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## **Environmental Analyses in Auxiliary Product Design and Development: A Stakeholder-based Framework**

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### **Abstract**

This study attempts to develop a stakeholder-based framework incorporating environmental analyses in auxiliary product design and development through a case study. The case firm is a manufacturer and trader of mining machinery specified on a variety of electronic measuring devices for mine pressure and safety. One technology that the firm holds is to measure the mining emulsified liquid thickness. Based on this existing technology capacity, the firm has designed and manufactured auxiliary product relating to measuring concentration of drink liquid including milk, alcohol, juice, and so on. The new product is expected to apply widely in schools, restaurants, families, milk makers, winery industry, and juice shops. Although the auxiliary product inherits major technique characteristics from the mainstream prototype product, the firm faces problems in continuously developing and renewing these auxiliary product in an environmental friendly way, for the new product engages an uncertain and unfamiliar application context different from the mining context that the firm is grounded on and is familiar with. To address this problem, this study advises with a framework based on stakeholder environmental concerns. It argues the stakeholders for auxiliary products are different from those for the mainstream products, so are environmental concerns of stakeholders. Identifying and addressing the new environmental concerns would spot the critical points for further sustainable product innovation and enhance the competitive advantages of the firm entering or opening a new market.

**Key words:** environmental analysis, auxiliary product, eco-innovation, stakeholder

## 1. Introduction

The conception of eco-innovation involve two key words, “stakeholder” and “environmental concern”. The achievement of sustainable development requires participation of different social actors, or stakeholders, including the customers, governments, communities, and labourers (Johansson and Magnusson, 1998) [1]. Consistent with this stakeholder-participated sustainability view, Howarth and Hadfield (2006) argue, a major challenge for product designers and developers is to include sustainable development aspects into their design programmes, so as to take into account of the interests and concerns of interested parties, that is, stakeholders [2]. And it is also widely accepted that central to eco-innovation is the environmental concern. James (1997) contends, the purpose of new product is to achieve a significant decrease in environmental impacts and increase in customer and business value at the same time [3]. Johansson and Magnusson (1998) suggest [4], the existing eco-innovation strategies or tools such as “Eco-compass”, “the Eco-design strategy wheel” (Brezet et al, 1997) [5], and “Material intensity per unit of service” (Schmidt-Bleek, 1996) [6], all similarly rest on the environmental performance. Frei (1998, p.16) argues, eco-product design “aims to systematically establish and implement goals in product design with the aims of improving environmental performance”, and “these goals should be based on significant environmental aspects of the products and take into account environmental requirements” [7].

Although the major topic of eco-innovation or sustainable product design has been well explored in previous studies, one aspect of this field seemingly rarely systematically researched is about the auxiliary product design. Auxiliary product to a firm is often considered complementary to the main prototype product. From a technological perspective, the auxiliary product is a transformed version of the prototype product, or a method to generalize the main product to new application context or new market. One reason for the firm to develop auxiliary product is to keep both technological and cost advantages: to exert an existing well-developed technology to enter or create a new market, rather than to spend much efforts and investment initiating an original product design project. But it is also problematic that the auxiliary product is concerned with a new context involving a new set of stakeholders, who are different from those stakeholders concerning the main prototype product from which the auxiliary product is transferred. Thus, it brings new problems for designers and developers due to the gap between the stakeholder environmental concerns of both product application contexts.

Different from the traditional Life-cycle assessment (LCA), triple-bottom-line analysis, and other holistic approaches to product design, this study applies a benchmark approach, where the eco-innovation is focused on addressing the difference between environmental concerns of the new stakeholders and the stakeholders for the prototype or main product. This approach is justified in that the auxiliary product is not an entirely new technology but is based on its prototype well developed, applied and marketed in an existing context. Thus, the innovation focus for developing auxiliary product is to renew or develop the prototype technological characteristics, in order to fix the environmental concern gap between the different stakeholder sets in the two application and market contexts.

