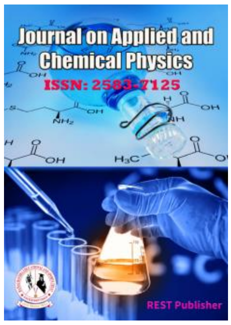
Journal on Applied and Chemical Physics

Vol: 2(3), September 2023

REST Publisher; ISBN: 2583-7125

Website: https://restpublisher.com/journals/jacp/

DOI: https://doi.org/10.46632/jacp/2/3/3



Optimal Selection of Cotton Fabrics: A WASPAS Method Approach

***Manjula Selvam, Ramya Sharma, M. Ramachandran, Vimala Saravanan**

REST Labs, Kaveripattinam, Krishnagiri, Tamil Nadu, India.

*Corresponding author Email: manjulaselvam2016@gmail.com

Abstract: *Always used for cotton-rich materials. WASPAS Cotton Fabric Selection in this paper, "the WASPAS method, a relatively fresh and computationally powerful MCDM (Multi-Criteria Decision Making) tool", is suggested to rank ten candidate cotton fabrics according to four cloth properties such as: "cover, thickness, area density, and permeability". The suggested fabrics are evaluated and chosen in order to achieve the best thermal comfort characteristics. "Sample Number 3 ranks first (best option) with the highest evaluation score of 0.95281, while Sample Number 6 ranks tenth with the lowest evaluation score of 0.50685." The proposed method's ranking results demonstrate a substantial agreement in ranking with previous approaches, as evidenced by the extremely high standard coefficients of correlation. With rank coefficients of correlation higher than 0.90, the ranking methods provided by the four hypothetical weight sets have the highest degree of agreement. Furthermore, even if the original making choices team is changed, that will be no rank reversal. As a result, sensitivity analyses based on altering criterion weights and the impact of dynamic matrices improve the proposed approach's stability and robustness in terms of ranking success.*

Keywords: *cotton-rich materials Cotton fabric, MCDM methods*

1. INTRODUCTION

Cotton cloth may outperform competitors in a particular attribute while being inferior in a different one. As a result, it is nearly impossible to have a specific fabric made of cotton with all physical characteristics as its support. For particular cotton fabric properties, higher values are desired, while lower ones are always preferred. Several conflicting fabric characteristics must be considered concurrently during the cotton fabric selection procedure. The best cotton fabric ought to possess a well-balanced and reasonable mix of all the properties under consideration. Clothing is referred to as man's second flesh because it serves as a protective layer against adverse environmental circumstances and allows the body's natural thermoregulatory system to function, which always aids in maintaining thermal balance/equilibrium between the skin as well as the atmosphere. Any type of fiber for clothing must be resilient, have adequate dimension stability during repetitive laundering, suit our body lines, and not fade while cleaned or washed. To ensure the wearer's optimum comfort. Fabric comfort is a multifaceted phenomenon that involves the physiological and bodily balance that happens between the surroundings and the human body. One of the most essential properties of textiles is warmth, which is closely related to clothing comfort. Heat and mass transfer behavior governs thermo-physiological clothing ease. The heat and moisture transfer process of fabric for clothing is critical in preserving thermo physiological comfort, and A variety of factors impact it, including fiber type, yarn properties, construction and fabric thickness, final treatments, and clothing conditions. Cover factor, porosity, bulk density (GSM), and width are all fabric characteristics that have a direct impact on garment comfort. Choosing the best cotton fabric from the many options available to satisfy the end-user requirements is a difficult task. In most instances, this selection entails determining the best alternative based on multiple physical characteristics that are inherently conflicting. Cotton fabric grading and choosing based on its physical characteristics is a common decision-making issue with many competing choice criteria. Another common MCDM issue is choosing cotton fabric to satisfy specified end criteria. To handle these types of selection problems, several tools and techniques for multi-criteria decision-making (MCDM) have been created.

"Many researchers have used various layers of multiple criteria decision making (MCDM) techniques to solve these types of fabric selection problems. Öztürk, Nergis, and Candan (2011) investigated the effect of fiber composition, yarn twist, and yarn ply on the comfort behavior of wool/acrylic blended fabrics. They used the technique of order preference by similarity to optimal solution (TOPSIS) to select the most suitable fabric based on the best comfort properties. Alam and Ghosh (2013) carried out fabric selection by evaluating thermal comfort index of fabrics, i.e. considering four physical fabric criteria namely fabric cover, thickness, areal density and porosity. After determining the weights of the considered criteria and applying the Analytical Hierarchy Process (AHP), the final selection or evaluation based on the fabric thermal comfort index was made by TOPSIS. Mitra (2013) used AHP method to rank and select the best alternative based on quality value from a set of 25 handloom cotton fabrics. In a later work, Mitra et al (2015) used both AHP and multiplicative AHP approaches to select the best alternative for 25 handloom cotton fabrics for summer wear. Chakraborty, Chatterjee and Das (2019) used a combined approach of gray correlation analysis and fuzzy logic to solve the above two cotton fabric selection problems by Alam and Ghosh (2013) and Mitra et al (2015)." According to the ongoing discussion, "fabric selection to meet specific end-use requirements determined by specific fabric properties has been an area of growing research interest over the years, and multiple popular layers of the MCDM have been successfully applied. In this paper, a first method of dealing with these cotton fabric selection issues is developed, and the efficacy of the suggested approach is contrasted to the prior strategy, followed by a sensitivity evaluation".

