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Analysis of Barriers and Drivers to Cleaner Production Implementation in Agro Based Industries: An Empirical Study

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ABSTRACT

Cleaner Production (CP) helps in choosing better processes and efficient utilization of resources which causes less environmental burden and better financial gains to organizations. Agro-based industries have crucial role in the economy since they enhance employment opportunities and national income despite mostly being micro, small, and medium sized enterprises (MSMEs). They are often lack professional and technical expertise thereby necessitating external assistance to improve their operations. Though implementation of CP strategy enhances the performance of this sector, it is not extensively achieved due to the presence of many barriers which are to be identified and busted. However, there are also several drivers propping up implementation of CP, which are to be prioritized. This paper aims to analyze barriers to CP and identify the critical ones in an agro-based industry using "Factor Analysis" approach. The drivers to CP implementation are prioritized employing Analytical Hierarchical Process (AHP). The results of the analysis revealed lack of Financial Resources, Appropriate Technologies, Policy and Regulatory Support, Awareness and Stake Holders Attitude as critical barriers to CP implementation. Further, Improvement of quality and productivity has emerged as the top driver. The findings of this study have useful implications in agro- based industry policy design.

Keywords: *Cleaner Production, Agro-based Industries, Factor Analysis, Analytical Hierarchical Process (AHP)* .

I. INTRODUCTION

Cleaner Production (CP) as defined by United Nations Environment Programme - UNEP (1994) is a continuous application of an integrated preventative environmental strategy to processes, products and services to increase efficiency and reduce risks to humans and the environment. CP offers multitude of benefits by less resource consumption, increased productivity, less waste generation, judicial use of by-products, improved environmental performance etc. There are different approaches for CP strategy implementation encompassing simple measures like better housekeeping to difficult options like modifying the process, redesigning the product or technology modifications. For effective implementation of the strategy the concept has to be clearly communicated apart from total involvement of every stakeholder.

Implementing CP strategy is an urgent need in the Micro, Small and Medium-sized Enterproses (MSMEs) sector for its survival and growth. MSMEs play an important role in terms of employment generation, contribution to gross domestic products (GDP) and exports, especially in the developing economies like India. However, they are plagued with technological stagnation and their quality, efficiency, and productivity have actually declined in environmental terms. MSMEs often display practices that are indifferent to environmental laws and standards. Andrews et al. (2002) found that MSMEs appear to be less involved in CP than their larger counter parts and have the view that CP practices benefit only large enterprises and can only be implemented by them. But researches have suggested that CP practice in MSMEs offers many payoffs if implemented and costs in several ways if not implemeted. To remain competitive, effective implementation of CP strategy in MSMEs has become utmost important and is possible if the barriers and drivers to implement this strtegy is understood. In this context, the current study attempts to explore the barriers and drivers to CP implementation in agro processing MSMEs.

Agro-processing industries process agricultural output into intermediate or final product and commonly uses energy, water, labour etc., as inputs for their operations. As they are normally MSME units, their individual pollution potential may not be very high. But they have opportunities in process improvement so that economical gains can be made apart from environmental benefits by adopting CP. The data for the current study is collected from cashew processing units through the adminstration of structured researcher administered questionnaire. The perceived barriers are obtained through five point Likert scale items and pairwise comparisions are solicited to prioritize the drivers to implement CP strtegy. Subsequently data analysis is carried out using "Factor Analysis" and "Analytical Hirarchy Process (AHP)" techniques for barriers and drivers respectively.

II. LITERATURE REVIEW

It has been observed that many MSMEs are today plagued with technological stagnation and their quality, efficiency and productivity have actually declined over the years. To remain competitive, the MSMEs need to adopt newer and innovative approaches to upgrade their technological capabilities but they lack resources for technological capability developments. A document on CP prepared by the UNIDO Secretariat (1995) concludes that CP represents an immediate and urgent need for industry until new generation of technologies and processes takes over from the present manufacturing systems. This preventive approach has not been given enough attention as compared to other environmental issues. Thus, it requires studies involving empirical data to analyze the reasons for such a state of affair. Basappaji et al. (2014) carried out data envelopment analysis (DEA) to benchmark cleaner production in MSMEs and found there is significant scope in improving inefficient operations. There are barriers and drivers for adoption of CP strategy in an organisation which are to be studied and properly addressed, so that the stakeholders can tackle them effectively. The barriers and drivers for CP are similar to those that exist for any other environmental initiatives; however they may be different for large industries and MSMEs due to their nature of operations and size. Altham (2007) identified number of barriers to CP that include identifying environmental aspects and cost, knowledge of methods to improve CP, and time to identify and implement CP. Purba Rao et al. (2006) perceived that critical obstacle in MSMEs, often operating on a hand-to-mouth basis, is the cost of undertaking any environmental initiative. Lin et al. (1997) discussed some barriers other than costs like lack of awareness about environmental practices, lack of technical expertise, and unavailability of appropriate technologies. There are also a few studies on drivers to CP. The drivers to CP implementation as brought out by Berkel (1999) are economic advantage through reduction of expenditures on input materials such as energy and water; reduction of expenditures on waste treatment; increase of production revenues; better product quality. Khan (2008) advocates the drivers for CP like positive environmental benefit, enhanced regulatory compliance, better social image and eco label marketing. It is evident from the literature that there are ample benefits from CP but there is a lack in realising these benefits.

