

Establishing Sustainable Manufacturing Practices in SMEs

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Abstract

During the last few years, drives towards environmentally sound practices have been getting stronger and stronger in most areas of business and society. In particular in Europe sustainability has become a major competitive factor for many manufacturing organisations. In New Zealand and many other countries in the Asia-Pacific region, market forces and social and environmental factors have also started to make manufacturing companies consider sustainability more seriously. However, the change towards environmentally friendly manufacturing poses a significant challenge for Small and Medium sized Enterprises (SMEs), which generally have relatively little experience in this area and few resources available for this task. This is particularly true if they operate in a business environment and within a legislative framework where sustainability is emerging as a relatively new business paradigm.

This paper discusses the issues and challenges that need to be considered in the process of establishing sustainable business practices in manufacturing SMEs. It draws on the experience gained from an ongoing sustainability project at a medium sized furniture manufacturer in New Zealand which started in early 2004. The paper includes the discussion of a range of analysis tools and methods which are useful to gain an understanding of the scope of the sustainability project, to formulate achievable project goals, to develop an effective project programme and work plan, and to optimise the use of project resources. The application of various ecolabelling schemes, environmental standards, and national and international certification programmes to maximise the benefits from the project activities are explored. Conclusions are drawn on the impact of issues such as market developments, government policies, and environmental legislation.

Keywords: sustainable manufacturing, SWOT analysis, trade-off analysis, stakeholder analysis, causal loop analysis, ecolabels

Introduction

Our perception of sustainability is more and more shaped by news and documentations in our daily life. Issues such as global warming and the rising costs of energy (petroleum, natural gas, electricity), linked with the scarcity of non-renewable resources keep reminding us that our current life styles and business paradigms are generally not in agreement with the principles of sustainability. As a consequence a shift has emerged in developed societies away from the traditional industrial model, in which environmental activity in a business were seen only as a cost, natural resources were viewed as freely available goods, and the social

implications of industrial activities were at best an afterthought (New Zealand Business Council for Sustainable Development, 2006).

In the last few years a growing range of businesses have included environmental principles in their operations, and there is an apparent shifting from the 'green consumer' to the 'responsible retailer' (see for example (Murphy, 2006)). Leading retailers and brand owners assume the obligation for ensuring that their customers can buy products and services with confidence in their sustainable source and manufacture. For manufacturers sustainability has thus been emerging as a new competitive requirement and a means to achieve differentiation in the market (Shahbazpour & Seidel, 2006). It is now generally recognised that sustainability and environmental concerns are important order winning factors (Burke & Logsdon, 1996; Menguc & Ozanne, 2005; Waddock & Graves, 1997).

The pressure on manufacturing organisations to give more priority on sustainability is also driven by media, campaigns of Non Governmental Organisations (NGOs), regulatory frameworks and consumer interests (Molnár, 2005). These pressures are particularly strong in countries of the European Union (EU), which is leading the world in terms of environmental legislation. However, New Zealand also has a particular interest in sustainability of its industry, as indicated by a statement of the New Zealand Business Council for Sustainable Development: "New Zealand has an image overseas of a clean, green country with products and services to match. With food and drinks export sales alone in the region of NZ\$14 billion (about €7.8 billion), New Zealand stands to lose a lot if it can not demonstrate to our customers around the world that it practices what it preaches" (Hume, 2006). Therefore a strong emphasis on environmental aspects is essential for New Zealand manufacturers as well as for its people.

However, developing and maintaining a focus on sustainability is a new and difficult challenge for New Zealand manufacturers. The industry consists predominantly of small and medium sized enterprises (SMEs), which have few financial and management resources and little experience in the environmental area. Also, as New Zealand's economy is mainly based on farming and other primary production, and due to the country's low population density and its remote location, environmental factors have long not been seen as critical as they have been in the EU. As these factors emerged relatively recently in New Zealand, the manufacturing industry has had little time to adjust to this new challenge. This paper illustrates the pathway of a New Zealand manufacturing SME towards sustainable manufacturing.

Case Study Background

CML Ltd is a family-owned, medium sized panel furniture manufacturer in Auckland. It is one of the leaders in the New Zealand market for Ready-To-Assemble (RTA) computer, office and home furniture. The company exports approximately 70 percent of its production to its main export markets Australia, USA and Asia. CML competes through offering its customers a broad range of well-designed products and a good cost-quality ratio. Strategic investments in manufacturing and information technology have created a sophisticated manufacturing setup and the capacity to manufacture over 500,000 pieces of furniture per annum at a high level of efficiency, and a continuous improvement approach is used to further enhance its manufacturing performance.