2. MATERIALS AND METHODS

Our primary criterion is that our clothes last more than a single season. Our garments should maintain their original shape and not expand or shrink over time. They should suit our body shape and not alter or restrict our movements. After a few applications or washes, the cloth will not pill or fade. We want our clothes to feel good against our skin so that we can appreciate them to the fullest [1]. A fabric's comfort is defined by several characteristics, including heat, vapor, and air transfer, a warm or cool sensation to the contact, absorbency, as well as wipe ability [2]. The type of raw substance, structural properties, and other factors all have an impact on these comfort properties and relevant process parameters. The study of available fabric properties will aid in evaluating the behavior of the fabric under consideration during its actual use. Choosing the best fabric made of cotton to achieve a set of preset goals specifications is a difficult job because it necessitates selecting the most suitable material from a pool of available options. The task of choosing the best fabric made of cotton to satisfy a set of preset end requirements is deemed complex because it involves selecting the most suitable material from a set of readily accessible alternatives that must be evaluated against several clashing physical characteristics. Cotton cloth may outperform competitors in one property and be inferior in another. As a consequence, it is nearly impossible to create a cotton fabric that uses all of its physical properties to its advantage. Higher values are chosen for some cotton fabrics, while smaller amounts are always favored for others. During the cotton material selection process, several conflicting fabric characteristics must be evaluated at the same time. All properties under evaluation should be well-balanced and reasonable in the best cotton fabric. To address these selection issues, various multi-criteria decision-making (MCDM) techniques and tools have been created.
The WASPAS method has two well-known uses. MCDM is a one-of-a-kind combination of two methods, WSM and WPM. Basically A unified criterion is desired. The WSM method is similar to the first measure of the best performance, i.e. the joint average achievement criteria. It is a popular and widely used MCDM method for weighing multiple alternatives against multiple decision criteria. Zavatskas et al. developed and refined the WASPAS and MCDM methods. This technique was applied to and extended in a large number of decision problems and contexts. Improved construction for a deep marine port to choose a location an integrated multi-criteria decision-making model was demonstrated using the WASPAS technique. In 2012, "WASPAS, one of the robust novel MCDM application deterministic approaches, was proposed for the first time. This technique combines the Weighted Product Model (WPM) and the Weighted Sum Model (WSM)". Which suggested and supported the WASPAS approach; its accuracy is higher than that of WPM and WSM. This novel method was suggested, and it was proven that the combined method outperforms other approaches. Recently, "several studies conducted using the WASPAS method are presented in the following scholars: Bagocius, Zavadskas and Turskis [160] used WASPAS to select a deep water port; Staniunas, Medinekinek, Savatskas, and Kalipatas [161] used WASPAS for an eco-economic assessment of the modernization of several residential houses; Zavadskas, Antucheviciene, Šaparuuskas and Turskis used WASPAS to evaluate facade alternatives; Zavadskas, Antucheviciene, Saparauskas, and Turskis used WASPAS to verify the robustness of methods for evaluating alternative solutions; Bitarafan, Zolfani, Arefi, Zavadskas and Mahmoudzadeh used WASPAS to evaluate real-time intelligent sensors for structural health monitoring of bridges; Dėjus and Antuchevičienė [165] used it to assess health and safety solutions at a construction site; and Hashemkhani Zolfani, Aghdaie, Derakhti, Zavadskas, and Morshed Varzandeh [166] used WASPAS for decision making regarding business problems in foresight."

3. RESULTS AND DISCUSSION

In In this article, the WASPAS technique is used to answer the cotton material selection problem using published cloth data for optimum Fabric relaxation characteristics. Alam and Ghosh's data collection was adapted (2013), "who investigated 10 cotton fabric samples and conducted or evaluated substitute ranking based on cover (FC), thickness (T), areal density (AD), and four fabric physical characteristics". Based on the optimum thermal comfort level, porosity (B) is calculated. Employing the AHP method, "the relative importance or weights of the four fabric attributes / criteria were estimated to be 0.221, 0.322, 0.186, and 0.271". The WASPAS approach was used to conduct a final assessment of candidate fabrics. Model 3 of the fabric was chosen as the best choice (ranked 1), while model 5 was chosen as the worst. Needless to say, "each of the four attributes/characteristics is regarded as beneficial (better-better type) criteria, since they all have a direct impact on clothing thermal comfort. Table 1 displays the relevant data for this fabric selection issue. The relevant decision matrix for the present selection problem is shown in Table 1, which contains ten fabric candidates labeled S1, S2,..., and S10". FC, T, AD, and P are all advantageous (best-in-class) factors and there are no cost/benefit (low-best category) criteria. This is a difficult decision issue because the efficiency values of the accessible solutions/alternatives are not just very close to each other but also contradictory in regard to the attributes/criteria taken into account. However, in order to compute the score for each of the alternatives, relative importance or weights must be given to all of the qualities ahead of time. Weights calculated with the WASPAS method are also used in this strategy for comparative analysis.

