IEEE Access
Multidisciplinary ⋮ Rapid Review ⋮ Open Access Journal

Received 7 November 2022, accepted 27 December 2022, date of publication 29 December 2022, date of current version 5 January 2023.

Digital Object Identifier 10.1109/ACCESS.2022.3233197

RESEARCH ARTICLE

Analyzing the Challenges to Circular Economy in Indian Fashion Industry

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ABSTRACT The fashion industry, during production and post-consumption, has major adverse environmental impacts. With the recent circular economy (CE) practices initiative, discarded fashion materials are reused to recover value from the waste. However, the CE practices initiative have not been well-received by society. The role of CE practices is very crucial in fashion industry as it helps in lowering the environmental burden caused by the discarded fashion materials, which in turn help to achieve the sustainable development goals (SDG). This study aims to collect and evaluate the challenges restricting the preference for CE practices initiative in Indian fashion industry. Based on literature review and inputs from the fashion industry experts, the study identified twenty-one challenges, in seven categories (Industrial management, Labour, Material, Regulations, Knowledge, Collaboration, and Infrastructure). An integrated multi-criteria decision-making (MCDM) approach comprising fuzzy Decision-Making Trial and Evaluation Laboratory Model (DEMATEL), Analytical Network Process (ANP), and Technique for Order Performance by Similarity to Ideal Solution (TOPSIS) is used to evaluate the challenges. The outcome of the study identifies costly raw materials, absence of certifications, problem in collection and separation, weak technical know-how, and absence of shared vision as the top five challenges to CE practices in Indian fashion industry. Further, the revelation of the causal interrelationship among the challenges helps the industrial management in taking appropriate steps to avert the challenges.

INDEX TERMS Circular economy (CE), fashion industry, fuzzy decision-making trial and evaluation laboratory model (FDEMATEL), India.

I. INTRODUCTION

Current fashion material consumption pattern i.e. fast fashion has caused great environmental concerns. As a result of fast fashion practice, in 2018, the fashion sector generated around 2.1 billion metric tons of greenhouse gas (GHG) emissions. The current fast fashion consumption practices have increased the quantity of fashion wastes, which are being incinerated, landfilled, or moved to developing countries [1]. Every year around 92 million tons of textile waste, approximately $400 billion worth of clothing, are discarded by society and are expected to further rise by 60% between 2015 and 2024 [2], [3]. Globally, only 25% of the fashion material wastes are recycled or reused while the remaining 75% remain in landfills [4]. The scenario is predominantly worse in India, the second largest populated country in the world [5]. In India, annually 1 million tonnes of fashion materials are discarded as wastes [6]. Owing to the customers' need for newness and novelty, the actual life of the clothes is being reduced, resulting in underuse of the cloth materials. Customers' preference for fashion materials at low costs has encouraged the fashion industry to come up with a material of inferior quality [7].

In recent times, there has been a growing concern among the public regarding the adverse impacts of discarded fashion materials on the environment. Awareness on sustainability

The associate editor coordinating the review of this manuscript and approving it for publication was Daniela Cristina Momete.

has been growing in the society and as a result, the industrial decision makers, and policy makers are looking sustainability options [8]. Becker-Leifhold and Iran [9] suggested collaborative fashion consumption as a viable option for reducing the adverse impact of fashion industry. Further, the increasing awareness about the sustainable practice among the public has pressurized the fashion industry to incorporate circular economy (CE) practices [10]. The increasing interest of consumers, government, and companies in sustainable industrial practice has given a great push for CE practices. The global value of the fashion industry is 3000 billion US dollars and it is more than 2% of the gross domestic product (GDP) [11]. An estimate in 2012 indicates that roughly 400 billion square meters of fabrics are consumed by the fashion industry globally. Out of this, nearly 15% of the fabrics remain unused and discarded into the environment as solid wastes resulting in landfills [12]. To manage the increasing fashion material wastes, and also recover value from the wastes, the fashion industry is in a position to adopt CE practices [13]. Further, the demand for fashion materials is expected to increase by three times more than the current demand i.e. 160 million tons in 2050. Whereas, the fashion industry is struggling in meeting the expected demand as it is facing an acute shortage of raw material (cotton) for production [14].

India, one of the major players in the global fashion industrial community is also witnessing problem in cotton procurement. Drastic climate change has altered the rainfall pattern and impacted the cotton cultivation in India and other parts of the world [15]. On one side, the fashion industry is facing shortage in procurement of raw materials while on the other side accounting for large quantity of wastes. Most of the wastes from the fashion industry are non-degradable and makes lasting environmental impacts. Advancements in technologies has given an ample opportunity of recovering values from these wastes [16]. Though the progress in technological innovations offers a ray of hope in recovering value from the wastes, its prevalence is mostly not the same in technologically developed and developing countries. Countries with suitable technological infrastructure are pioneering in recovering value from the wastes whereas countries with limited technological access and infrastructure are sluggish in value recovery practices. Such difference could be better understood when a comparison is made between China and other developing countries [17].

Though the interest in CE practices is gaining significant momentum among the fashion industry community, there are many barriers that hamper the adoption of CE practices. In a study regarding the barriers to CE practices in the fashion industry in Industry 4.0 era, Kumar et al. [18] identified a list of 15 barriers and pointed out lack of skilled workforce, weak legislation, poor framework, and short-term vision as the critical barriers. In another study, Vecchi [19] recognized that the fashion industry is faced with problems in in all the major six phases namely resources consumption, design, production, retail, consumption, and end-of-life which are essential in the adoption of CE practices. Shortage of human and financial resources, and capabilities has been cited as the major barriers in the movement of the European fashion industries preference for CE practices [20].

From the above information, it could be perceived that to manage waste and in moving toward sustainable industrial activity, the fashion industry needs to opt for CE practices. India, the most populated country consumes more fashion materials, and eventually, generates more waste. These wastes generated provide an opportunity for the fashion industry to recover value from the wastes, which may reduce the input capital cost of the raw materials [21]. However, as of now, no visible initiatives have been made by the fashion industry in India regarding CE practices [22]. Bearing this in mind, this research raises the following for analyzing the challenges that restricts CE practices by Indian fashion industry. In a nutshell, this study focuses on the following research questions.

i) What are the various challenges that inhibit CE practices by the Indian fashion industry?

ii) What are the relationships between the different challenges and which of them need immediate attention?

iii) What is the relationship between the categories of the CE practices challenges, and which one is the most important?

