International Journal of Sustainable Development and Planning
Vol. 17, No. 7, November, 2022, pp. 2097-2107
Journal homepage: http://iieta.org/journals/ijsdp

Preliminary Development of Indicators for Assessing the Sustainability of Indonesia's Natural-Dye-Based Batik Industry

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https://doi.org/10.18280/ijsdp.170710

Received: 24 January 2022
Accepted: 3 August 2022

Keywords:
batik industry, natural dyes, sustainability indicators, Preketek company

ABSTRACT

Indonesia's batik industry is growing rapidly, including the segment specializing in natural dyes. However, this has produced concerns regarding sustainability deriving from, for example, the use of environmental pollutants in the field. This research aims to propose a set of preliminary indicators to facilitate the assessment of the sustainability of the natural-dye-based batik industry. We selected Batik Preketek, a company in Pekalongan City, Indonesia, as a case study and received support from representative panellists who were knowledgeable on these issues. We employed a mixed-methods approach, with data collected from field observations, laboratory analyses, structured and semi-structured interviews and secondary sources. The validated indicators were then applied to assess the current sustainability of batik production. The indicators used included five indicators from the environmental dimension, four from the economic dimension and six from the social dimension. Assessment of the company's sustainability level produced a score of 77.50, indicating that it could be categorized as sustainable. The instrument developed was proved capable of capturing major sustainability issues and delivering prioritized strategies to improve sustainability.

1. INTRODUCTION

Batik cloth is a traditional-artistic heritage that reflects Indonesia's culture in the textiles sector. Batik has been recognized as part of 'The Intangible Cultural Heritage of Humanity from Indonesia' since 2009, which has made the product increasingly popular in both national and international markets [1]. Indonesia features 6,120 batik industry units employing a 37,093-person workforce and having a production value of around IDR 407.5 billion each month, which is equivalent to IDR 4.89 trillion per year (i.e. 20% of the country's total national textile SMEs) [2]. Besides the patterns, colour is a fundamental element of batik's charm, adding to its uniqueness and beauty. Indonesia's regions all have their own unique style and colours. Batik dyes initially derived from natural sources, extracted from plant parts containing dye-making pigments, including roots, wood, leaves, seeds, stems, bark, and flowers [3-5]. However, modernization and market demand forced the batik industry to introduce synthetic dyes, which are advantageous in terms of colour variation, practicality, price and ease of access [6].

Gradually, synthetic dyes displaced natural dyes, worsening environmental problems related to the soil and the water [7]. Wastewater from colouring processes contains high levels of contaminants, including naphthol and indigosol, as well as suspended solids and inorganic and organic chemical elements [8-10]. Due to improper treatment, toxic waste eventually disrupts the aquatic environment, contaminates the groundwater and threatens the health of the people who use these resources [11]. The wastewater discharged from the batik industry generally features coloured characteristics and contains oil, phenols and heavy metals. According to Riyanto et al. [12], the compounds contained in batik wastewater that significantly impact the environment are ammonia and sulphide, which poison aquatic organisms and pollute the water.

In response, Indonesia's government issued the Regulation of the Minister of Environment No. 5/2014 Concerning Wastewater Quality Standards [13, 14]. However, its implementation remains ineffective. Additionally, the global market continues to demand that the batik industry meet the environmental sustainability requirements agreed to in a declaration at the World Batik Summit 2011 in Jakarta, Indonesia [15]. This declaration mandates the Indonesian batik

industry to predicate its activity on protecting nature and the environment, initiate research into natural dyes and use natural dyes at a large scale. Increasing awareness of the need for environmental protection has cultivated desire for the sustainable transformation of the batik business, necessitating the development of measures for a more sustainable batik industry.

Many Indonesian regions are batik industry centres, including Solo, Cirebon, Yogyakarta and Pekalongan [16]. Recently, many batik craftspeople have returned to using natural dyes to produce high-quality artistic products that feature distinctive colours and environmentally friendly, as well as exclusive to their ethnic identity. These qualities make natural-dye-based batik more attractive and generate increased market potential in the global context. However, this has also prompted concern about sustainability issues associated with the natural-dye-based batik industry. As a manufacturing industry, the business is facing challenges from stakeholders who are curious about its economic, social and environmental sustainability [17]. Thus far, there are no available measures capable of assessing the sustainability of the natural dye-based batik industry, despite a green industry benchmark having been issued by Indonesia's national government. Notably, industries with certain input materials, processes and products are not always compatible with green industry standards. For example, the natural-dye-based batik industry requires biological resources whose existence in nature requires preservation; this aspect is irrelevant to standard manufacturing industries. Therefore, it is necessary to develop relevant indicators to facilitate sustainability assessment and verify whether the batik companies have adopted sustainability principles and understand the challenges confronting them in this process.

Compiling relevant benchmarks is essential to providing appropriate management and suitable strategies. Accordingly, this research constitutes a preliminary development of indicators for sustainability assessment that are comprehensive by synthesizing relevant reference points and involving key stakeholders. Such an instrument can be used to investigate problems in the natural-dye-based batik industry and identify steps to promote improved sustainability.

2. METHODOLOGY

2.1 Research object

The research comprises a case study of Batik Preketek, a natural-dye-based batik company located in Pekalongan City, Central Java Province, Indonesia, and which pertains to the small and medium enterprises (SMEs) category (Figure 1). This company moved from a synthetic to a natural-dye-based process and established 'Atika Warna Alam', a cluster of 24 SMEs in the field. The batik craftspeople who are members of this cluster often participate in exhibitions at the national and international level, including Jakarta Fashion and Food Festival Week, Nusantara Batik Week and New York Fashion Week. Additionally, as a pioneer, Batik Preketek is involved in public education, especially consumer education, promoting batik culture in term of its history, processes and environmental impact. Batik Preketek's role in promoting environmentally friendly batik manufacture has substantially impacted Pekalongan City's environmental management efforts.

The process for producing batik using natural dyes is similar to the process associated with the use of conventional dyes and includes cutting cloth, mordanting, wax patterning (*ngecap* or *mbatik*), colouring (*nyolet*), wax covering (*nembok*), dyeing (*mbesut*), fading (*mlorod*), and rinsing (*mbilas*) (Figure 2). The batik manufacturing process also involves chemicals such as wax, TRO, alum and soda ash [18, 19]. Natural dyes are essential ingredients in two of the colouring steps: *nyolet* and *mbesut*.

