problem method, smoothing out the ambiguous MCDM problem.

Performance evaluation

Performance appraisal is the determination of an employee's work and results based on their work responsibilities Is defined as the systematic and production process for measuring. Ideally, employees do their job They will be graded annually at the annual festival, based on which they will be promoted or paid The hike is provided by the appropriate distribution. Performance appraisal is the work of an employee and their as a systematic and productive process for measuring results in terms of work responsibilities Is defined. Total Employee Income (ROI) on Industrial Standards and Investment Compared, increased business income Basically the value added by an employee It is used to measure size. By focusing inward towards their employees "from within All companies that have learned the art of "success", without missing out on employee performance Rely on a systematic performance appraisal process for measuring and evaluating. Better, Employees will be graded annually at their work anniversary, based on them Appropriate distribution of promotion or salary increase is provided. Performance appraisal, for employees Plays a direct role in providing feedback from time to time [18]. Explore performance assessment model Purpose of the sheet. This paper is about the ambiguous analysis hierarchical process Basically creates an evaluation model and the best solution, order by analogy with obscure TOPSIS Performance technique enables industrial practitioners to evaluate performance in ambiguous environments. Values are parameters with triangular

obscure numbers. ODM companies for different notebook systems The purpose of this research is to develop an ambiguous AHP and ambiguous TOPSIS model for evaluation. Productivity, finance, innovation, supply chain, human resources and service quality In the performance assessment for notebook computer ODM companies included [19]. Introducing the FCM / TOPSIS Ranking Approach, Multiple Multidimensional Performance Evaluation and Decision Making We think we can set the stage for applications. For example, sustainability, supplier Management, location analysis and other criteria to be considered simultaneously Complex decision-making environments such as operational and strategic decisions can benefit from the use of this technique [20]. The purpose of this study is funding for the banks in fund and exploring non-financial indicators services sector Is basically proposing a vague performance appraisal model. According to this, FAHP proposed because it is more flexible in performance evaluation than traditional methods Aims to be informative and transformative. The Topsis method is briefly compressed in Section 5. In the next section, performance in the Turkish banking sector The application for evaluation has been given. Further In the last part of the results and recommendations for future studies [21]. The rest of this sheet is as follows Are sorted. In the second category, companies Rates used in performance appraisal Briefly explained. Performance assessment. Bozdag˘, Kahraman and Ruan (2003) Best Computer Has four different ambiguities to choose from production method several characteristic groups proposed decision-making methods. One of these methods is FAHP and the other is Yagarin Weighted targets method, Flynn approach and ambiguous artificial rating. Chang, Cheng and Wang (2003) Air For performance appraisal of stations created the system.

