KEY PERFORMANCE INDICATORS FOR ADOPTING SUSTAINABILITY PRACTICES IN FOOTWEAR SUPPLY CHAINS

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Abstract: *The footwear industry has contributed notably to different countries' economic development. Therefore, it needs to focus on operational excellence in order to achieve a sustainable level of development. Achieving sustainability in the footwear industry, however, is a complex task since various issues are involved in the footwear manufacturing process. Currently, in order to see how firms can sustain their place in the competitive global business environment, researchers and practitioners are giving special attention to operational excellence in the footwear manufacturing industry. Operational excellence is a business term that indicates the actual performance of an organization. To make the supply chain agile, resilient, and sustainable, it is imperative that firms incorporate sustainable practices in the footwear industry, and operational excellence can help in this regard. The sustainability of the footwear industry can be examined by using a set of key performance indicators (KPIs). Therefore, identifying and examining the KPIs for adopting sustainable practices in the footwear supply chain is a very important task. There is still a knowledge gap in research on the KPIs for attaining sustainability in the footwear industry. To fill in this knowledge gap, this study contributes to the existing literature by identifying and assessing the KPIs by using a novel multi-criteria decision-making (MCDM) method named the best-worst method (BWM). This study uses a previous study to identify some relevant KPIs, some of which were included in the assessment process based on footwear industry experts' feedback. After finalizing the relevant KPIs, BWM was utilized to find the most important KPIs for adopting sustainability practices in the footwear industry's supply chains. The findings of this study reveal that the KPIs "quality production", "timely order processing" and "accuracy of moulding" received the first three positions in the rankings we performed. The results of this study will help practitioners, industry experts, and decision-makers to find out a pathway for easily adopting sustainability practices in the footwear supply chains.*

Keywords: *Sustainability, footwear industry, key performance indicators, best worst method, operations excellence.*

JEL Classification: *C44, L25, L67, M11.*

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Introduction

A supply chain is the integrated part of an organization in which the suppliers, manufacturers, distributors, and consumers are involved and the information flow is linked through networks (Towill et al., 1992). Sustainability requires having sustainable business practices (Lai et al., 2020). From a practical point of view, sustainability focuses on minimizing the harmful impact of a firm on the environment, on enhancing good social relations, and on increasing the economic benefits of the firm, at the same time (Hendiani et al., 2020). The sustainability of the supply chain is therefore an important issue for the business organizations that are looking to attain a sustainable level in the global market (Kumar et al., 2019). To make the supply chain sustainable and resilient, it is essential to identify the basic performance indicators. By investigating the existing performance of an organization, a firm can take action against the problems that exist.

The footwear industry of Bangladesh produced 378 million pairs of shoes in 2019, and 200–250 million pairs were bought by local consumers. Local and international demand for footwear is increasing by the day (Kumar, Moktadir et al., 2020). In addition, the contributions of the footwear industry is remarkable in terms of foreign exchange (Moktadir, Rahman et al., 2019). Accordingly, the export of footwear to foreign countries is increasing, which indicates that it is important for different countries' rates of development. According to data from the fiscal years of 2018–2019, footwear items made of leather earned 607.88 million USD. Hence, the footwear sector is a growing sector given that its earnings in foreign currency is increasing. Along with its remarkable contribution to earnings in foreign currency, the industry is facing trouble benchmarking its in order to better its practices. Therefore, this study looks to identify the KPIs needed to examine the existing performance of footwear firms in order to be able to set long-term goals.

The literature on key performance indicators is well established, and several studies have been done on other KPIs. For example, Elhuni and Ahmad (2017) showed the importance of the KPI in the context of the oil and gas sector, which is one of the most significant sectors for maintaining a sustainable level of development for any country. Setijono and Dahlgaard (2007) worked on customer value, which is indicated as a KPI. Larrea (2013) tried to investigate the KPIs to use for humanitarian logistics. Dočekalová and Kocmanová (2016) worked on finding a composite indicator for the assessment of sustainability. Ishaq Bhatti and Awan (2014) worked on finding KPIs for the assessment of organizational performance. Pakzad and Osmond (2016) developed sustainability indicators for evaluating the performance of green infrastructure. Lavy et al. (2014) worked on the KPIs for the assessment of facility performance. Selmeci et al. (2012) investigated the KPIs for the evaluation of the performance of enterprise resource planning (ERP).