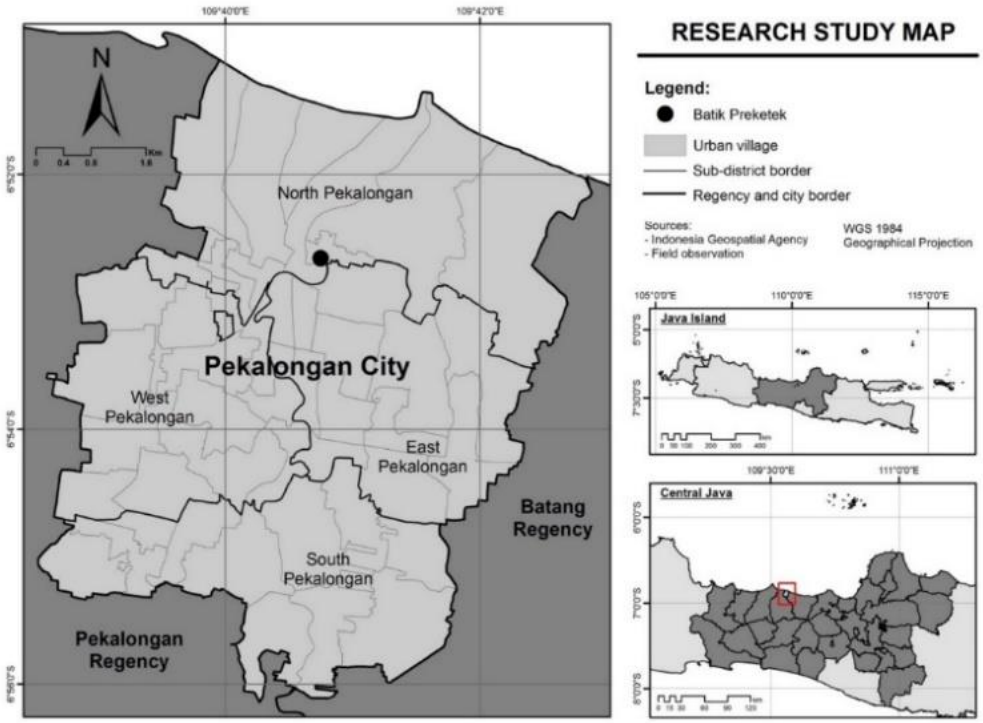

Figure 1. Location of Batik Preketek in Pekalongan City

2.2 Sustainability indicators and strategy development

This research employed a sequential mixed-methods approach that used quantitative and qualitative approach interchangeably [20]. A quantitative approach was used to validate the indicators that resulted from the screening, as well as for sustainability assessment. Meanwhile, a qualitative approach was used to develop strategies for improving sustainability. Data collection was conducted using various techniques, including field observation, laboratory analysis, structured and semi-structured interviews and data collection from secondary sources. Details of the research, parameters, data collection process and sources are presented in Table 1.

A set of indicators for sustainability assessment was developed by reviewing the available literature concerning the batik industry, green industries and sustainable manufacturing. These indicators were subsequently categorized into three pillars of sustainability: environmental, economic and social [21]. Then, these indicators were validated and scored by panellists from stakeholder segments, as well as batik and environmental science experts, especially academics and practitioners. Compiling and validating these indicators was intended to provide the most suitable and prioritized set of indicators based on the perspective of different actors. There were 12 panellists, including three people from the state government (Ministry of Environment and Forestry, Ministry of Industry and BPPT), three people from Pekalongan City Government (Environmental Agency, Trade, Cooperatives and SMEs Agency, and Manpower and Transmigration Agency), three academics (Politeknik Batik Pusmanu Pekalongan, the Faculty of Batik at Universitas Pekalongan and the Center for Participatory Development Planning Services at Universitas Diponegoro), and three batik craftsmen.

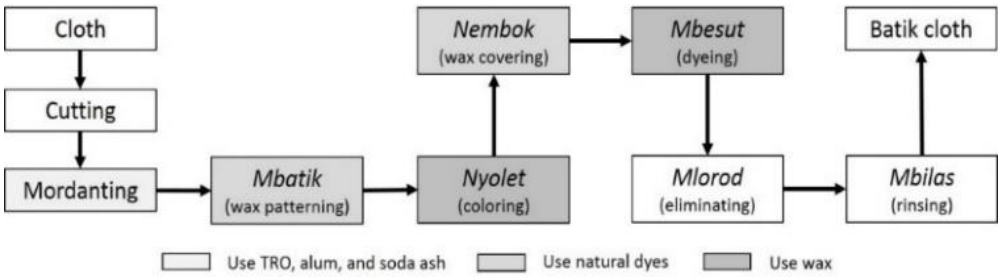

Figure 2. Batik production process using natural dyes

Table 1. Research aspects, parameters and data collection

Aspect		Parameter	Source
Environmental dimension	Waste management	Wastewater quality (temperature, pH, content of BOD, COD, nitrate and other pollutants); Wastewater quantity (volume per day); Implementation of cleaner production and waste prevention.	Observation and measurement; Laboratory analysis; Interview
	Resources	Water use efficiency (recommended standard); Energy use intensity (kerosene, gas, firewood and electricity); Proportion of renewable raw materials; Availability of natural dyes (sustainable capacity).	Secondary data; Interview
Economic dimension	Business eligibility	Net present value of investment over project living; Benefit-cost ratio in terms of net present value and net costs; Internal rate of returns (the maximum interest rate that can be paid with the current interest rate).	Secondary data
	Financial health	Current ratio-based liquidity (total current assets per total current liabilities); ROA profitability (net profit per total assets).	Secondary data
	Product marketing	Market segment; Focus on marketing goals.	Interview
Social dimension	Worker wage	Worker wages compared to the standard minimum wage in Pekalongan City.	Interview
	Underage workers	Workers under 18 years old.	Interview
	Occupational health and safety	Prevention efforts; Use of PPE; Occupational accident frequency.	Interview
	Justice	Incidence of racial and social discrimination.	Interview
	Education and training	Training and capacity building for workers (form and frequency).	Interview
	Community	Actual contribution to the surrounding community; Mechanisms for preventing and handling negative impacts on society.	Interview
Strategy to optimize sustainability	Efforts to maintain or enhance the sustainability	Strengths, weaknesses, opportunities, and threats.	Interview; Focus group discussion

The sustainability instrument's framework derives from the concept of sustainable manufacturing, a series of production processes that can minimize negative impacts on the environment, energy-saving and natural resources, as well as improve safety (for workers, communities, and consumers) and financial health [22, 23]. This instrument corresponds to the aforementioned three pillars of sustainable development, prioritizing synergies between the environmental, economic and social dimensions. Additionally, indicator selection also considers the criteria of measurability, relevance, ease of understanding and use, availability of guaranteed data, timeliness and long-term feasibility [24]. Then, each indicator was scaled according to one of five levels to represent the degree of importance: not at all important (score of 1), less important (score of 2), slightly important (score of 3), important (score of 4), and very important (score of 5). The scores provided by panellists were summarized and arranged according to top-to-bottom rankings [25, 26]. Indicators with average values below 4 were omitted.

