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Evaluating Applicability of VIKOR Method of Multi-Criteria Decision Making for Parameters Selection Problem in Rotor Spinning

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Abstract: Optimum spinning machine parameters selection among available alternatives with different significances is a difficult task in textile industry. To overcome disadvantages associated with statistical methods that are used in such kind of problems, multi-criteria decision making approaches (MCDM) were employed by researchers. TOPSIS, AHP-TOPSIS and ELECTRE are three popular techniques in spinning problems. VIKOR, the Serbian name; Vlse Kriterijumska Optimizacija I Kompromisno Resenje, means multi-criteria optimization and compromise solution is a novel approach that has priority over other MCDM methods in terms of precision in final ranking. In this study, selecting the appropriate doffing tube components and its adjustment for 30Ne rotor spun yarn that is intended to be used for weft-knitted fabric will be provided by this approach. Yarn samples were spun considering three variables namely, the distance between the nozzle and rotor, the extractive nozzle and the draw-off tube. Feasible alternatives were ranked on the basis of the yarn quality parameters by the VIKOR and the best alternative for increasing weft-knitting machine efficiency was introduced. According to the final ranking, the spinning condition in which the sample was spun using a spiral nozzle, a doffing tube without a torque stop and a closer setting had the highest performance.

Keywords: Doffing tube, Extractive nozzle, Multi-criteria decision making method, Rotor spun yarn, VIKOR, Weft-knitted fabric

Introduction

Spinning is one of the most important production processes in the field of textile science. Quality of the resulting yarn is very important in determining its application possibilities [1]. However, quality parameters of the yarn are affected by the characteristics of raw materials, process variables, machine parameters and machine parts selection [2]. Among various variables in rotor spinning process, the distance between the nozzle and the rotor, the yarn extractive nozzle, and the torque stop are three factors at the peel-off point that affect the mechanical properties, quality characteristics, and surface morphology of the spun yarns [3].

In rotor spinning system, twist is created with the help of the nozzle. The rotation of the yarn around the inner wall of the nozzle creates false twists between the rotor groove and the draw-off tube. Since over-twisting and yarn ruptures can occur at higher rotor speed when smooth nozzles are used, grooves are cut or pressed into the nozzle, which briefly lift the yarn off the nozzle surface, reduce rolling friction and increase sliding friction moment. These vibrations facilitate the twist propagation into the rotor groove [3,4].

Torque stop is another component of the spin box that increases and saves twist between the deflecting point and the rotor. Yarn hairiness and imperfections are increased by using a torque stop [5]. Consequently, the quality parameters of the yarn are improved by choosing a closer setting between the nozzle and rotor. However, less distance is a reason for increased spinning instability [4].

Considering the various factors that affect spun yarn properties, optimum rotor spinning machine parameters selection from the feasible alternatives at the peel-off point is a difficult task and a multi-criteria decision making problem. Several studies were carried out about the effects of rotor machine parameters on yarn quality and different methods, such as the non-parametric technique, factorial analysis and analysis of variance (ANOVA), were used by researchers for parameters selection [3]. Since in these methods the preferences of the producer about yarn properties are not taken into account, it is better to use multi-criteria decision making (MCDM) methods for such a problem.

Multi-criteria decision making as one of the laborious tasks of the management is divided to two different branches. The first one is the multi attribute decision making (MADM). In this method, the best solution is selected among several alternatives including the same attributes. TOPSIS, AHP, ELECTRE, SAW, VIKOR, PROMETHEE and WSM are some of the most popular approaches in MADM. In the second group of MCDM namely, multi objective programming, alternatives are not predetermined but a set of objective functions are optimized to a set of constraints [6]. In recent decade, MADM has been employed extensively in various scientific disciplines ranging from product design, transportation, human resource, manufacturing, water management, quality control, selecting shopping center site and renewable energy [6].

There are many researches that used MADM for textile

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problems. The technological value of the cotton fibers is determined by a hybrid method of MCDM [7]. Kaplan *et al.* (2006) applied ELECTRE outranking method for selecting nozzles in a rotor spin-box [3]. MADM method was used to select cotton fibers and lay-down in blow-room [8]. Satapathy and Bijwe used MCDM for ranking organic fibers [9]. However, there is not published literature that focuses on selecting the optimum spinning processing conditions using VIKOR method. Therefore, in this study, assistance in reaching acceptable solution in order to select the appropriate setting in rotor spin box that results spun yarn with the best quality parameters will be provided by this approach.