In early 2004 sustainability was identified as a new opportunity to improve CML's competitiveness (Howe, 2004). One of the main reasons for CML to initiate this project was that this was seen to provide the company with an opportunity to be a forerunner of sustainable thinking in its New Zealand market and its main export markets Australia and

USA. Sustainable manufacturing practices were also expected to open new market opportunities in Asia and Europe, and to help maintain the company's established reputation of an innovative and modern enterprise with responsibility for the environment. As only a small minority of NZ manufacturers so far have acquired environmental certifications or started initiatives in terms of sustainable management, CML considered this a good opportunity to become a member of this 'elite' group (Molnár, 2005), and to develop its competitiveness in new and existing markets through the development of a 'green' brand for its organisation and products. However, CML is a typical SME with very limited staff and financial resources, and is operating in a very competitive market with product price being a major determinant of consumer choice. Therefore the sustainability initiative was required to be approached in a very effective way, using minimum staff resources, in order to optimise the strategic outcomes without creating a potential cash flow problem in the short term.

Tools and methods applied

Project initiation

The original objectives of the sustainability project were developed in early 2004 under the main theme "To assist in design and implementation of a number of initiatives to kick-start the 'Green Manufacturing' project at CML" (Howe, 2004). The project scope was covered under four main headings:

1. Assist in performing a supply chain analysis for the purpose of acquiring Forest Stewardship Council (FSC) certification. In order to get FSC certification, CML must provide proof that its raw material (Medium Density Fibreboard (MDF) and particle board wooden panels) come from sustainable forests.
2. Assist in identification of strategic threats or opportunities through researching relevant local and international environmental laws and regulations.
3. Assist in review of CML's waste management policies according to these laws and regulations, by providing relevant data and intelligence. This requires collecting, collating and documenting data regarding the type and amount of waste generated during the production processes and the cost of their disposal.
4. Assist in starting a Product Stewardship project. This involves identification of opportunities and recommendation of ideas for elimination or sustainable management of packaging material, such as cardboard and polystyrene.

The first stage of the project work was dedicated to building the foundation for the strategic integration of sustainability in CML's management processes, in order to make optimum progress and to gain the maximum benefit from the project developments. A prerequisite for this was to develop an in-depth understanding of sustainability in general, and of its benefits, risks and opportunities for CML in particular. To achieve this it was necessary to evaluate CML's current situation, and to identify the factors in its business environment and its existing and prospective markets with a potential impact on or benefit from sustainable production. Another important aspect was to identify tools, methods and mechanisms, as well as support programmes and best practice examples, that could be used to make progress.

SWOT, stakeholder and causal loop analysis

The systematic analysis of Strengths, Weaknesses, Opportunities and Threats (SWOT) creates a framework for achieving insights and formulating development goals in line with the requirements of the organisation and other stakeholders, while taking into consideration the salient parameters of the existing and future external environment. Data for the CML SWOT

analysis (see Table 1) was collected and evaluated through a series of interviews and group discussions with stakeholders, and evaluation of a wide range of relevant literature, case studies and other sources.

Table 1: SWOT Analysis of Sustainability Implementation at CML (from (Marco Oudshoorn, 2005))

Strengths:	Weaknesses:	Opportunities:	Threats:
High standard of production and information technology, quality management and health and safety management	Lack of experience and resources	Cost reduction (energy, waste disposal, raw materials, etc.)	Growing low cost competition from Asia reducing margins and opportunities for sustainable production
High degree of support from representatives from territorial authorities, regional councils, central government, business groups and industry associations	No strong drivers for sustainability outside the project	Increased market shares in New Zealand, Australia and USA	Loss of market share if no progress on sustainability
Availability of internationally accepted and locally proven cleaner production methodology	No quantified short and long term benefits as yet	New market opportunities in Europe and Asia	Competitors faster in development of sustainable brand
Proven benefits of cleaner production and waste minimisation in both financial and environmental terms		New product ranges for environmentally conscious customers	Global economic crisis could stifle demand for sustainable products
		Early alignment with future environmental legislation, avoiding costly ad hoc initiatives	Upcoming local legislation with unforeseen impacts, e.g. New Zealand Packaging Accord, etc
		Powerful branding and marketing tool	New international trade boundaries based on new environmental legislation
			Long term benefits hard to quantify