The literature survey confirms that no one has worked on the KPIs for the assessment of sustainability in the footwear industry supply chain. Therefore, this research focuses on the identification and investigation of the KPIs for the assessment of sustainability in the footwear industry in the era of operational performance. The research objectives of the research are listed below:

a) Identify the KPIs for the assessment of sustainability in footwear manufacturing operations.
b) Investigate and assess the impact of selected KPIs for footwear manufacturing operations.
c) Propose the proactive, active, and reactive approaches to achieving sustainability in the footwear manufacturing sector.

To attain these research goals, several techniques have been used. First, a survey was done of the existing literature in order to collect the relevant KPIs for the assessment of sustainability. Then, the KPIs were reviewed and validated by experts for their final evaluations. Finally, the MCDM model was applied for the investigation of the relative importance of the selected KPIs.

1. Literature Review

1.1 Importance of KPIs

Key performance indicators (KPIs) are criteria that help to evaluate the performance of a system. They can be used as an important decision-making tool for the manufacturing process or operations. They can also assist industrial decision-makers in making their decisions more effective and efficient. KPIs can contribute significantly to the task of setting the target goals of a company looking to improve its performance. They can also help to identify and root out the causes of any problems in different organizations. In a performance assessment system, the main task is to find the KPIs that can help to assess its operation. To help an organization be more sustainable and efficient, a set of KPIs can be identified and assessed.

In addition, a KPI is a computable value that demonstrates how efficiently a company is attaining its objectives. For monitoring the effectiveness and the cost of the supply chain, a set of KPIs helps a supply chain manager take better measurements. KPIs also play a large role in helping to identify if a business is making improvements. Using KPIs to perform the continuous monitoring of a business process is done easily using measurements (Velimirović et al., 2011). The goal of including KPIs in the production process is to deliver support for the managers of the production processes and plants and enable them to act transparently and swiftly while also allowing them to have complete supervision over the state of the production process in all its parts.

1.2 Existing Works on KPIs

Exploring the use of KPIs for achieving sustainability is an important issue, especially in terms of improving business policies and to cope with existing competitors in the market. Many scholarly publications describe the importance of KPIs for industrial fields. For example, Elhuni and Ahmad (2017) investigated the use of KPIs in the context of the oil and gas sector, one of the most significant sectors for attaining a sustainable level of development in any country. In this research, the authors identified a set of KPIs while focusing on the three aspects of sustainability: environmental, social, and economic. An analytical hierarchy process (AHP) can be used to assess which are the most important KPIs with the assistance of industrial decision-makers. KPIs and different methods of analysis were performed in the construction industry in South Africa to access the sustainability of its infrastructure. Similarly, KPIs were used to look at sustainable development in many other sectors. Ugwu and Haupt (2007) employed MCDM models to assess the environmental sustainability of six pharmaceutical firms while highlighting the use of a five-level indicator hierarchy. Mezouar et al. (2016) developed a four-level model focusing on business process modelling notation and supply chain operations in order to assess sustainability. On the basis of goal setting theory, 15 performance objectives were selected for the investigation of the use of KPIs in public-private partnerships (PPPs) by means of a well-made inspection. Using a well-structured questionnaire, a conceptual framework for KPIs was established from these findings (Yuan et al., 2009). A study conducted by British Aerospace was performed in order to make its supply chain more sustainable. It examined the drivers and key features of sustainability. From this study, two frameworks were obtained that show an interdependence among the constituents of the supply chain and the triple bottom line (Gopalakrishnan et al., 2012). Konsta and Plomaritou (2012) investigated the applicability and utility of KPIs in shipping management for tanker shipping companies in Greece. A SCOR-based model for assessing supply chain performance was evaluated in the context of the Brazilian footwear industry (Sellitto et al., 2015). The study involved four suppliers, one local footwear manufacturer, a return channel, and three distribution channels, and it used 85 indicators in its evaluation. The performance level of the whole supply chain was 75.29% (Sellitto et al., 2015). Moktadir et al. (2020) demonstrated the use of KPIs in the context of the leather products industry supply chain in looking at reaching sustainability. In this research, the authors identified and examined the KPIs using BWM, and then they evaluated the performance of the case-study companies using these KPIs. Jiang et al. (2020) identified and investigated KPIs using Z-DEMATEL in order to measure hospital performance management. Li et al. (2020) offered a set of system-level KPIs for quantifying the level of building energy performance. Andersson and Thollander (2019) demonstrated that KPIs can be used for energy management in the the Swedish pulp and paper industry. Alvandi et al. (2012) developed a set of appropriate KPIs utilizing a balanced scorecard approach for SAPCO and using the MCDM method. Dev et al. (2019) outlined a decision support model for companies looking to evaluate their KPIs in a real-time dynamic system in the case of big data architecture. Chand et al. (2020) adopted a hybrid exploratory three-phased MCDM model in order to analyze supply chain performance (SCP) metrics for Indian mining and earth moving equipment companies. In this model, the authors first applied the Delphi method to identify the critical SCP metrics. In addition, the authors used BWM to rank the SCP metrics. Finally, the authors used the decision-making trial and evaluation laboratory (DEMATEL) method to determine the interactions among the SCP metrics. A study was carried out by Sharifi et al. (2016) to investigate and rank KPIs using the BSC method in the Isfahan Central Post Office. The ranked KPI's were then analyzed according to their level of sensitivity. Amrina and Vilsi (2015) proposed using a set of KPIs for assessing the sustainability of the manufacturing process in the cement industry on the basis of the three aspects of sustainability. In this study, AHP was applied to summarize the opinions of experts. The list of the KPIs and sub-KPIs are shown in Tab. 1.

