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Role of Ergonomic Factors Affecting Production of Leather Garment-Based SMEs of India: Implications for Social Sustainability

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Abstract: This paper aims to identify, evaluate, and measure the ergonomic factors hampering the production of leather garment-based small and medium-sized enterprises (SMEs). Ergonomic problems faced by the workers largely impact the health of individuals and also the productivity of a firm. Based on experts' opinions and a literature survey, three emerging categories—namely, occupational disease, personal factors, and the industrial environment—with a total of twenty factors were identified to examine symmetrical impact in five leather garment companies. In this research work, Cronbach's α was evaluated to check the validity of the ergonomic factors identified through the literature survey. Then, using the fuzzy analytic hierarchy process (FAHP), the identified ergonomic factors were evaluated. A sensitivity analysis was carried out to validate the robustness of the results obtained using the integrated approach. Outdated machinery, vibration, operational setup, fatigue, and poor ventilation and lighting are the top five factors inducing ergonomic-related problems and hampering the production of the leather garment companies in India. These top ergonomic factors are the result of a failure in the provision of an ambient working environment. Providing ergonomically designed working environments may lower the occurrence of ergonomic problems. The findings of this study will assist industrial managers to enhance production rate and to progress towards social sustainability in Indian SMEs. The proposed symmetrical assessment in this study could also be considered as a benchmark for other companies in which human–machine interaction is significant.

Keywords: ergonomic factors; fuzzy AHP; social sustainability; sensitivity analysis

1. Introduction

According to Workplace Safety and Health Guidelines, an Occupational Disease (OD) is contracted as a result of exposure to risk factors in a working environment [1]. The incidence of occupational disease is increasing among workers in production sectors [2]. This issue has received much attention, but only after the United Nations, with their sustainable development goals (SDG), defined sustainable industrialization as one of seventeen goals to alleviate poverty, improve workers' health, and enhance social prosperity. In connection with the United Nations SDGs, many manufacturing companies in developed countries started providing a safe working environment. However, manufacturing companies, especially small and medium-sized enterprises (SMEs), in developing countries, face challenges in following the ergonomics practice [3]. Providing an ergonomically designed working environment allows for the manufacturing company to produce quality goods and to enhance the workers' well-being, thus increasing employee productivity. The SMEs of developing countries, in recent years, have provided a considerable contribution to the economy of most developing nations [4]. India, a developing country, mainly relies on SMEs to combat problems, such as high unemployment, unstructured business organizations, and a lack of foresighted business policy. Noticeably, these sectors hold a considerable share in a country's Gross Domestic Product (GDP) and offer employment opportunities for economically weaker sections [5]. As a result, there are more SMEs in India than large companies [6]. Although SMEs do provide employment and financial assistance for the economically marginalized and semi-skilled population, most of the SMEs are unaware of sustainable development goals [7]. As largely known, the sustainability concept covers three areas, including economic, environmental, and social areas. However, most industrial perspectives note their primary concern as economically sustainable success in financial markets [8]. Due to pressure from the customers for sustainable manufacturing practices and to meet the government's environmental norms, the manufacturing sector has necessarily started to concentrate on matters of environmental and social sustainability [9].

Social sustainability is related to the creation of a social system that enables the rise of workers' wealth and health, and that contributes to the nation's development; environmental sustainability is related to the minimization of natural resource utilization [10]. Industrial factors affecting the workers' health may result in the frequent absenteeism of workers and in the loss of production hours, which hampers the production rate. Hence, there is a need to understand the relationship and synergy between the working environment and workers' health. The problem in social sustainability occurs mainly in four areas: internal human resources, external populations, stakeholder participation, and social performance issues [11]. In the four problematic areas, Indian SMEs primarily struggle with the utilization of internal human resources and social performance [12]. The Bureau of Indian Standards (BIS) states that an industry's workspace and work environment should be designed in accordance with the anthropometric dimensions of the workforce and environmental firms. However, most of the SMEs do not adhere to these standards; many are unaware of the importance of the ergonomic problems associated with their production [13]. The SMEs were of the mindset that they can hire workers for a minimum wage who are ready to work in a poor working environment [14]. Working under such environments may lead to painful disorders in the muscles, joints, nerves, tendons, and soft tissues of the body, which are collectively called "work-related musculoskeletal disorder (WMSD)" [15]. The majority of the workforce in the manufacturing sector suffers from WMSDs, knowingly or unknowingly, and it results in low productivity [16,17].

Recently, in the health and safety management area, the concept of "vision zero" is gaining significant importance [18]. The concept emphasizes three core aspects, health, safety and well-being of the workers. "Vision Zero" was first introduced by the International Labour Organization (ILO) in Singapore in 2017. There is a perception that "vision zero" will assist in industrial progress towards SDGs. Though the concept was conceived in a constructive manner, reluctance and poor adherence by the business organization puts a big question on the success of the concept [19]. Additionally, the industrial sectors in developing countries are not even aware of the concept. As a result, the prevalence of occupational accidents and injuries is high in developing countries such as India. In India, there exists a void in understanding the significance of ergonomic issues and its influence on the production capacity of the manufacturing sector [20].

From the above information, it is apparent that the majority of Indian SMEs are not aware of the synergy between ergonomic importance and productivity. Further, research work on ergonomic problems in the context of developing countries is very scant. In a study carried out by [21] Bernard et al. (2020), it was reported that the number of occupation-related illness in the Brazilian industrial sector has increased progressively in the last 6 years. Not only in Brazil, but the prevalence of occupational illness is also increasing steeply in many developing countries where the knowledge and significance of ergonomics are meagre. This finding was endorsed by [22] Olabode et al. (2017) in a study which indicated the absence of strict legislation and reforms as the reason for this. Such an indication suggests the need for potential intervention in industries based on the nature of occupational hazards [23]. Most of the industries in developing countries, such as India, are unaware of ergonomics and are reluctant to improve the working environment [24]. The condition is similar in other developing countries such as China and Bangladesh, where socio-economic conditions hamper the improvised ergonomic conditions [25,26].

From this perspective, this study intends to identify the critical ergonomic factors that hamper productivity based on symmetry principles. For this, we selected the leather garment industry, which is one of the principal niches of the Indian economy. In connection with this, this research work carries out multiple case studies among workers from five leather garment companies. The reason why a case study in the leather sector is particularly important is because leather exports are expected to be 9 billion by 2020; 2019 figures stand at 5.85 billion (http://www.makeinindia.com/sector/leather). The findings of the study under Indian leather garments can be used as a benchmark for other developing countries such as China, Indonesia, and Bangladesh as the socio-economic conditions are similar. Additionally, the economies of these countries are significantly enhanced by leather garments. As a matter of fact, it should be noticed that many countries located in Asia are players in the global leather trade. Besides this, we have selected the leather garment industry mainly for two reasons. Firstly, the foreign trade of India largely depends on the leather garment industry. At the same time, this industry faces serious issues such as workers' safety, health risks, and employee rights. Secondly, this sector is well-established and needs best practices in the social sustainability context to reshape its negative social reputation.