Brief Overview of Vlse Kriterijumska Optimizacija I Kompromisno Resenje Method (VIKOR)

The compromise ranking method called VIKOR was presented by Opricovic in 1998 and Opricovic and Tzeng in 2002 for multi-criteria optimization of complex systems [10,11]. VIKOR determines the compromise ranking-list, the compromise solution, and the weight stability intervals for preference stability of the compromise solution obtained with the initial (given) weights. This method focuses on ranking and selecting from a set of alternatives in the presence of conflicting criteria. It introduces the multi-criteria ranking index based on the particular measure of closeness to the ideal solution [12].

Most multi-criteria methods require definition of quantitative weights for the criteria, in order to assess the relative importance of the different criteria. The stability of the ranking results is considered during changes of the criteria weights. The values of the weight of one criterion within the stability interval do not alter the results obtained with the initial set of weights. New types of stability analysis have been considered for additive MCDM methods, including additive utility function and outranking methods such as PROMETHEE. However, the compromise ranking method (VIKOR) does not belong to this class of methods, but rather determines the weight stability intervals [12].

VIKOR has different domains of applications in various engineering fields. Kuo *et al.* (2011) combined VIKOR with GRA technique to evaluate service quality of airports under fuzzy environment [13]. Comparison between three analytical methods for knowledge community group-decision analysis was discussed by Chu *et al.* [14]. Kaya *et al.* (2010) selected the best renewable energy alternative for Istanbul by using an integrated VIKOR-AHP methodology [15]. Opricovic *et al.* (2002) illustrated Multi-criteria planning of post-earthquake sustainable reconstruction [11].

In the VIKOR method the normalized values do not depend on the evaluation unit of a criterion because the VIKOR method uses linear method for normalizing. As regards the aggregating function, the VIKOR method introduces an aggregating function representing the distance from the ideal solution, considering the relative importance of all criteria, and a balance between total and individual satisfaction. However, the reference point could be a major concern in decision-making, and to be as close as possible to the ideal is the rationale of human choice [16].

Within the VIKOR method, the various j alternatives are denoted as $a_1, a_2, \ldots, a_j$. For alternative a_j the rating of the ith aspect denoted by f_{ij}, i.e. f_{ij} is the value of the ith criterion function for the alternative a_j; and n is the number of criteria. Developing the VIKOR method started with the following form of the L_p-metric.

$$L_{P,j} = \left\{ \sum_{i=1}^{n} [w_i(f_i^* - f_{ij})/(f_i^* - f_i^-)]^p \right\}^{1/p}$$

$$1 \le p \le \infty \quad j = 1, 2, \ldots \tag{1}$$

Within the VIKOR method $L_{1,j}$ (as S_j in equation (1)) and $L_{\infty,j}$ (as R_j in equation (2)) are used to formulate ranking measure. The solution obtained by $\min_j S_j$ is with a maximum group utility ("majority" rule); and the solution obtained by $\min_j R_j$ is with a minimum individual regret of the "opponent".

The compromise solution F^c is a feasible solution that is the "closest" to the ideal F^*, and compromise means an agreement established by mutual concessions by $\Delta f_1 = f_1^* - f_1^c$ and $\Delta f_2 = f_2^* - f_2^c$. The compromise ranking algorithm VIKOR has the following steps.

Step 1: Determine the best f_i^* and the worst f_i^- values of all criterion functions, $i = 1, 2, \ldots, n$. If the ith function represents a benefit then: $f_i^* = \max_j f_{ij}$ and $f_i^- = \min_j f_{ij}$

Step 2: Compute the values S_j and R_j, $j = 1, 2, \ldots, J$ by the relations:

$$S_j = \sum_{i=1}^{n} w_i(f_i^* - f_{ij})/(f_i^* - f_i^-) \tag{2}$$

$$R_j = \max_i[w_i(f_i^* - f_{ij})/(f_i^* - f_i^-)] \tag{3}$$

Where w_i is the weight of criterion, expressing its relative importance

Step 3: Compute the values Q_j, $j = 1, 2, \ldots, J$ by the relation:

$$Q_J = V(S_J - S_J^*)/(S_J^- - S_J^*) + (1 - \upsilon)(R_j - R_j^*)(R_j^- - R_j^*) \tag{4}$$

Where, $S^* = \min_j S_j$, $S^- = \max_j S_j$, $R^* = \min_j R_j$, $R^- = \max_j R_j$.