The main benefits from adopting sustainable manufacturing practices identified in this analysis were summarised as follows:

- Products qualify for entry into markets with more stringent environmental legislation such as Europe and Japan.
- The company will gain the image of being the forerunner in the furniture market in Australasia.
- Sustainability can be added as a new order-winning criterion to CML's mix of capabilities, to further differentiate its products in the local market which is heavily under competition from Chinese manufacturers.
- Significant reductions in energy usage and savings in waste disposal are achievable.
- Risks due to up and coming environmental legislation in New Zealand will be significantly reduced.

To provide further insights into the benefits and risks of integrating sustainability in the CML's processes, an analysis of the internal and external stakeholders of the company was also performed (M. Oudshoorn, 2005). A stakeholder is any group or individual who can affect or is affected by the achievement of an organisation's objectives (Freeman, 1984). When the salient stakeholders do not get the attention they should have, some benefits may disappear and risks can become critical. Stakeholders also influence the life cycle of the products. Enviro-Mark[®] NZ also acknowledges the importance of knowing their stakeholders when demanding that an organisation should "establish and maintain procedures for receiving, documenting and responding to communications (internal and external) from relevant interested parties concerning its environmental impacts and their management"

(Enviro-Mark Systems Ltd. and Landcare Research New Zealand Ltd, 2001). In order to perform a structured analysis and to achieve more specific and meaningful results, a stakeholder analysis was performed by considering the three dimensions that determine the salience of stakeholders, namely power, legitimacy and urgency (Mitchell, 1997). Stakeholders were differentiated into the categories of internal stakeholders, stakeholders along the value chain, stakeholders in the local community, and societal stakeholders (Figge, 2001).

From this analysis it was concluded that CML needed to implement a process or tool to quickly identify the stakeholders that are involved in and important to a decision by the company. For CML's sustainability project different governmental institutions and environmental groups in New Zealand and Australia were identified as the most critical stakeholders at the moment, in terms of opportunities as well as threats. It was also determined that CML needed to monitor its customers' behaviour and preferences towards 'green' furniture very closely in order to prevent their claims becoming urgent. Lastly, it was noticed that international competition could become a dangerous stakeholder if they decided to move into CML's markets.

Causal loop analysis was the third tool applied to identify the dynamic nature of the changes caused by the introduction of sustainable manufacturing in the company (see Figure 1).