Given the importance of the ergonomic problem in the Indian context, this study addresses the critical gap in the literature. First, the study made a literature review to identify various ergonomic problems faced by workers in a manufacturing background and in the context of developing countries. From the literature review, the study identified 20 critical ergonomic factors and categorized three important categories—occupational disease, industrial environment and personal factors. From the results, the study postulates practical implications, such as providing reasonable pay irrespective of the gender, conducting frequent motivational programs for the workers, and the provision of comfortable and aesthetic working environments, which will reduce ergonomic problems within working environments. Such steps by the industries will assist in the progress towards SDGs.

The justification behind the proposed study is to understand the significance of ergonomic factors and its influence on the production capacity of the manufacturing sector. In this study, Indian leather garments were chosen as a case industry as they contribute significantly to economic development. Additionally, at present, India is on the track of massive development and has one of the most anticipated economies in the world.

From this perspective, this research explores some questions for analysis, as follows:

I. What are the critical ergonomic factors affecting production in the leather garment industry of India?
II. What are the vital sustainability-related social implications of ergonomic factors in Indian SMEs?

To reveal the answers to the above research questions, an SPSS statistical software-assisted fuzzy AHP-based symmetrical assessment approach was used. Here, SPSS statistical software was utilized for statistical analysis of the ergonomic factors identified through a literature survey. Then, fuzzy AHP was used to evaluate and prioritize those ergonomic factors. Finally, some implications for attaining social sustainability were suggested.

The remainder of the paper is organized as follows: Section 2 details the literature review, Section 3 describes the materials and methods, Section 4 presents the data evaluation, Section 5 presents the results, Section 6 provides discussion. Finally, Section 7 concludes this paper.

2. Literature Review

2.1. Emerging Economy

Emerging economies denote the economic conditions of the developing nations, which concentrate more on the production sector [27]. These developing countries are striving hard to attain the status of developed countries by giving great impetus to manufacturing sectors. The industrial advancement of developing countries is important for developed countries as their economy depends on developing countries [3]. Recently, the World Bank classified world economies into four categories—high, upper-middle, lower-middle, and low. According to this, countries whose income is less than USD 1025 are low-income economies, and countries with an income greater than USD 12,375 are high-income economies. Under this classification, India, with an income of USD 2020, is categorized as a lower-middle income economy [28]. From the report, it is evident that India is an emerging nation with a higher rate of unemployment, an unorganized business sector and a lack of foresight for economic reforms. Hence, the effective functioning of the present manufacturing sector may help in moving the country's economy forward.

2.2. Ergonomics Problems

Although most of the industries in India are desperate to increase their production rate, they are reluctant to make technological changes [29,30]. On investigation, it was identified that most of the manufacturing units in India are small and medium industries (SMEs), which have inadequate financial support. Leather garment industries are one of the SMEs in India contributing immensely to the economic growth of the country. Leather garments play an important role in alleviating poverty by providing job opportunities to uneducated and semi-skilled people. Hence, SMEs in India are showing interest in hiring workforces at minimal wage rather than implementing advanced manufacturing techniques. The Bureau of Indian Standards (BIS) has listed several norms for industries—providing sufficient space and designing tools and machines in accordance with the anthropometric data of workers. However, the majority of the industries, especially SMEs, are not adhering to the rules and regulations [31,32]. Any discomfort felt by the workforce within the working environment shows its impact on the production rate of a firm. Industrial factors, such as plant layout, workstation design, working capacity, and working schedule, were identified as the primary potential threats affecting the physical and mental health of workers [33,34]. Any shortcomings in providing industrial hygiene may largely influence the mental and physical health of workers as they are constrained to work in a limited environment for hours [35,36]. Such discomforts felt by the workers, both physically and mentally within industrial environments, are collectively termed as ergonomic problems [37,38].

2.3. Ergonomics in Leather Garments

Persons working in garments have to work under some common constraints such as limited space for movement, sizes/weights of scissors, poor lighting, and having to connect thread and needle with great difficulty [39,40]. Repetitive low-load tasks in an awkward position for a long duration, lifting heavy weights, and moving items manually have been reported as the potential contributors for WMSDs [41–44]. The risk of WMSDs is usually related to age, stature, gender, frequency of work, and travel distance. Any machine or instrument used in an industry must be designed in accordance with the anthropometric data of the workforce. Human factors, such as anthropometry data, age, and gender, should be considered while designing a workplace's layout or when assigning tasks, as these detail the physical well-being of a worker. Instruments designed without considering anthropometric data are not ergonomically designed and may impose discomfort for workers [45]. Prolonged use of out dated machinery in manufacturing results in vibrations which induce Hand-Arm Vibration Syndrome (HAVS) and hearing problems among workers [46]. Leather garments rely on outdated second-hand machines because they are cheap rather, than buying the latest machines which are expensive. Attention must be given to anthropometric data as these have a huge impact on leather garment production, where monotonous and repetitive activity is prevalent [47–49].

2.4. Factors of Ergonomics Problems

Ergonomics is a scientific approach concerned with the understanding of human interaction with the machine and applies theories and principles for the optimization of human well-being [50]. Ergonomics is a broad concept that covers wide areas—namely, physical (health, motion, perception), cognitive (attention, communication, knowledge, memory, and reasoning), physiological (emotions, relationships, self-management), and anthropometric data of humans—and their influence on the working environment. Addressing the ergonomics problems is important for industries, as an ergonomically designed working environment ensures an aesthetic working atmosphere. Aesthetic working environment enhances the working enthusiasm among workers, resulting in increased production rates [51]. The nature of work is related to the kind of task the worker is performing and it determines the rate at which an individual is exposed to stress and pain [52]. Repeatedly carrying out a particular task over a long period may induce pain or soreness in a particular part of the body [53].

Human aspects are related to an individual's physical capacity, upon which variation in the rate of fatigue exposure varies among workers. Variation in the level of exposure to fatigue, loss of strength, age, and gender to a great extent influence the production rate of a manufacturing firm [54]. Industrial hygiene is a crucial aspect in ensuring the safety and health of the workers. From providing proper ventilation and lightening to ensuring the safety of workers, industrial hygiene plays a critical role [55]. The factors of ergonomic problems are listed in Table 1.

Table 1. List of identified ergonomic factors affecting production.