TABLE 1. A data set having scores for various cotton fabric properties

Fabric samples	Fabric over [FC]	Thickness (mm)[T]	Areal density (g/m2) [AD]	Porosity [P]
S1	0.94	0.44	151	0.77
S2	0.957	0.32	169	0.65
S3	0.979	0.95	534	0.63
S4	0.881	0.37	173	0.69
S5	0.906	0.28	151	0.64
S6	0.917	0.23	144	0.58
S7	0.918	0.31	161	0.65
S8	0.923	0.29	166	0.62
S9	0.93	0.42	292	0.54
S10	0.944	0.32	210	0.56

Table 1 illustrates the set of data used to calculate "the final value of Fabric over [FC], Thickness (mm) [T], Areal density (g/m2) [AD], and Porosity [P] of Fabric samples S1, S2, S3, S4, S5, S6, S7, S8, S9, and S10".

TABLE 2. Performance value

Fabric samples	Fabric over [FC]	Thickness (mm)[T]	Areal density (g/m2) [AD]	Porosity [P]
S1	0.96016	0.46316	0.28277	1.00000
S2	0.97753	0.33684	0.31648	0.84416
S3	1.00000	1.00000	1.00000	0.81818
S4	0.89990	0.38947	0.32397	0.89610
S5	0.92543	0.29474	0.28277	0.83117
S6	0.93667	0.24211	0.26966	0.75325
S7	0.93769	0.32632	0.30150	0.84416
S8	0.94280	0.30526	0.31086	0.80519
S9	0.94995	0.44211	0.54682	0.70130
S10	0.96425	0.33684	0.39326	0.72727

Table 2 gives the end value of the Performance value of "Fabric over [FC], Thickness (mm) [T], Areal density (g/m2) [AD], and Porosity [P] of Fabric samples S1, S2, S3, S4, S5, S6, S7, S8, S9, and S10".

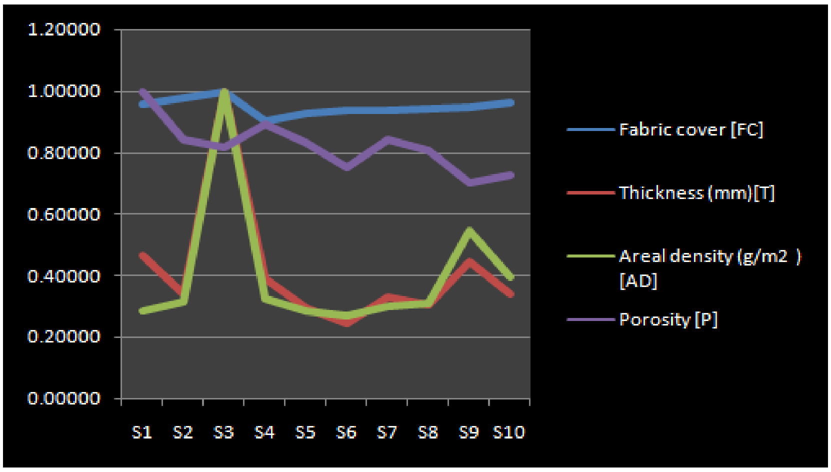


FIGURE 1. Performance value

Figure 1 shows the end value of the Performance value of "Fabric over [FC], Thickness (mm) [T], Areal density (g/m2) [AD], and Porosity [P] of Fabric samples S1, S2, S3, S4, S5, S6, S7, S8, S9, and S10".

TABLE 3. Weighted

Fabric samples	Fabric cover[FC]	Thickness (mm)[T]	Areal density (g/m2) [AD]	Porosity [P]
S1	0.221	0.322	0.186	0.271
S2	0.221	0.322	0.186	0.271
S3	0.221	0.322	0.186	0.271
S4	0.221	0.322	0.186	0.271
S5	0.221	0.322	0.186	0.271
S6	0.221	0.322	0.186	0.271
S7	0.221	0.322	0.186	0.271
S8	0.221	0.322	0.186	0.271
S9	0.221	0.322	0.186	0.271
S10	0.221	0.322	0.186	0.271

Table 3 displays the weights of the data collection, where the weight is equal to "the fabric cover values, thickness values, areal density values," and porosity values in Table 1. The weight is multiplied with the previous table to get the next value.

TABLE 4. WSM weighted standardized decision matrix

Fabric samples	Fabric cover [FC]	Thickness (mm)[T]	Areal density (g/m2) [AD]	Porosity [P]
S1	0.21220	0.14914	0.05260	0.27100
S2	0.21603	0.10846	0.05887	0.22877
S3	0.22100	0.32200	0.18600	0.22173
S4	0.19888	0.12541	0.06026	0.24284
S5	0.20452	0.09491	0.05260	0.22525
S6	0.20700	0.07796	0.05016	0.20413
S7	0.20723	0.10507	0.05608	0.22877
S8	0.20836	0.09829	0.05782	0.21821
S9	0.20994	0.14236	0.10171	0.19005
S10	0.21310	0.10846	0.07315	0.19709

"The weighted normalized decision matrix for WSM for the cotton Fabric using the WASPAS method is shown in Table 2, which is computed by dividing the value in the dataset by the highest value of a given value in the dataset."