Then, the validated indicators were evaluated for the viability of their practice or adoption using relevant criteria, references or standards. Evaluation results were presented in indices to enable grading using normalization, weighting and aggregation steps:

a. Normalization was conducted because the data used different measurement units; thus, uniformity was attained by scoring [27]. Scoring was prepared in one direction, with the lowest score indicating the worst performance and vice versa (i.e. 0 = bad, 1 = moderate, and 2 = good). This approach was applied to all indicators with the exception of wastewater quality standards and labour regulations, which followed the recommended standard set by the Indonesian government. Those two indicators were graded as either 0 (bad) or 2 (good), with 0 indicating the requirements had not been fulfilled and 2 indicating that they had been fulfilled.
b. Each indicator was weighted equally – i.e. each indicator was similarly important – this approach is commonly used for multi-criteria decision-making in geographical and environmental studies [28].
c. The values of each indicator multiplied with the weighting factor were then aggregated. The aggregations based on the average scores of these indicators were then converted into values on a 0–100 scale to avoid decimal numbers and facilitate interpretation of the results [29]. The aggregation results were classified into three classes of sustainability level: 0–33 (*unsustainable*), 34-66 (*moderately sustainable*) and 67–100 (*sustainable*).

The sustainability assessment results were then built upon to formulate strategies for improving business sustainability. A strength, weaknesses, opportunities and threats (SWOT) analysis was chosen as the approach due to its enabling identification of the strengths and weaknesses of current conditions and the opportunities and threats in the future based on focus group discussions involving the researchers and panellists [30]. A SWOT analysis can identify and analyse external factors impacting an organization and can be adjusted according to capabilities that are developed to address complex strategic issues, reduce information quantity and strengthen decision making [31, 32]. As the step employed panelists, the results are expected to be more objective, comperhensoive and relevant. A SWOT analysis is useful for combining strengths and weaknesses with opportunities and threats to produce the optimum sustainability strategy. The integration of sustainability indicators into the SWOT analysis is presented in Figure 3.

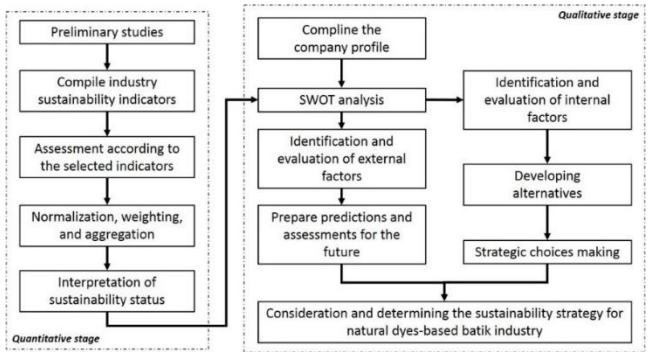

Figure 3. Formulation of indicators and sustainability

3. RESULT AND DISCUSSION

Batik Preketek employs nine workers originating from the surrounding company sites. The daily operational period is seven hours (08.00 to 16.00 GMT+7), excluding a one-hour lunch break (12.00 to 13.00 GMT+7). Production activities are conducted six days each week, with Friday a non-operational day. The company produces up to 200 pieces of batik cloth (400 m) every week. The main raw materials it uses to produce batik are cotton, dyes and additives. Batik Preketek uses natural dyes derived from *Ceriops tagal, Terminalia belerica, Caesalpinia sappan* and *Indigofera tinctoria*. Its additives are wax, *gondorukem*, lard, micro wax, resin, alum, lime, gazebo and soda ash.

3.1 Instrument indicators of sustainability assessment

A set of indicators for sustainability assessment was obtained by synthesizing relevant sources, including the Global Reporting Initiative [33], the Organization for Economic Cooperation and Development [34], wastewater quality standards and labour regulations from the Indonesian government, and previous studies concerning cleaner production practices and implementation of occupational health and safety procedures. Twenty-one (21) initial indicators were validated by panellists and assessed (scored) based on the perceived level of importance, with average scores ranging from 3.42 to 4.67 (see Figure 4). The set of indicators included five indicators from the environmental dimension, four indicators from the economic dimension and six indicators from the social dimension.

Wastewater quality and target market were attributed the highest importance score (average of 4.67). Six indicators received an average score below 4 (four): wastewater quantity, profitability, the proportion of renewable raw materials use, liquidity, frequency of work accidents and underage workers. Upon omitting these indicators, 15 of 21 indicators (71.4%) remained (see Figure 5). According to Lapinskaite and Radikaite [35], utilizing 70% of the total proposed indicators indicates an effective and efficient instrument for evaluation purposes.

Of this total, there were 5 (five) indicators from the environmental dimension: waste treatment, cleaner production, resources used and natural dye availability. These indicators

appeared inseparable from production activities that depend on natural raw materials and additives. The main raw materials for natural dye-based batik include cotton and dyes from the plant parts, with additional materials including substances that are used to improve the batik [36]. These indicators also apparently represented the importance of electricity, fuel and water consumption during production. In the economic dimension, indicators related to investment schemes, asset management, bank financing repayments and market segmentation. These indicators apparently mirrored broader SMEs-related issues. For the case study in question, a household-scale production, such indicators are critical. Ultimately, there were 4 (four) economic indicators used, three concerning business feasibility and 1 (one) pertaining to product marketing. The social dimension included 5 (five) indicators regarding employment and 1 (one) concerning the company's contribution to society. Business feasibility and employment are common social issues because these businesses tend to be managed traditionally on a microeconomic basis (village scope or smaller) and implicate the economic empowerment of the surrounding community [37].

3.2 Current implementation of sustainability indicators

3.2.1 Environmental sustainability dimension

Environmental sustainability describes an effort to minimize negative impacts on the environment and make the production process efficient and effective [30]. In terms of validated indicators, environmental sustainability assessment focused on wastewater quality, the availability of natural dyes, clean production and waste prevention implementation, intensity of energy use and efficiency of water use. The degree of adoption of environmental sustainability measures by Batik Preketek is presented in Table 2. Not all wastewater quality parameters met the established standards, despite Batik Preketek having already installed a wastewater treatment plant with two sedimentation tank systems. Analysis of wastewater samples indicated that the levels of both BOD5 and COD exceeded the maximum limits. Thus, Batik Preketek received a score of 0 (bad) for wastewater quality.