To answer the above research questions, initially an extensive literature review and interaction with the industrial community were carried out to identify the challenges restricting the preference of the Indian fashion to CE practices. The list of challenges provided in this study may act as a catalogue for the fashion industries that are interested in CE practices. Next, to evaluate the challenges, an integrated approach of fuzzy Decision-Making Trial and Evaluation Laboratory Model (DEMATEL) – Analytical Network Process (ANP) – Technique for Order Performance by Similarity to Ideal Solution (TOPSIS) is used. DEMATEL, introduced by Gabus and Fontela [23], is a graph theory based technique, used to categorize the challenges under consideration into cause and effect groups. To categorize the challenges, a pairwise comparison between the challenges is made initially. Next, ANP, an extension of analytical hierarchy process (AHP), developed by Saaty [24], is used to rank the challenges by considering the weight importance. Then, TOPSIS, developed by Hwang and Yoon [25], is used to rank the categories. This integrated approach has been used in earlier researches for ranking barriers in green manufacturing [10], and selection of best strategy for sustainable food manufacturing [26]. By revealing the relationship among the challenges and by prioritizing the challenges, this study provides some valuable insights for the industrial practitioners in developing suitable framework to combat the challenges.

The research paper is structured into a total of 5 sections. Section 2 involves the literature review, section 3 explains the application of the solution methodology in evaluating the challenges to CE practices in Indian fashion industry, whereas section 4 explains the results. Section 5 concludes the study by highlighting the key findings and future scope of the study.

II. LITERATURE REVIEW

The literature review is discussed in four sub-headings, namely (a) need for CE practices in the fashion industry (b) key challenges to CE practices in the fashion industry, and (c) research gaps. These three sub-headings will provide better insights about the problem the manuscript deals with and also the existing research gaps and the contribution of this study.

A. NEED FOR CE PRACTICES IN THE FASHION INDUSTRY

As the public becomes more concerned about the environmental impact, the industrial community has started showing more interest in moving towards environment friendly industrial practice and policies. The sustainable performance of a firm can be measured by analyzing the environmental, social, and governance scores [27]. CE practices are one of the initiatives taken by the industrial community with the concern on environment. CE practices are a kind of practices in which the useful lifetime of a product is extended to the maximum possible extend. In other words, in CE practices, the product is kept in the value chain as much as possible [28]. CE practices mainly focus on three principles: waste elimination and pollution minimization, circulation of the products to the possible extent, and regeneration of nature [29]. The present-day linear economy paradigm i.e., take-make-dispose followed by the fashion industry has substantial adverse impacts on the environment and also acts in a direction opposite to the sustainable development goals (SDGs) postulated by the United Nations (UN) [30]. Such drawbacks of the conventional linear practices clearly indicate the need of CE practices for the fashion industry. Further, to act in line with SGDs, the fashion industry community need to incorporate CE practices as it helps in lowering the environmental burden caused by the discarded fashion materials [31]. In a study, Shirvanimoghaddam et al., [3] observed that during the past two decades, along with the increase in the production of fashion materials, the mean worldwide yearly consumption of fashion materials has increased from 7 kg to 13 kg per person. Increased consumption of fashion materials may consequently result in an increased generation of fashion waste.

In the fashion industry, the CE practices, on one hand, extend the end of life of the fashion material and products by allowing recycling and reuse, and, on the other hand, ensure the effective utilization of resources [30] Dissanayake and Weerasinghe [32] suggested four strategies, namely, efficient resource utilization, including circularity in design, product life extension, and end-of-life circularity, which could help the fashion industry in the successful adoption of CE practices. Through second-hand consumption of discarded fashion materials, the industries engaged in the production of fashion materials may reduce the raw material cost and may recover value from the wastes. The success of the incorporation of CE practices in the fashion industry is determined by external (government regulations, environmental norms, and corporate social responsibilities) and internal factors (organizational culture, innovations, material efficiency, and increased customer satisfaction) [33]. For a fruitful benefit of CE practices in the fashion industry, all the stakeholders involved needs to work in harmony. Studies by Saidani et al., [34] and Prieto-Sandoval et al. [35] highlights that the stakeholders in a CE practices may operate at micro, meso, and macro levels. Hence, the fashion industry interested in CE practices need to overcome many challenges which are discussed in the next section. In a study, Dicuonzo et al., [36] insists that organizational culture, commitment of the supplier along with the consumers may motivate the fashion industries towards CE practices.

B. KEY CHALLENGES TO CE PRACTICES IN THE FASHION INDUSTRY

Apart from the CE practice which is a closed-loop supply chain network, the conventional linear supply chain network followed in the fashion industry is full of complications. A systematic study carried out by Jia et al., [37] regarding the understanding of CE practices in the fashion industry identified barriers in terms of organizational policies, absence of appropriate performance metrics, low level of education and training, and poor strategic planning. Though some technological innovations are introduced to lower the adverse environmental impacts of the fashion industry through CE practices, most of the innovations are properly utilized by the fashion industry especially located in the developing countries. Reasons such as lack of commitment, cost of the technological innovations, and poor cooperation from the stakeholders are cited as the reasons by the fashion industries of the developing countries [38]. Apart from the challenges in processing stage, even the post consumption stage also possesses severe threat to the environment. Most of the clothes coming out of the fashion industry today are manufactured using synthetic materials [39]. When such kind of materials is disposed into the environment, they remain non-decomposed. However, the advancements in the technological innovations provide the opportunity of recovering value from the wastes. For effective recovery of value from the wastes, the clothes thrown away as the wastes have to be properly collected. Reverse supply chain plays a crucial role in ensuring sequential flow of waste materials into the recycling facility [40]. However, in most cases, the waste materials are not properly collected and supplied to the fashion industry interested in green clothing. Hence, the industries are facing insufficiency

in getting adequate quantity of waste material for recycling. Even if some fashion industry shows interest in CE practices, the response from the society is poor. Without sufficient market demand, the interest of the fashion industry is limited. Also, the fashion material developed through CE practices must be provided at low price. Hence, it is necessary to provide sufficient subsidy for the fashion material developed through CE practices. A study of Kazancoglu et al., [41] the barriers identified problem in collecting, sorting, and recycling facility, poor commitment from top management, problem regarding standardization, and weak technical knowledge as the major barriers to the adoption of CE practices in the fashion industry. Similar study carried out by Kazancoglu et al., [42] identified a list of 25 barriers under nine categories namely management and decision-making, labour, design challenges, materials, rules and regulations, lack of knowledge and awareness, lack of integration and collaboration, cost, and technical infrastructure. However, in a study, Chen et al., [43] pointed out that customers lack of knowledge and awareness about CE practices, absence of framework to implement CE practices, and absence of knowledge transfer among the stakeholders are the major barriers in incorporating CE practices. A thorough search of the literature indicated a list of 21 challenges and is given in Table 1.