Tab. 1: List of KPIs and sub-KPIs – Part 1

Main KPI	Sub-KPI	Explanation	References
Planning	Collaborative forecasting support	Collaborative forecasting is a dynamic tool which can help companies to make effective decisions. This process internally & externally reaches for gathering information; helps to make the best output from the forecast.	Helms et al., 2000
	Inventory turnover	Inventory turnover can be defined as a ratio which shows how many times a company has traded and exchanged its inventory within a time period. This calculation helps to take many important decisions for business improvement regarding inventory.	Madhusudhana Rao & Prahlada Rao, 2009
	Inventory records	It is a process of listing all brochures, files, accounts created and maintained by any organization. Usually, it helps in describing much important information and helps to create record maintenance schedule.	Bruccoleri et al., 2014
	Forecast vs. order	Forecast helps to achieve the efficiency of supply chains and it depends on timely order processing.	So & Zheng, 2003
Sourcing	Order lead time	The order lead time means the time taken to receive a customer's order & shipment of goods.	Bhagwat & Sharma, 2007
	Vendor managed inventory (VMI)	By creating a VMI relationship, the provider, usually the manufacturer but on occasion a wholesaler, sorts the main inventory replenishment decisions for the organization.	Waller & Johnson, 1980
	Timely order processing	Order processing is the key performance indicator for a company as it helps to ensure timely order processing to the consumers or buyers. Timely order processing is one of the KPI for footwear supply chains.	Ala-Harja & Helo, 2016; Arzu Akyuz & Erman Erkan, 2010
	Maintain materials standard	Material standard means to meet the desired properties of the specific materials delivered by the supplier. Supplied raw materials must be checked before entering into footwear industry.	Weich & Lewis, 1998

Tab. 1: List of KPIs and sub-KPIs – Part 2

Main KPI	Sub-KPI	Explanation	References
Production	Production lead time	Lead time is the expanse of time between process launch and its accomplishment. So, it can be considered as KPI for better performance evaluation.	Karmarkar, 2008
	Quality production	Quality production can be marked as KPI for the quality assessment of the system as well as quality of products. It can help to find the overall standard of the system of products.	Xu et al., 2006
	Capacity utilization	Capacity utilization can be marked to be one KPI for the assessment of the capacity that is being used for the supply chain demand or the process utilization.	Coelli et al., 2002; Niekerk, 2010
	Efficient manpower	Manpower management for better quality is an imperative issue for footwear production.	Du et al., 2015
	Machine utilization	This KPI is an important for the manufacturing firms that can be helped to know the current utilization of machine in the production process.	Palau et al., 1999
Deliver	In-time delivery	Timely delivery of products helps to achieve efficiency of the supply chains. JIT helps to reduce the amount of materials held in stock, thus increasing the business profit.	Weingart et al., 2006
	Order fulfilment	In general sense, it is a process from point of sales analysis to delivery of a product to the end user. In broader sense, it refers to the way in which firm react to the customer orders.	Amer et al., 2007
	In-stock availability	In modern business practices it is very important to have available stock of his products to deliver the customers immediately in a short time than the others (competitors).	Blake, 1984

Source: own

2. Methodology

2.1 Research Design

In this research, a work-flow was designed so that the research goals were met. For this purpose, a set of KPIs for assessment of sustainability of manufacturing companies were identified from a survey of the literature as well as from feedback from experts. After finalizing a set of the relevant KPIs, an assessment, multi-criteria decision-making tool named the best-worst method was used to find the impact of each of the KPI for the manufacturing firms.