The solution calculated by S^* is with a maximum group utility, the solution calculated by R^* is with a minimum individual regret of the opponent and υ is the weight of the strategy "of the majority of criteria".

Step 4: Rank the alternatives, sorting by the values S, R, Q in decreasing order. The results are three ranking lists.

Step 5: Propose as a compromise solution the alternative (a') which is ranked the best by the measure (Q) (minimum) if the following two conditions are satisfied:

1) Acceptable advantage; $Q(a'')-Q(a')\geq 1/(1/(J-1))$

Where a'' is the alternative with the second position in the ranking list by Q, J is the number of alternatives.

2) "Acceptable stability in decision making": alternative a' is 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 consists of:

· Alternatives a' and a'' if only condition (2) is not satisfied

· Alternatives a' and a'' and a^M if condition (1) is not satisfied; and a^M is determined by the relation $Q(a^M)-Q(a')<1(J-1)$ for maximum M (the positions of these alternatives are "in closeness").

The best alternative, ranked by Q is the one with the minimum value of Q. The main ranking result is the compromise ranking list of alternatives, and the compromise solution with the "advantage rate".

Ranking by VIKOR may be performed with different values of criteria weights, analyzing the impact of criteria weights on proposed compromise solution. VIKOR is a helpful tool in multi-criteria decision making, particularly in a situation where the decision maker is not able, or does not know to express his/her preference at the beginning of system design. The obtained compromise solution could be accepted by the decision makers because it provides a maximum "group utility" of the "majority", and a minimum of the individual regret of the "opponent". The compromise solutions could be the basis for negotiations, involving the decision makers' preference by criteria weights [12,16].

Materials and Methods

Cotton fiber with 25 mm mean fiber length, 3.8 micronaire fineness and 0.8 fiber maturity index were furnished as a third draw frame passage sliver with linear density of 5 ktex. The 30Ne yarn was spun on a Rieter-RU04 rotor spinning machine with 940 tpm. The opening roller speed was 8100 t·min^{-1}. The 35 mm diameter rotor worked at a speed of 75000 t·min^{-1}.

There were four extractive nozzle types made of ceramic material. These included spiral nozzle, grooved nozzle (4 grooves), grooved nozzle (8 grooves), grooved and notched nozzle (4 grooves - 4 notches). One of the draw-off tubes had a fixed torque stop, while the other did not have a torque stop. Two different distances of 1.5 and 2 mm were used between the entry of the extractive nozzle and the rotor. Sixteen different yarn samples were produced according to the variables and specifications as shown in Table 1.

The load-elongation characteristics of the yarns were examined with an Uster Tesorapid3. A test specimen of 500 mm was elongated at an extension rate of 500 mm/min. The unevenness and imperfections of 5 yarn samples for each group were measured with the Uster Tester 4 with a test speed of 400 m/min for 2.5 min. The hairiness of the yarns was measured with Premier Tester 7000. In the test, 10 samples with 100 m length were examine

Table 1. Specifications of cotton rotor spun yarn samples

Alternative	Extractive nozzle	Draw-off tube	Distance (mm)
A1	4 grooves - 4 notches	With torque stop	2
A2	4 grooves - 4 notches	With torque stop	1.5
A3	4 grooves - 4 notches	Without torque stop	2
A4	4 grooves - 4 notches	Without torque stop	1.5
A5	8 grooves	Without torque stop	2
A6	8 grooves	Without torque stop	1.5
A7	8 grooves	With torque stop	2
A8	8 grooves	With torque stop	1.5
A9	spiral	With torque stop	1.5
A10	spiral	With torque stop	2
A11	spiral	Without torque stop	2
A12	spiral	Without torque stop	1.5
A13	4 grooves	Without torque stop	1.5
A14	4 grooves	Without torque stop	2
A15	4 grooves	With torque stop	2
A16	4 grooves	With torque stop	1.5

Results and Discussion

The results of the experiments are shown in Table 2. A one-way ANOVA test was applied to determine the effects of considered factors on yarn quality parameters. Average values of the yarn quality parameters (Table 2) were compared at 5 % significance level and grouped according to the Duncan Multiple Range Test. Statistical analysis showed that, the effect of each factor itself and interactive effect of the three factors on yarn properties are meaningful in 5 %.