Factors	Sub-Factors	Description	Supporting Literature
Occupational disease (E1)	Spinal cord problem (E11)	Prevalent among workers working in a static position for a long duration	[48]
	Shoulder pain (E12)	Occurs in persons working with inappropriate height tables	[34,44,48,53]
	Low Back Pain (E13)	Common among workers engaged in lifting heavy weights	[34,44,48,56]
	Knee joint pain (E14)	Predominant among workers involved in movement of raw materials within the workplace	[44]
	Sore feet (E15)	Seen among workers working in a standing position for a long duration	[57,58]
	Neck pain (E16)	Repeated to-and-fro movement of the neck induces neck pain	[34,44,48,56]
	Wrist pain (E17)	Use of heavy scissors cause wrist pain	[34,44]
Personal factors (E2)	Fatigue (E21)	Repeated, monotonous work without sufficient break intervals causes fatigue	[59]
	Job satisfaction (E22)	Appraisal, rewards and salary hike for the work executed	[60]
	Self-motivation (E23)	Internal force motivating the worker to move towards the goal	[61]
	Conscientiousness (E24)	Being hardworking, dutiful, and reliable	[33]
	Extraversion (E25)	Ability to be cheerful, spread positive energy and spirited	[62]
	Competence (E26)	Capacity of a person in carrying out the task	[33,62]
	Role perception (E27)	Central concept through which the individual and workers interact	Proposed in this article
Industrial environment (E3)	Vibration (E31)	Old and repaired machine often cause vibration	[51,63]
	Outdated machinery (E32)	Old, traditional machines which are not ergonomically designed	[42,44]
	Operational setup (E33)	Adequate spacing must be provided between machines and machines must be arranged on the basis of work sequence	[37,54]
	Poor ventilation and lighting (E34)	Adequate light and air circulation must be ensured	[40,62,64]
	Shock (E35)	Proper insulation must be provided for electric wires	Proposed in this article
	Industrial hygiene (E36)	Pest and microbe free working environment must be provided	[65]

2.5. Ergonomics Based Research Gap in Indian Context

The knowledge of the ergonomics problem and its impact on production rate is very scant among Indian industries, in particular, SMEs. Most leather garment producers (case industry considered in this study) are trying to increase their production rate but most of them fail in addressing ergonomic problems. The literature on ergonomic problems in the Indian context is not well established. Research on the ergonomics problems may help SMEs in enhancing their production rate. This research work intends to identify the common ergonomics problem faced by leather garment workers and suggests some practical implications in overcoming ergonomics problems that may help industrialists in increasing the production rate.

3. Materials and Methods

The research layout of this work is given in Figure 1. To identify the common ergonomic factors affecting the production rate of leather garment workplaces, we first reviewed relevant papers on various ergonomic factors and their roles/importance in leather garments of different countries; we then collected those common factors (Table 1).

The data collected need to be reliable and valid for further analyses and future studies. Reliability refers to the degree of consistency. Validity refers to the degree to which the factors considered measure the intended purpose. The reliability of the data was evaluated by calculating Cronbach's α using SPSS tool. For this, 100 participants (50 males and 50 females), working for not less than 8 years from the five leather garment companies were asked to express their opinions about the importance of the selected ergonomic factors via a five-point Likert's scale (5–strongly agree, 4—agree, 3—neutral, 2—disagree, and 1—strongly disagree) [55]. After consolidating the workers' responses, Cronbach's α was calculated for the identified ergonomic factors using SPSS statistical software [66]. The value of cronbach's α should lie between 0 and 1. In most general cases, a minimum α value of 0.70 is considered as a criterion for establishing internal consistency. Sampling adequacy for a normal distribution was measured by Barlett's test of sphericity and Kaiser–Mayer–Olkin (KMO) test. In some case—i.e., non-normal distribution—Levene's test is used instead of Barlett's test of sphericity. Using Barlett's test of sphericity, the null hypothesis was eliminated—i.e., the variances are equal for all samples. Statically, the null hypothesis is given as $H_0 : {\sigma_1}^2 = {\sigma_2}^2 = \ldots = {\sigma_k}^2$. The Breusch–Pagan test is conducted to reject the null hypothesis of heteroskedasticity. The KMO value lies between 0 and 1. KMO values between 0.8 and 1 indicate the sampling adequacy [67]. When the collected data satisfied the validity and reliability test (Table 2), the ergonomic factors hindering production rate of leather garments were evaluated using FAHP. The factors and sub-factors of ergonomic causing production loss were also evaluated using FAHP.

The statistical results after the deletion of the factors are summarized in Table 3. The Cronbach's α value, including all the factors, was 0.877, indicating that the data used for the study were reliable. Additionally, Cronbach's α value of factors should be noted if the item deleted is less than 0.877. Hence, all factors under study are reliable. As far as the inter-item correlation matrix is considered, it should be noted that all the factor values are greater than 0.3. This indicates that the factors are likely to have common factors.

Table 2. Reliability statistics.

Cronbach's α	Cronbach's α Based on Standardized Items	No. of Items
0.873	0.877	20

A combined fuzzy set based AHP using a linguistic scale [68] is widely used to solve actual-time problems that include human factors as it helps to clear up imprecise information. Generally, there are two types of fuzzy numbers—namely triangular and trapezoidal fuzzy numbers. In this study, trapezoidal fuzzy numbers were preferred over triangular fuzzy numbers as they are more representative of linguistic estimations in ergonomic evaluation. In comparison with triangular fuzzy numbers, the trapezoidal fuzzy numbers offer more choice of expressions. In FAHP, the consistency ratio (CR) was calculated and it must agree with the CR value.