2.2 Best Worst Method

As noted in the literature, numerous MCDM tools are available. One of the most used tools is the so-called "best-worst" MCDM tool. It was established by Professor Rezaei in 2015 (Rezaei, 2015). For solving problems in multi-criteria decision-making, this system works better than other tools, such as AHP. The unique advantages of BWM are: I) it requires less time and effort when compared to AHP; II) it requires less pairwise comparison matrices; and III) the obtained results from the BWM analysis is more consistent and reliable than AHP (Stević et al., 2018; Pishdar et al., 2019; Moktadir et al., 2020). These special advantages have made the tool more beneficial than other tools. Using this method, the results derived are more consistent than other MCDM techniques. Moreover, it helps researchers and decision-makers in finding more reliable results and in less time since the BWM method requires fewer pairwise comparison matrices in order to obtain an improved outcome (Rezaei et al., 2016). These are the key advantages for selecting the MCDM tool for this research.

BWM is well known in the literature. Many researchers have used this method for different purposes. For example, Rezaei et al. (2015) have used BWM in order to create different supplier management strategies involving different industry segments and to make links with supplier development. Gupta (2018) utilized BWM for evaluating the service quality of the airline industry. Van de Kaa et al. (2019) analyzed competing technologies for realizing a smart meter by using BMW while Li et al. (2019) used the fuzzy-based BWM in an MCDM analysis. Moktadir, Ali et al. (2019) utilized BWM to examine the key factors of success in the energy-efficient supply chain. Moktadir et al. (2018) used BWM for assessing the challenges of implementing Industry 4.0. Rezaei et al. (2018) used BWM to measure the importance of logistics performance index indicators. Wang et al. (2019) identified and analyzed the risks of the energy performance contracting (EPC) industry in China while using BWM. Ghimire et al. (2016) used BWM and a discrete choice experiment to look at consumer shares for turfgrass attributes. Omrani et al. (2020) used the BWM & MULTIMOORA methods for the calculation of the semi-human development index in the provinces of Iran. A combined method based on BWM, that is, an integrated BWM-VIKOR framework, was used to evaluate and rank the selection criteria for sustainable outsourcing partners (Garg & Sharma, 2020). Kumar, Aswin et al. (2020) evaluated the green performance of airports using the BWM and VIKOR methods. This study found that green policies and regulations were the most important indicators of a green airport. A case study from Budapest used the AHP-BWM method to evaluate the factors of driver behavior in terms of road safety (Moslem et al., 2020). Yazdi et al. (2020) used the BWM method for the selection of a maintenance strategy for offshore operations. Muravev and Mijic (2020) proposed a BWM-MABAC model that examined its applicability as a novel integrated multi-criteria model. Zhang et al. (2020) offered a hybrid multi-expert MCDM model by integrating the BWM and combined compromise solution (CoCoSo) methods using the interval rough boundaries for SSS for housing development. Some other applications include performing a BWM analysis for landslide susceptibility mapping, using MCDM in the application of a hybrid GIS spatial scheme (Gigović et al., 2019), prioritizing a sustainable manufacturing barrier (Malek & Desai, 2019), accessing the risk of suppliers (Er Kara & Oktay Fırat, 2018), selecting sustainable suppliers (Yazdani et al., 2019; Amiri et al., 2020), preventing cardiovascular disease through a combination of GIS with a fuzzy MCDM algorithm (Naeini et al., 2019), and many others.

The step-wise process of BWM could be described in the following (Rezaei, 2015; Gupta et al., 2017):

Identify the KPIs and sub-KPIs

In this stage, a set of KPIs $\{kp_1, kp_2, ..., kp_n\}$ are estimated.

Fixing of the best and worst KPIs

In this stage, decision makers will identify the best and worst KPIs without any comparison.

Assessment of the best KPI over the other KPIs

In this stage, decision makers will make the comparison vector for the best KPI over the other KPIs using 1–9 scale rating scale. The rating value 1 indicates equal preference and 9 indicates the strongly preference. The best-to-others (BO) vector of KPIs is given below:

$$A_B = (a_{B1}, a_{B2}, ..., a_{Bn})$$

where a_{Bj} represents the preference of best KPI over the KPI j. Hence, $a_{BB} = 1$.