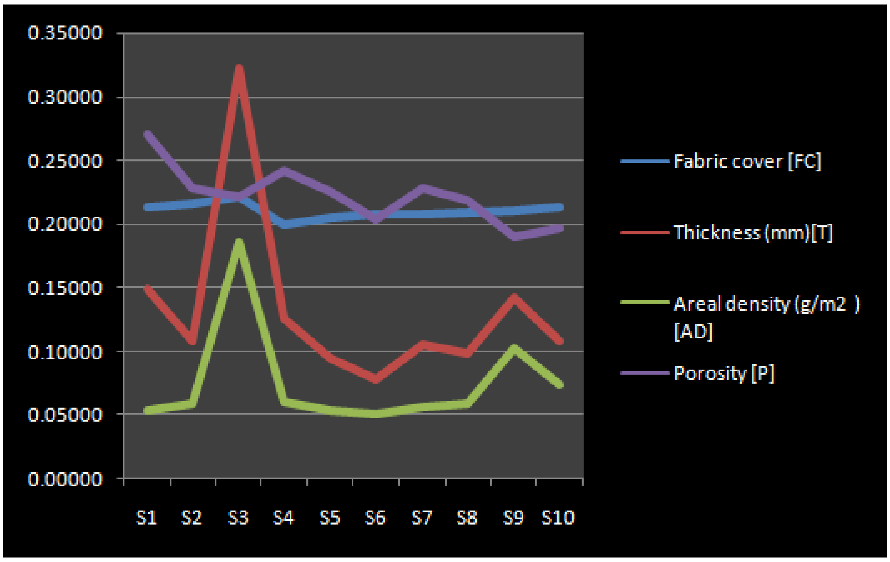


FIGURE 2. WSM weighted standardized decision matrix

"The weighted normalized decision matrix for WSM of the cotton Fabric using the WASPAS method is shown in Figure 2, which is computed by dividing the value in the dataset by the maximum value of a given value in the dataset."

TABLE 5. Weighted normalized decision matrix for WPM

Fabric samples	Fabric cover [FC]	Thickness (mm)[T]	Areal density (g/m2) [AD]	Porosity [P]
S1	0.99106	0.78049	0.79062	1.00000
S2	0.99499	0.70442	0.80735	0.95513
S3	1.00000	1.00000	1.00000	0.94707
S4	0.97696	0.73813	0.81087	0.97071
S5	0.98302	0.67477	0.79062	0.95112
S6	0.98565	0.63336	0.78367	0.92608
S7	0.98588	0.69725	0.80010	0.95513
S8	0.98707	0.68244	0.80467	0.94297
S9	0.98872	0.76888	0.89380	0.90832
S10	0.99199	0.70442	0.84064	0.91732

"The weighted normalized decision matrix for WPM of cotton Fabric using the WASPAS method is shown in Table 2, which is computed by dividing the value in the dataset by the maximum value of a given value in the dataset."

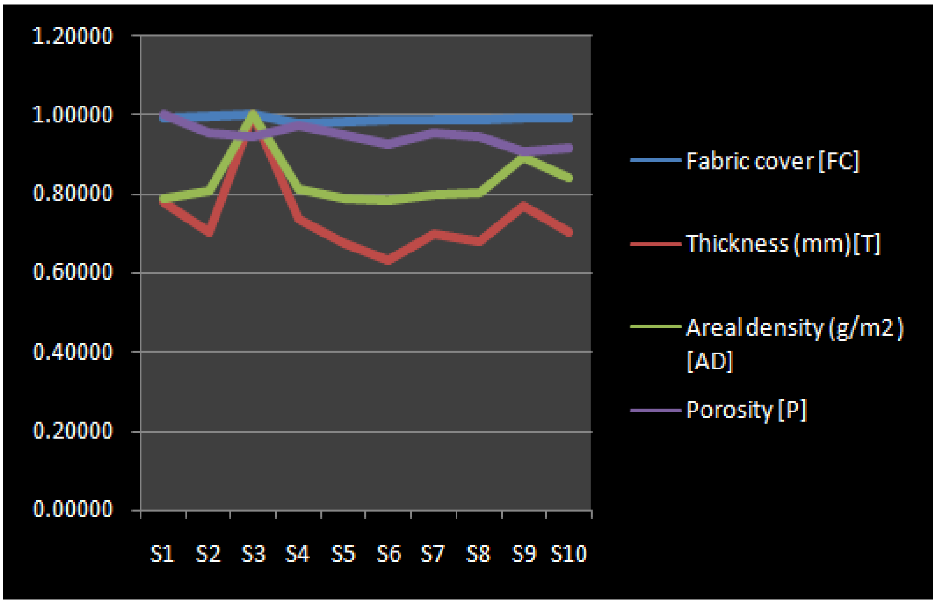


FIGURE 3. Weighted normalized decision matrix WPM

'Figure 2 depicts the weighted normalized decision matrix for WPM of cotton Fabric using the WASPAS technique, which is calculated by dividing the value in the dataset by the maximum value of a given value in the dataset'.

TABLE 6.WSM and WPM Weighted sum Model value and WASPAS Coefficient

Fabric samples	WSM Weighted sum Model value	WPM Weighted sum Model value	WASPAS Coefficient
S1	0.684928	0.611547	0.648238
S2	0.612128	0.540474	0.576301
S3	0.950727	0.94707	0.948899
S4	0.627391	0.567615	0.597503
S5	0.577268	0.498796	0.538032
S6	0.539249	0.453057	0.496153
S7	0.597148	0.52532	0.561234
S8	0.582681	0.511126	0.546904
S9	0.644056	0.617176	0.630616
S10	0.591799	0.538849	0.565324

Table 6 displays the WSM weighted sum model's preference score, which is determined by adding the values in the rows of the weighted normalized result matrix. The WPM weighted product model's priority score is computed by multiplying the number found in the row Matrix of weighted adjusted results. The WASPAS coefficient is calculated by multiplying the WPM and WSM by the lambda value (0.5). Later WPM and WSM will be added.