## 2. The stakeholder-based framework for environmental analysis

We propose a stakeholder-based framework for environmental analysis for the auxiliary product design:

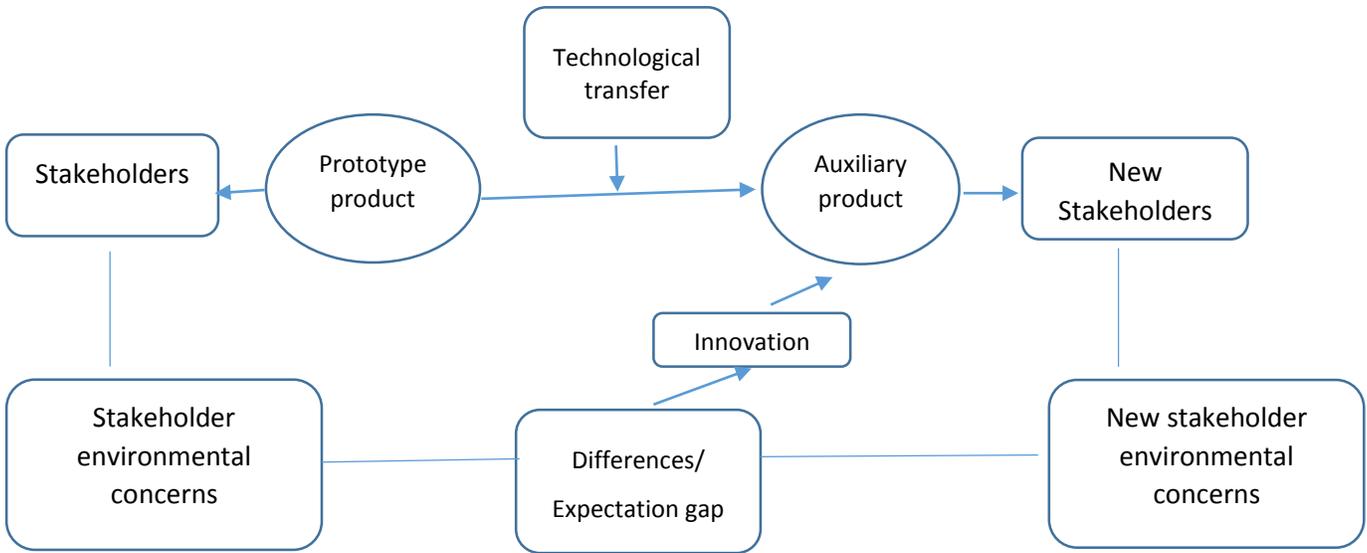


Figure 1: the stakeholder-based framework for eco-innovation in transferring prototype product to auxiliary product.

## 3. The case of designing auxiliary product

The case firm is a manufacturer and trader for mining machinery specified on mining pressure monitoring and measurement devices in China. In the past several decades, the firm has successfully developed and marketed a variety of related products widely applied in mining areas across the whole nation. Currently the firm attempts to develop new markets with its existing technological capacity and market resource.

One technology that the firm holds is to measure the thickness of emulsified liquid applied to the mining pressure machinery system. The firm has recognized that this research and development capacity is an opportunity to open a drink-making market, for this technology can be also used to measure concentration of drinking liquid including milk, soy, sugar, juice, alcohol, and tea, in a wide application context covering restaurants, drink shops, families, milk factories, and winery industry. Regarding it is complementary to its mainstream mining machinery market, the firm has developed drink-thickness measurement device mostly similar to its mining prototype to attempt the new market opportunities. Although the auxiliary product has obtained some positive response from the new market and users, the firm faces problems in continuously developing and renewing the auxiliary product in an environmental friendly way, for it engages an uncertain and unfamiliar application context different from the mining context that the firm is grounded on and is familiar with.

Current auxiliary product tends to be a “copy” of its prototype with these technological characteristics.

- The mechanical system structure: it comprises of two parts, a plastic tube (extractor) and the measurement pen. The measurement pen includes two main components, the “pen tail” as the liquid sample platform, and the “pen head” as observation lens working as a tiny telescope.
- The assessment procedure: the manipulator uses the tube to extract a liquid sample; and then drops the sample to the sample platform (pen tail); and observe the thickness data through the telescope (pen head), where the telescope lens is required to be adjusted in an appropriate distance to the eyesight lens.
- The measurement scale is 0% to 15%;
- The accuracy is  $\pm 0.2\%$ ;
- The device weights light and is portable.