Although the company has attempted to maintain the balance between the supply and consumption of natural dyes through intensive cultivation activities, it has faced many obstacles (Table 2). Regarding the fact that there is no guarantee of future natural dye availability, material availability received a score of 1 (moderate), indicating limited quantities and a lack of future certainty. The needs of natural dyes can be practically obtained from the market or through cooperation with partners to obtain planting land, adequate cultivation facilities and development of a modern agricultural industry that is independent of biogeophysical factors [38]. The site observation revealed that the company had implemented cleaner production and waste prevention by adopting 12 out of 16 measures (75%). The company was consistently practising reuse principles, for example, by using batik wax released during the mlorod (elimination) step. This practice implies the reduction of oil content in wastewater and the reduction of costs for wax purchasing. Additionally, this company benefits from recycling used materials as production equipment in the context of the immersion, melting and rinsing stages. Meanwhile, for clean production, Batik Preketek received a score of good (2).

Concerning energy use, batik manufacturers usually require a variety of energy sources (e.g. electricity, wood, and fossil fuels). Electricity consumption is substantially influenced by water volume during batik processing. However, in addition to pumping the groundwater, electricity is also used for lighting and air conditioning. To respond to its energy consumption, Batik Preketek was making annual savings efforts based on internal evaluations of data from the previous two years. It received a score of good (2) for the energy use intensity indicator. Regarding water consumption, each square metre of batik cloth requires 6.75 litres of water. According to Tresnawati et al. [39], optimal water uses in batik production ranges from 25-50 litres per metre. Production was very efficient and used far less water than the recommendation, leading to a score of good (2).

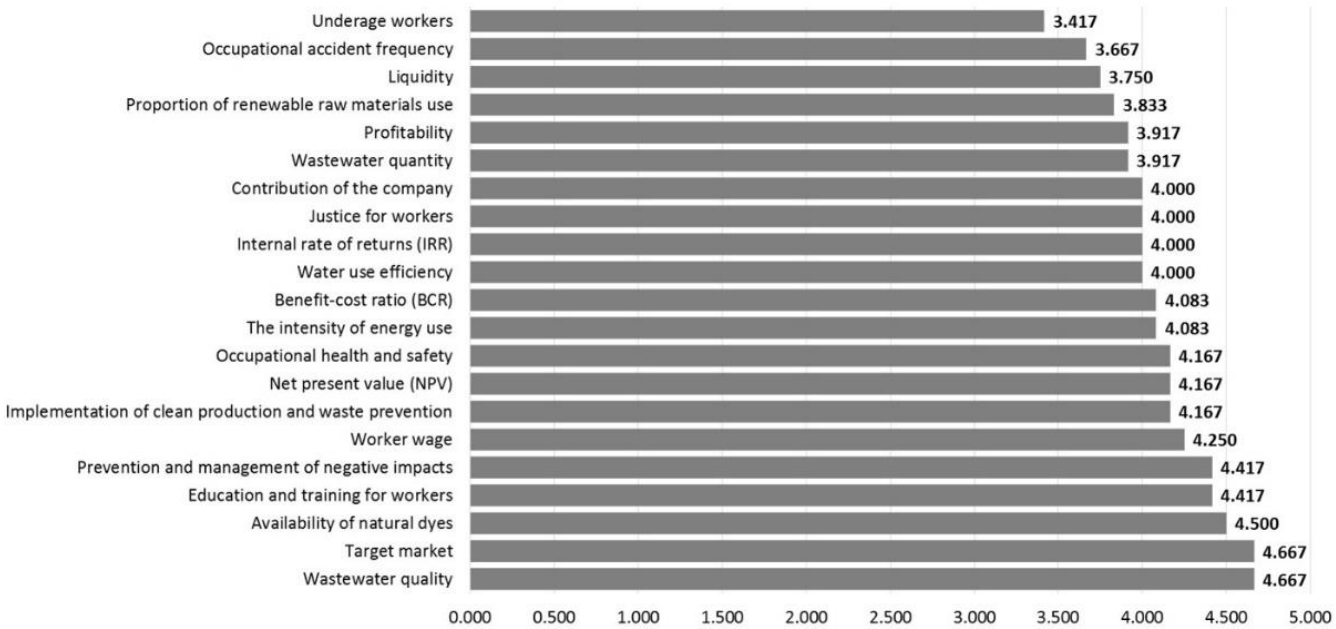

Figure 4. The validated and scored sustainability indicators for the natural-dye-based batik industry

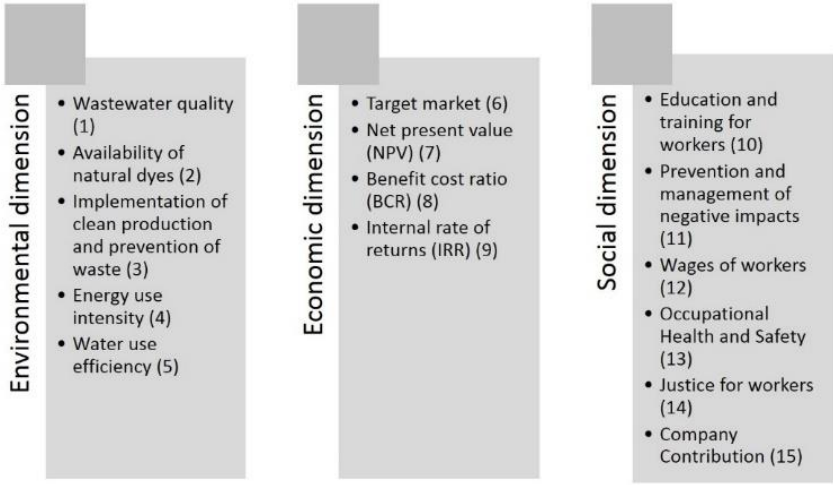

Figure 5. The three dimensions for sustainability measures and the indicators included

Table 2. Criteria for sustainability assessment and scores for the environmental dimension

Indicator	Criteria of assessment	Score	Ref*	Information
A.			Wastewater management	
1. Wastewater quality	(0) fulfill (2) not fulfill	0	[40]	Wastewater quality (temperature, BOD5, COD, TSS, phenol, chromium, ammonia [NH3-N], sulphide [S], oil and grease, pH).
2. Implementation of clean production and prevention waste	(0) 0–33% implementation (1) 34–66% implementation (2) 67–100% implementation	2	[39]	Application of clean production practices and waste prevention from the planning stages to batik processing and waste treatment.
B.			Resources	
3. Efficient water use	(0) > 50 litre per meter (1) 25–50 litre per meter (2) < 25 litre per meter	2	[34]	Water consumption per unit of output; Efficiency of water usage per metre of product based on benchmark data (optimal water use is 25–50 litres per metre of cloth).
4. The intensity of energy use	(0) increasing; (1) steady; (2) decreasing	2	[34]	Trend and intensity of energy use (electricity, gas, kerosene) during the previous six months.
5. Availability of natural dyes	(0) less available, hard to obtain (1) available, less difficult to obtain (2) more available, easily obtained	1	[34]	Availability of natural resources for natural dyes; Sustainable capacity for present and future needs.