Fuzzy TOPSIS

Fuzzy TOPSIS (Order Priority Technique by Similarities to Ideal Solution) Best of Similar Options Is one of the best ways to get the solution. It also has the option to automate the process The ambiguity in the process can also be used to overcome uncertainty. Of this study paper The purpose is to provide a general overview of the development of obscure TOPSIS systems. We are a literary We start with the review and the different obscure models used in the decision-making field Let's explore. Finally, we offer some applications of obscure topsis [22]. An ambiguous TOPSIS approach to plant habitat selection has been proposed, where diversity Estimates of different alternative locations and weights of different criteria under the criteria are unclear Are estimated on the basis of linguistics represented by numbers. As proposed, Estimates and an average of weights assigned by decisions Calculated and comparable ones are normalized. Member function of each normal weight estimate is of obscure numbers Spacing can be generated by arithmetic [23]. Obscure TOPSIS methods are not efficient enough because "Obscure positive-optimal Obscure ranking approaches to obtain "solution" and "ambiguous negative-optimal solution" Are used, however no one can rank vague. In all cases Satisfactory numbers in situations. Vague TOPSIS Processes, ambiguous set, hesitant Other methods associated with fuzzy topsides, such as fuzzy sets or intuitive fuzzy sets Such as ambiguous analysis hierarchical process (AHP) or improvements to team decision making Approaches are explored and compared. Many alternatives and criteria used. This In the paper, an overview of the implementation of ambiguous TOPSIS methods is analyzed. In the last decade (2009-2018 years) 25 articles and studies reviewed and compared. Reluctantly vague Obscurity related to studied literature such as topsis or intuitive obscurity topsis The applications of the variants of topsis are outlined [24]. To solve the limitations, an ambiguous TOPSIS method is recommended for the robot selection problem, which is different Significance of criteria for weights and for various alternatives under different subjective criteria Estimates are estimated on a linguistic basis represented by triangular obscure numbers [25]. Global top four with fuzzy TOPSIS techniques with proposed fuzzy AHP and MCDM This research invites 10 experts to evaluate the performance of notebook computer ODM companies. Obscure Used to determine the preferred weight of the AHP rating. Then, the actual performance values And between following the desired positions in each dimension and criterion Based on the four proposed companies, to improve the replacement gaps This research also follows the obscure TOPSIS to find the best alternatives to achieve the desired / desired levels [26]. The method developed can be used successfully to solve decision making problems in various fields. So, surprisingly, many of the documents in the literature are routine, interval-valued, and ambiguous Dedicated to the successful real-world applications of Topy's methods. Consider this With that, our common ambiguous TOPSIS method is said to provide the best results in many cases It can be said, because it has no limits of known methods and takes into account the most important information Makes it possible to take, especially the expert approach of the method. Integration of local criteria [27]. To use ambiguous TOPSIS for the MCGDM problem, the selection criteria must be the same. However, based on the above comments, ambiguous tops are more appropriate and Direct. The ambiguous TOPSIS method was used to construct the selection criteria previously described [28]. Proposal obscure tapis system research Different shopping websites with calls These are the 12 experts who evaluate. Vague is TOPSIS The weight is four shopping to determine the rating criteria It is also used to sort alternatives to websites. Administration in the field of web shopping This research aims to provide some empirical strategies for improving performance [29]. In this work, several criteria for selecting a green supplier Brazilian electronics company We have followed the vague TOPSIS method for resolving decision making issues. This part is vague Packages and Linguistics Variables, Topsis Mode and the proposed vague TOPSIS method Briefly describes [30]. Evaluating alternatives with obscure topsis and final determining the ranking. In the first phase, in projects Change the criteria used, their as the assessment is determined and decided Is being created. AHP model alternates between objective first level and criteria second level the projects are structured to be tertiary. At the last stage of the first stage, excision making by the decision-making body Hierarchy is recognized [31]. Unclear Gallery theory in production management Succulently Set and Implemented. Modeling and ambiguous synthesis theory as a means of Analysis of decision-making systems, facility Dealing with location selection issues The application is very interesting for researchers, However, there are small studies in use. ambiguous TOPSIS for facility location selection [32]. Fuzzy TOPSIS Total scores for uniform assessment Build and choose the best

alternative The application is very interesting and used for researchers. The ambiguous TOPSIS approach is the ambiguity of the Criteria and replacements in Topsis includes ratings (Hwang & Yoon, 1981). TOPSIS The approach is very close to the positive ideal solution and far away from the best solution of negative Selects an alternative in.