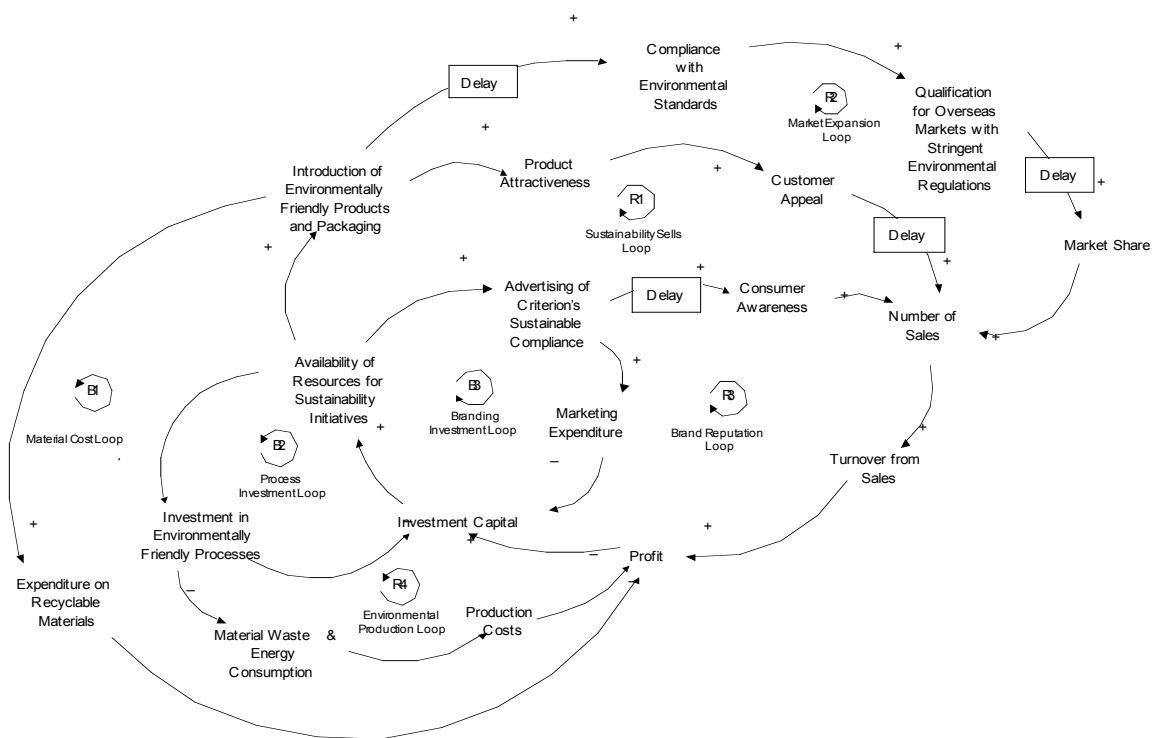


Figure 1: Causal loop diagram of sustainability implementation

The causal loop analysis identified four major reinforcing loops (Ri), and three balancing loops (Bi). The diagram represents the behaviour of the system as sustainable products and processes are developed and put in place. The implementation of sustainability at CML requires various environmentally friendly product and process improvement projects to be undertaken which require 'Investment Capital'. The 'Material Cost Loop' and the 'Process Investment Loop' (balancing loops B1 and B2) show the short term decreasing effect of sustainability on CML's 'Profit' and 'Investment Capital'. On the other hand, as can be seen in the 'Environmental Production Loop' (reinforcing loop R4), the increase of 'Investment in

Environmentally Friendly Processes' leads to an instant decrease in the 'Material Waste and Energy Consumption'. When the 'Material Waste and Energy Consumption' is decreased the 'Production Costs' are also decreased, leading to an increase in 'Profit'.

The implementation of environmentally friendly products and processes lead to financial rewards for CML through increased product sales and waste reduction. The 'Sustainability Sells Loop' (reinforcing loop R1) shows the competitive advantage that CML can achieve through the increase in the 'Product Attractiveness' of its environmentally friendly furniture and packaging. Another strategic advantage is the qualification of CML's products into overseas markets through compliance with environmental standards. The 'Market Expansion Loop' (reinforcing loop R2) shows that CML can increase its 'Market Share' through the increased 'Introduction of Environmentally Friendly Products and Packaging'. There is an initial delay after the 'Introduction of Environmentally Friendly Products and Packaging' due to time it takes for 'Compliance with Environmental Standards' (e.g. it took CML two years to comply with the Enviro-Mark[®] standard, due to the time it takes for external auditing, etc.). The increase in 'Market Share' is also delayed because the growth does not occur instantaneously immediately after the qualification for the market, rather it increases as products become established on the market and consumer awareness rises over time.

By advertising CML's environmentally friendly products and manufacturing processes the company can develop a reputation as a sustainable business and reap the associated increase in product sales. The 'Brand Reputation Loop' (reinforcing loop R3) shows that increasing the 'Advertising of CML's Sustainable Compliance', increases the 'Consumer Awareness' and therefore the 'Number of Sales' of furniture products and 'Profit' increase. There is a delay in the consumer awareness, because it takes time for the advertising to take effect by filtering through to more customers. The 'Brand Investment Loop' (balancing loop B3) counter-acts this positive influence because 'Advertising of CML's Sustainable Compliance' will lead to increased 'Marketing Expenditure' resulting in a decrease in CML's 'Investment Capital'.

The 'Sustainability Sells Loop' is currently one of the most important and influential loops, because customers around the world are beginning to demand environmentally friendly goods. The 'Brand Reputation Loop' also currently has a strong influence on product sales, and through fast advertising of CML's sustainable compliance, the company has the opportunity to get the 'first to market' advantage for sustainable furniture manufacturing in Australasia.

Perhaps the most important loops in CML's situation at the moment are the three balancing loops, as they represent the initial investment hurdle that the company has to overcome in order to fully implement its 'green manufacturing' aspirations. As time goes by, the influence of these loops will decrease, after having made the required initial investments. In the coming years, once CML has established itself as a complying sustainable manufacturing company, the 'Market Expansion Loop' will become very important.