* Reference for evaluation of each indicator

Table 3. Criteria for sustainability assessment and scores for the economic dimension

Indicator	Criteria for assessment	Score	Ref*	Information
A.			Business eligibility	
1. Net present value (NPV)	(0) NPV < 0 (1) NPV = 0 (2) NPV > 0	**2**	[41, 42]	The NPV of investment during the project's life; a greater NPV indicates better business feasibility.
2. Benefit-cost ratio (BCR)	(0) BCR < 0 (1) BCR = 0 (2) BCR > 0	**2**	[42]	Comparison between NPV and total net cost.
3. Internal rate of returns (IRR)	(0) IRR < interest rate (1) IRR = interest rate (2) IRR > interest rate	**2**	[42]	The maximum interest rate an activity can pay.
B.			Product market	
4. Market target	(0) local (1) national (2) international	**1**	[43]	Market segments or potential consumers that are used as a focus of marketing activities.

* References for evaluation of each indicator

3.2.2 Economic sustainability dimension

Economic sustainability indicators for natural-dye-based batik companies considered the target market determination of the products, and business feasibility in terms of net present value (NPV), benefit-cost ratio (BCR) and internal rate of return (IRR) (see Table 3). Regarding target market, Batik Preketek concentrated on serving certain market segments because its prices were not always affordable for all consumers.

The target group prioritized national consumers over local consumers, considering both their purchasing power and the regulatory barriers hindering export to international markets. For this indicator, the company was rated as moderate (1). The NPV indicator was used to measure the value (price) currently generated by investing in economic activities [44]. The NPV for the natural-dye-based batik business reached IDR 631,617,146.15, indicating that the business is feasible [42]. Therefore, Batik Preketek received a rating of good (2) for the NPV indicator.

The BCR indicator compares NVP against all cost values. All cost and benefit flows are measured in present money values (incorporating inflation). The BCR value is 1.76, meaning that the batik industry can provide benefits of up to 1.76 times the investment costs incurred. Thus, the BCR indicator received a rating of 2 (good). Meanwhile, the IRR indicates NPV with total costs of economic activity; that is, the interest rate with all net cash flows after present-value and investment costs. The IRR is the maximum interest rate that can be paid by an economic activity, and a business is feasible if the IRR value is above the prevailing interest rate [45]. At Batik Preketek, the IRR value was 55.41%, substantially above the usual loan interest rate assumption in Indonesia (15%). Therefore, the company received a rating of good (2) for the IRR indicator.

3.2.3 Social sustainability dimension

Social sustainability concerns satisfying human needs, exercising rights and the freedom to aspire and creating a better life [46]. In the natural-dye-based batik business, social sustainability indicators include the education and training for workers, prevention and handling of negative impacts, worker wages, occupational health and safety, justice for workers and company contributions to society (see Table 4). The owner of Batik Preketek is serious about maintaining good relations with workers through, for example, holding discussions and meetings outside of working hours. The workers have developed an entrepreneurial spirit, ensuring that they can operate their own business if they are interested in becoming an entrepreneur. In a planned albeit non-formal manner, this company has implemented the transfer of knowledge and skills. Thus, the company received a rating of moderate (1) for the education and training for workers indicator.

Batik Preketek features mechanisms enabling the prevention of negative impacts on the environment, although these remain incidental. For the social sustainability indicator, this company was rated 2 (good). To anticipate social problems, the company has established procedures for handling complaints and processing evaluations. This can importantly minimize negative impacts on the surrounding community [47]. The daily employee wage was IDR 80,000.00 (US$ 1.00 = IDR 13,746.00) regardless of a particular employee's duties. Workers also received a daily food ration at the factory. Given there are six working days per week, the total monthly wages per worker are IDR 1,920,000.00. This wage is above the minimum for Pekalongan City; as such, the company was rated good (2) for this indicator. Regarding occupational health and safety, the company has implemented 13 out of 23 standardized procedures (56.52%), leading to a moderate (1) rating. Deficiencies in this aspect include the availability of sufficient personal protective equipment (PPE) and the absence of a culture of using PPE for reasons of comfort reasons. Additionally, there exist assumptions that using PPE is not important and detracts from working productivity and that the working conditions are low risk [48]. Concerning the justice indicator, the workers testified that they had never been discriminated against by Batik Preketek. Therefore, the company was rated as good (2) for fairness. Finally, regarding social contribution, the company has significantly contributed to the surrounding community despite a lack of formal planning. Such sporadic activity is a common feature of SMEs featuring traditional or semi-modern management [49]. Thus, for this indicator, Batik Preketek received a rating of moderate (1).

Table 4. Criteria for sustainability assessment and scores for the social dimension

Indicator	Criteria for assessment	Score	Ref*	Information
A. Workers				
1. Worker wage	(0) below the regional minimum wage (1) equal to the regional minimum wage (2) above the regional minimum wage	**2**	[50]	The wage received by workers for one month compared to the regional regulations (UMK).
2. Occupational safety and health (K3)	(0) 0–33% (1) 34–66% (2) 67–100%	**1**	[51]	Implementation of occupational health and safety (K3) procedures in the company.
3. Justice	(0) there is discrimination (2) there is no discrimination	**2**	[33]	The company does not discriminate against workers based on gender, religion or ethnicity.
4. Education and training	(0) never held (1) occasionally held (2) programmed	**1**	[33]	The frequency of capacity and skill-building activities for workers organized by the company.
B. Community				
5. Contribution of the company	(0) none (1) occasionally (2) programmed	**1**	[33]	The company's contribution to public interest or community initiatives.
6. Prevention and handling of negative impacts	(0) none (1) only one (2) both	**2**	[33]	Prevention mechanisms against potential negative impacts that may arise; Efforts made to overcome such impacts

* Reference for evaluation of each indicator

3.3 Sustainability strategies for the natural-dye-based batik industry

This study's assessment of natural-dye-based batik manufacturing importantly confirms the sustainability of the industry as part of Indonesia's cultural heritage and local wisdom. Table 5 summarizes the results for all environmental, economic and social indicators for Batik Preketek. The total value of the indicators can be categorized in an index to provide general sustainability information for the company. This produced a sufficient level of sustainability for the company, returning a score of 77.50. Although Batik Preketek has met the sustainability criteria overall, there was a disparity between the three dimensions, with its performance in the environmental dimension the worst. Meeting recommended levels for wastewater quality and ensuring the continued availability of materials for natural dyes remains a challenge for the company. According to Santosa [52], government intervention and support from entrepreneurs are required to meet the environmental challenges of natural-dye-based batik companies operating at the SMEs scale.