Assessment of all the other KPIs over the worst KPI

In this stage, decision makers will make the comparison vector for the others-to-worst KPI using 1–9 scale rating scale. Therefore, the others-to-worst vector can be presented as follows:

$$A_W = (a_{1W}, a_{2W}, ..., a_{nW})^T$$

where a_{jW} indicates that the preference of the j KPI over the worst KPI and $a_{WW} = 1$.

Searching the optimal weights of KPIs ($w_1^*, w_2^*, ..., w_n^*$)

The optimal weights of the KPIs can be find by fullfiling below mention constraints and conditions: for each pair of w_B/w_j and w_j/w_W, the best desirable output is where $w_B/w_j = a_{Bj}$ and $w_j/w_W = a_{jW}$. Therefore, to acquire the best solution, the maximum need to be minimized among the set of $\{|w_B - a_{Bj}w_j|, |w_j - a_{jW}w_W|\}$, and the real life problem can be explained as follows Formula (1):

$$\min \max_j \{|w_B - a_{Bj}\, w_j|, |w_j - a_{jw}\, w_w|\}$$
$$\text{s.t.,}$$
$$\textstyle\sum_j w_j = 1, \qquad (1)$$
$$w_j \geq 0, \text{ for all } j.$$

Formula (1) is converted to a linear model and is shown as Formula (2):

$$\min \xi^L,$$
$$\text{subject to,}$$
$$|w_B - a_{Bj}\, w_j| \leq \xi^L, \text{ for all } j;$$
$$|w_j - a_{jw}\, w_w| \leq \xi^L, \text{ for all } j; \qquad (2)$$
$$\textstyle\sum_j w_j = 1;$$
$$w_j \geq 0, \text{ for all } j.$$

The best possible optimal weights (w_1^*, w_2^*, ..., w_n^*) and ξ^L can be acquired by solving the liner programming (LP) problem presented in Formula (2). The consistency of the comparison matrices can be assessed by the notation ξ^L. The value near to zero indicates the grater consistency of the obtained results and vice versa.

3. Application of the Proposed Model Highlighting Footwear Company

To assess the KPIs, this research focuses on the footwear industry supply chain. A footwear company was selected for important reasons: I) the contribution of the footwear industry is remarkable; II) the performance of the footwear industry has not been examined before; and III) the footwear industry needs operational improvement order to sustain itself in the global market. Accordingly, the footwear industry is looking to improve its operational performance in order achieve long-term sustainability. Currently, the footwear industry faces some problems when trying to assess the performance of industry activities. There are no well formulated assessment tools or research on the topic in the literature. Therefore, this research has developed new assessment tools for the evaluation of performance in the footwear industry supply chain. In this research, we have selected two large-sized, one medium-sized, and one large-sized footwear companies for collecting data and evaluating the KPIs. Experts were selected based on their interest in the topics as well as their experience in the footwear industry supply chain. We selected four experts for the KPI selection and the evaluation of the data. Two experts were from a large-sized, one was from a medium-sized, and one was from a small-sized type of footwear company. Expert 1 is a supply chain manager working in a the footwear industry. He has 19+ years of working experience in the footwear industry. Expert 2 is a production manager working in the footwear industry. His role in the footwear industry is to produce good quality footwear and to control the production system. He has 15+ years of active working experience in the field. Experts 3 and 4 also work in the footwear industry as senior production manager and senior merchandiser, respectively. Experts 3 and 4 have more than 25 years and 15 years of work experience in the industry, respectively.

3.1 Determination of the KPI

In this phase, the KPI for achieving the best sustainability practices in the footwear supply chain are investigated via a combination of a literature review and using expert feedback. We provided an initial list of the KPIs (shown in Tab. 1) to the four experts, and they assessed the importance of each KPI based on their preference and suitability for the footwear supply chain. After reviewing the experts' feedback, we selected 10 KPIs for the final evaluation process that are the most important for the footwear industry supply chain. During this process, one expert suggested a KPI to include in the final list, which was the "accuracy of moulding". This KPI means the following: moulding is the process in which a material is transformed into its expected shape by means of a mechanical and chemical operation. To maintain the proper quality of footwear, accurate moulding must be maintained. The final list of the selected KPIs for the BWM evaluation process is presented in Tab. 2.

3.2 Determination of the Best KPIs and the Worst KPIs

At this stage, each of the four decision makers selected the best and the worst KPIs from the list. The responses are given in Tab. 3. Please note that E denotes expert.