The firm acknowledge these key technological characteristics effectively address the requirements of measuring emulsified liquid thickness in mining environment. Normally, the thickness of mining emulsified liquid adopts 5 % to 8 % within the maximum measurement scale. The plastic extractor is suitable to the emulsified liquid; no negative consequence is generated when it works for emulsified liquid. The plastic exactor fits the underground mining environment, the temperature of which between 10 °C to 20 °C.

But the firm faces uncertainty of the environmental issues when applying the device in the new context.

#### **4. Application of the stakeholder-based framework**

In this case, the stakeholder-based framework is operationalized into the following analytical model

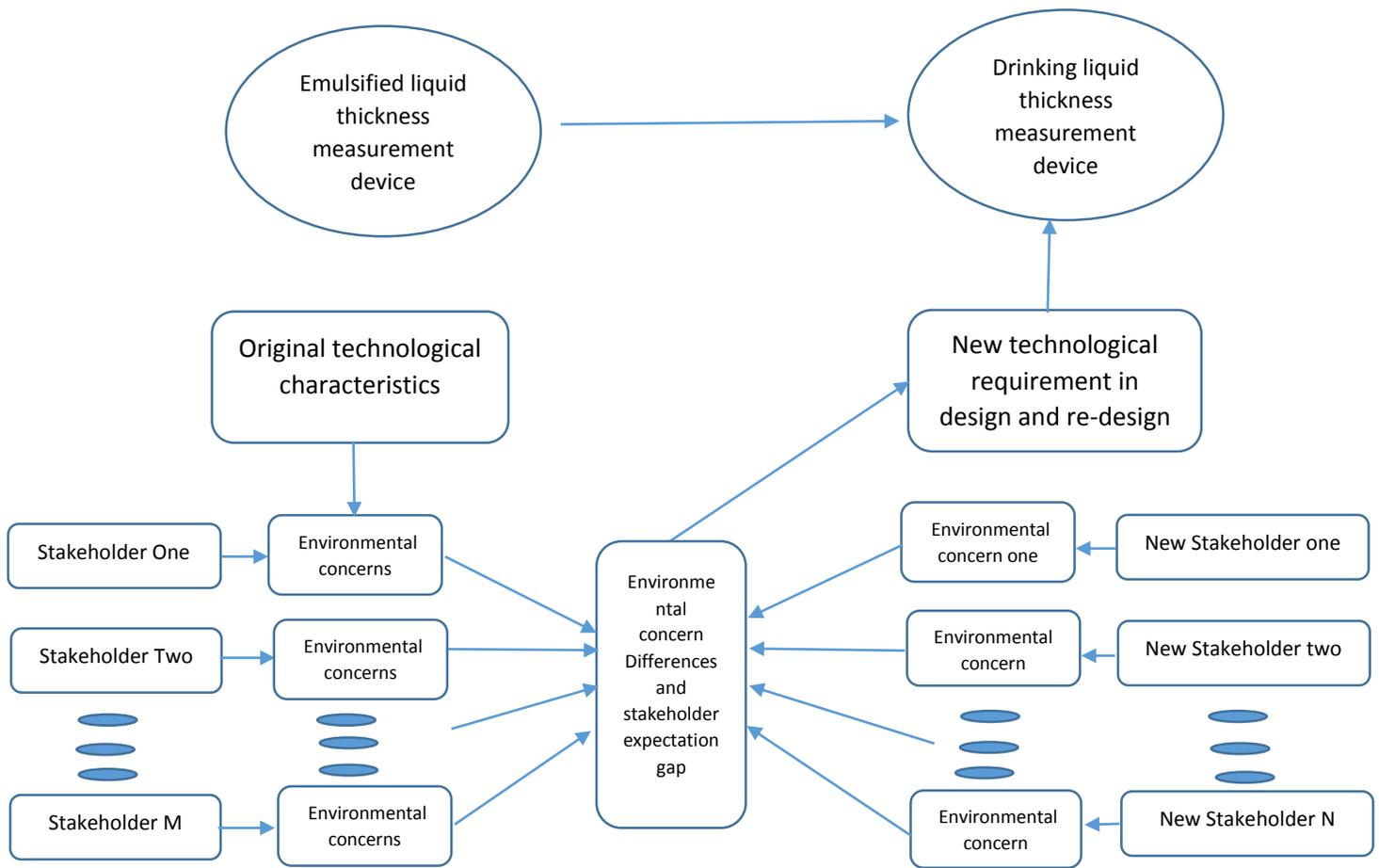


Figure 2: the applied model of the stakeholder-based framework for auxiliary product eco-innovation

The analysis involves three steps: step one, identification of the different stakeholder sets; step two, a comparison between the stakeholder environmental concerns; step three, suggestion for innovation.