3.4 SWOT analysis and sustainability strategies

Natural-dye-based batik companies have strengths in terms of product quality and added value in terms of heritage and cultural value, commitment to environmental improvement and information disclosure. These factors constitute necessary capital in the formulation of strategies to increase sustainability. However, there several noticeable weaknesses must be anticipated, including non-optimal marketing, limited financial capital, human resources, production technology and poor management. Promoting batik based on natural colour depends upon conventional strategies rather than strategies based on information and technology. The production process and wastewater treatment are traditional technologies resulting in low production capacity and depleted wastewater quality. Meanwhile, a lack of financial capital presents an obstacle for the procurement of raw materials, while human resources issues (e.g. limited education) and poor organizational structures challenge company sustainability. In terms of opportunities, there are possibilities for optimizing sustainability. These include increasing the number of consumers with environmental concerns and developing facilities for the provision of credit (loans) to SMEs. At present, there is broad access to information and technology, especially social media and online marketplaces [53]. Community support – in the form of cultural and fashion events promoting batik – is also available. The local government has introduced a policy of using batik '*Jlamprang motif*' for civil servants to support the natural-dye-based batik industry. Significant threats to the industry are the limited availability of raw materials for natural dyes and competition from the herbal medicine industry [54]. The industry is also exposed to fluctuations in inflation rates and increased competition caused by the growth of batik producers from other regions.

Based on discussions with the owner of Batik Preketek, five priority strategies were designed to improve its sustainability in view of practicality and financial concerns (see Table 6):

1. The first strategy is the application of appropriate technologies to increase productivity and minimize environmental impacts by optimizing wastewater treatment plants to meet quality standards. Improvements in production techniques by applying current technology can also increase garner support from the government and competent academics.
2. The second strategy is to increase networking with similar companies. Networking with similar batik companies can promote confronting problems in unison and facilitating of marketing, as well as resource sharing, reductions in the price of materials and the maintenance of product quality [55, 56]. Increasing the efficiency of raw material and resource use in the production process can be achieved by optimizing clean production practices, with consequences including reduced production costs and reduced prices of finished products.
3. The third strategy involves guaranteeing competitive prices and high quality by broadening the market to reach more consumers.
4. The fourth strategy concerns organizational arrangements, management and corporate financial administration. By distributing responsibilities more robustly, the company's performance and productivity are likely to be more effective and efficient [57].

Table 5. Sustainability of the natural-dye-based batik industry

	Indicator	Score	Dimension value	Sustainability status
1	Wastewater quality	0		
2	Availability of natural dyes	1		
3	Implementation of clean production and waste prevention	2	Environment 70.00 (sustainable)	
4	Intensity of energy use	2		
5	Water use efficiency	2		
	Sub-total	7		
6	Target market	1		
7	Net present value (NPV)	2		
8	Benefit-cost ratio (BCR)	2	Economic 87.50 (sustainable)	Index 77.50 (sustainable)
9	Internal rate of returns (IRR)	2		
	Sub-total	7		
10	Education and training	1		
11	Prevention and handling of negative impacts	2		
12	Worker wage	2		
13	Occupational health and safety	1	Social 75.00 (sustainable)	
14	Justice for workers	2		
15	Contribution of the company	1		
	Sub-total	9		

5. The final strategy is encouraging the government to promote the cultivation of natural dyes. Pekalongan City's Environmental Agency has initiated the preservation of plants used for natural dyes in urban forests. The synergy between the government and natural-dye-based batik manufacturers should be well established to ensure the availability of natural dyes for present and future needs.

Table 6. Formulation of sustainability strategies

Internal Factor / **External Factor**	Strengths (S) Product quality and added value Strong environmental brand An open attitude to information as well as criticism and suggestions from outside parties	Weaknesses (W) Marketing and promotion are not optimal Limited financial capital Using traditional processes Less knowledgeable human resources Poor management
Opportunities (O) Market potential Facilities to obtain credit Access to information and technology Community support for promotion Government support through policy	S-O Using appropriate technology to increase productivity and minimize the impact on the environment Networking with similar companies	W-O Utilizing online media for product promotion and marketing Organizational arrangements, preparation of corporate financial management and administration
Threats (T) Limited natural dye resources Fluctuating inflation rates Increase in competitors	S-T Decreasing prices while maintaining product quality Encouraging the government to promote natural dye cultivation	W-T Expanding marketing and promotion channels through online media

4. CONCLUSIONS

The preliminary development of sustainability indicators for the natural-dye-based batik industry has validated fifteen indicators drawn from the environmental, economic and social dimensions. Environmental indicators included wastewater quality, availability of natural dyes, implementation of clean production and waste prevention, intensity of energy use and efficiency of water use. Economic indicators included target market, NPV, BCR and IRR. Meanwhile, social indicators included the prevention and handling of negative impacts, worker wages, occupational health and safety, justice for workers and company contributions. These indicators could reliably capture the major sustainability problems associated with natural-dye-based batik production. The case study company, Batik Preketek, received an overall rating of 77.50, indicating that it was sustainable. The SWOT analysis produced five priority strategies: utilizing appropriate technologies, networking with similar companies, reducing prices while maintaining product quality, improving company organization and management, and encouraging the government to promote natural dye cultivation. This industry needs government support in terms of regulation, capital, marketing and the preservation of the biological resources required for natural dyes, especially given the substantial potential of the industry in terms of economy, environment and society.

Few notes need to be considered before this instrument formally adpoted: (1) inclusion of the indicators that have score below 4 need to be reconsidered in order to meet more globalized standard, and (2) the use of this instrument in the evaluation process need to involve more cases to strengthen objectivity.

ACKNOWLEDGEMENTS

The authors thank the National Development Planning Agency's (Bappenas) Pusbindiklatren initiative for supporting this research. They also extend their appreciation to the Batik Preketek company and the Pekalongan City government for permitting entry and providing facilities to the authors during the research. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. This work was partly supported by the Academic Leadership Grant (ALG) No. 1959/UN6.3.1/PT.00/2021, Universitas Padjadjaran, in particular in the stage of manuscript preparation and English proofreading.

REFERENCES

[1] UNESCO & Ministry of Culture and Tourism of The Republic of Indonesia. (2009). Practikal Handbook for Inventory of Intangible Cultural of Haritage of Indonesia. Jakarta: Ministry of Culture and Tourism of the Republik of Indonesia.