Tab. 2: Final KPIs for BWM analysis

Sub-KPI	Notation	Sources
Collaborative forecasting support	KPI1	LR
Inventory turnover	KPI2	LR
Order lead time	KPI3	LR
Vendor managed inventory (VMI)	KPI4	LR
Timely order processing	KPI5	LR
Production lead time	KPI6	LR
Quality production	KPI7	LR
Accuracy of moulding	KPI8	Survey
Efficient manpower	KPI9	LR
In-time delivery	KPI10	LR

Source: own

Note: LR = Literature review.

Tab. 3: Best and the worst KPIs selected by experts (1–4)

Sub-KPI	Notation	Best KPI identified by manager	Best worst KPI identified by manager
Collaborative forecasting support	KPI1		
Inventory turnover	KPI2		E2
Order lead time	KPI3		E1, E3, E4
Vendor managed inventory (VMI)	KPI4		
Timely order processing	KPI5	E2, E3	
Production lead time	KPI6		
Quality production	KPI7	E1, E4	
Accuracy of moulding	KPI8		
Efficient manpower	KPI9		
In-time delivery	KPI10		

Source: own

3.3 Determination of the Best KPI over the Other KPIs

During this step, the decision makers rated the selected KPIs using a ranking scale from one to nine. The feedback of expert 1 is given in Tab. 4. The feedback of experts 2 to 4 are given in Tab. A1 in Appendix.

3.4 Determination of the Other KPIs over the Worst KPI

In this phase, the decision makers rated the selected KPIs using a one-to-nine ranked scale, which is shown in Tab. 5 for expert 1. The feedback of experts 2 to 4 are given in Tab. A2.

3.5 Determination of the Optimal Weights of the KPIs

In this step, the optimal weights of each selected KPI are determined using Formula (2), and they are tabulated in Tab. 6 for expert 1. The optimal weights of each KPI for experts 2 to 4 are displayed in Tab. A3.

The average weights and rankings of the selected KPIs for the four experts are tabulated in Tab. 7. In addition, the weights of each KPI are displayed in Fig. 1.

Tab. 4: Best KPI over the other KPIs determined by expert-1

Best to others	KPI1	KPI2	KPI3	KPI4	KPI5	KPI6	KPI7	KPI8	KPI9	KPI10
KPI7	4	6	9	3	8	7	1	2	5	7

Source: own

Tab. 5: Other KPIs over the worst KPI determined by expert-1

Others to the worst	Worst KPI3
KPI1	6
KPI2	3
KPI3	1
KPI4	5
KPI5	4
KPI6	7
KPI7	9
KPI8	8
KPI9	3
KPI10	2

Source: own

Tab. 6: Optimal weights of the identified KPIs for expert-1

KPIs	KPI1	KPI2	KPI3	KPI4	KPI5	KPI6	KPI7	KPI8	KPI9	KPI10	k*
Weights	0.0937	0.0625	0.0210	0.1249	0.0468	0.0535	0.2817	0.1874	0.0750	0.0535	0.0931