C. RESEARCH GAPS

According to Ki et al., [44], with the current linear economy practice, the fashion industries are adversely impacting all three dimensions (economic, environment, and social) of sustainability. By considering the adverse environmental impacts of the fashion industry, mainly post-consumption, Gazzola et al., [45] stressed on the fashion industry to adopt CE practices. With the environmental norms becoming more stringent and the raising environmental awareness in society also pressed the fashion industry to embrace CE practices. In a study, Karuppiah et al., [46] advocated that the adoption of CE practices helps the global nations in the movement towards the attainment of SDGs. However, a study of Kalmykova et al., [47] regarding the rate of implementation of CE practices observed a wider gap between the developed and developing countries and also among various industrial sectors. Many earlier works on CE practices [11] emphasizes mainly on the merits and its role in the attainment of SDGs. Though it is acceptable that the incorporation of CE practices greatly helps the industry in recovering value from the wastes and also in the attainment of SDGs, the path to the incorporation of CE practices is full of impediments. Hence, the difficulties faced by the industrial management in the embracement of CE practices need to be studied. In this consideration, this study aims to identify and analyze, various challenges faced by the Indian fashion industry in the adoption of CE practices. For this, an integrated multi-criteria decision making (MCDM) framework has been utilized to evaluate the challenges to CE practices in the fashion industry. This study aims to reveal the causal interrelationship among the challenges and also to rank the categories of challenges.

III. METHODS

A. PROBLEM DESCRIPTION

According to Khare [50], the value of the Indian textile industry is 223 billion dollars in 2021 and its value is expected to increase with a sharp rise in the domestic demand and exports. Among the south-east Asian countries, India is ranked as the second-largest producer and consumer of fashion materials, next to China, accounting for 35% of the market. Being yielded to the raising environmental concern, the fashion industrial community of China has moved towards sustainable industrial practice and has started promoting CE practices. As a result, the discarded fashion materials have been reused and reintroduced into the market to promote CE practices. However, the picture is entirely different in India [58]. According to a report by McKinsey, nearly three-fifths of all the fashion materials manufactured and purchased are ending up in landfills within a year [59]. The production of fashion materials has doubled since 2000, which may further add more pressure on the environment. Being concerned about the adverse environmental impacts, the fashion industries of western countries have been moving toward CE practices. However, due to lack of awareness and poor societal support, the transition towards CE practices has not been well-established in India [60]. Also, absence of reliable and robust reverse supply chain management has made CE practices a mess for the Indian fashion industry. By considering the adverse impact of the fashion industry, it could be understood that transition towards CE practices is imperative for Indian fashion industry. Studies focusing on CE practices are mostly from the developed countries while only few studies were devoted to developing countries like India. Contrarily, the need and the possibility of enhancing CE practices are more important in developing countries than in developed countries [61]. There is still a significant gap between their knowledge and practice of CE practices in India as it is still in its early stages. It is critical to impart knowledge on the benefits of CE practices to the public. Despite the fact that public opinion polls show that individuals are worried about environmental issues, several studies have found that customers who appear to possess responsible beliefs usually do not translate their goals into accountable buying performance [62]. As a result, it is crucial to study the causes of this performance and, if possible, devise a solution to make sustainable products more appealing to consumers. This study helps in understanding the challenges to CE practices, as well as the connections that exist between them. Thus, giving a clarity or aid in the ease of understanding CE practices; this study provides a long-term assistance for the Indian fashion industry to a more sustainable. To evaluate the challenges

TABLE 1. Identified challenges to CE practices in fashion industry.

Challenges	Description	Reference(s)
Inefficient performance evaluation system	Absence of well-defined measurement system	[43], [51], [52]
Reluctance to new business model	Most business fear that switching to new model requires drastic change in the organizational structure and functioning	[53], [54]
Lack of traceability	In CE model, it is necessary to know the movement of the materials and its basic information	[42]
Absence of skilled workforce	CE practices need highly skilled workers	[37]
Inadequate training facility	No proper guidelines and training facilities are available regarding CE practices	[55], [56]
Inadequate recyclable materials	Limited availability of recycling materials is unfit for CE practices	[52]
Lack of high quality	Second-hand material collected for CE practices are mostly inferior in quality	[42]
Mixed material configuration	As the fashion materials are made from various materials, it is difficult to use in CE practices	[53]
Costly raw materials	The cost involved in turning collected materials into virgin material incurs high cost	[54]
Absence of standardization	Absence of certain standards questions the quality and efficiency of CE practices	[43], [55]
Absence of certifications	Certification need to be provided for the suppliers who are supply materials for CE practices	[55], [56]
Poor CE awareness	Poor understanding about the CE practices among the various stakeholders involved in SC network of fashion industry	[43], [55]
Insufficient theoretical data	Information regarding the type of material to be used in CE practices is missing	[57]
Weak technical know-how	Companies have no idea about where to start the CE practices	[52]
Absence of information sharing	Poor communication within the various stakeholders involved in the SC network of CE practices	[51]
Absence of constant supplier	Difficult to ensure constant quantity of material supply required for CE practices	[51], [57]
Absence of shared vision	Most of the stakeholders involved fails to work unanimously towards a common goal	[37], [54]
Failure to scale up production	Owing to poor market demand for the products developed by following CE practices, the companies have not scaled up their production capacity	[42]
Poor reverse logistics facility	Very minimal members are involved in reverse logistics	[43]
Inadequate processing facility	Poor technical assistance for processing the waste materials collected	[37], [52]
Problem in collection and separation	Problems exists in separation of the various sources of waste materials collected	[53], [56]

to CE practices, this study uses an integrated approach of fuzzy DEMATEL-ANP-TOPSIS. The framework utilized in this study is given in Fig. 1.

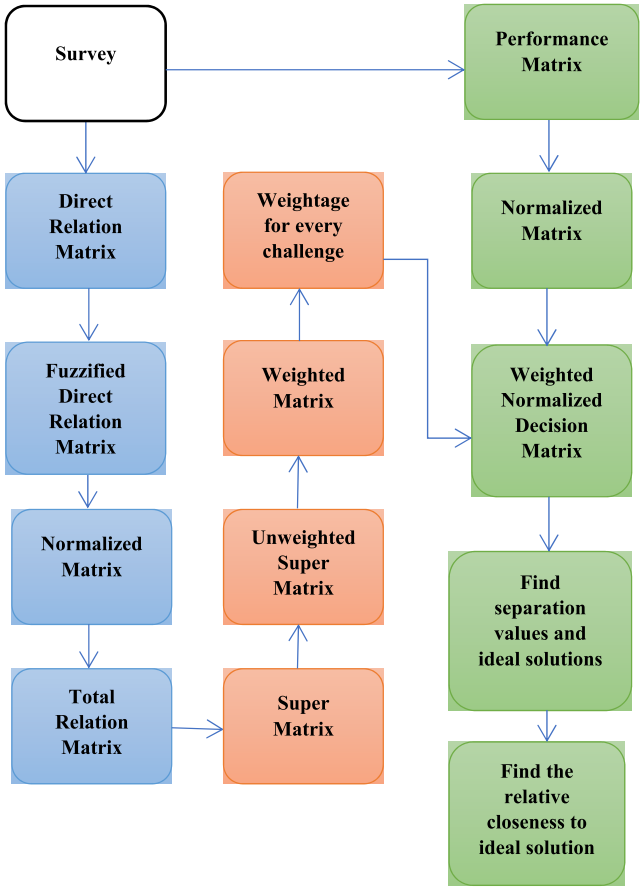

FIGURE 1. Framework of the integrated MCDM approach.