[2] Hakim, L.M. (2018). Batik Sebagai Warisan Budaya Bangsa dan Nation Brand Indonesia. Nation State: Journal of International Studies, 1(1): 61-90. https://doi.org/10.24076/NSJIS.2018v1i1.90

[3] Fauziyah, N., Hakim, L. (2015). Plants as natural dyes for Jonegoroan batik processing in Jono cultural Tourism Village, Bojonegoro, East Java. Journal of Indonesian Tourism and Development Studies, 3(2): 41-44.

[4] Widiawati, D. (2018). The utilization of Batik pattern and natural dyes as valuation of the local value in Batik Society. Jurnal Sosioteknologi, 17(2): 208-219. https://doi.org/10.5614/sostek.itbj.2018.17.2.3

[5] Martuti, N.K.T., Hidayah, I., Margunani, M., Alafima, R.B. (2020). Organic material for clean production in the batik industry: A case study of Natural Batik Semarang, Indonesia. Recycling, 5(4): 28. https://doi.org/10.3390/recycling5040028

[6] Broadbent, A.D. (2001). Basic principles of textile coloration. Bradford: Society of Dyers and Colourists.

[7] Mirjalili, M., Nazarpoor, K., Karimi, L. (2011). Eco-friendly dyeing of wool using natural dye from weld as co-partner with synthetic dye. Journal of Cleaner Production, 19(9-10): 1045-1051. https://doi.org/10.1016/j.jclepro.2011.02.001

[8] Bechtold, T., Turcanu, A., Ganglberger, E., Geissler, S. (2003). Natural dyes in modern textile dyehouses—how to combine experiences of two centuries to meet the demands of the future? Journal of Cleaner Production, 11(5): 499-509. https://doi.org/10.1016/S0959-6526(02)00077-X

[9] Dewi, R.S., Kasiamdari, R.S., Martani, E., Purwestri, Y.A. (2018). Decolorization and detoxification of batik dye effluent containing Indigosol Blue-04B using fungi isolated from contaminated dye effluent. Indonesian Journal of Biotechnology, 23(2): 54-60. https://doi.org/10.22146/ijbiotech.32332

[10] Handayani, W., Widianarko, B., Pratiwi, A.R. (2020). Water footprint of the natural coloured batik-making process: A study on a batik small enterprise in Jarum Village, Klaten Regency, Indonesia. Chemical Engineering Transactions, 78: 223-228. https://doi.org/10.3303/CET2078038

[11] Claudio, L. (2007). Waste couture: Environmental impact of the clothing industry. Environmental Health Perspective, 115(9). https://doi.org/10.1289/ehp.115-a449

[12] Riyanto, Sidiq, N.Y., Hidayah, N. (2017). Treatment of batik waste using distillation method. In AIP Conference Proceedings, 1911: 20029. https://doi.org/10.1063/1.5016022

[13] Ministry of Environment. (2014). The Minister of Environment Decree No. 5 Year of. 2014, Concern of Various Industries Waste Water Standard. Jakarta.

[14] Dewi, R.S., Kasiamdari, R.S., Martani, E., Purwestri, Y.A. (2019). Efficiency of Aspergillus sp. 3 to reduce chromium, sulfide, ammonia, phenol, and fat from batik wastewater. In IOP Conference Series: Earth and Environmental Science, 308: 12003. https://doi.org/10.1088/1755-1315/308/1/012003

[15] Rizali, N., Sudardi, B. (2019). Identity and creativity in Parang Sukawati Batik. In ICONECT 2019: Proceeding of the 2nd International Conference Education Culture and Technology, ICONECT 2019, 20-21 August 2019, Kudus, Indonesia. https://doi.org/10.4108/eai.20-8-2019.2288136

[16] Tresnadi, C., Sachari, A. (2015). Identification of values of ornaments in Indonesian batik in visual content of Nitiki game. Journal of Arts and Humanities, 4(8): 25-39. https://doi.org/10.18533/journal.v4i8.797

[17] Martins, A. (2021). Green marketing and perceived SME profitability: The meditating effect of green purchase behaviour. Management of Environmental Quality: An International Journal, 33(2): 281-299. https://doi.org/10.1108/MEQ-04-2021-0074

[18] Kusumastuti, A., Syamwil, R. (2016). The recycle of batik wax: An effort towards environmental friendly process. Int. J. Innov. Res. Adv. Eng, 3(5): 48-51.

[19] Nuzul, Z., Talib, S.N., Johari, W.L.W. (2020). Water quality of effluent treatment systems from local batik industries. In IOP Conference Series: Earth and Environmental Science, 476: 12097. https://doi.org/10.1088/1755-1315/476/1/012097

[20] Bowen, P., Rose, R., Pilkington, A. (2017). Mixed methods-theory and practice. Sequential, explanatory approach. International Journal of Quantitative and Qualitative Research Methods, 5(2): 10-27.

[21] Rickels, W., Dovern, J., Hoffmann, J., Quaas, M.F., Schmidt, J.O., Visbeck, M. (2016). Indicators for monitoring sustainable development goals: An application to oceanic development in the European Union. Earth's Future, 4(5): 252-267. https://doi.org/10.1002/2016EF000353

[22] Rosen, M., Kishawy, H. (2012). Sustainable manufacturing and design: Concepts, practices and needs. Sustainability, 4(2): 154-174. https://doi.org/10.3390/su4020154

[23] Abubakr, M., Abbas, A.T., Tomaz, I., Soliman, M.S., Luqman, M., Hegab, H. (2020). Sustainable and smart manufacturing: An integrated approach. Sustainability, 12(6): 2280. https://doi.org/10.3390/su12062280

[24] Joung, C.B., Carrell, J., Sarkar, P., Feng, S.C. (2013). Categorization of indicators for sustainable manufacturing. Ecological Indicators, 24: 148-157. https://doi.org/10.1016/j.ecolind.2012.05.030

[25] Albaum, G. (1997). The Likert scale revisited. Market Research Society. Journal., 39(2): 1-21. https://doi.org/doi.org/10.1177/147078539703900202

[26] Joshi, A., Kale, S., Chandel, S., Pal, D.K. (2015). Likert scale: Explored and explained. British Journal of Applied Science & Technology, 7(4): 396. https://doi.org/10.9734/BJAST/2015/14975

[27] Rahdari, A.H., Rostamy, A.A.A. (2015). Designing a general set of sustainability indicators at the corporate level. Journal of Cleaner Production, 108: 757-771. https://doi.org/10.1016/j.jclepro.2015.05.108

[28] Widiawaty, M.A. (2019). Mari Mengenal Sains Informasi Geografis. Bandung: Aria Mandiri Group.