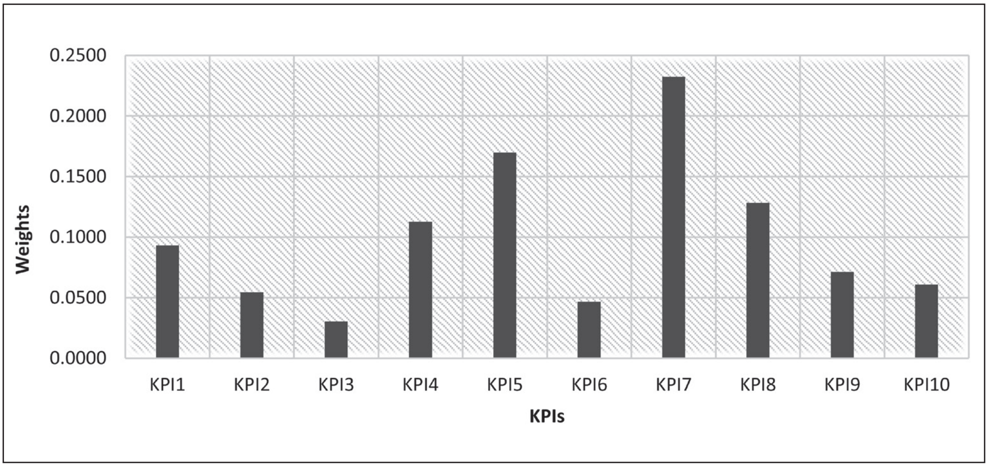
Source: own

Tab. 7: Average weights and ranking of the selected KPIs

Name of KPI with code	Average weight	Average k*	Final rank
Collaborative forecasting support (KPI1)	0.0931	0.0714	5
Inventory turnover (KPI2)	0.0546		8
Order lead time (KPI3)	0.0305		10
Vendor managed inventory (KPI4)	0.1126		4
Timely order processing (KPI5)	0.1698		2
Production lead time (KPI6)	0.0467		9
Quality production (KPI7)	0.2323		1
Accuracy of moulding (KPI8)	0.1283		3
Efficient manpower (KPI9)	0.0713		6
In-time delivery (KPI10)	0.0608		7

Source: own

Fig. 1: **Weights of each KPIs**



Source: own

4. Results and Discussions

Tab. 7 represents the final results of the study. This result will help managers and decision makers to select KPIs while implementing and improving their sustainability practices in the footwear industry.

Among the selected KPIs, the one for "quality production" was ranked the highest. This means that this KPI has a significant contribution to make in the improvement of a company's performance. Without quality products, no one can attain sustainability in the manufacturing process. If the quality of the products decrease, the market can be lost and the profit margin will go down. This KPI makes a good contribution to the improvement of performance. Additionally, in order to achieve sustainability for any company in the footwear industry, it is very important that the company produces a quality product. This can be achieved by delivering all of the elements and factors of production in a well-balanced way.

The KPI for "timely order processing" placed second in the analysis. To maintain a delivery schedule and provide a proper commitment to buyers, orders must be processed in a timely way. This helps in gaining the faith of the customer and for the company to remain sustainable in the existing market. Without providing timely orders, it is impossible to sustain a company in the market. Footwear companies thus need to give special attention to this KPI to improve the sustainability of their manufacturing activities. Hence, this study indicates its importance for the footwear company supply chain.

The KPI "accuracy in moulding" placed third in the final ranking. The moulding process is one of the most important steps in making footwear (especially the bottom-sole preparation). The outlook and stability of the sole depend on the moulding process. Accurate moulding of the sole is important for improving the life of footwear. It also helps in keeping customers faithful in terms of using shoes from a specific company. Therefore, in the footwear manufacturing process, the accuracy of moulding should be ensured for the sustainability of products as well as for their aesthetic appeal. The footwear industry needs to ensure the quality of its moulding at all of the production stages.

In the analysis, the KPI "vendor managed inventory" placed fourth in the ranking, which indicates its importance for the footwear supply chain in terms of achieving sustainability. It is one of the most important KPIs for achieving sustainability in the footwear industry. Since vendors are in direct contact with the customers, they could easily find out the number of products that are needed by the consumers for a specific period (e.g. the upcoming three to six months).

This specifically helps to cut down inventory costs and also helps in preparing customer-based products. Therefore, the performance of the footwear industry can be assessed based on this KPI.

The next important KPI is “collaborative forecasting support”, which placed fifth in the final ranking. Collaborative forecasting support can aid manufacturing firms to achieve sustainability since it can help reduce the significant amount of time involved in the production process. By sharing this information among the members of the supply chain who are making decisions, it is possible to make the best use of available resources. By doing this, it will be easier to adopt sustainability practices because all members of the supply chain are involved equally and can make the best decision for improving the productivity and goodwill of an organization.

The KPI “efficient manpower” placed sixth in the analysis. To achieve sustainability in the footwear industry, it is necessary to recruit skilled personnel who can manufacture quality products. Efficient manpower can be identified as a significant KPI for the footwear supply chain given that the quality of footwear manufacturing largely depends on having skilled management. Therefore, efficient manpower is one of the key factors in achieving the best outcome for any organization.

Next, the KPI “in-time delivery” placed seventh in the final position, and it is also an important KPI for the footwear industry supply chain. This is needed for any organization to achieve a customer’s satisfaction. The supply chain department needs to provide timely delivery that is part of the consistent, vital, and customer-friendly service of any organization. The footwear industry needs to provide on-time delivery, which will also help in achieving sustainability. Therefore, managers of footwear companies should give special attention to this KPI to improve the performance of manufacturing activities.

The next KPI is “inventory turnover”, which placed eighth. This is a measurement of how many times a company has sold and replaced its inventory during a given period. Depending on whether it has a low or high level of inventory turnover, the manager could make a proper decision as to the manufacturing, pricing, marketing, and purchasing of new inventory. This helps in properly using the inventory of any organization. The footwear industry needs to better calculate its inventory turnover. If it does, then the decisions needed to maintain sustainability will be easier.