Ideal solution

The best solution is a homogeneous mixture of materials with physics properties that are directly related to the properties of the pure components. The classic of this position The claim is the Rout rule, which is valid for many highly dilute solutions and a particular type of concentrated solution, i.e. solvent and solvent Interactions between molecules are between molecules. Every object is itself. Benzene with very similar molecular structures and Toluene solutions are the best: any mixture of the two is equal to the sum of the volumes of the individual components, and the mixing process Occurs without heat absorption or evolution. The vapor pressures of solutions are mathematically represented by the linear action of the molecular compound. n Chemistry is a solution that exhibits thermodynamic properties such as a better solution or a better mixture of gases. Of the mixture Antelope is zero, as well as the volume change of the compound by definition; If the enthalpy of the mixture is close to zero, the behavior of the solution is very high Will become "better". The vapor pressure of the solvent and solvent obeys Rowell's law and Henry's law, respectively, and the functional coefficient (which Measure deviation from ideal) Each component is equal to one [33]. Order Performance Technique similar to TOPSIS known as Classical MCDM One of the methods was first developed by Hwang and to solve the MCDM problem. Created. The selected alternative is positive and the short distance from the ideal solution is negative Based on the idea that the ideal solution should have the most distance. The shortest distance from the selected alternative positive ideal solution and the negative ideal solution The basic principle is to have the most distance [34]. (MOLSNLP) Problem Solving Unity Better Solution (TOPSIS) Approach to Order Option We are expanding the technique. Compromise (TOPSIS) control reduces the distance, which is close The solution should have the shortest distance from the positive ideal solution (PIS) and the longest distance from the negative ideal solution (NIS) [35]. Overall performance appraisal of individual performance scores against MADM approaches activities to be combined into scores. The aggregation process is through the use of measurements Brings a sequence of individual scores obtained. In this study, the proposed PMM's The AHP approach is used to weigh dimensions and their components. Ideal solution Gain total scores using the Order Priority Technique through the (TOPSIS) approach Weights and performance scores are linked [36]. Classical is one of the best known methods for MCDM. The basic logic of TOPSIS, the best solution and Is to define the negative ideal solution. The best solution is to increase the cost criteria and cost The solution is to reduce the criteria, while the best solution to the negative is the cost criteria The solution is to increase and decrease the benefit criteria. In short, the ideal solution is by criteria Has all the best values achievable, whereas in the negative ideal solution criteria with all the worst values that can be achieved. Negative even the shortest distance from the best solution The optimal alternative is to have more distance from the ideal solution. In Sen's work, he is the best solution and developed the inherent values for the negative ideal solution based on the criteria. The best Negative optimal solution in default values and criteria for solution is always (1, 1, 1) and (0, 0, 0) respectively [37]. In this article, we look at the technique for order prioritization by unity for a Better Solution (TOPSIS) We will discuss the weights of DMs. The basic idea of TOPSIS is very straightforward. It is simultaneous Distance between Positive Ideal Solution (PIS) and Negative Ideal Solution (NIS) Considers, and an optional sequence of their relative proximity and the combination of these two distance measurements Is basically ranked. We define the positive best solution as the average of the group decision. Negative The ideal solution consists of two parts: the left and right negative ideal solution, which are the minimum and maximum teams of group decision, respectively.

Conclusion

The ability to improve all areas of decision making in engineering from design to manufacturing is multifaceted Contains decision-making (MCDM), but only for applications in high-tech market sectors Would be very useful. Very small gains in material performance. Performance evaluation is a The system for measuring an employee's work and results based on their work responsibilities and is defined as the production process. Best of all, employees celebrate their work year Will be graded annually, on the basis of which they are eligible for promotion or pay rise Distribution is provided. Fuzzy TOPSIS (Order Priority by Similarities to Ideal Solution) Technique) is one of the best ways to get the best solution out of similar options. It also helps to automate the process and the ambiguity and uncertainty in the selection process Can also be used for moving. The best solution is physics, which relates directly to the properties of the pure elements Is a homogeneous mixture of substances with properties. The classic statement of this condition is Rowlt As a rule, it is valid for many highly dilute solutions and a particular type of concentrated solution, viz. The relationships between solvent and solvent molecules are the same as between molecules Will be. Every object is itself. Multi-criterion decision making (MCDM) or multi-criterion decision Analysis (MCDA) is a subdivision of functional research that is involved in decision making (daily In life and in organizations such as business, government and medicine) with many conflicting criteria Apparently evaluates).