The 'Environmental Production Loop' will have a constant influence over time, because the financial benefits of less wasteful manufacturing processes and lower production costs will always exist. Overall it can be concluded that the short term decreasing impacts on the Profit and 'Investment Capital' of the balancing loops are outweighed by the reinforcing loops. It is widely predicted that the demand for sustainable products will increase in the coming years and companies will need to comply with environmental regulations in order to remain competitive in the market. In the long term CML will benefit by establishing themselves early and gaining the environmentally friendly reputation and production process abilities. On the other hand, it is easy to see the difficulties for the company in investing in sustainability

because of the requirement and effects of the short term investment costs on the overall capital.

Ecolabels - Enviro-Mark® NZ

Apart from cost savings, for example through energy efficiency and waste reduction measures, most of the economic benefits of sustainable production can only be met if the message on the sustainability of a company's products is clearly and effectively communicated to the market. A credible environmental label, called ecolabel, is a label that correctly identifies the environmental impact of a product in production and use. Thus ecolabels offer customers the opportunity to choose products with low environmental impact. For manufacturers such labels, which are generally controlled by a third party, are an instrument to reward their environmental leadership in the market place (Ministry for the Environment, 2001). While there are many different voluntary and mandatory environmental performance labels and declarations with different levels of credibility, they all share a common goal, which is: "...through communication of verifiable and accurate information, that is not misleading, on environmental aspects of products and services, to encourage the demand for and supply of those products and services that cause less stress on the environment, thereby stimulating the potential for market-driven continuous environmental improvement" (Global Ecolabelling Network, 2006).

To achieve this goal it was necessary to identify the most appropriate type of environmental labelling for CML's situation. Particular emphasis was put on identifying New Zealand and international ecolabels which would offer the most effective means of promoting CML's environmental achievements. Another important aspect was the availability of a support programme or a step by step approach associated with some ecolabels that could help CML achieve the required standards of sustainability.

The three ecolabels that were considered the most promising for CML's purposes were:

- Environmental Choice New Zealand label,
- Forest Stewardship certification,
- Enviro-Mark® NZ standards.

Environmental Choice (Environmental Choice New Zealand, 2006), part of the Global Ecolabelling Network (GEN) (Global Ecolabelling Network, 2006), has developed a set of specifications and licence criteria for New Zealand businesses that want to use their label. The label is supported by the New Zealand Government and is subsidised by the Ministry for the Environment. At the stage of the analysis Environmental Choice was deemed to still lack a strong impact on the New Zealand market. Also, there were no label specifications available for the furniture category, and the efforts and cost for developing an appropriate specification and for using the label were considered relatively high. Therefore it was concluded that the Environmental Choice label did not provide a feasible option for CML.

The Forest Stewardship Council (FSC) is an independent international non-governmental organisation which supplies accreditation services and a trademark for companies that are using wood from forests that are managed in an "environmentally suitable, economically compatible and socially advantageous" way (Forest Stewardship Council, 2006). Although CML already complied with most of the criteria for FSC Chain of Custody certification, and its MDF board originates from sustainably managed forests, research determined that it did not appear to be economically feasible for CML to apply for certification (M. Oudshoorn, 2005).

Enviro-Mark[®] NZ (Enviro-Mark[®] NZ, 2006) is a business standard which is marketed and supported in New Zealand by Landcare Research, the nationally licensed certification authority. The certification process is a five stage, step-by-step pathway to reaching objective evidence of an organisation's accomplishments in Health, Safety and Environmental (HSE) management. At the end of this programme the organisation is prepared for international environmental management systems standards such as ISO14001.

For CML, the Enviro-Mark[®] NZ programme offered a range of advantages: The HSE management practices in the programme include assured compliance with relevant legislation and improved resource productivity through waste reduction, energy efficiency or raw material reduction. Other factors apart from enhanced public image, brand value, and marketing ability through use of the label, are more effective risk management and lower insurance cost. The five stage approach starting from Bronze Level (indicating compliance with current HSE legislation) to Diamond Level (implementation of an internal management and audit programme to correct and drive continual improvement) fitted exactly the requirements of the medium-sized, under-resourced CML organisation.