III. METHODOLOGY

The objective of this study is to investigate the drivers and barriers to the adoption of CP strategy in an agro based industry cluster. The data is collected from 40 cashew processing MSME units in the coastal region of Karnataka State, India. In the process of implementing CP strategy, investigating the barriers and drivers to CP adoption involving the stake holders is of primary importantance. Thus, the entrepreneurs who are the main stake holders of MSMEs are involved here in recognizing and analyzing the barriers and drivers to CP.

To capture the various dimensions of different barriers, data is collected comprising 14 variables related to environmental initiatives or CP implementation. These variables are finalized based on the literature review and discussions with subject experts. These variables extract the responses of stake holders understanding regarding the following; are they familier with strategy, are they getting sufficient information, are they intersted to implement it, will its implementation increases profit, will the strtegy yield success, is appropriate technologies are available, are available technologies user friendly, are they updated with technological information, is any financial assistance available, existance of any financial incentives, is payback period is long, is promotion of strtegy happening, are they getting guidance to implement it and whether sufficient R&D exists.The perceptions of MSME entepreneurs regarding these variables are recorded using a five point Likert Scale. The scale is anchored with labels; strongly disagree, disagree, undecided, agree and strongly agree. To identify underlying structure among the variables, exploratory "Factor Analysis" is used, which is a multivariate statistical procedure that attempts to reveal a simple underlying structure that is presumed to exist within a set of multivariate observations. Measure of Sample Adequacy (MSA) is an important issue in factor analysis. There are several guiding rules of thumb cited by Tabachnick et al. (2007) regarding sample adequacy. But according to MacCallum et al. (1999), and Henson et al. (2006) such rules of thumb may be misleading and often do not take in to account many of the complex dynamics of factor analysis. They have illustrated that when communalities are high (greater than 0.60) and each factor is defined by several items, samples can actually be relatively small. Guadagnoli et al. (1998) studied the relationship of sample size with stability of component patterns and observes there are number of cases which have used sample sizes smaller than 50, probably because this is considered a reasonable absolute minimum threshold. Keeping this in mind, and based on the constraints of time and resources the current study has adopted a sample size of 40 MSME units for the research study. While investigating the drivers to CP implementation, prioritization of recognized drivers is carried out based on the stake holder's opinion and value judgement in practicing CP strategy. The prioritization of drivers to CP is performed using Analytic Hierarchy Process (AHP) developed by Saaty (1980) which is useful in evaluating complex multi-attribute alternatives involving subjective criteria. Nagesha et al. (2006) have fruitfully employed AHP for prioritization of barriers to energy efficiency in the context of MSMEs and Rajkumar et al. (2013) estimated the wind-mill cluster performance. The pair-wise comparisons are made on nine point scales which express the preferences between options as equal importance; moderate importance; strong importance; very strong importance; extremely strong importance. In this study the recognised drivers to CP implementation are; financial benefit (FB), improved compliance with regulations (IC), minimized environmental degradation (MD), social image (SI), and improved quality and productivity (QP).

IV. RESULTS AND DISCUSSION

Barriers to CP implementation

At the outset, in the barrier analysis, reliability coefficient (Cronbach's Alpha) was computed for each variable to estimate the internal consistency of measurements and it yielded values above 0.6 for all of them indicating the acceptability. Before carrying out the factor analysis for analyzing barriers to CP, the suitability of the data is to be checked prior to factor extraction. This is indicated by Bartlett's test of sphericity giving the overall significance of all correlations within a correlation matrix; KMO index gives the adequacy of samples; communality gives the total amount of variance an original variable shares with all other variables included in the analysis. For suitability of factor analysis, Hair et al. (1995) mentions Bartlett's test of sphericity should be significant ($p < 0.05$) and KMO (ranging from 0 to 1) index > 0.50. The empirical data obtained through the survey of 40 cashew processing MSME units exhibited suitability for factor analysis as shown in Table 1. The Bartlett's test of sphericity yielded a significance level of 0.000, thus asserting the high degree of overall significance. The KMO index obtained is at 0.560, thus ensuring the adequacy of samples. The principal component communalities ranged from 0.643 to 0.793 indicating satisfactory level.