B. PREPARATION STAGE

As an initial step of answering the research questions, this study begins with the identification of challenges to CE practices. To identify the challenges, an extensive literature survey was carried out. The literature for review was selected from the commonly used scientific databases such as Scopus, ScienceDirect, EBSCO, and GoogleScholar. Also, several keywords connected using the Boolean operators, such as ''Circular Economy'' AND 'India'', ''Circular Economy'' OR ''Sustainable Production'', and ''Circular Economy'' AND ''Fashion Industry'' are used for collecting literature. Mostly, the articles published after 2015 were preferred for literature review. Initial search resulted in the identification of 76 articles. Then, as suggested by Mohamed Shaffril et al., [63], some inclusion and exclusion criteria are applied for finalizing the articles for further review processing. Inclusion criteria includes select the article for review only if the central focus of the study is on CE practices rather than keywords in title, and abstract, articles published only in English, and articles published after 2015. Exclusion criteria include articles published in conferences, short communications, editorials, and duplicative works. Using the inclusion and exclusion criteria, out of 76 articles only 40 articles were retained and considered for further review process. By analysing the 40 articles, the challenges to CE practices are identified and are given in Table 1. The number of challenges considered and evaluated in this study is acceptable in comparison with earlier studies ([42], [43]) where less number of challenges is evaluated.

C. EVALUATION PHASE

The transition from the linear production process to CE practices is influenced by numerous factors and hence a comprehensive approach is needed to evaluate this problem. To evaluate the identified challenges to CE practices, an integrated MCDM approach comprises of fuzzy DEMATEL-ANP-TOPSIS. MCDM approaches have been used in many earlier studies where multiple factors are analyzed. As MCDM is impacted by so many variables, there is a lot of uncertainty. Fuzzy set theory is used in conjunction with MCDM approaches in order to overcome this constraint. Velasquez and Hester [64] argue that fuzzy optimization helps in handling uncertainties in the decision making. For instance, Karuppiah et al., [46] utilized an integrated MCDM approach cosisting of grey-DEMATEL and fuzzy-COPRAS to evaluate the inhibitors that are impeding the transition of the Indian leather industries from the linear practices to CE practices. Singh et al., [65] utilized grey DEMATEL for evaluating the barriers in the supply chain of fresh products. Likewise, Ali et al., [66] applied fuzzy Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) for evaluating the barriers in the implementation of CE practices in Pakistan food industry. In another study, Khan and Ali [67] used an integrated fuzzy step-wise weight assessment ratio analysis (SWARA) – VlseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR) to evaluate the facilitators of CE practices in Pakistan electronic waste management. In their study, fuzzy SWARA was used to rank the facilitators while fuzzy VIKOR was used to prioritize the strategies for electronic waste management. Similarly, Hasheminasab et al., [68] used an integrated an approach of SWARA and Measurement of Alternatives and Ranking according to COmpromise Solution (MARCOS) techniques for evaluating the impacts of CE practices in energy industry. From the above-discussed studies, it is clear that MCDM techniques have been widely used by researchers in evaluating both the challenges and the impacts of CE practices on the sustainable performance of the industries.

The steps followed in the integrated approach used in this study are detailed as follows [10]:

1) ESTABLISHING CAUSAL RELATIONSHIP AMONG THE CHALLENGES

Step 1: Develop a fuzzy direct-relation matrix $\tilde{A}$. Denote the matrix as $\tilde{a}_{ij} = (l_{ij}, m_{ij}, n_{ij})$ to indicate the influence of

criteria i over factor j according to the experts. The experts were requested to create a pairwise comparison matrix ($\tilde{A}$) between different challenges to denote the impact of one criterion over the other.

Step 2: Normalize the matrix ($\tilde{A}$) using the Eq. (1) to obtain normalized matrix $\tilde{X}$.

$$\text{Given that, } \tilde{a}_{ij} = \left(l_{ij}, m_{ij}, n_{ij}\right) \text{ and } s = \frac{1}{\max\limits_{1\le i\le n}} \sum_{j=1}^{n} u_{ij}, \text{ then}$$

$$\tilde{X} = s \times \tilde{A} \tag{1}$$

Step 3: Construct the fuzzy total-relation matrix (TRM) $\tilde{T}$ using the Eq. (2), where I is an identity matrix.

Let, $\tilde{X}_{ij} = \left(l_{ij}, m_{ij}, n_{ij}\right)$ which can be represented as three different crisp matrices where each element is obtained from the matrix $\tilde{X}$.

$$X = \begin{bmatrix} 0 & u_{12} & \cdots & m_{1n} \\ m_{21} & \ddots & \cdots & m_{2n} \\ \vdots & \cdots & \ddots & \vdots \\ m_{n1} & \cdots & \cdots & 0 \end{bmatrix},$$

$$\tilde{T} = \tilde{X}\left(I - \tilde{X}\right)^{-1}$$

$$\tilde{T} = \begin{bmatrix} \tilde{t}_{11} & \cdots & \cdots & \tilde{t}_{1n} \\ \vdots & \ddots & \iddots & \vdots \\ \vdots & \iddots & \ddots & \vdots \\ \tilde{t}_{n1} & \cdots & \cdots & \tilde{t}_{nn} \end{bmatrix} \tag{2}$$

Step 4: Find r and s values summing the rows and columns respectively using the Eqs. (3) and (4).

$$r = [r_i]_{n\times 1} = \left[\sum_{j=1}^{n} t_{ij}\right]_{n\times 1}, \; s = \left[s_j\right]_{n\times 1} = \left[\sum_{i=1}^{n} t_{ij}\right] \tag{3}$$

$$T = \left[t_{ij}\right], \; i, j = 1, 2, \ldots, n \tag{4}$$

Step 5: Use the r and s values to draw the causal diagram.

Step 6: Determine the unweighted super matrix W.

$$W = (T)'.W' \tag{5}$$

Step 7: Estimate the weighted super matrix W^{α}

$$W^{\alpha} = T^{\alpha} \times W \tag{6}$$

where, W^{α} is the normalized total-influence matrix.