Therefore the programme was adopted at an early stage of the project. Bronze and Silver Level certification were achieved in 2005, and Gold Level in August 2006. CML is currently preparing for the Platinum Level audit. In the meantime, the company has already started using the Enviro-Mark[®] NZ label on its packaging, in its consumer brochures and its marketing material. Also, the structured development approach of the Enviro-Mark[®] NZ programme has provided CML with an additional, external framework, which supplements and supports project planning and organisation of the ongoing student projects.

Life Cycle Inventory

A life cycle inventory of CML's products was prepared to create an overview of all materials that go into each step of the production process, and of the elements that are the outputs of that particular step. The life cycle inventory has been used as a tool throughout the project for identifying opportunities for improvements. As all products are assembled from a range of panels which have different treatments, the life cycle inventory was created as one single flow diagram with multiple possible process routes. The inventory was the basis for identifying waste in the process, and for quantifying the potential for improvement of each waste element. In order to prioritise the improvement measures, each element was assessed against four ranking criteria, which are:

- possible financial benefits;
- quantity of waste produced;
- severity of consequences of waste production;
- likelihood of future cost increase.

The impact of each waste element for each CML was then rated on a six-point scale ranging from 'none' to 'very high'. The result was a ranked list of priorities for waste reduction efforts. MDF board off-cuts were found to be the most critical waste element with a total rating of 84. MDF sawdust came second with a rating of 80, followed by vinyl and process chemicals at 64 and 52, respectively. The lowest rated waste elements were water, cardboard, noise and heat with ratings of 24, 24, 20 and 8, respectively (M. Oudshoorn, 2005).

Trade-off analysis

In order to reap the long-term benefits of sustainable manufacturing, CML needs to eliminate the trade-offs between sustainability and other important performance measures. Two of the major trade-offs identified are quality and cost, which are discussed briefly below.

Quality is related to the reliability of the operations and manufacturing processes in delivering the end products according to design specifications, leading to customer satisfaction. A trade-off between this objective and sustainability will occur if reducing waste, energy usage or other environmental impacts of the production processes results in defective or less capable products.

An example of such a trade-off at CML involves the recycling of board off-cuts back into the particle board production process. The board containing the recycled material causes 'chipping' problems during the cutting, shaping and drilling processes at CML. The degree of 'fine-ness' of the board, as a material property was identified as the critical element of this trade-off. More research is currently under way in this particular area to solve the problem. One idea is to use the recycled material in the middle section of the board, and use the 'finer' material on the outside surface.

Cost is always an important factor for businesses when considering the implementation of an improvement in their products or processes. Trade-offs between sustainability and cost are crucial factors in the development and success of sustainable manufacturing at CML. CML's limitation of investment resources mean that the capital available for the implementation of sustainability at the company is not significant. In fact, lack of available resources was one of the first and most important factors which were discussed when CML management was considering the sustainability initiative. There was, however, general agreement amongst managers and directors that the implementation of sustainability would be a significant step towards improved competitiveness of the company in the future (M. Oudshoorn, 2005).

The cost of CML management and staff to research and implement the various aspects of the sustainability project has been a particularly important cost vs. sustainability trade-off consideration. To resolve this it was decided to develop ties with The University of Auckland and use low cost student projects to implement the sustainability initiatives. Other examples of sustainability versus cost trade-offs are the use of alternative material options for vinyl (used for lamination) and the implementation of emission prevention measures to comply with local government regulations. In all these cases CML needed to weigh up the long term benefit of the increased product desirability and marketability leading to increased number of sales, compared with the short term increased expenditure on materials and sustainable processes (see causal loop diagram, Figure 1).

Conclusions

This paper illustrates the benefits of applying a structured approach and a range of analysis tools for the implementation of sustainable manufacturing in a New Zealand manufacturing SME. The direct involvement and strong commitment of top management of the company has proven crucial for the success of the project. The Enviro-Mark[®] process has provided a solid pathway, with a step-by-step approach and clearly defined objectives and milestones (bronze, silver, gold, etc.) which are helpful for giving the project direction and for keeping on track. The collaboration with the University of Auckland meant that the company had access to a vast knowledge base, specialist expertise and student manpower at minimal cost.

The case study has identified lack of financial and management resources as the main impediment for SMEs to embrace sustainability. Therefore it would be useful for the

Government to provide financial support and other incentives to businesses to allow them to overcome the initial hurdle, after which they can reap the benefits of their environmentally friendly operations.

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