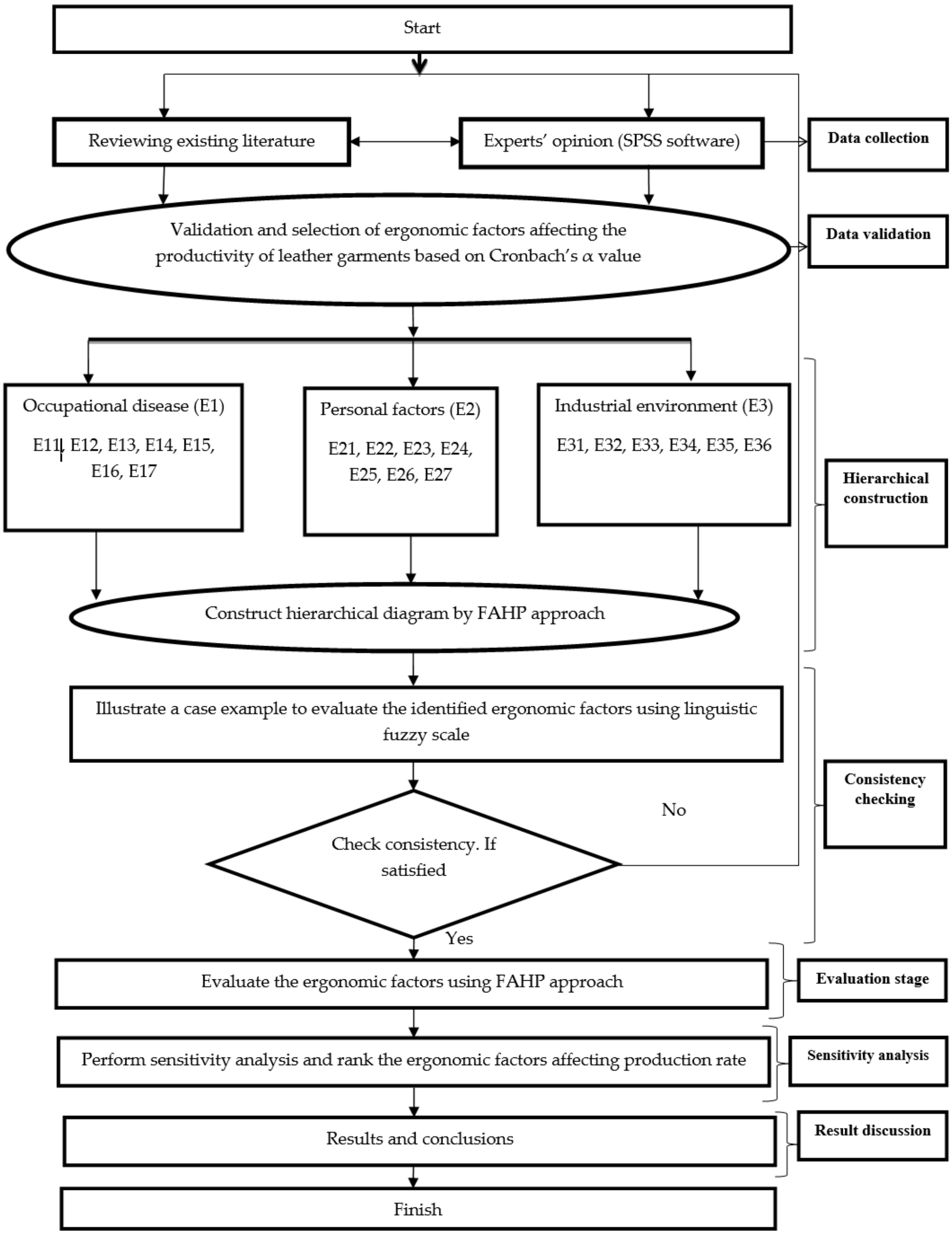

Figure 1. Proposed methodology to explore ergonomic factors affecting production.

Table 4 shows two tests that measure the data adequacy. The KMO measure of sampling adequacy value in this study was 0.802. High values (close to 1.0) indicate that the factor under study is suitable for further analysis. However, when the value is less than 0.5, the data are not useful for analysis. In our case, the KMO value is 0.802, which is close to 1.0 and, hence, the data are suitable for analysis. Next, the significance level in the Barlett's test was 0.00 in our case. Small values (less than 0.05) of the significance level indicate that the factor is useful.

Table 3. Cronbach's α (if item deleted).

	Scale Mean If Item Deleted	Scale Variance If Item Deleted	Corrected Item—Total Correlation	Squared Multiple Correlation	Cronbach's α If Item Deleted
Spinal cord problem (E11)	92.5510	15.377	0.346	.	0.871
Shoulder pain (E12)	92.6020	14.733	0.478	.	0.867
Low Back Pain (E13)	92.5867	14.326	0.569	.	0.863
Knee joint pain (E14)	92.6684	13.423	0.661	.	0.859
Sore feet (E15)	92.6684	14.879	0.304	.	0.873
Neck pain (E16)	92.6684	14.295	0.438	.	0.868
Wrist pain (E17)	92.6888	14.349	0.416	.	0.869
Fatigue (E21)	92.6939	14.111	0.457	.	0.868
Job satisfaction (E22)	92.6122	14.690	0.448	.	0.868
Self-motivation (E23)	92.6531	14.279	0.535	.	0.864
Conscientiousness (E24)	92.6378	14.109	0.554	.	0.864
Extraversion (E25)	92.6684	14.079	0.583	.	0.862
Competence (E26)	92.6276	14.532	0.459	.	0.867
Role perception (E27)	92.6378	14.489	0.532	.	0.865
Vibration (E31)	92.5969	14.765	0.512	.	0.866
Outdated machinery (E32)	92.6684	14.797	0.318	.	0.873
Operational setup (E33)	92.6939	14.285	0.462	.	0.867
Poor ventilation and Lighting (E34)	92.6020	14.641	0.555	.	0.865
Shock (E35)	92.6071	14.558	0.543	.	0.865
Industrial hygiene (E36)	92.5612	15.181	0.421	.	0.869

Table 4. KMO and Barlett's test.

KMO and Barlett's Test	
Kaiser–Meyer–Olkin measure of sampling adequacy	0.802
Barlett's Test of Sphericity	
Approx. χ^2	1379.913
df	190
Sig.	0.000

Trapezoidal fuzzy numbers are given in Table 5 [65]. The scale of significance, given in Table 5, is used to represent the significance level of each ergonomic factor. In this study, a five-point significance scale, representing the level of each ergonomic factor, is used. Initially, evaluation is made using the significance scale. Later, the significance scale value is converted in the trapezoidal number, given in Table 5, and evaluated.

Table 5. Scale of significance used in the pair-wise comparison of fuzzy AHP.

Linguistic Variables	Scale of Significance	Trapezoidal Fuzzy Numbers	Trapezoidal Fuzzy Reciprocal Numbers
Equally significant (E)	1	(1,1,1,1)	(1,1,1,1)
Weakly significant (W)	3	(2, 5/2, 7/2, 4)	(1/4, 2/7, 2/5, 1/2)
Really significant (R)	5	(4, 9/2, 11/2, 6)	(1/6, 2/11, 2/9, 1/4)
Very strongly significant (VS)	7	(6, 13/2, 15/2, 8)	(1/8, 2/15, 2/13, 1/6)
Absolutely significant (A)	9	(8, 17/2, 9, 9)	(1/9, 1/9, 2/17, 1/8)

Before calculating the weight of the ergonomic factors, the consistency ratio (CR) value has to be calculated (Table 6). Based on the number of factors, the recommended CR value varies. For the corresponding number of factors, the CI was defined. Only when the calculated CR value was satisfied were the factors subjected to weight calculation.

Table 6. Random Index and recommended consistency ratio (CR) values.

Size (n)	3	4	5	6	7	8	9	10
CI	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49
Recommended CR value	<0.05	<0.08	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10

The steps involved in fuzzy extent in AHP are given below [67].

A trapezoidal fuzzy number, denoted as $\hat{E} = (l, m, n, u)$, has the following membership function:

$$\mu\hat{E}(x) = \begin{cases} \frac{x-l}{m-l} & l \leq x \leq m \\ 1 & m \leq x \leq n \\ \frac{s-x}{s-n} & n \leq x \leq s \end{cases} \tag{1}$$

where (m, n) are called the mode interval of $\hat{E}$, and parameters l and u are the lower and upper bound of $\hat{E}$, which limits the field of possible calculation. Let us consider two trapezoidal numbers, $\hat{E_1}$ and $\hat{E_2}$, $\hat{E_1} = (l_1, m_1, n_1, u_1)$ and $\hat{E_2} = (l_2, m_2, n_2, u_2)$. The main operational laws for these two trapezoidal numbers, $\hat{E_1}$ and $\hat{E_2}$, are listed below:

$$\hat{E_1} \oplus \hat{E_2} = (l_1 + l_2, m_1 + m_2, n_1 + n_2, u + u_2) \tag{2}$$

$$\hat{E_1} \otimes \hat{E_2} = (l_1 l_2, m_1 m_2, n_1 n_2, u_1 u_2) for l_i \geq 0, m_i \geq 0, n_i \geq 0, u_i \geq 0, i = 1,2 \tag{3}$$

$$\lambda \otimes \hat{E} = (\lambda l_1, \lambda m_1, \lambda n_1, \lambda u_1), for \lambda > 0, \lambda \in R, l_1 > 0, m_1 > 0, n_1 > 0, u_1 > 0 \tag{4}$$

$$\hat{E} = \left(\frac{1}{u_1}, \frac{1}{n_1}, \frac{1}{m_1}, \frac{1}{l_1}\right), for l_1 > 0, m_1 > 0, n_1 > 0, u_1 > 0 \tag{5}$$

Weight Calculations

In this study, trapezoidal fuzzy numbers are used to represent a pair-wise comparison. Here, a 9-point scale is used to represent trapezoidal fuzzy numbers in the pair-wise comparison.