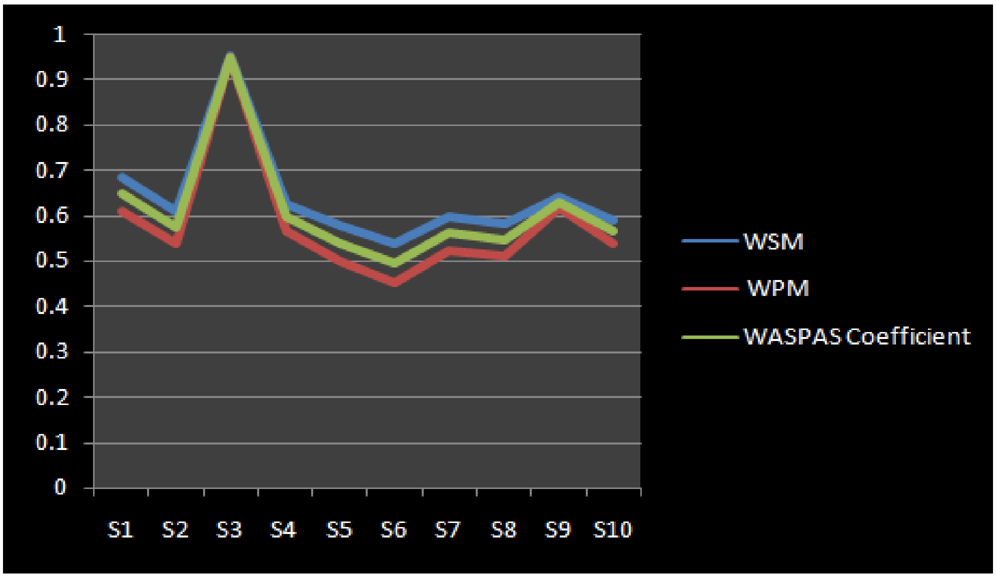


FIGURE 4. WSM , WPM and WASPAS Coefficient

Figure 5 depicts the WSM weighted sum model's preference score, which is determined by summing the values in the matrix's rows. WPM is a weighted priority score product model that is determined by multiplying the value in the row by the number of rows. Matrix of weighted adjusted results. WPM and WSM computation.

TABLE 7. Ranking

S1	2
S2	5
S3	1
S4	4
S5	9
S6	10
S7	7
S8	8
S9	3
S10	6

Table 9 given the rank of the data set S3 is on 1st rank, S1 is on 2nd rank, S9 is on 3rd rank, S4 is on 4th rank, S2 is on 5th rank, S10 is on 6th rank, S7 is on 7th rank, S8 is on 8th rank, S5 is on 9th rank and A1 is on 10th rank.

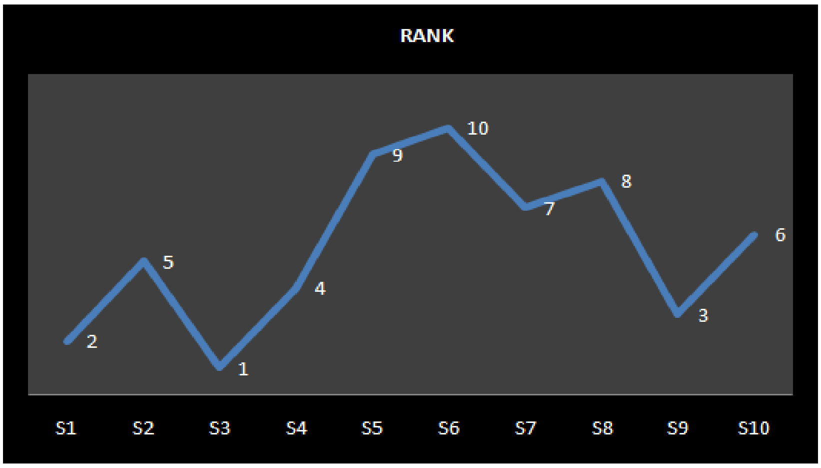


FIGURE 5. Rank for the data set Inter-company comparison

Figure 7 shows the rank of the data set S3 is on 1st rank, S1 is on 2nd rank, S9 is on 3rd rank, S4 is on 4th rank, S2 is on 5th rank, S10 is on 6th rank, S7 is on 7th rank, S8 is on 8th rank, S5 is on 9th rank and A1 is on 10th rank.