Importance of the Yarn Quality Parameters for Knit-ability

Knit-ability, known as knitting performance of a structure for a given yarn, affects knitting machine efficiency. Studies have shown that, the mechanical and physical properties of a yarn running into a large diameter circular knitting machine are important technological parameters that affect knitting machine failure and yarn breakage [17-20].

Higher tenacity and elongation at break of the yarn and lower friction between yarn and machine parts (needle) are useful to reduce yarn breakage. However, mechanical properties of a yarn are functions of yarn imperfections and unevenness. The more the imperfections and unevenness are, the more yarn breakages occur [21]. Hairiness is another factor that affects friction between needle and yarn. Increase in hairiness and wrapper fibers, produces more friction between the yarn and metal surface and increases yarn bending flexural rigidity. Increase in friction leads to an increase in yarn tension and breakage [17-20].

Table 2. Quality parameters of the sample yarns (criteria)

Sample	Tenacity (cN/tex)	Elongation (%)	Yarn evenness and imperfections				Hairiness(H)
			(CV %)	Thin places (−50 %)	Thick places (+50 %)	Neps (+280 %)	
1	11.15	5.52	15.40	58.60	66.00	77.40	7.04
2	11.18	5.53	15.52	55.00	66.80	83.40	7.10
3	10.99	5.59	14.71	29.80	50.80	65.00	6.73
4	9.71	5.11	15.08	52.60	60.20	62.80	7.65
5	11.08	5.82	15.10	38.00	97.40	91.40	4.68
6	11.56	5.59	15.17	26.60	97.80	97.60	5.05
7	10.78	5.64	15.38	46.80	76.00	91.20	5.34
8	10.56	5.58	15.07	47.00	57.60	77.40	4.89
9	10.49	5.54	14.73	30.40	68.80	70.80	4.34
10	11.07	5.68	14.82	39.20	49.20	60.80	4.30
11	11.54	6.05	14.81	20.80	59.40	60.40	4.26
12	11.86	6.09	14.55	19.00	53.60	48.40	4.18
13	11.23	5.89	15.31	39.80	96.80	79.40	4.87
14	11.49	6.03	14.71	22.20	73.00	53.60	4.38
15	11.37	5.65	15.33	31.40	95.60	122.40	4.88
16	11.57	5.91	14.86	30.00	81.40	102.60	5.13

Table 3. Intensity of the effect of yarn properties on weft knitting machine efficiency (from one to ten)

Company	Tenacity	Elongation	Hairiness	Unevenness	Thick places	Thin places	Neps
A	5	3	10	8	10	5	7
B	5	5	10	10	10	5	10
C	3	4	10	10	10	3	10
D	5	5	10	10	10	5	10
E	5	5	10	10	10	5	10
F	2	1	10	10	10	5	10
G	5	5	10	10	10	5	10
H	7	3	9	10	8	4	7
Relative importance (RI_j)	7.375	3.875	9.875	9.750	9.750	4.625	9.250
Weight of each criterion ($RI_j/\Sigma_{j=1}^{j=n}RI_j$)	0.0850	0.0752	0.1917	0.1893	0.1893	0.0898	0.1796

Performing VIKOR Approach

If a ranking between these properties is needed, the most important one to increase machine efficiency and reduce yarn breakage during knitting process is assumed to be yarn hairiness followed by unevenness, thick places, neps, thin places, tenacity and elongation. In this study, tenacity and elongation are shown by positive signs. It means that, higher value of the property is better to raise knit-ability. Also, hairiness, coefficient of mass variation and imperfections are shown by negative signs.

The alternatives were evaluated on the basis of these quality parameters which are the criteria of the VIKOR. The weights of these criteria which are necessary inputs for VIKOR application were determined according to their importance level for knit-ability and end breakage. Five of the criteria (CV%, thin places, thick places, nep and hairiness) were required to be minimized and others (tenacity, elongation) to be maximized.