Step 1: Pair-wise comparison matrix establishment

As per the pair-wise comparison, a matrix $\hat{E}$ is constructed.

$$\hat{E} = \begin{bmatrix} \hat{E_{11}} & \dots & \hat{E_{1n}} \\ \vdots & \dots & \vdots \\ \hat{E_{n1}} & \dots & \hat{E}_{nn} \end{bmatrix} \tag{6}$$

where $\hat{E_{ij}}$ is the scale of T_i compared with T_j. Similarly, the scale is $\hat{E_{ij}} = \left(\hat{E_{ij}}\right)^{-1}$ when T_j is compared to T_i.

$$\hat{E_{ij}} = (l_{ij}, m_{ij}, n_{ij}, u_{ij}) \tag{7}$$

$$\hat{E_{ji}} = (\hat{E_{ij}})^{-1} = (u_{ij}^{-1}, n_{ij}^{-1}, m_{ij}^{-1}, l_{ij}^{-1}) \tag{8}$$

Step 2: Consistency checking

It is necessary to check the consistency of a pair-wise comparison matrix before calculating the weights of sub-factors. To verify the consistency of the pair-wise comparison matrix, fuzzy numbers are improved to crisp numbers. The result of the defuzzified crisp matrix is:

$$E = \begin{bmatrix} E_{11} & \dots & E_{1n} \\ \vdots & \dots & \vdots \\ E_{n1} & \dots & E_{nn} \end{bmatrix} \tag{9}$$

To calculate the consistency index (CI), $\lambda_{\max}$ has to be calculated. To calculate $\lambda_{\max}$, W' has to be calculated.

$$W = \begin{bmatrix} W_1 \\ W_2 \\ . \\ W_n \end{bmatrix} and W_i = \frac{\sum\limits_{i-1}^{n} \alpha_{ij}}{n} \tag{10}$$

$$W' = EW = \begin{bmatrix} W'_1 \\ W'_2 \\ . \\ W'_n \end{bmatrix} \tag{11}$$

$$\lambda_{\max} = \frac{1}{n}\left(\frac{W'_1}{W_1} + \frac{W'_2}{W_2} + \ldots\ldots + \frac{W'_n}{n}\right) \tag{12}$$

Using Equation (13), the consistency index of the comparison matrix can be calculated.

$$Consistency\ Index_{(CI)} = \frac{\lambda_{\max} - n}{n-1} \tag{13}$$

where $\lambda_{\max}$ is the largest Eigenvalue of the comparison matrix and n is the dimension of the matrix.

$$Consistency\quad Ratio\quad (CR)\ = \frac{CI}{Random\quad Index\quad (RI)} \tag{14}$$

Step 3: Calculate the weights

Let $\hat{\mathrm{E}} = \left(e_{ij}\right)_{nn}$ be the fuzzy pair-wise comparison matrix, where $\hat{e_{ij}} = (l_{ij}, m_{ij}, n_{ij}, u_{ij})$. The weight can be calculated as follows:

$$\alpha_j = \left[\prod_{j=1}^{n} l_{ij}\right]^{1/n} \tag{15}$$

$$\beta_j = \left[\prod_{j=1}^{n} m_{ij}\right]^{1/n} \tag{16}$$

$$\chi_j = \left[\prod_{j=1}^{n} n_{ij}\right]^{1/n} \tag{17}$$

$$\delta_j = \left[\prod_{j=1}^{n} u_{ij}\right]^{1/n} \tag{18}$$

Thus:

$$\alpha = \sum_{j=1}^{n} \alpha_j \tag{19}$$

$$\beta = \sum_{j=1}^{n} \beta_j \tag{20}$$

$$\chi = \sum_{j=1}^{n} \chi_j \tag{21}$$

$$\delta = \sum_{j=1}^{n} \delta_j \tag{22}$$

Fuzzy weights can be computed as:

$$\hat{\omega}_j = \left(\alpha_j\delta^{-1}, \beta_j\chi^{-1}, \chi_j\beta^{-1}, \delta_j\alpha^{-1}\right), for j = 1, \ldots\ldots n \tag{23}$$

Fuzzy weight vector $\hat{\omega}$ can be obtained.

$$\hat{W} = (\hat{w}_1, \hat{w}_2, \ldots\ldots, \hat{w}_n) \quad (24)$$

After calculating the individual weights of all the sub-factors within the main factors, the global weight of the factors is calculated. Equation (25) is used to calculate the global weight of the factors.

$$GS_{ij} = \sum (CW_{ij} X GW^c_{ij}) \quad (25)$$

where

GS_{ij}—global score of sub-factors;
CW_{ij}—local weight of sub-factors with respect to the main factor;
$CW^c{}_{ij}$ —global weight of the main factor.

4. Data Evaluation

After accessing the validity and reliability of the factors, an expert panel comprising of ten members (Appendix A Table A1) was asked to rate the level of influence of the factors in the production capability of the industries. For this, the experts were provided with a questionnaire containing the ergonomic factors along with the fuzzy scale (Table 5). Based on the experts' responses, the ergonomic factors were analyzed using FAHP. In evaluating the factors influencing the leather garments production, the significance of each factor must be considered. Hence a pair-wise comparison of each factor was carried out. The established pair-wise comparison matrix is shown in Table 7. All the trapezoidal fuzzy numbers were normalized to crisp numbers. The largest eigenvalue and eigenvector were calculated using Equations (11) and (12), as shown in Table 8.

Table 7. Factor to Factor (F–F) Pair-wise comparison matrix.

Main Factors	E1	E2	E3
E1	(1,1,1,1)	(1/4, 2/7, 2/5, 1/2)	(1/9,1/9,2/17,1/8)
E2	(2,5/2,7/2,4)	(1,1,1,1)	(1/4,2/7,2/5,1/2)
E3	(8,17/2,9,9)	(2,5/2,7/2,4)	(1,1,1,1)

Table 8. Largest Eigenvalue and Eigenvector.

Main Factors	W	W′	λ_{max}	CR Value
Occupational disease (E1)	0.08	3.06	3.0517	CI = (3.0517 − 3)/2 = 0.02585
Personal factors (E2)	0.24	3.02		CR = 0.02585/0.58 = 0.044
Industrial environment (E3)	0.68	3.07		

Then, the Consistency Index (CI) and Consistency Ratio (CR) were calculated using Equations (13) and (14). The calculated consistency ratio was 0.044, which was in accordance with the recommended consistency ratio, given in Table 6. The ranking of the main factors is presented in Table 9. Similarly, the pair-wise comparison matrix of sub-factors, with respect to E1, E2, and E3, was carried out. However, in this paper, the pair-wise comparison of main factors alone is displayed. The consistency ratio for all sub-factors within the main factors was calculated and found to satisfy the required condition. Once the individual weight of the sub-factors in each main factor was calculated, the global priority weight of the sub-factors was calculated. The global weights of the sub-factors were calculated using Equation (25) and their priority rank is shown in Table 10.