4. CONCLUSION

The WASPAS approach, a relatively fresh and computationally powerful tool of the MCDM method, can be seen step by step for rating and thus choosing ten potential cotton fabrics based on all four fabrics to achieve optimal thermal properties. Cover, thickness, areal density, and permeability are examples of parameters/properties. Fabric sample S3 ranks first (most favored option) with an evaluation score of 0.9838, while sample S6 ranks tenth with an evaluation score of 0.49615. The suggested method's performance and stability are further investigated using different sensitivity analyses. “The sensitivity analysis findings based on changing the weights of the criteria demonstrate unequivocally that the proposed WASPAS method is extremely stable even when the weights of the attributes/criteria are changed”. Model S3 achieves rank 1 for all four ranking methods with four sets of weights produced, and model S6 achieves rank 10, which is similar to the parameter weights' actual/original ranking. The overall ranking patterns produced by the four fictitious/simulated pounds sets are strikingly identical. as demonstrated by extremely high standard correlation coefficients. Furthermore, the suggested WASPAS model can be utilized for handling other multi-criteria decision analysis issues because it is adaptable and straightforward while remaining mathematically robust.

REFERENCE

[1]. Mitra, Ashis. "Selection of Khadi fabrics for optimal comfort properties using multi-criteria decision-making technique." *Research Journal of Textile and Apparel* 27, no. 1 (2023): 118-140.
[2]. Chakraborty, Shankar, Prasenjit Chatterjee, and Partha Protim Das. "Cotton fabric selection using a grey fuzzy relational analysis approach." *Journal of the Institution of Engineers (India): Series E* 100 (2019): 21-36.
[3]. Ghorabaee, Mehdi Keshavarz, Edmundas Kazimieras Zavadskas, Maghsoud Amiri, and Ahmad Esmaeili. "Multi-criteria evaluation of green suppliers using an extended WASPAS method with interval type-2 fuzzy sets." *Journal of Cleaner Production* 137 (2016): 213-229.
[4]. Tasisa, Yirgalem Bekele, and Kogila Palanimuthu. "Psychosocial Impacts of Imprisonment among Youth Offenders in Correctional Administration Center, Kellem Wollega Zone, Ethiopia." *Medico-legal Update* 21, no. 2 (2021).
[5]. Sridharan, Sujatha. "Assimilating Novel Perspectives of Complimentary Feeding among Mothers of Infants." *Indian Journal of Public Health Research & Development* 11, no. 4 (2020).
[6]. Zhang, P., Y. Watanabe, S. H. Kim, H. Tokura, and R. H. Gong. "Thermoregulatory responses to different moisture-transfer rates of clothing materials during exercise." *Journal of the Textile Institute* 92, no. 1 (2001): 372-378.
[7]. Varesano, Alessio, Annalisa Aluigi, Luca Florio, and Riccardo Fabris. "Multifunctional cotton fabrics." *Synthetic Metals* 159, no. 11 (2009): 1082-1089.
[8]. Kalliala, Eija M., and Pertti Nousiainen. "Environmental profile of cotton and polyester-cotton fabrics." *AUTEX Research Journal* 1, no. 1 (1999): 8-20.
[9]. Palanimuthu, Kogila, Eshetu Fikadu Hamba Yigazu, Gemechu Gelalcha, Yirgalem Bekele, Getachew Birhanu, and Birhanu Gutu. "Assessment of stress, fear, anxiety and depression on COVID-19 outbreak among adults in South-Western Ethiopia." *Prof.(Dr) RK Sharma* 21, no. 1 (2021): 440.
[10]. Bawa, Surjit Singh. "Implement gamification to improve enterprise performance." *International Journal of Intelligent Systems and Applications in Engineering* 11, no. 2 (2023): 784-788.