The determination of the weights require the input of expert's opinion. Relative importance of the effective factors on machine efficiency was picked up based on the 24 expert's opinion that were proficient in weft-knitting industry. Table 3 shows results of the discussion about importance of the rotor yarn properties and relative importance of each criterion. Relative importance of the criteria was considered from one to ten. Considering the

Table 4. The normalized decision matrix

Alternatives	Tenacity	Elongation	CV	Thin	Thick	Nep	Hairiness
A1	0.906	0.963	0.993	1.000	0.675	0.632	0.920
A2	0.910	0.943	1.000	0.939	0.683	0.690	0.928
A3	0.919	0.927	0.948	0.509	0.519	0.531	0.880
A4	0.840	0.819	0.972	0.898	0.616	0.513	1.000
A5	0.954	0.934	0.973	0.648	0.996	0.747	0.611
A6	0.918	0.975	0.978	0.454	1.000	0.797	0.660
A7	0.926	0.909	0.992	0.799	0.777	0.745	0.698
A8	0.916	0.891	0.971	0.802	0.589	0.632	0.640
A9	0.910	0.884	0.950	0.519	0.642	0.578	0.567
A10	0.933	0.945	0.956	0.669	0.503	0.497	0.563
A11	0.995	0.973	0.954	0.355	0.607	0.493	0.558
A12	1.000	1.000	0.938	0.324	0.548	0.395	0.546
A13	0.969	0.948	0.987	0.679	0.990	0.649	0.637
A14	0.990	0.970	0.948	0.379	0.746	0.438	0.573
A15	0.928	0.959	0.988	0.536	0.978	1.000	0.639
A16	0.837	0.976	0.957	0.512	0.832	0.838	0.671

Table 5. The best f_i^* and the worst f_i^- values for each criterion functions

Criteria	Tenacity	Elongation	Cv	Thin	Thick	Nep	Hairiness
Type	Benefit	Benefit	Cost	Cost	Cost	Cost	Cost
Best	1	1	0.938	0.324	0.503	0.395	0.546
Worst	0.837	0.819	0.992	0.898	1	1	1

Table 6. The values of S_j

S_j	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8
	0.658	0.704	0.323	0.638	0.545	0.572	0.613	0.423
	S_9	S_{10}	S_{11}	S_{12}	S_{13}	S_{14}	S_{15}	S_{16}
	0.283	0.211	0.149	0.017	0.566	0.179	0.665	0.086

Table 7. The values of R_j

R_j	R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8
	0.194	0.219	0.141	0.192	0.188	0.189	0.189	0.116
	R_9	R_{10}	R_{11}	R_{12}	R_{13}	R_{14}	R_{15}	R_{16}
	0.054	0.062	0.057	0.017	0.185	0.093	0.181	0.132

different importance of each criterion and calculating vector of the criteria, the normalized decision matrix was constructed using linear normalization technique. Calculated matrix has been shown in Table 4.

As indicated above, the first step in decision making using VIKOR approach is obtaining the best f_i^* and the worst f_i^- values for each criterion function. If the ith function shows a benefit, then $f_i^* = \max_j f_{ij}$ and $f_i^- = \min_j f_{ij}$, while if the ith function shows a cost $f_i^* = \min_j f_{ij}$ and $f_i^- = \min_j f_{ij}$. Table 5 shows the best and the worst values for each criterion function.

At the second step of the VIKOR method, the values of S_j and R_j, $j = 1, 2, \ldots, J$ are calculated based on the equations (2), (3) and weight of each criterion (Table 3). Tables 6, 7 show values of S_j and R_j respectively. Computing the values of Q_j according to the best and the worst values of S_j and R_j is the third step in this algorithm. Results of the calculation have been shown in Tables 8 and 9.

As mentioned above, υ is the weight of the strategy "of the majority of criteria". Here we can use $\upsilon = 0.50$ for final ranking [12, 16]. Table 10 shows the values of Q_j, S_j and R_j when $\upsilon = 0.50$.

Table 8. Values of Q_j for different values of υ ($0 \leq \upsilon \leq 0.5$)

υ	0	0.1	0.2	0.3	0.4
Q(1)	0.875	0.881	0.887	0.893	0.898
Q(2)	1.000	1.000	1.000	1.000	1.000
Q(3)	0.613	0.596	0.579	0.563	0.5461
Q(4)	0.865	0.869	0.873	0.877	0.881
Q(5)	0.845	0.837	0.830	0.823	0.814
Q(6)	0.853	0.848	0.844	0.840	0.835
Q(7)	0.853	0.8545	0.856	0.857	0.858
Q(8)	0.491	0.501	0.511	0.521	0.531
Q(9)	0.184	0.204	0.225	0.245	0.265
Q(10)	0.220	0.226	0.23	0.240	0.245
Q(11)	0.198	0.1971	0.197	0.196	0.195
Q(12)	0.000	0.000	0.000	0.000	0.000
Q(13)	0.833	0.830	0.827	0.823	0.820
Q(14)	0.374	0.360	0.3469	0.333	0.319
Q(15)	0.810	0.824	0.837	0.850	0.864
Q(16)	0.567	0.520	0.473	0.427	0.380