Table 9. Ranking of main factors influencing leather garment production.

Main Factors	Preference Weight	Ranking
Occupational disease (E1)	0.08	3
Personal factors (E2)	0.24	2
Industrial environment (E3)	0.68	1

Table 10. Local and global weights of main and sub-factors of the leather garment industry.

Factors	Weight	Rank	Sub-Factors	Local Weight	Rank	Global Weight	Rank
E1	0.08	3	E11	0.3153	1	0.025224	10
			E12	0.1259	5	0.010072	16
			E13	0.1400	3	0.0112	14
			E14	0.2013	2	0.016104	13
			E15	0.0458	6	0.003664	19
			E16	0.1399	4	0.011192	15
			E17	0.0318	7	0.002544	20
E2	0.24	2	E21	0.3702	1	0.088848	4
			E22	0.2129	2	0.051096	6
			E23	0.1707	3	0.040968	7
			E24	0.1036	4	0.024864	11
			E25	0.0913	5	0.021912	12
			E26	0.0267	6	0.006408	17
			E27	0.0246	7	0.005904	18
E3	0.68	1	E31	0.2270	2	0.15436	2
			E32	0.3884	1	0.264112	1
			E33	0.1612	3	0.109616	3
			E34	0.1293	4	0.087924	5
			E35	0.0513	5	0.034884	8
			E36	0.0428	6	0.029104	9

5. Results

5.1. Reliability and Validity Analysis

The calculated Cronbach's α value is shown in Tables 2 and 3. In our case, the Cronbach's α is 0.873, which is acceptable. The Cronbach's α value, if item deleted for all factors, is above 0.8. Hence, from this it could be inferred that all 20 factors considered in this study are reliable and can be used for future study. In this case, the KMO value is 0.802 (Table 4), which indicates the sampling is adequate. Thus, we finalized the ergonomic factors hindering the production rate of leather garment-based SMEs. After finalization using FAHP, the factors and sub-factors of ergonomics causing production loss were evaluated.

5.2. Weight of Ergonomic Factors

After accessing the validity and reliability, the factors were evaluated by the experts using fuzzy AHP. Before calculating the weights of the factors, the consistencies of the factors were checked. The consistency ratio (CR) calculated is shown in Table 8. Here, the CR value is 0.044 which is accepted, as per the standard given in Table 6. After this, the preference weight of the main factors was calculated and is given in Table 9. Likewise, the local weight of sub-factors was also calculated, as shown in Table 10. Then, the local weight of sub-factors was multiplied with the preference weight of the main factor to get global weight. The calculated global weight of the sub-factors is given in Table 10.

5.3. Sensitivity Analysis

Normally, responses received through questionnaires are based on human judgments, and hence they are prone to imprecision and vagueness. A small variation in relative weights will largely influence the final ranking of variables [69]. The final rank check is mandatory as the inputs used in fuzzy AHP are based on human linguistic judgments. In this work, a sensitivity analysis was carried out to monitor the priority ranking of ergonomic factors in leather garments production. To illustrate the effect of the sensitivity analysis in this work, the dimensions of the most influencing factor "Industrial environment (E3)" is increased from 0.1 to 0.9 with an increment of 0.1. As weights of main factors change, the ranking of sub-factors also changes. Table 11 shows corresponding global weight change in sub-factors. The rank of the sub-factors based on the sensitivity analysis is shown in Figure 2.

Table 11. Global weights for sub-factors by sensitivity analysis.

	0.1	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.68 (Normal)**	**0.7**	**0.8**	**0.9**
E11	0.0709	0.0630	0.0551	0.0473	0.0394	0.0315	0.0252	0.0236	0.0157	0.0078
E12	0.0283	0.0251	0.0220	0.0188	0.0157	0.0125	0.0100	0.0094	0.0062	0.0031
E13	0.0314	0.0279	0.0244	0.0209	0.0174	0.0139	0.0112	0.0104	0.0069	0.0034
E14	0.0452	0.0402	0.0352	0.0301	0.0251	0.0201	0.0161	0.0150	0.0100	0.0050
E15	0.0103	0.0091	0.0080	0.0068	0.0057	0.0045	0.0036	0.0034	0.0022	0.0011
E16	0.0314	0.0279	0.0244	0.0209	0.0174	0.0139	0.0111	0.0104	0.0069	0.0034
E17	0.0071	0.0063	0.0055	0.0047	0.0039	0.0031	0.0025	0.0023	0.0015	0.0007
E21	0.2499	0.2221	0.1943	0.1666	0.1388	0.1110	0.0888	0.0833	0.0555	0.0277
E22	0.1436	0.1277	0.1117	0.0957	0.0798	0.0638	0.0510	0.0478	0.0319	0.0159
E23	0.1152	0.1024	0.0896	0.0768	0.0640	0.0512	0.0409	0.0384	0.0256	0.0128
E24	0.0699	0.0621	0.0543	0.0466	0.0388	0.0310	0.0248	0.0233	0.0155	0.0077
E25	0.0616	0.0547	0.0479	0.0410	0.0342	0.0273	0.0219	0.0205	0.0136	0.0068
E26	0.0180	0.0160	0.0140	0.0120	0.0100	0.0080	0.0064	0.0060	0.0040	0.0020
E27	0.0166	0.0147	0.0129	0.0110	0.0092	0.0073	0.0059	0.0055	0.0036	0.0018
E31	0.0227	0.0454	0.0681	0.0908	0.1135	0.1362	0.1543	0.1589	0.1816	0.2043
E32	0.0388	0.0776	0.1165	0.1553	0.1942	0.2330	0.2641	0.2719	0.3107	0.3495
E33	0.0161	0.0322	0.0483	0.0644	0.0805	0.0967	0.1096	0.1128	0.1289	0.1450
E34	0.0129	0.0258	0.0387	0.0517	0.0646	0.0775	0.0879	0.0904	0.1034	0.1163
E35	0.0051	0.0102	0.0153	0.0205	0.0256	0.0307	0.0348	0.0359	0.0410	0.0461
E36	0.0042	0.0085	0.0128	0.0171	0.0213	0.0256	0.0291	0.0299	0.0342	0.0385

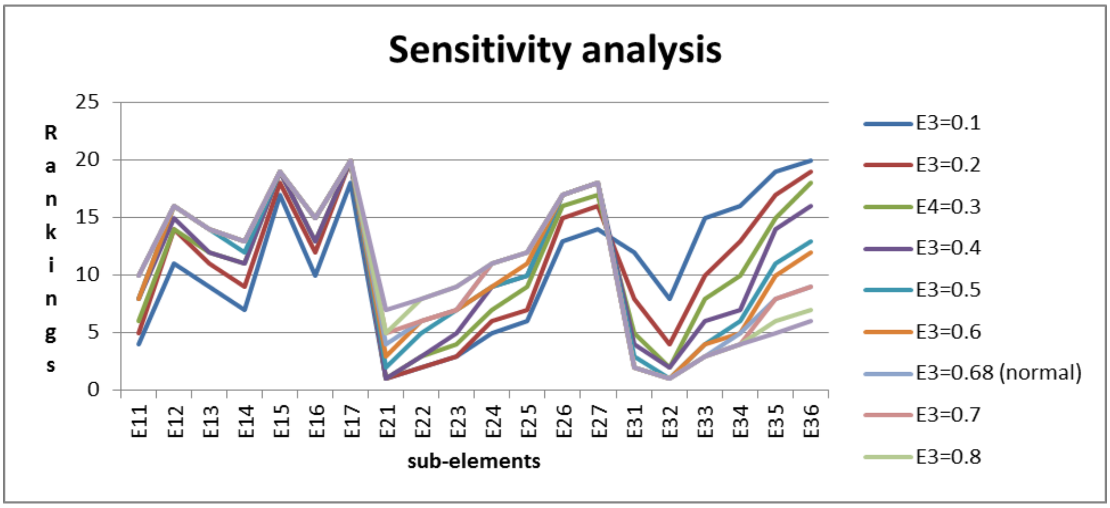

Figure 2. Sensitivity analysis of sub-factors (rank).