Reference

1. Behzadian, Majid, S. Khanmohammadi Otaghsara, Morteza Yazdani, and Joshua Ignatius. "A state-of the-art survey of TOPSIS applications." *Expert Systems with applications* 39, no. 17 (2012): 13051-13069.
2. Chen, Chen-Tung. "Extensions of the TOPSIS for group decision-making under fuzzy environment." *Fuzzy sets and systems* 114, no. 1 (2000): 1-9.

3. Nădăban, Sorin, Simona Dzitac, and Ioan Dzitac. "Fuzzy TOPSIS: a general view." *Procedia computer science* 91 (2016): 823-831.
4. Salih, Mahmood M., B. B. Zaidan, A. A. Zaidan, and Mohamed A. Ahmed. "Survey on fuzzy TOPSIS state-of-the-art between 2007 and 2017." *Computers & Operations Research* 104 (2019): 207-227.
5. Zavadskas, Edmundas Kazimieras, Abbas Mardani, Zenonas Turskis, Ahmad Jusoh, and Khalil MD Nor. "Development of TOPSIS method to solve complicated decision-making problems—An overview on developments from 2000 to 2015." *International Journal of Information Technology & Decision Making* 15, no. 03 (2016): 645-682.
6. de Lima Silva, Diogo Ferreira, and Adiel Teixeira de Almeida Filho. "Sorting with TOPSIS through boundary and characteristic profiles." *Computers & Industrial Engineering* 141 (2020): 106328.
7. Wang, Tien-Chin, and Hsien-Da Lee. "Developing a fuzzy TOPSIS approach based on subjective weights and objective weights." *Expert systems with applications* 36, no. 5 (2009): 8980-8985.
8. Wu, Cheng-Shiung, Chin-Tsai Lin, and Chuan Lee. "Optimal marketing strategy: A decision-making with ANP and TOPSIS." *International Journal of Production Economics* 127, no. 1 (2010): 190-196.
9. Vavrek, Roman. "Evaluation of the Impact of Selected Weighting Methods on the Results of the TOPSIS Technique." *International Journal of Information Technology & Decision Making* 18, no. 06 (2019): 1821-1843.
10. Zamri, Nurnadiah, Lazim Abdullah, Muhammad Suzuri Hitam, Noor Maizura Mohammad Noor, and Ahmad Jusoh. "A novel hybrid fuzzy weighted average for MCDM with interval triangular type-2 fuzzy sets." *WSEAS Transactions on Systems* 12, no. 4 (2013): 212-228.
11. Ballı, Serkan, and Serdar Korukoğlu. "Operating system selection using fuzzy AHP and TOPSIS methods." *Mathematical and Computational Applications* 14, no. 2 (2009): 119-130.
12. Kuo, Ting. "A modified TOPSIS with a different ranking index." *European journal of operational research* 260, no. 1 (2017): 152-160.
13. Dağdeviren, Metin, Serkan Yavuz, and Nevzat Kılınç. "Weapon selection using the AHP and TOPSIS methods under fuzzy environment." *Expert systems with applications* 36, no. 4 (2009): 8143-8151.
14. Shyur, Huan-Jyh. "COTS evaluation using modified TOPSIS and ANP." *Applied mathematics and computation* 177, no. 1 (2006): 251-259.
15. Jahanshahloo, Gholam Reza, F. Hosseinzadeh Lotfi, and A. R. Davoodi. "Extension of TOPSIS for decision-making problems with interval data: Interval efficiency." *Mathematical and Computer Modelling* 49, no. 5-6 (2009): 1137-1142.