Table 9. Values of Q_j for different values of υ ($0.6 \leq \upsilon \leq 1.0$)

υ	0.6	0.7	0.8	0.9	1
Q(1)	0.910	0.916	0.922	0.927	0.933
Q(2)	1.000	1.000	1.000	1.000	1.000
Q(3)	0.512	0.513	0.479	0.462	0.445
Q(4)	0.889	0.910	0.897	0.901	0.905
Q(5)	0.799	0.809	0.784	0.776	0.769
Q(6)	0.826	0.839	0.817	0.812	0.808
Q(7)	0.861	0.880	0.864	0.866	0.867
Q(8)	0.551	0.5789	0.571	0.581	0.591
Q(9)	0.306	0.344	0.346	0.367	0.387
Q(10)	0.257	0.281	0.269	0.276	0.282
Q(11)	0.194	0.211	0.193	0.193	0.192
Q(12)	0.000	0.017	0.000	0.000	0.000
Q(13)	0.813	0.827	0.806	0.803	0.800
Q(14)	0.291	0.295	0.264	0.250	0.236
Q(15)	0.890	0.921	0.917	0.930	0.944
Q(16)	0.2874	0.258	0.194	0.147	0.101

Based on the values of S, R, Q ranking of the preference order of all alternatives in descending order is as below (descending order). According to the last step, the best alternative for weft knitting machine is selected as sample No.12 with Q_j, S_j and R_j of 0, 0.017, 0.017 respectively and the worst alternative is sample No.2 with Q_j, S_j and R_j of 1, 0.704 and 0.219. According to the final ranking, yarn sample spun by using spiral nozzle, doffing tube without a torque stop and closer setting between nozzle and rotor has the best performance based on the VIKOR ranking (Figure 1). On the other hand, using yarn sample No. 12 to produce weft knitted fabric leads to higher machine efficiency and lower yarn failure. The best performance of the yarn sample is attributed to the appropriate yarn properties including more strength and elongation at break and less hairiness and imperfections.

Table 10. Values of Q_j, S_j and R_j when υ=0.50

Alternatives	Q_j	S_j	R_j
A1	0.904	0.658	0.194
A2	1.000	0.704	0.219
A3	0.529	0.323	0.141
A4	0.885	0.639	0.192
A5	0.807	0.545	0.188
A6	0.830	0.572	0.189
A7	0.860	0.613	0.189
A8	0.541	0.423	0.116
A9	0.285	0.283	0.054
A10	0.251	0.211	0.062
A11	0.195	0.149	0.057
A12	0.000	0.017	0.017
A13	0.816	0.566	0.185
A14	0.305	0.18	0.093
A15	0.877	0.665	0.181
A16	0.334	0.087	0.132

A_{12}, A_{11}, A_{10}, A_9, A_{14}, A_{16}, A_3, A_8, A_5, A_{13}, A_6, A_7,A_{15}, A_4, A_1, A_2

Figure 1. Final ranking of the alternatives using VIKOR method.

Conclusion

In the present work applicability of VIKOR approach is assessed in obtaining appropriate doffing tube components and its adjustment for rotor spun yarn intended to be used in weft knitting machine. Sixteen different yarn samples were spun considering three factors in spin box. Mechanical properties, imperfections and hairiness of the samples were assessed according to the standard methods. Relative steps of the VIKOR algorithm were executed for available data and finally the ranking of the alternatives were performed based on the efficiency of circular knitting machine. Results showed that, this method is able to present the best condition among possible alternatives. Yarn sample spun by using spiral nozzle, doffing tube without a torque stop and closer setting between nozzle and rotor has priority over other samples in terms of end breakage and machine efficiency when used as the raw material for weft knitted fabric. Also, proposed final ranking is stable even for the different values of υ. As the results of this method being dependent on the preferences of the decision-makers, results put forward in this study are valid only for this particular case.

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