Next, the KPI “production lead time” placed ninth in the final ranking. It is an important KPI for the footwear industry. The lower the production lead time of any factory and the smarter the service a company can provide, and this provides a significant advantage for the footwear supply chain. If any factory has a short lead time, it could accomplish the whole production process in terms of quick responses. Hence, the company’s order fulfilment becomes easier. By strictly maintaining a shorter lead time, the footwear industry could become more sustainable than other industries. Therefore, the performance of the footwear industry can be improved by knowing the current condition of this KPI. This KPI will also enable companies to be more flexible.

Finally, the KPI “order lead time” came in the last position. The minimum amount of time between the date when a purchase order is received by the supplier and the date of the delivery of the product to the shipping location is known as the lead time of the order. It is the sum of the material lead time and the factory lead time. The lower the amount of order lead time a factory has, the more it indicates that a company is efficient. Minimizing the length of the order lead time for the footwear industry will help it achieve sustainability in the long run.

Conclusions

Practicing sustainability is one of the most important things for companies to do in the era of Industry 4.0. In general, this refers to the capacity for the biosphere and human civilization to coexist. During the era of industrialization, the number of companies in the footwear industry is increasing every day. In order to make the footwear supply chain more sustainable, this study has investigated the most important KPIs to be adopted. By using the best-worst method (BWM), the average weight of each KPI was obtained and finally a ranking was set up among them.

The findings from this study demonstrate that “quality production”, “timely order processing”, and the “accuracy of moulding” are the three most important KPIs. Besides these, other KPIs are also important for achieving sustainability. When the footwear supply chain becomes more sustainable, it will be easier to lead to the overall processes of the footwear industry being more sustainable for the future world.

There are many footwear companies around the world. Footwear production is one of the most common industrial sectors. For obtaining a better outcome, sustainability practices must be put in place in the footwear industry supply chain. By making the supply chain more sustainable, management in the industry will become easier. The major implications of this study can be summarized as follows:

a) This study will help managers to choose a set of KPIs according to the ranking established here with the help of the BWM method.
b) This study provides information to decision makers who are making long-term plans to be part of a sustainable industry in the long run.
c) This study on KPI identification will help supply chain managers to adopt these in their companies, and this can be the case in any new industry that is looking to adopt sustainability practices.

The study has some limitations that can be pointed out: I) only 10 KPIs were used for the BWM analysis; II) we considered only a few footwear companies while evaluating the sustainability performance for manufacturing activities. In the future, the performance index of footwear companies can be made using mathematical tools. Moreover, future researchers can try to check the overall performance of the footwear industry by performing a cross-country analysis to set the benchmarks for performance.

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Appendix

Tab. A1: Best KPI over the other KPI determined by experts 2–4

Experts	KPIs	KPI1	KPI2	KPI3	KPI4	KPI5	KPI6	KPI7	KPI8	KPI9	KPI10
E2	Best (KPI5)	5	9	7	4	1	8	2	3	4	6
E3	Best (KPI5)	4	6	9	6	1	8	2	3	7	5
E4	Best (KPI7)	3	5	9	2	7	8	1	4	5	6

Source: own

Tab. A2: Other KPIs over the worst KPI determined by experts 2–4

KPIs	Experts		
	E2	E3	E4
	Worst (KPI2)	Worst (KPI3)	Worst (KPI3)
KPI1	4	6	7
KPI2	1	4	5
KPI3	4	1	1
KPI4	5	4	8
KPI5	9	9	3
KPI6	2	2	2
KPI7	8	8	9
KPI8	7	7	6
KPI9	6	3	5
KPI10	5	5	4

Source: own

Tab. A3: Optimal weights of the identified KPIs for expert 2–4

Experts	KPIs	KPI1	KPI2	KPI3	KPI4	KPI5	KPI6	KPI7	KPI8	KPI9	KPI10	k*
E2	Weights	0.0701	0.0246	0.0501	0.0876	0.2859	0.0438	0.1752	0.1168	0.0876	0.0584	0.0645
E3		0.0900	0.0600	0.0257	0.0600	0.2958	0.0450	0.1800	0.1200	0.0514	0.0720	0.0643
E4		0.1186	0.0712	0.0254	0.1779	0.0508	0.0445	0.2922	0.0889	0.0712	0.0593	0.0635

Source: own