16. Mahdavi, Iraj, Nezam Mahdavi-Amiri, Armaghan Heidarzade, and Rahele Nourifar. "Designing a model of fuzzy TOPSIS in multiple criteria decision making." *Applied Mathematics and Computation* 206, no. 2 (2008): 607-617.
17. Wang, Ying-Ming, and Taha MS Elhag. "Fuzzy TOPSIS method based on alpha level sets with an application to bridge risk assessment." *Expert systems with applications* 31, no. 2 (2006): 309-319.
18. Sun, Chia-Chi. "A performance evaluation model by integrating fuzzy AHP and fuzzy TOPSIS methods." *Expert systems with applications* 37, no. 12 (2010): 7745-7754.
19. Bai, Chunguang, Dileep Dhavale, and Joseph Sarkis. "Integrating Fuzzy C-Means and TOPSIS for performance evaluation: An application and comparative analysis." *Expert Systems with Applications* 41, no. 9 (2014): 4186-4196.
20. Seçme, Neşe Yalçın, Ali Bayrakdaroğlu, and Cengiz Kahraman. "Fuzzy performance evaluation in Turkish banking sector using analytic hierarchy process and TOPSIS." *Expert systems with applications* 36, no. 9 (2009): 11699-11709.
21. Ertuğrul, İrfan, and Nilsen Karakaşoğlu. "Performance evaluation of Turkish cement firms with fuzzy analytic hierarchy process and TOPSIS methods." *Expert Systems with Applications* 36, no. 1 (2009): 702-715.
22. Chu, T-C. "Selecting plant location via a fuzzy TOPSIS approach." *The International Journal of Advanced Manufacturing Technology* 20, no. 11 (2002): 859-864.
23. Yong, Deng. "Plant location selection based on fuzzy TOPSIS." *The International Journal of Advanced Manufacturing Technology* 28, no. 7 (2006): 839-844.
24. Chu, T-C., and Y-C. Lin. "A fuzzy TOPSIS method for robot selection." *The International Journal of Advanced Manufacturing Technology* 21, no. 4 (2003): 284-290.
25. Sun, Chia-Chi. "A performance evaluation model by integrating fuzzy AHP and fuzzy TOPSIS methods." *Expert systems with applications* 37, no. 12 (2010): 7745-7754.
26. Dymova, Ludmila, Pavel Sevastjanov, and Anna Tikhonenko. "An approach to generalization of fuzzy TOPSIS method." *Information Sciences* 238 (2013): 149-162.
27. Bottani, Eleonora, and Antonio Rizzi. "A fuzzy TOPSIS methodology to support outsourcing of logistics services." *Supply Chain Management: An International Journal* (2006).
28. Sun, Chia-Chi, and Grace TR Lin. "Using fuzzy TOPSIS method for evaluating the competitive advantages of shopping websites." *Expert Systems with Applications* 36, no. 9 (2009): 11764-11771.
29. Kannan, Devika, Ana Beatriz Lopes de Sousa Jabbour, and Charbel José Chiappetta Jabbour. "Selecting green suppliers based on GSCM practices: Using fuzzy TOPSIS applied to a Brazilian electronics company." *European Journal of operational research* 233, no. 2 (2014): 432-447.
30. Amiri, Morteza Pakdin. "Project selection for oil-fields development by using the AHP and fuzzy TOPSIS methods." *Expert systems with applications* 37, no. 9 (2010): 6218-6224.
31. Chu, Ta-Chung. "Facility location selection using fuzzy TOPSIS under group decisions." *International journal of uncertainty, fuzziness and knowledge-based systems* 10, no. 06 (2002): 687-701.