[29] Weis, D., Willems, H. (2017). Aggregation, validation, and generalization of qualitative data-methodological and practical research strategies illustrated by the research process of an empirically based typology. Integrative Psychological and Behavioral Science, 51(2): 223-243. https://doi.org/10.1007/s12124-016-9372-4

[30] Shafieyan, M., Homayounfar, M., Fadaei, M. (2017). Identification of strategies for sustainable development of rice production in Guilan province using SWOT analysis. International Journal of Agricultural Management and Development (IJAMAD), 7(2): 141-153. https://doi.org/10.22004/ag.econ.262635

[31] Oreski, D. (2012). Strategy development by using SWOT-AHP. Tem Journal, 1(4): 283-291. https://doi.org/10.1108/JMD-05-2019-0157

[32] Pazouki, M., Jozi, S.A., Ziari, Y.A. (2017). Strategic management in urban environment using SWOT and QPSM (case study). Global Journal of Environmental Science and Management, 3(2): 207-216. https://doi.org/10.22034/gjesm.2017.03.02.009

[33] Global Reporting Initiative. (2011). Sustainability reporting guidelines version 3.1. Amsterdam: GRI.

[34] OECD Indicators. (2011). Towards Green Growth: Monitoring Progress. OECD: Paris, France.

[35] Lapinskaite, I., Radikaite, G. (2015). Analysis of measurement of sustainable development in the insurance company. European Scientific Journal, 11(13): 446-464.

[36] Haji, A., Naebe, M. (2020). Cleaner dyeing of textiles using plasma treatment and natural dyes: A review. Journal of Cleaner Production, 265: 121866. https://doi.org/10.1016/j.jclepro.2020.121866

[37] Setyorini, C.T., Pinasti, M., Rokhayati, H. (2013). Strengthening the internal factors of batik cluster SMEs in Indonesia: A case of six districts in south-central java.

International Journal of Business, Humanities and Technology, 3(1): 21-28.
[38] Widiatmaka, Sutandi, A., Iswandi, A., Daras, U., Hikmat, M., Krisnohadi, A. (2014). Establishing land suitability criteria for cashew (Anacardium occidentale L.) in Indonesia. Applied and Environmental Soil Science, 2014: 743194. https://doi.org/10.1155/2014/743194
[39] Tresnawati, N., Saleh, I., Wardani, S. (2020). Scientific reconstruction of local plants as the basic materials of Batik Natural Dyes. In Journal of Physics: Conference Series, 1511(1): 012062. https://doi.org/10.1088/1742-6596/1511/1/012062
[40] Central Java Regional Government. (2012). Regional Regulation Number 5 of 2012 Amendment to Central Java Provincial Regulation Number 10 of 2004 concerning Wastewater Quality Standards. Semarang: Central Java Regional Government.
[41] Wood, R., Hertwich, E.G. (2013). Economic modelling and indicators in life cycle sustainability assessment. The International Journal of Life Cycle Assessment, 18(9): 1710-1721. https://doi.org/10.1007/s11367-012-0463-2
[42] Gray, R. (2002). The social accounting project and Accounting Organizations and Society Privileging engagement, imaginings, new accountings and pragmatism over critique? Accounting, Organizations and Society, 27(7): 687-708. https://doi.org/10.1016/S0361-3682(00)00003-9
[43] Kotler, P., Armstrong, G. (2010). Principles of Marketing. Pearson Education.
[44] Juhász, L. (2011). Net present value versus internal rate of return. Economics & Sociology, 4(1): 46-53. https://doi.org/10.14254/2071-789X.2011/4-1/5)
[45] Devarakonda, S. (2019). Calculating the economic viability of corporate trainings (Traditional & eLearning) using Benefit-Cost Ratio (BCR) and Return on Investment (ROI). Int. J. Adv. Corp. Learn., 12(1): 41-57. https://doi.org/10.3991/ijac.v12i1.9735
[46] Eizenberg, E., Jabareen, Y. (2017). Social sustainability: A new conceptual framework. Sustainability, 9(1): 68. https://doi.org/10.3390/su9010068
[47] Governor of Central Java. (2016). Central Java governor decree number 560/50 year 2016 minimum wage in 35 (thirty five) regencies/cities in central Java Province Year 2017. Semarang: Governor of Central Java.
[48] Ansori, N., Novianti, T., Agustina, F., Rakhmawati, N. (2015). Safety Performance Index Industri Batik Tulis Berdasarkan Kriteria Majemuk. Jurnal Teknik Industri, 17(2): 105-110. https://doi.org/10.9744/jti.17.2.105-110
[49] Moreno, A., Capriotti, P. (2009). Communicating CSR, citizenship and sustainability on the web. Journal of Communication Management, 13(2): 157-175. https://doi.org/10.1108/13632540910951768
[50] Ansori, N., Widyanti, A. (2021). The role of safety silence motives to safety communication and safety participation in different sectors of small and medium enterprises: investigation results on two kinds of industries in Indonesia. Safety and Health at Work, 12(2): 192-200. https://doi.org/10.1016/j.shaw.2020.10.001
[51] Maksum, I.R., Rahayu, A.Y.S., Kusumawardhani, D. (2020). A Social enterprise approach to empowering micro, small and medium enterprises (SMEs) in Indonesia. J. Open Innov. Technol. Mark. Complex., 6(3): 50. https://doi.org/10.3390/joitmc6030050
[52] Santosa, W.Y. (2009). Legal aspects in management of hazardous and toxic waste. Mimbar Hukum-Fakultas Hukum Universitas Gadjah Mada, 29(2): 335-345. https://doi.org/10.22146/jmh.24082
[53] Vuksanović Herceg, I., Kuč, V., Mijušković, V.M., Herceg, T. (2020). Challenges and driving forces for industry 4.0 implementation. Sustainability, 12(10): 4208. https://doi.org/10.3390/su12104208
[54] MacFoy, C. (2004). Ethonobotany and sustainable utilization of natural dye plants in Sierra Leone. Economic Botany, 58(1): S66-S76. https://doi.org/10.1663/0013-0001(2004)58[S66:EASUON]2.0.CO;2
[55] Kenny, B., Fahy, J. (2011). Smes' networking capability and international performance. Baxter, R. and Woodside, A.G. (Ed.) Interfirm Networks: Theory, Strategy, and Behavior (Advances in Business Marketing and Purchasing, Vol. 17), Emerald Group Publishing Limited, Bingley, 199-376. https://doi.org/10.1108/S1069-0964(2011)0000017006
[56] Skarpova, L., Grosova, S. (2015). The application of business network approach for small and medium enterprises (SME) with regard to their buying behavior. Journal of Competitiveness, 7(3): 62-74. https://doi.org/10.7441/joc.2015.03.05
[57] Kurochkina, A.A., Voronkova, O.V., Lukina, O.V., Bikezina, T.V. (2019). Management features of small and medium-sized business enterprises. Revista Espacios, 40(34).