Table 1 KMO Index and Bartlett's test of Sphericity

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.574
Bartlett's Test of Sphericity	Approx. Chi-Square	199.399
	Degrees of freedom	91
	Significance	.000

To extract the factors, Principal Component Analysis (PCA) is done and a correlation matrix is obtained for all the variables considered. The Eigen values for the first five principal components were greater than one and they explain about 72% of variation. Thus the complexity of the data is reduced using these five

factors with only 28% loss of information as given in Table 2. Another way to determine the number of factors to extract in the final solution is Cattell's scree plot which is a plot of the Eigen values associated with each of the factors extracted, against each variable.

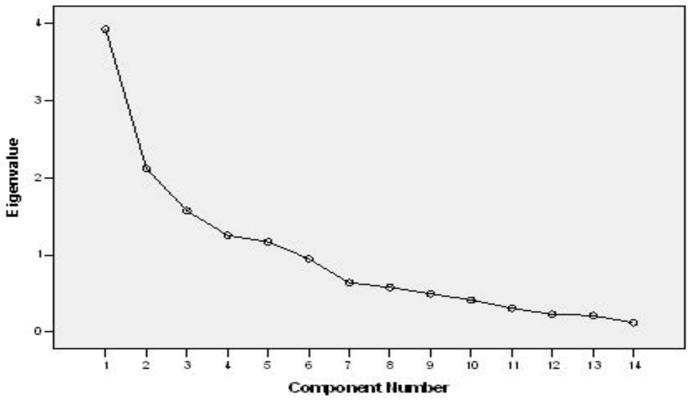

Figure: 1. Scree Plot

The Scree plot shown in Fig. 1 helps to determine the optimal number of factors. The extracted components in Table 2 gives the information about how many factors are used for representing variables and what amount of variations are explained by them.

Table 2 Total Variance Explained by the Extracted Components

Factors	Initial Eigen values			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.924	28.031	28.031	3.924	28.031	28.031	2.414	17.243	17.243
2	2.121	15.147	43.179	2.121	15.147	43.179	2.084	14.885	32.128
3	1.574	11.240	54.419	1.574	11.240	54.419	1.937	13.834	45.963
4	1.254	8.957	63.376	1.254	8.957	63.376	1.892	13.513	59.476
5	1.168	8.346	71.722	1.168	8.346	71.722	1.714	12.246	71.722

The next step in factor analysis is to obtain the factor loadings from rotation. The solution is obtained from varimax rotation which is an orthogonal rotation method and produces a more interpretable and simplified solution. The rotation maintains the cumulative percentage of variation explained by the extracted components, but the variation is spread more evenly over the components. The rotated component matrix will be easier to interpret than the unrotated matrix. Table 3 gives rotated factor loadings and the variables under each factor. The final step in the factor analysis is examining which variables are attributable to a given factor and what is the appropriate underlining factor name. All the five factors in this study are loaded with at least two variables. Any item that cross-loaded on more than one factor was categorised under the factor where its interpretability was best. Table 3 gives the factor loadings with the appropriate names that reflect the theoretical and conceptual intent.

Table 3. Factor loadings with recognised barriers

Factors	Variables under the Factor	Factor Loadings	Factor Name
1	Long payback period	0.828	Financial Barrier
	No financial assistance	0.797	
	No incentives	0.696	
2	Difficulty in accessing technological information	0.802	Technological Barrier
	No better technologies available	0.800	
	Technologies are not user friendly	0.745	
3	Lack of motivational measures	0.789	Policy and Regulatory Barrier
	Lack of effective dissemination of strategy	0.743	
	No guidance to address the problems	0.698	
4	Adoption of strategy will not increase profits	0.849	Awareness Barrier
	Not familiar with the concepts	0.780	
5	Success is not assured	0.872	Attitudinal Barrier

	No need to adopt the strategy More Research and Development required	0.630 0.419	

The first component is highly correlated with the payback on the investment made to adopt CP strategy apart from the lack of financial assistance and incentives, subsidies, tax holidays etc. and thus it is named "Financial Barrier". The second factor has the factor loadings from the variables that related to technological status of CP and hence appropriately named as "Technological Barrier". The third factor highlights that there are lack of motivational measures and effective dissemination of the CP strategy. It also

stresses that MSMEs are not getting proper guidance to address the environmental problems and hence it is clearly related to "Policy and Regulatory Barrier". The fourth factor is loaded with variables that underline ignorance about the benefit and non familiarity of CP concept. And hence is rightly named as "Awareness

Barrier". The fifth and final factor named as "Attitudinal Barrier" involves the perceptions of respondents related to lack of faith in the strategy and also the negligence.