Step 8: Limit the weighted super matrix. This is done by increasing the weighted super matrix to a particular power, this is done to stabilize the matrix

$\lim_{h\to\infty} (W^{\alpha})^{h}$ where, h indicates any number of powers.

2) RANKING THE CHALLENGES

Step 1: Create the fuzzy decision matrix with m alternatives and n criteria as follows:

$$\tilde{E} = \begin{array}{c} \\ A_1 \\ A_2 \\ A_3 \\ A_4 \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \cdots & C_n \end{array} \\ \begin{bmatrix} \tilde{X}_{11} & \cdots & \cdots & \tilde{X}_{1n} \\ \vdots & \ddots & \iddots & \vdots \\ \vdots & \iddots & \ddots & \vdots \\ \tilde{X}_{m1} & \cdots & \cdots & \tilde{X}_{mn} \end{bmatrix} \end{array}$$

Step 2: Compute normalized decision matrix $\tilde{Z}$

$$\tilde{Z} = \left[\tilde{z}_{ij}\right]_{m\times n}, \quad i = 1, 2, \ldots, m; j = 1, 2, \ldots, n$$

$$\tilde{Z}_{ij} = \left(\frac{a_{ij}}{c_j^{+}}, \frac{b_{ij}}{c_j^{+}}, \frac{c_{ij}}{c_j^{+}}\right) \tag{7}$$

Step 3: Calculate the weighted decision matrix using Eq. (8)

$$\tilde{v}_{ij} = \tilde{z}_{ij} \otimes \tilde{w}_{ij} \tag{8}$$

where, $\tilde{w}_{ij}$ is the weight for the criteria j.

Step 4: Calculate the distance from the positive and negative ideal points.

$$A^{+} = \left\{\tilde{v}_1^{+}, \ldots., \tilde{v}_n^{+}\right\}, A^{-} = \left\{\tilde{v}_1^{-}, \ldots., \tilde{v}_n^{-}\right\} \tag{9}$$

Let, $\tilde{v}_1^{+} = \{1, 1, 1\}$; $\tilde{v}_2^{+} = \{0, 0, 0\}$

$$s_i^{+} = \sum_{j=1}^{n} d(\tilde{v}_{ij}, \tilde{v}_j^{+}), \quad i = 1, 2, \ldots, m; j = 1, 2, \ldots, n. \tag{10}$$

$$s_i^{-} = \sum_{j=1}^{n} d(\tilde{v}_{ij}, \tilde{v}_j^{-}), \quad i = 1, 2, \ldots, m; j = 1, 2, \ldots, n. \tag{11}$$

$$s(\tilde{A}, \tilde{B}) = \sqrt{\frac{1}{3}\left[(a_1 - b_1)^2 + (a_2 - b_2)^2 + (a_3 - b_3)^2\right]} \tag{12}$$

Step 5: Calculate the value of relative closeness using the following Eq. (13)

$$R_j^{*} = \frac{D_j}{D_j^{*} + D_j}, \quad j = 1, 2, \ldots, n. \tag{13}$$

Step 6: Rank the criteria conforming to the variable found according to preference order.

3) FINALIZATION AND EVALUATION OF BARRIERS TO CE PRACTICES IN THE FASHION INDUSTRY

To ensure the appropriateness of the challenges CE practices identified through the literature review, opinions from the respondents who are engaged with the fashion industry were sought. To obtain the opinion, a questionnaire containing the identified challenges was developed and given to the respondents. The questionnaire given to the respondents is given in Appendix 1. The questionnaire was mailed to the

respondents. Frequent reminders were given to the respondents to obtain their opinions. Initially, the respondents were asked to answer either 'YES' (deemed appropriate) or 'NO'' (not deemed appropriate). As the respondents found all the challenges appropriate, they were asked to fill the questionnaire (Appendix 1) evaluating every challenge on a qualitative 5 point Likert scale (1 - Strongly Disagree and 5 - Strongly agree), similar to many past research works [69]. The results of the questionnaire were converted into quantitative values. These values were analyzed to find the corresponding relative importance of each challenge using the average values. Opinions were obtained from a total of 100 respondents. These 100 respondents are directly and indirectly connected with the fashion industry and possess vast knowledge and experience in the functioning of the fashion industry. The respondent group was fixed at 100 numbers through comparison with similar papers: 127 respondents [70], 125 respondents [71]. The details of the respondents were not obtained to maintain anonymity which will allow for more honest responses to the questionnaire. Based on the experts' opinion, the challenges to CE practices is finalized and are further categorized under seven categorizes (industrial management, labour, material, regulations, knowledge, collaboration, and infrastructure) as shown in Table 2.

After finalization, a group of five experts were approached to evaluate the challenges. The number of experts considered in this study is sufficient as in earlier studies [33], [41] similar number of experts used. For evaluation purpose, the experts were asked to rate the challenges using the triangular fuzzy numbers given in Table 3. Here, triangular fuzzy numbers (TFN) are used as it is comprehensive for both qualitative and quantitative analysis. Further, with triangular fuzzy numbers, it is easy to give appropriate rating for the factors under consideration [72]. Individual response from the five experts were collected and aggregated. The aggregated responses of the experts are used in the integrated approach.

Table 4 depicts the relationship matrix of categories used to create the weightages for fuzzy TOPSIS methodology. This initial relationship matrix 'K'. Using Eq. (1), the initial relationship matrix is normalized. Next, total-Influence Matrix 'T' is obtained using Eq. (2) and is given in Appendix 2 (a). The sums of rows and columns of categories and challenges are calculated using Eqs. (3) and (4) and are given in Tables 5 and 6.

TABLE 2. Categorization of challenges to CE practices in the fashion industry.

Challenges	Category
Inefficient performance evaluation system (B1)	Industrial management (C1)
Reluctance to new business model (B2)	
Lack of traceability (B3)	
Absence of skilled workforce (B4)	Labour (C2)
Inadequate training facility (B5)	
Inadequate recyclable materials (B6)	Material (C3)
Lack of high quality (B7)	
Mixed material configuration (B8)	
Costly raw materials (B9)	
Absence of standardization (B10)	Regulations (C4)
Absence of certifications (B11)	
Poor CE awareness (B12)	Knowledge (C5)
Insufficient theoretical data (B13)	
Weak technical know-how (B14)	
Absence of information sharing (B15)	Collaboration (C6)
Absence of constant supplier (B16)	
Absence of shared vision (B17)	
Failure to scale up production (B18)	Infrastructure (C7)
Poor reverse logistics facility (B19)	
Inadequate processing facility (B20)	
Problem in collection and separation (B21)	

TABLE 3. Fuzzy scale.