6. Discussion

From Table 9, the rank of the main factors is obtained as follows: E3 > E2 > E1. "Industrial environment (E3)" receives the highest weight in the priority ranking. This indicates that the impact of the industrial environment on workers' health is more pressing when compared to the other categories of factors. The effective utilization of manpower in companies is often jeopardized by poor machine design, plant layout, and poor infrastructure [70]. Persons working with inappropriate table height over a short or long period are exposed to MSDs; such tables force the workers to work in awkward positions. A study carried by Bontrup et al. [71] insisted that poor industrial working environment may limit the quality of workers' health and may lead to frequent absenteeism. The abovementioned research works confirm that industrial environments definitely influence workers' health. Next, "Personal factors (E2)" occupies the second position in the priority ranking, another important ergonomic factor. Personal factors include fatigue, job satisfaction, endurance, and self-motivation; these factors determine the working capacity of workers. In a study carried out by Vulović et al. [72] in a call center, the rate of exposure of workers to low back pain is directly linked with an individual's health aspects. Based on the duration of the employees having to sit, the severity of low back pain may be acute or chronic.

The study also confirmed that sitting behavior and low back pain are inherently linked. Those reviewed research works confirm that personal factors play a pivotal role in enhancing the production rate and it is also an important factor of ergonomic problems. "Occupational disease (E1)" occupies the third rank in the priority ranking. However, occupational disease remains a significant influence on workers' health and their production rate. The occurrence of ergonomic-related problems differs from workplace to workplace and depends upon the actual work being done. Persons working in sectors such as construction work or being a driver or porter are exposed to different types of ergonomic problems. Employees who spend hours in front of computers develop the possibility of quick exposure to MSDs. Generally, people who spend more time on computers experience neck pain, wrist pain, and back pain [73]. These findings confirm that occupational disease induces different types of pain among workers.

6.1. Sub-Factors Ranking Using FAHP

6.1.1. Occupational Disease

Occupational disease results from the kind of work performed by a worker. While the factor "occupational disease" holds the third position in the priority ranking, it still needs due consideration in preventing the occurrence of ergonomic problems. The ranking of sub-factors placed under occupational disease are as follows: E11 > E14 > E13 > E16 > E12 > E15 > E17 (Table 10). "Spinal cord problem" occupies the first position in the ergonomic problem arising among workers. The finding aligns with the results of [74]. These authors report that the majority of workers in the leather garments industry are prone to spinal cord injuries because they work in awkward positions for long durations. "Knee joint pain", ranked second, is the most common ergonomic problem among workers in garment sectors. Prolonged standing within a restricted space aggregates the possibility of knee joint pain. Sitting in a constrained space and working in a leaning forward position monotonously induces "low back pain" and it secures the third rank. Additionally, the provision of improper height tables may trigger the occurrence of low back pain.

6.1.2. Personal Factors

Personal factors include self-motivation, job satisfaction, and fatigue, and play a significant role in executing an assigned work task. The ranking of sub-factors under personal factors are: E21 > E22 > E23 > E24 > E25 > E26 > E27 (Table 10). "Fatigue" is ranked first in personal factors. Only low-quality products are manufactured by workers when they suffer fatigue [75]. The sub-factor "job satisfaction" comes next in the priority ranking. Extended working hours may develop fatigue and hatred on the job. Lack of respect, no sense of appreciation, and few rewards are the main reasons that create job dissatisfaction. The sub-factor "self-motivation" holds third place in the priority ranking among personal factors. Unless the workers are self-motivated, they will not be able to perform the assigned work in the stipulated time in a precise manner. Lack of self-motivation will result in delayed work completion, poorly done or incomplete work, and work with more flaws.

6.1.3. Industrial Environment

Industrial environment includes aspects such as providing basic infrastructure and an ambient working atmosphere. Providing an aesthetic pleasing working environment for workers is vital in nurturing both the physical and mental health of workers. The ranking of sub-factors under the industrial environment are as follows: E32 > E31 > E33 > E34 > E35 > E36 (Table 10). "Outdated machinery" holds the top position in the industrial environment. The usage of outdated machinery triggers other ergonomic factors, such as low back pain, neck pain, and vibrations, which hinder the production rate of leather garments [12]. "Operational setup" comes next in the priority ranking of sub-factors. For carrying the assigned works without much repetition or duplication of efforts, a well-designed industrial layout is needed. The layout should be designed depending on the sequence of operations to be carried out. "Industrial hygiene" is very important in leather garments because the possibility of contracting fungal and bacterial infection is high. Hence, providing a hygienic working environment is imperative [36]. Companies must ensure they provide a hygienic working environment.

6.2. Sensitivity Analysis

The result obtained in this study is completely based on the opinions of experts and hence they are subjective to bias. Therefore, there is a need to check the reliability and robustness of the result. For this, sensitivity analysis is performed. Usually, sensitivity analysis is performed either by changing the preference weight of the experts or by changing the weight of factors with the highest weight. In this case, the weight of the factor receiving the highest weight is changed with an increment of 0.1 from 0.1 to 0.9. Similar kinds of work have been performed in earlier studies [76,77]. In our case, the factor "industrial environment" has the highest weight and the weight is changed from 0.1 to 0.9. The change in the weight of sub-factors with respect to change in the weight of the main factors is given in Table 11. From Table 11 and Figure 2, it could be inferred that sub-factor "fatigue (E21)" occupies the highest rank with values 0.1 to 0.4, while sub-factor E36, "industrial hygiene", occupies the lowest rank with a value 0.1. From values 0.2 to 0.9, sub-factor "wrist pain (E17)", occupies the lowest rank. Sub-factor "outdated machinery (E32)" secures the highest rank with values from 0.5 to 0.9. From this, it is understood that usage of "outdated machinery" has been the prime reason for the occurrence of allied ergonomic problems. Further, poor working environment and work schedule imposes "fatigue" among the workers. Poor working environment is a big threat for the hygiene of the workers. Such environment brings in health issues, such as breathing problem and skin allergies.

6.3. Managerial Implications

Leather garment companies in India immensely contribute to the nation's economic development. However, workers at these industries suffer an enormous amount of pain while the garments industry itself struggles to attain social sustainability. This research may help industrial managers in identifying ergonomic factors and in providing an ergonomically designed working environment. This research offers the following managerial implications for social sustainability.