[11]. Ponnada, Venkata Tulasiramu, and SV Naga Srinivasu. "Efficient CNN for lung cancer detection." *Int J Recent Technol Eng* 8, no. 2 (2019): 3499-505.
[12]. Dehabadi, Vahid Ameri, Hans-Jürgen Buschmann, and Jochen Stefan Gutmann. "Durable press finishing of cotton fabrics: An overview." *Textile Research Journal* 83, no. 18 (2013): 1974-1995.
[13]. Liu, Yuyang, John Haozhong Xin, and Chang-Hwan Choi. "Cotton fabrics with single-faced superhydrophobicity." *Langmuir* 28, no. 50 (2012): 17426-17434.
[14]. Kogila, P. "Prevention of home accidents among mothers of toddler." *The Journal of Nursing Trendz* 8, no. 3 (2017): 15-17.
[15]. Xin, John Haozhong, W. A. Daoud, and Y. Y. Kong. "A new approach to UV-blocking treatment for cotton fabrics." *Textile Research Journal* 74, no. 2 (2004): 97-100.
[16]. Palanimuthu, Kogila, Birhanu Gutu, Leta Tesfaye, BuliYohannis Tasisa, Yoseph Shiferaw Belayneh, Melkamu Tamiru, and Desalegn Shiferaw. "Assessment of Awareness on COVID-19 among Adults by Using an Online Platform: 26 Countries View." *Medico-legal Update* 21, no. 1 (2021).
[17]. Ponnada, Venkata Tulasiramu, and SV Naga Srinivasu. "Integrated clinician decision supporting system for pneumonia and lung cancer detection." *International Journal of Innovative Technology and Exploring Engineering (IJITEE)* (2019).
[18]. Yadav, A., Virendra Prasad, A. A. Kathe, Sheela Raj, Deepti Yadav, C. Sundaramoorthy, and N. Vigneshwaran. "Functional finishing in cotton fabrics using zinc oxide nanoparticles." *Bulletin of materials Science* 29, no. 6 (2006).
[19]. Riaz, S., M. Ashraf, T. Hussain, M. T. Hussain, A. Younus, M. Raza, and A. Nosheen. "Selection and Optimization of Silane Coupling Agents to Develop Durable Functional Cotton Fabrics Using TiO 2 Nanoparticles." *Fibers and Polymers* 22 (2021): 109-122.
[20]. Aswini, S., S. Tharaniya, R. J. Joey Persul, B. Avinash Lingam, and P. Kogila. "Assessment of Knowledge, Attitude and Practice on Immunization among Primi Mothers of Children." *Indian Journal of Public Health Research & Development* 11, no. 3 (2020).
[21]. Bawa, Surjit Singh. "Implementing Text Analytics with Enterprise Resource Planning." *International Journal of Simulation--Systems, Science & Technology* 24, no. 1 (2023).
[22]. Balaguru S, Vela Murali & Chellapandi P & Manoj Gupta 2020, Effect of Dilution on Micro Hardness of Ni-Cr-B-Si alloy Hardfaced on Austenitic Stainless Steel plate, Nuclear Engineering and Technology, vol. 52, pp. 589-596. (IF: 2.817, CS: 4.2, SCI, Elsevier) https://doi.org/10.1016/j.net.2019.08.011
[23]. Alam, Md Samsu, and Anindya Ghosh. "Selection of cotton fabrics for optimal comfort properties using multi-criteria decision making." *Journal of Textile and Apparel, Technology and Management* 8, no. 3 (2013).
[24]. Jisha, L., P. Jayaprabha, S. Gnanawel, K. Gowtham Kumar, and P. Kogila. "Assessment of the Prevalence of Febrile Seizure and Associated Factors among Children: A Retrospective Study." *EXECUTIVE EDITOR* 11, no. 03 (2020): 3179.
[25]. Chakraborty, Shankar, and Prasenjit Chatterjee. "A developed meta-model for selection of cotton fabrics using design of experiments and TOPSIS method." *Journal of the Institution of Engineers (India): Series E* 98 (2017): 79-90.
[26]. Chakraborty, Shankar, Prasenjit Chatterjee, and Partha Protim Das. "Cotton fabric selection using a grey fuzzy relational analysis approach." *Journal of the Institution of Engineers (India): Series E* 100 (2019): 21-36.
[27]. Loh, Tiffany Y., Aleksi J. Hendricks, Jennifer L. Hsiao, and Vivian Yan Shi. "Undergarment and fabric selection in the management of hidradenitis suppurativa." *Dermatology* 237, no. 1 (2021): 119-124.
[28]. Ponnada, Venkata Tulasiramu, and S. V. Naga Srinivasu. "Edge AI system for pneumonia and lung cancer detection." *Int J Innov Technol Exploring Eng* 8, no. 9 (2019).
[29]. Mandala, Vishwanadham, T. Senthilnathan, S. Suganyadevi, S. Gobhinath, DhanaSekaran Selvaraj, and R. Dhanapal. "An optimized back propagation neural network for automated evaluation of health condition using sensor data." *Measurement: Sensors* 29 (2023): 100846.
[30]. Bawa, Surjit Singh. "How Business can use ERP and AI to become Intelligent Enterprise." *vol* 8 (2023): 8-11.
[31]. Potey, Pranita Manish, and Kushal Tuckley. "Design of wearable textile antenna with various substrate and investigation on fabric selection." In *2018 3rd international conference on microwave and photonics (ICMAP)*, pp. 1-2. IEEE, 2018.
[32]. Mitra, Ashis, Abhijit Majumdar, Anindya Ghosh, Prabal Kumar Majumdar, and Debamalya Bannerjee. "Selection of handloom fabrics for summer clothing using multi-criteria decision making techniques." *Journal of Natural Fibers* 12, no. 1 (2015): 61-71.
[33]. Chakraborty, Shankar, and Edmundas Kazimieras Zavadskas. "Applications of WASPAS method in manufacturing decision making." *Informatica* 25, no. 1 (2014): 1-20.
[34]. Balaguru S, Mohammad Abid & Manoj Gupta 2020, Investigations on different hardfacing processes for High temperature applications of Ni-Cr-B-Si alloy hardfaced on austenitic stainless steel components, Journal of Materials Research and Technology, vol. 9, pp. 10062-10072. (IF: 6.4, SCI, Elsevier) https://doi.org/10.1016/j.jmrt.2020.07.010
[35]. Ghorabaee, Mehdi Keshavarz, Edmundas Kazimieras Zavadskas, Maghsoud Amiri, and Ahmad Esmaeili. "Multi-criteria evaluation of green suppliers using an extended WASPAS method with interval type-2 fuzzy sets." *Journal of Cleaner Production* 137 (2016): 213-229.
[36]. Bawa, Surjit Singh. "Enhancing Usability and User Experience in Enterprise Resource Planning Implementations."
[37]. Mardani, Abbas, Mehrbakhsh Nilashi, Norhayati Zakuan, Nanthakumar Loganathan, Somayeh Soheilirad, Muhamad Zameri Mat Saman, and Othman Ibrahim. "A systematic review and meta-Analysis of SWARA and WASPAS methods: Theory and applications with recent fuzzy developments." *Applied Soft Computing* 57 (2017): 265-292.
[38]. Bijanvand, Sajad, Mirali Mohammadi, Abbas Parsaie, and Vishwanadham Mandala. "Modeling of discharge in compound open channels with convergent and divergent floodplains using soft computing methods." *Journal of Hydroinformatics* 25, no. 5 (2023): 1713-1727.
[39]. Shatjit yadav; M. Ramachandran; Chinnasami Sivaji; Vidhya Prasanth; Manjula Selvam, "Investigation of Various Solar Photovoltaic Cells and its limitation", Renewable and Nonrenewable Energy, 1(1), 2022, 22-29.
[40]. Rudnik, Katarzyna, Grzegorz Bocewicz, Aneta Kucińska-Landwójtowicz, and Izabela D. Czabak-Górska. "Ordered fuzzy WASPAS method for selection of improvement projects." *Expert Systems with Applications* 169 (2021): 114471.