Five-point score	Linguistic constants and their description	Triangular Fuzzy Numbers
0	No influence (NO)	(0, 0, 0.25)
1	Very low influence (VL)	(0, 0.25, 0.5)
2	Low influence (L)	(0.25, 0.5, 0.75)
3	High influence (H)	(0.5, 0.75, 1)
4	Very high influence (VH)	(0.75, 1, 1)

TABLE 4. Initial relationship matrix of categories.

	C1	C2	C3	C4	C5	C6	C7
C1	0	2	3	4	3	2	1
C2	4	0	3	2	2	1	4
C3	1	2	0	2	4	3	2
C4	2	3	2	0	2	4	2
C5	2	3	4	2	0	1	3
C6	3	4	2	3	3	0	3
C7	1	2	4	2	3	3	0

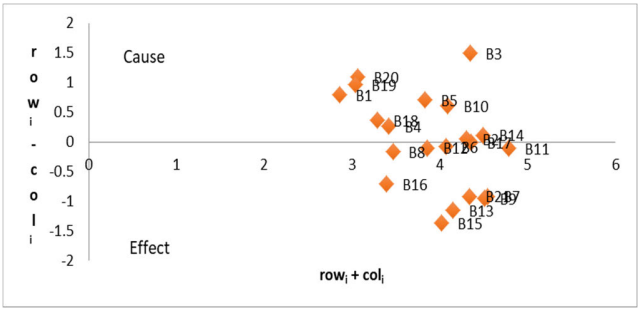

FIGURE 2. Causal Diagram.

Then, using the sums of the rows and columns, '$row_i + \text{col}_i$' and '$row_i - \text{col}_i'$, a graph (Fig. 2) representing the causal relationship among the challenges is plotted. Using Eq. (5), an unweighted super matrix ' W ' is obtained. Weighted super matrix ' W^{α} ' is obtained using Eq. (6). Using Eq. (7), a normalized matrix is developed. The weighted matrix is calculated using Eqs. (8) and (12). Table 7 shows the relative closeness calculated using Eq. (13).

IV. RESULTS AND DISCUSSIONS

The methodology involved numerous steps comprising of three different MCDM methodologies paired with fuzzy theory. Initially fuzzy DEMATEL was used to find the ranking of the influence of each challenge and whether the challenge is a cause (it influences other factors) or is an effect (easily influenced by other criteria). According to the results derived as shown in Table 4, the biggest cause challenge is "Lack of traceability (B3)" while the biggest effect challenge is "Absence of certifications (B11)".

The challenges can be segregated into two groups, cause group challenges and effect group challenges. This segregation is based on the nature of the $row_i - col_i$ value, negative values come under the effect categories while the positive values go under the cause category. The cause group includes challenges such as "Inefficient performance evaluation system (B1)", "Reluctance to new business model (B2)", "Lack of traceability (B3)", "Absence of skilled workforce (B4)", "Inadequate training facility (B5)", "Absence of standardization (B10)", "Weak technical know-how (B14)", "Failure to scale up production (B18)", "Poor reverse logistics facility (B19)", and "Inadequate processing facility (B20)". These challenges are in the cause group because they are the main influencers that create challenges for the industrial management in efficient incorporation of CE practices. Similarly the challenges in the effect group are: "Inadequate recyclable materials (B6)", "Lack of high quality (B7)", "Mixed material configuration (B8)", "Costly raw materials (B9)", "Absence of certifications (B11)", "Poor CE awareness (B12)", "Insufficient theoretical data (B13)", "Absence of information sharing (B15)", "Absence of constant supplier (B16)", "Absence of shared vision (B17)", and "Problem in collection and separation (B21)". These challenges are easily influenced since they are the result of other driving factors.

Fig. 2 depicts the causal linkages between the challenges. The 'cause' hurdles need to be addressed immediately and eradicated. The positive value of $(row_i - col_i)$ denotes that the influential impact (row_i) is greater than the influencing impact (col_i). High-importance categories and challenges $(row_i + col_i)$ will strongly impact and be influenced by other challenges. Without delay, these categories and impediments must be categorised.

"Lack of traceability (B3)" has been identified as the most crucial challenge to the incorporation of CE practices in the fashion industry. As the CE practices concept has not been well received by society, most people are still throwing their used fashion materials into the open space as a landfill or incinerating them. Another major reason for this challenge is that the reverse supply chain network has not been well established in India. Although the reverse supply chain practice for e-waste is slowly gaining pace in India, the awareness regarding fashion waste management is very limited [73]. Adding to that, the lack of communication and cooperation

TABLE 5. Causal relationship of challenges.

Challenges	row_i	col_i	$row_i + col_i$	Rank	$row_i - col_i$	Cause/Effect
B1	1.825	1.034	2.858	21	0.791	Cause
B2	2.174	2.130	4.304	8	0.044	Cause
B3	2.918	1.424	4.342	6	1.494	Cause
B4	1.844	1.575	3.418	16	0.269	Cause
B5	2.273	1.561	3.834	14	0.712	Cause
B6	1.993	2.075	4.068	11	-0.081	Effect
B7	1.710	2.627	4.337	7	-0.917	Effect
B8	1.653	1.815	3.468	15	-0.162	Effect
B9	1.779	2.729	4.508	3	-0.950	Effect
B10	2.347	1.744	4.090	10	0.603	Cause
B11	2.342	2.445	4.786	1	-0.103	Effect
B12	1.879	1.980	3.859	13	-0.101	Effect
B13	1.498	2.649	4.147	9	-1.151	Effect
B14	2.304	2.191	4.496	4	0.113	Cause
B15	1.331	2.692	4.023	12	-1.361	Effect
B16	1.343	2.051	3.394	17	-0.708	Effect
B17	2.174	2.178	4.353	5	-0.004	Effect
B18	1.830	1.463	3.293	18	0.367	Cause
B19	2.003	1.034	3.037	20	0.969	Cause
B20	2.081	0.988	3.069	19	1.093	Cause
B21	1.817	2.732	4.548	2	-0.915	Effect

among the few companies engaged in the collection of discarded fashion materials creates problems in the traceability of discarded fashion materials. All together results in the supply of an insufficient quantity of waste fashion materials for the companies showing interest in CE practices [74]. Next important challenge to CE practices in fashion industry is

TABLE 6. Causal relationship among categories.

	row_i	col_i	$row_i + col_i$	Rank	$row_i - col_i$	Cause/Effect
C1	3.567061	3.391405	6.958466	3	0.175656	Cause
C2	4.445342	3.676089	8.121431	1	0.769253	Cause
C3	3.185463	4.130372	7.315835	2	-0.94491	Effect
C4	3.112345	2.962436	6.074781	6	0.1499.9	Cause
C5	3.126534	3.001221	6.12775	5	0.125313	Cause
C6	3.121245	3.665425	6.78667	4	-0.54418	Effect
C7	2.145632	2.123125	4.268757	7	0.022507	Cause

"Problem in collection and separation (B21)". Apart from the collection of discarded fashion materials, the separation remains an uphill task. Since a variety of materials are used by the fashion industry in production and are consumed by the end users, there comes a problem in separation of discarded fashion wastes. In reusing of discarded fashion materials, not all materials can be used. Hence, it is essential to separate the materials that are fit for reuse [75]. Then, "Costly raw materials (B9)" is another important challenge to CE practices in the fashion industry. Here, the costly raw materials refer to the cost involved in the conversion of collected fashion waste materials into raw materials for the production of new fashion products. With inadequate technological assistance and limited skilled manpower, the conversion of waste into value always remains a challenge for the companies engaged in CE practices [76].