Enhancing the workers' welfare in attaining social sustainability: In our study, it has been revealed that the use of "outdated machinery" in leather garments is the prominent factor affecting the health of workers. Such an undesired impact on the workers poses a question regarding the social responsibility of industrial management. As a step towards social sustainability, the management must nurture the workers' welfare. For this, industrial management has to replace the existing outdated machines with new ergonomically designed machines. Next, by providing reasonable pay for the workers, it is possible to alleviate the poverty of the workers [64]. Reasonable pay for all employees will aid in overcoming gender inequality regarding income. Frequent motivational programs for workers will encourage them to carry out their assigned work tasks in a whole-hearted manner [78]. Further, management must establish an ambient working atmosphere where workers can perform the assigned task with ease. By providing an ample working environment, management may ensure the workers' health and safety. Waste from leather companies remains a major concern for the local community. Hence, proper waste management practices, such as 6R (recycle, redesign, reuse, repair, reduce, rethink), and effluent treatment plants, must be used. By practicing skillful waste management, the leather garment industry may establish a good reputation in society and develop a reputation for caring about the community [79].

Emphasizing personal factors during workers selection: Being the major player in deciding production capacity, workers' physical and mental aspects must be considered as important factors. Fatigue has also been identified as a major ergonomic factor. Performing routine work without sufficient intervals may quickly expose workers to fatigue. Fatigue affects cognitive skill and interest in work. Hence, it is important to address the fatigue problem of workers. Frequent motivational and meditation programs must be conducted to nurture mental health. Mutual respect and trust between top-level management and the worker will improve the job satisfaction factor [80]. A stress-free friendly environment reduces worker fatigue and increases endurance level. A proper blend of younger and more experienced employees should be considered since, in some situations, experience would be welcomed, whereas in other situations a younger worker might be better equipped to carry more weight. Reasonable wages based on the mode of work should be paid regardless of gender. Job rotation must be implemented to minimize fatigue among workers and to enhance mental sharpness.

Establishing ergonomically designed working environment: An ergonomically designed workplace will ensure increased productivity. An industrial environment with adequate space and lighting will prevent the workers from ergonomic exposure. Hence, it becomes mandatory for industrial management to provide a worker-friendly environment. By replacing old machines with newer ergonomically designed machines that offer inclined arm rests and back support, workers' exposure to MSDs can be minimized [81]. Maintaining a hygienic environment within companies is vital as it directly influences the health of workers who directly determine the production capacity. Sufficient space must be provided between each section and sections should be designed sequentially, depending on the operational sequence. Further, proper ventilation and shock arresters must be provided to ensure a better workplace. Cushion mat flooring will mitigate heel pain when workers stand for a long duration. Height-adjustable chairs lower neck and back pain. Ensuring the adequate presence of carriages, automated guide vehicles (AGVs), and wagons for transporting raw materials and finished products from one place to another, will reduce the movement of workers. With industries becoming digitalized, industrial management need to integrate digitized technology [82,83]. Worksite physical activities between work tasks will reduce suffering.

7. Conclusions

Ergonomic issues faced by the workers within the working environment to a large extent reduce the working efficiency. In some cases, ergonomic issues may bring in severe complexities, such as musculoskeletal disorders (MSDs), breathing difficulties and skin problems. Such complexities may increase the frequency of absenteeism of workers, resulting in decreased production and loss of working hours. Realizing the influence of ergonomic issues in industrial performance, developed countries have started paying significant attention in providing ergonomic free working environments. However, due to a lack of awareness about ergonomic issues and the availability of a cheap workforce, developing countries are not considering ergonomic issues as a serious. Hence, this study intends to identify the ergonomic problems faced by workers in leather garment industries in Southern India. For identifying the ergonomic factors, the extant literature was reviewed, and industrial experts' opinions were sought. Then, using the SPSS tool, the twenty most influential identified ergonomic factors were validated. The twenty identified factors were classified under three categories. To evaluate the identified ergonomic factors, a multiple case study was carried out in five leather garment companies. The fuzzy AHP method was used to prioritize the identified ergonomic factors. The rankings of the main ergonomic factors using fuzzy AHP were obtained as follows: Industrial environment, Personal factors, and Occupational disease. The factor "industrial environment" secured the highest rank and it needs immediate attention from management in enhancing production rate and also in attaining social sustainability. The sub-factors of ergonomic problems were also prioritized in this study. In this work, the sub-factor of outdated machinery (found within the industrial environment category) secures the first rank in the priority ranking. So, the management of the garment must replace existing outdated machinery with new ergonomically designed machines. A sensitivity analysis was carried out to ensure the priority ranking of sub-factors obtained through fuzzy AHP.

This study has some significant contributions. Firstly, this work imparts knowledge and awareness about the importance of addressing ergonomic issues from the context of the developing nation. Such types of work in developing nation contexts are scant. Secondly, in this work, the validity of the data was assessed using SPSS software by calculating the Cronbach's and Barlett's test. In earlier studies, Cronbach's alone is calculated. Finally, this work has considered and evaluated the role of personal factors in ergonomic issues, a factor not considered in earlier studies.

To overcome the identified ergonomic issues, some possible managerial implications are suggested. Firstly, the industries must replace existing outdated machinery with the latest machines. Machines with adjustable height must be provided as it greatly reduces the occurrence of back pain of the workers. Next, industrial management must pay attention to the provision of hygienic working environments. Providing a hygienic working environment may reduce the workers' exposure to health hazards. Finally, work schedules with adequate intervals must be provided. Additionally, frequent motivational programs must be conducted to reduce the fatigue of the workers. The findings of this study should not be limited only to the leather garment industry; the findings are applicable to other SMEs, such as handloom weaving companies, spinning mills, or packaging companies in which human and machine interaction is imperative.

Though this study contributes significantly to the literature on ergonomic issues, it also has several limitations. For instance, the ergonomic factors considered and evaluated in this study were collected from the Indian context. So, caution must be exercised while carrying an ergonomic studies considering these factors in other developing countries. Next, this study only evaluates the weight of ergonomic factors.

As a future direction of the study, a study using DEMATEL and ISM may reveal the inter-relationship among these factors, both in an Indian context and in the contexts of other countries. Some of the factors considered in this study may become insignificant in a future study. For instance, the factor "outdated machinery" may become insignificant in future, as India is on a path of development. At present, a lot of manual work is exerted from the workers by industrial management and hence, the study evaluated the factors related to physical health. However, in future, with technological advancement, the study on the ergonomic problem may be more focused on psychological and cognitive factors. Further, with the concept of corporate social responsibility (CSR) gaining attention, the future study of ergonomics may be merged with the CSR concept.

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Appendix A

Table A1. Profile of the experts.

Characteristics	Classifications	Experts	Percentage (%)
Gender	Male	6	6.00
	Female	4	4.00
Age	Up to 30 years	2	2.00
	31–45	4	4.00
	46–60	4	4.00
Experience	1–10	3	3.00
	11–20	4	4.00
	21–30	3	3.00
Education	Graduate	3	3.00
	Postgraduate	4	4.00
	Doctorates	3	3.00

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