32. Awasthi, Anjali, Satyaveer S. Chauhan, and Hichem Omrani. "Application of fuzzy TOPSIS in evaluating sustainable transportation systems." *Expert systems with Applications* 38, no. 10 (2011): 12270-12280.

33. Jahanshahloo, Gholam Reza, F. Hosseinzadeh Lotfi, and Mohammad Izadikhah. "An algorithmic method to extend TOPSIS for decision-making problems with interval data." *Applied mathematics and computation* 175, no. 2 (2006): 1375-1384.

34. Abo-Sinna, Mahmoud A., and Azza H. Amer. "Extensions of TOPSIS for multi-objective large-scale nonlinear programming problems." *Applied Mathematics and Computation* 162, no. 1 (2005): 243-256.

35. Yurdakul*, Mustafa, and Y. Tansel Ic. "Development of a performance measurement model for manufacturing companies using the AHP and TOPSIS approaches." *International Journal of Production Research* 43, no. 21 (2005): 4609-4641.

36. Wang, Yu-Jie, and Hsuan-Shih Lee. "Generalizing TOPSIS for fuzzy multiple-criteria group decision-making." *Computers & Mathematics with Applications* 53, no. 11 (2007): 1762-1772.

37. Yue, Zhongliang. "A method for group decision-making based on determining weights of decision makers using TOPSIS." *Applied Mathematical Modelling* 35, no. 4 (2011): 1926-1936.

38. Dr. Amol Lokhande, Dr. C. Venkateswaran, Dr. M. Ramachandran, C. Vidhya, R. Kurinjimalar, A Study on Various Implications on Reusing in Manufacturing, REST Journal on Emerging trends in Modelling and Manufacturing 7(2), 2021,63-69.

39. Dr. Amol Lokhande, Dr. C. Venkateswaran, Dr. M. Ramachandran, S. Chinnasami, T. Vennila, A Review on Various Implications on Re engineering in Manufacturing, REST Journal on Emerging trends in Modelling and Manufacturing Vol: 7(3), 2021,70-75.

40. Dr. Amol Lokhande, Dr. C. Venkateswaran, Dr. M. Ramachandran, C. Sathiyaraj, K. Nathiya, Recycling Process Impact in Current Scenario Manufacturing: A Study, Recent trends in Management and Commerce Vol: 2(1), 2021, 20-25.

41. Gadde Mehar Chaitanya, M.P.Jenarthanan, C. Sathiyaraj, A Review on Glass fibre Reinforced Composites with Different Matrix, REST Journal on Emerging trends in Modelling and Manufacturing Vol: 7(1), 2021, 18-24.

42. R. Kurinjimalar, S. Vimala, M. Silambarasan, S. Chinnasami, A Review on Coir fibre Reinforced Composites with Different Matrix, REST Journal on Emerging trends in Modelling and Manufacturing Vol: 7(2), 2021, 25-32.

43. P. K. Chidambaram, Dr. Amol Lokhande, Dr. M. Ramachandran, Vimala Saravanan, Vidhya Prasanth, A Review on Biodiesel Properties and Fatty acid composites, REST Journal on Emerging trends in Modelling andManufacturing Vol: 7(3), 2021, 87-93.

44. Dheenadhayalan, V. "An Analysis of Financial Health of Select Indian Bulk Drugs and Formulations Companies* Mrs. R. Selvi."

45. Dheenadhayalan, V., and R. Devianbarasi. "Financial health of cooperative sugar mills-a case study of NPKRR cooperative sugar mill ltd." Indian Cooperative Review 46, no. 3 (2009): 192-197.

46. Banana, K. R. I. S. H. N. A., and R. V. Chepuri. "Role of recovery channels in managing non-performing assets in scheduled commercial banks." International Journal for Innovative Research in Multidisciplinary Field 2, no. 10 (2016): 355-359.

47. Dheenadhayalan, V. "Mudra-A Tool for Uplifting Micro Enterprises in India." International Journal in Management & Social Science 4, no. 12 (2016): 235-246.

48. Dheenadhayalan, V., and D. Rajaprabu. "Loan Assets in New Private Sector Banks in India." Asian Journal of Management 5, no. 3 (2014): 347-353.

49. Dheenadhayalan, V. "Mudra-A Tool for Uplifting Micro Enterprises in India." International Journal in Management & Social Science 4, no. 12 (2016): 235-246.

50. Dheenadhayalan, V. "Impact of E-Commerce on the Changes in Consumer's Buying Behaviour in Malappuram District." Annals of the Romanian Society for Cell Biology (2021): 3441-3452.

51. Dheenadhayalan, V., and R. Shanmuga Priya. "Influencing Factors on Purchase Decision of Women Two-Wheeler Users." Annals of the Romanian Society for Cell Biology (2021): 3430-3440.