According to the ranking based on the $row_i + col_i$ values the importance of the found barriers are as follows: B11>B21>B9>B14>B17>B3>B7>B2>B13>B10>B6>B15>B12>B5>B8>B4>B16>B18>B20>B19>B1. The highest ranked barrier is "Absence of certifications (B11)" as identified by Gleim et al., (2013). Most consumers prefer buying clothes from the same brand since it saves them decision time. Another barrier that's important is that most consumers do not believe the garment company's sustainability initiatives are actually sustainable.

From Table 5 we can also interpret which of the broad categories are influential or easily influenced. The categories "Industrial management (C1)", "Labour (C2)", "Regulations (C4)", "Knowledge (C5)", and "Infrastructure (C7)" are the cause categories with "Material (C3)" and "Collaboration (C6)" being the effect category. This goes to show that economic and social factors are the driving factors to sustainable developments in the field of green clothing purchase and marketing. It can also be identified that the "Labour (C2)" category is the most influential followed by "Material (C3)", "Industrial management (C1)", "Collaboration (C6)", "Knowledge (C5)", "Regulations (C4)", and "Infrastructure (C7)".

TABLE 7. Results of fuzzy TOPSIS.

	S_i+	S_i-	R_i	Rank
C1	0.038916	0.021625	0.357196	3
C2	0.02588	0.03844	0.59764	1
C3	0.034217	0.025168	0.42381	2
C4	0.022535	0.012231	0.12110	6
C5	0.011231	0.001231	0.22121	4
C6	0.010121	0.010012	0.20102	5
C7	0.021011	0.001232	0.11203	7

The results from fuzzy TOPSIS are congruent with the results on the causal study on the categories. As mentioned in Table 7. The closeness coefficient for each barrier was derived and the results indicate that "Labour (C2)" is the most crucial category of barriers followed by "Material (C3)", "Industrial management (C1)", "Knowledge (C5)", "Collaboration (C6)", "Regulations (C4)", and "Infrastructure (C7)" barriers in the same order.

A. COMPARISON OF RESULT

In this study, absence of certifications (B11) has been recognized as the most critical challenge faced by the Indian fashion industries in the transition towards CE practices. This findings is found to be in agreement with the study of Saha et al., [78] which indicates certification problem as the major challenge for fashion industry located in India, Bangladesh, and Vietnam. Similarly, lack of traceability (B3) of the discarded fashion material waste is also an important challenge. As the reverse supply chain in the fashion industry is not well-established, there always occurs a retrieving sufficient amount of waste material. Studies by Huynh [79] and Huang et al., [7] also indicates lack of traceability as the important barrier in the transition of fashion industry towards CE practices. Next, cost raw materials (B9) is the third important challenge. Haseeb et al., [58] highlighted that the transition towards CE practices demands huge financial investment. Therefore, the findings of this study seem to be in alignment with earlier works.

V. IMPLICATIONS OF THE STUDY

This study offers some valuable contributions to the literature on CE practices in the fashion industry. For instance, while many of the earlier studies focusing on CE practices in the fashion industry insist and emphasize on the positive paradigm, this study focuses on the challenges ahead in the incorporation of CE practices by the fashion industry. Since, the transition from conventional linear practice to CE practice has become mandatory, compared with large-scale industries, the small-scale fashion industries are faced with many challenges. Hence, this problem deserves immediate attention. Regardingly, this study provides a list of challenges faced by the fashion industries in the transition towards CE practices. Further, the interrelationship among the challenges has also been revealed. Understanding the interrelationship may help industrial management in taking appropriate actions.

The findings of the study insist on costly raw materials, absence of certifications, problem in collection and separation, weak technical know-how, and absence of shared vision as the top five challenges to CE practices in the Indian fashion industry. Here, the costly raw materials indicate the cost involved in turning the waste into useful material. Since the technology for turning waste into useful material is costly; many fashion industries are unable to afford it. Hence, the government was expected to provide some financial assistance for the fashion industry in affording the needed technological infrastructure. Also, the government must provide licenses only for those fashion industries which are following sustainable industrial practices. An important problem in the transition towards CE practices is the lack of skilled expertise. So, it is essential to develop a knowledge-based workforce for the successful incorporation of CE practice by the fashion industry.

VI. CONCLUSION

Rising environmental awareness and consciousness among the society have forced the industrial community to come up with environmentally friendly industrial practices. As a result, the sustainability concept has received significant attention from the industrial community. One of the recent sustainability concepts is CE practices. It primarily emphasizes the development of fashion materials from discarded fashion materials. Also, it signifies reutilizing the discarded fashion materials. However, the practice of CE practices is often jeopardized by many impediments. Keeping this in mind, this study identifies and evaluates the challenges to CE practices using an integrated MCDM approach. Using literature review and opinions of the respondents, a list of 21 barriers under seven categories was identified. Then, an integrated approach of fuzzy DEMATEL-ANP-TOPSIS has been used to evaluate the barriers. The outcome of the study indicates costly raw materials, absence of certifications, problem in collection and separation, weak technical know-how, and absence of shared vision as the top five challenges to CE practices in Indian fashion industry.

This study offers some valuable implications for the industrial managers and policymakers that may help in promoting CE practices. The important challenge to CE practices is the low level of public awareness. Almost, nearly three-fifths of the fashion materials consumed is discarded into the environment by the users. Hence, to recover value from the wastes, the discarded wastes have to be properly collected and supplied back to the fashion industry. For this, the establishment of a reverse supply chain has to be done by the fashion industry. Like, plastic and e-waste reverse supply chain networks, the reverse supply chain network have to be established in a robust and reliable manner by the fashion industry. The efficiency of the reverse supply chain to a large extent depends on the active participation of society. However, in most cases, the active participation of society remains a big question. Most of the users are either discarding the used fashion materials in landfills or incinerating them. Both such kinds of practices aggregate the pollution level.