[41]. Herath, Madhawa, Tharaka Jayathilaka, Hazi Mohammad Azamathulla, Vishwanadham Mandala, Namal Rathnayake, and Upaka Rathnayake. "Sensitivity analysis of parameters affecting wetland water levels: A study of flood detention basin, Colombo, Sri Lanka." *Sensors* 23, no. 7 (2023): 3680.
[42]. Pravin R Lokhande, Balaguru S 2020, 'The Quantification of Percentage Filling of Gutta-percha in Obturated Root Canal using Image Processing and Analysis', Journal of Oral Biology and Craniofacial Research, vol.10, pp. 28-32. (H-index 28, CS: 4.2, Scopus, Elsevier) https://doi.org/10.1016/j.jobcr.2020.01.008
[43]. Bawa, Surjit Singh. "Automate Enterprise Resource Planning with Bots."
[44]. Badalpur, Mohammadreza, and Ehsan Nurbakhsh. "An application of WASPAS method in risk qualitative analysis: A case study of a road construction project in Iran." *International Journal of Construction Management* 21, no. 9 (2021): 910-918.
[45]. Tuş, Ayşegül, and Esra Aytaç Adalı. "The new combination with CRITIC and WASPAS methods for the time and attendance software selection problem." *Opsearch* 56, no. 2 (2019): 528-538.
[46]. Ponnada, Venkata Tulasiramu, and SV Naga Srinivasu. "End to End System for Pneumonia and Lung Cancer Detection using Deep Learning." *Int. J. Eng. Adv. Technol* 8 (2019).
[47]. Sellamuthu, Suseela, Srinivas Aditya Vaddadi, Srinivas Venkata, Hemant Petwal, Ravi Hosur, Vishwanadham Mandala, R. Dhanapal, and Jagendra singh. "AI-based recommendation model for effective decision to maximise ROI." *Soft Computing* (2023): 1-10.
[48]. Dr. N. subash, M. Ramachandran, Vimala Saravanan, Vidhya prasanth,, "An Investigation on Tabu Search Algorithms Optimization", Electrical and Automation Engineering 1(1) 2022, 13-20.
[49]. Lashgari, Shima, Jurgita Antuchevičienė, Alireza Delavari, and Omid Kheirkhah. "Using QSPM and WASPAS methods for determining outsourcing strategies." *Journal of Business Economics and Management* 15, no. 4 (2014): 729-743.
[50]. Mishra, Arunodaya Raj, Pratibha Rani, Kamal Raj Pardasani, and Abbas Mardani. "A novel hesitant fuzzy WASPAS method for assessment of green supplier problem based on exponential information measures." *Journal of Cleaner Production* 238 (2019): 117901.
[51]. Gharehbaghi, Amin, Redvan Ghasemlounia, Ehsan Afaridegan, AmirHamzeh Haghiabi, Vishwanadham Mandala, Hazi Mohammad Azamathulla, and Abbas Parsaie. "A comparison of artificial intelligence approaches in predicting discharge coefficient of streamlined weirs." *Journal of Hydroinformatics* 25, no. 4 (2023): 1513-1530.
[52]. Baykasoğlu, Adil, and İlker Gölcük. "Revisiting ranking accuracy within WASPAS method." *Kybernetes* (2019).
[53]. Mampitiya, Lakindu, Namal Rathnayake, Lee P. Leon, Vishwanadham Mandala, Hazi Md Azamathulla, Sherly Shelton, Yukinobu Hoshino, and Upaka Rathnayake. "Machine learning techniques to predict the air quality using meteorological data in two urban areas in Sri Lanka." *Environments* 10, no. 8 (2023): 141.
[54]. Mishra, Arunodaya Raj, Rahul Kumar Singh, and Deepak Motwani. "Multi-criteria assessment of cellular mobile telephone service providers using intuitionistic fuzzy WASPAS method with similarity measures." *Granular Computing* 4, no. 3 (2019): 511-529.
[55]. Fuladipanah, Mehdi, H. Md Azamathulla, Kiran Tota-Maharaj, Vishwanadham Mandala, and Aaron Chadee. "Precise forecasting of scour depth downstream of flip bucket spillway through data-driven models." *Results in Engineering* 20 (2023): 101604.
[56]. Sangeetha Rajkumar, M. Ramachandran, Vimala Saravanan, Prabakaran Nanjundan, "Environmental Impact Assessment United States of India Using GRA Method", Aeronautical and Aerospace Engineering, 1(2), June 2023, 35-42