Drivers to CP implementation

The identification and prioritization of drivers to CP adoption in the selected agro based industry is also undertaken in this study. Based on the literature review and discussion with experts in the field, five drivers are considered. The drivers are financial benefit (FB), improved compliance with regulations (IC), minimized environmental degradation (MD), social image (SI), and improved quality and productivity (QP). To analyse the perception of stakeholders and rank order the drivers AHP is used. AHP is one of the Multi-Criteria decision making methods which is developed by Saaty (1980). The empirical data is collected by asking the preferences of cashew processing MSME operators about what drives them to adopt CP strategy. The responses are collected by pair-wise comparison of five identified drivers based on their opinion and value judgements. In this study, MSME entrepreneurs responded to the questionnaire without prior discussion amongst themselves. In such situations, Saaty (1980) suggests the geometric mean of all pair-wise comparisons for generalizing the preferences. In the pair-wise comparison the relative importance scale defined by Saaty (2005) between two alternatives varies from 1 to 9, the scale determines the relative importance of an alternative when compared with the other alternative results in 10 comparisons for five drivers. A reciprocal matrix is created using the preferences as shown in table 4. The upper triangular matrix is filled with preference values and the lower one with corresponding reciprocals. Using the comparison matrix a priority vector is computed which is actually normalized Eigen vector of the matrix.

Table 4. Comparison Matrix of Drivers

	FB	IC	MD	SI	QP
FB	1	0.923	0.554	0.351	0.300
IC	1.083	1	0.549	0.772	0.173
MD	1.805	1.821	1	1.658	0.433
SI	2.849	1.295	0.603	1	0.315
QP	3.333	5.780	2.309	3.174	1

The Eigen vector calculation is a short computational method to obtain the ranking. This is done by first squaring the comparison matrix and row sums are calculated. Further these row sums are normalized to obtain the Eigen vector. This process must be iterated till the Eigen vector values does not change from the previous iteration. Based on Eigen values the drivers are ranked as given in the table 5.

Table 5. Ranking of Drivers to CP

Drivers	Eigen Vector	Rank
Financial Benefit (FB)	0.094885	**5**
Improved Compliance with Regulations (IC)	0.099719	**4**
Minimized environmental Degradation (MD)	0.196688	**2**
Social Image (SI)	0.159729	**3**
Improved Quality and Productivity (QP)	0.448979	**1**

V. CONCLUSIONS

The agro based industries mostly function in MSME sector and are faced with the financial hurdle and lack of availability of appropriate technology. The aim of this study was to understand the barriers and drivers for CP strategy adoption in an agro processing industry sector. The cashew processing units were considered for this purpose. The factor grouping of the barriers is obtained by exploratory factor analysis and drivers are prioritized using AHP. The factor extraction resulted in five main factors and each factor is named based on the variables loaded under them. The Financial factor, Technological factor, Policy and Regulatory factor, Awareness factor and Attitudinal factor have emerged as the key barriers deserving attention. They have to be addressed by providing financial support in the form of subsidies; tax

holidays, etc., and promote clean technology development especially for MSMEs. The policies have to be designed to motivate/reward for taking up environmental initiatives with a "carrot and stick approach". The information on benefits and technology has to be disseminated. Trainings, workshops, seminars etc., can be arranged to provide awareness and guidance to adopt good production practices. It has to be realized by all that concepts like CP are never a burden but a boon to improve the business standards. These efforts, if done systematically, would educate the stake holders and facilitates them to appreciate pro-environmental activities. The driver assessment revealed that MSME operators are having more concern about improving quality and productivity of their operations than financial benefits which gained least priority. Minimized environmental degradation, aspiring for social image and compliance to policy and regulations took the subsequent preferences. Thus, quality improvement through CP should be designed as a package to drive them towards implementing CP. The outcome of this study has implications for the authorities to frame appropriate policies and programmes to promote CP strategy for the survival and growth of MSME sector in the long run.

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