This study primarily focuses on the challenges to CE practices in the Indian fashion industry context. So, the outcome of the study cannot be generalized. Hence, a comparative study between the two countries has to be carried out. Carrying such kind of comparative study may help in generalizing the outcome of the study. Also, only the causal interrelationship among the challenges has been revealed in this study. As a future scope of the study, the structural relationship among the challenges could be revealed using structural equation modeling (SEM).

APPENDIX A

This work is to analyze the challenges to CE practices in the fashion industry. Select the most appropriate response to the statement to the best of your knowledge.

No.	Challenges	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
B1	Inefficient performance evaluation system	☐	☐	☐	☐	☐
B2	Reluctance to new business model	☐	☐	☐	☐	☐
B3	Lack of traceability	☐	☐	☐	☐	☐
B4	Absence of skilled workforce	☐	☐	☐	☐	☐
B5	Inadequate training facility	☐	☐	☐	☐	☐
B6	Inadequate recyclable materials	☐	☐	☐	☐	☐
B7	Lack of high quality	☐	☐	☐	☐	☐
B8	Mixed material configuration	☐	☐	☐	☐	☐
B9	Costly raw materials	☐	☐	☐	☐	☐
B10	Absence of standardization	☐	☐	☐	☐	☐
B11	Absence of certifications	☐	☐	☐	☐	☐
B12	Poor CE awareness	☐	☐	☐	☐	☐
B13	Insufficient theoretical data	☐	☐	☐	☐	☐
B14	Weak technical know-how	☐	☐	☐	☐	☐
B15	Absence of information sharing	☐	☐	☐	☐	☐
B16	Absence of constant supplier	☐	☐	☐	☐	☐
B17	Absence of shared vision	☐	☐	☐	☐	☐
B18	Failure to scale up production	☐	☐	☐	☐	☐
B19	Poor reverse logistics facility	☐	☐	☐	☐	☐
B20	Inadequate processing facility	☐	☐	☐	☐	☐
B21	Problem in collection and separation	☐	☐	☐	☐	☐

APPENDIX B

Total influence matrix (T) of challenges.

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16	B17	B18	B19	B20	B21
B1	0.035	0.08	0.048	0.103	0.068	0.079	0.089	0.063	0.137	0.063	0.13	0.076	0.136	0.122	0.098	0.069	0.126	0.098	0.035	0.033	0.135
B2	0.058	0.086	0.104	0.061	0.059	0.143	0.147	0.068	0.111	0.064	0.09	0.107	0.147	0.091	0.151	0.132	0.134	0.107	0.076	0.071	0.166
B3	0.055	0.138	0.076	0.129	0.128	0.165	0.192	0.124	0.196	0.139	0.185	0.15	0.183	0.159	0.197	0.135	0.11	0.104	0.103	0.1	0.15
B4	0.033	0.067	0.084	0.056	0.114	0.097	0.15	0.065	0.147	0.078	0.149	0.068	0.139	0.123	0.137	0.066	0.067	0.047	0.035	0.034	0.088
B5	0.04	0.097	0.109	0.114	0.067	0.084	0.168	0.126	0.156	0.139	0.153	0.113	0.155	0.14	0.133	0.081	0.13	0.069	0.043	0.046	0.107
B6	0.037	0.138	0.066	0.056	0.056	0.073	0.141	0.068	0.139	0.066	0.145	0.132	0.143	0.09	0.143	0.076	0.132	0.054	0.037	0.038	0.162
B7	0.064	0.127	0.099	0.084	0.053	0.118	0.083	0.055	0.083	0.056	0.137	0.063	0.094	0.069	0.096	0.061	0.113	0.051	0.035	0.035	0.134
B8	0.033	0.076	0.043	0.049	0.049	0.059	0.107	0.062	0.141	0.07	0.122	0.121	0.109	0.098	0.093	0.063	0.09	0.044	0.03	0.063	0.132
B9	0.032	0.095	0.048	0.05	0.062	0.064	0.114	0.111	0.082	0.109	0.139	0.081	0.145	0.131	0.132	0.097	0.066	0.049	0.036	0.036	0.101
B10	0.047	0.152	0.063	0.078	0.114	0.135	0.138	0.127	0.162	0.075	0.131	0.144	0.121	0.139	0.11	0.087	0.14	0.091	0.074	0.094	0.127
B11	0.042	0.088	0.108	0.114	0.098	0.131	0.159	0.11	0.171	0.136	0.105	0.088	0.158	0.141	0.169	0.083	0.086	0.108	0.046	0.044	0.156
B12	0.035	0.129	0.047	0.049	0.051	0.065	0.099	0.115	0.145	0.09	0.091	0.072	0.149	0.121	0.138	0.121	0.081	0.052	0.038	0.037	0.153
B13	0.03	0.06	0.053	0.044	0.044	0.068	0.118	0.084	0.084	0.08	0.114	0.105	0.07	0.061	0.085	0.102	0.069	0.043	0.032	0.031	0.123
B14	0.041	0.085	0.07	0.094	0.095	0.091	0.154	0.128	0.155	0.123	0.159	0.132	0.155	0.091	0.168	0.141	0.094	0.072	0.044	0.042	0.169
B15	0.028	0.063	0.035	0.05	0.04	0.049	0.075	0.047	0.062	0.044	0.056	0.081	0.123	0.082	0.066	0.115	0.081	0.039	0.041	0.026	0.128
B16	0.044	0.068	0.038	0.039	0.037	0.084	0.092	0.041	0.062	0.04	0.056	0.048	0.093	0.062	0.125	0.056	0.089	0.069	0.079	0.039	0.082
B17	0.054	0.131	0.071	0.094	0.113	0.142	0.152	0.085	0.132	0.118	0.127	0.079	0.13	0.114	0.103	0.123	0.084	0.059	0.042	0.073	0.151
B18	0.089	0.134	0.051	0.05	0.048	0.121	0.132	0.053	0.129	0.054	0.078	0.062	0.116	0.079	0.098	0.131	0.137	0.052	0.088	0.035	0.091
B19	0.09	0.128	0.111	0.056	0.056	0.125	0.092	0.061	0.14	0.06	0.083	0.07	0.095	0.078	0.156	0.126	0.14	0.106	0.045	0.04	0.144
B20	0.1	0.087	0.053	0.123	0.111	0.121	0.108	0.098	0.159	0.066	0.105	0.072	0.1	0.097	0.146	0.12	0.14	0.054	0.038	0.038	0.146
B21	0.047	0.1	0.048	0.081	0.098	0.062	0.115	0.23	0.136	0.071	0.091	0.115	0.089	0.105	0.145	0.068	0.07	0.096	0.036	0.034	0.086

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