*Step one: identification of the different stakeholder sets*

We identify the different stakeholder sets for both the main prototype product applied in mining context, and the auxiliary product transformed from the main prototype product but applied in non-mining context respectively.

The stakeholders concerned with the mining product are: governments setting environmental laws and regulations; mining equipment industry association setting environmental standards; the mining corporations; the mining manipulators (users) of the product; and the miners (mining labourers).

The stakeholders concerned with the auxiliary product are: governments; light electronic industry association; the customer businesses (including milk makers, soy makers, and restaurants and so on); the manipulators of the measurement device; the consumers of the customer business.

*Step two: a comparison of environmental concerns of the different stakeholder sets*

The case firms applied the method of survey, interview and secondary and primary data analysis to obtain the understanding of the environmental concerns of the different stakeholder sets regarding the two products.

The environmental concerns of the stakeholder set of the mining emulsified liquid measurement device are:

- Governments and industrial associations: the environmental laws and regulations related to mining safety monitoring. The regulations and standards on special industrial equipment manufacturing.
- The mining corporations (customer business) and the mining labourers: primary focus on safety factors such as flammability and explosiveness in the underground mining environment.
- The manipulators (direct users): like the mining corporation, they tend to concern primarily the flammability and explosiveness, and moreover, the accuracy and timing of obtaining the measurement results are also key factors in considerations.

The environmental concerns of the stakeholder set of the drinking liquid thickness measurement device are:

- Governments and industrial associations: the health and safety laws and regulations regarding producing foods. Normally the original technological characteristics designed for the stricter standards in mining industry meet the major quality requirements of the new context.
- The customer businesses (restaurants, milk makers, soy makers, juice shops, winery industry, some families, etc.). First, they require a relatively large scale of the measurement. For sometimes the drinking liquid may be much thicker than emulsified liquid. For example, the juice that juice shops make and sell is normally times higher than 15%, the maximum scale of current device. Second, some also point out the problem about the material of extractor, for the plastic extractor suitable for emulsified liquid in normal temperature may be incompatible with the drinking liquid in a higher temperature. In this case, the plastic extractor may not only release toxic stuff to contaminate the liquid, but also itself risk being damaged. And third, in restaurant workshop circumstance, the plastic extractor may be damaged by the fire, hot oil and hot water. But the high level of accuracy seems not a focus of their concern.
- The manipulators (direct users): they require an easy and direct way to measure and obtain the data. They are not satisfied with the current approach to observe the data. Some users complaint that the “lens seeing” may negatively impact the eyesight and especially not apply to the old householders or staff. And it is inconvenient to adjust the telescope lens position; which seems much technical to

the users in drink-making context. And the procedure tends to be complex. And the plastic extractor may be slipper when sticked by oil. It not only adds difficulty to hold the extractor but also a risk for the food health problem if it dropped into the drink liquid.

### *Step three: Suggestions for innovation*

From the step two, we identify some gaps regarding the environmental requirements from the new stakeholders that the prototype technology has not addressed. Based on the new stakeholder environmental concerns, the suggestions for innovation of this auxiliary product are as following.

First, the extractor of the device must keep clean to avoid any contamination to the drink liquid; and the device must be suitable to apply in “hot working environment” rather than the “cool underground” where its prototype applies. This may be achieved by using new materials like glass, metal, china or solid plastic to make the extractor. And the designers should establish new guidelines for using, storing and cleaning the device in different working circumstances.

Second, the measurement scale must be enlarged significantly. The product designers or developers should explore new measurement method or system to achieve this. If necessary, the high accuracy characteristic can be satisfied for the upcoming large scale characteristic. This innovation may require much effort and time.

Third, to make a holding loop or some tiny blocks in the smooth surface of the extractor to add friction avoiding the holding difficulty. To provide manipulator the information how to clean the extractor if it is sticked with oil or oiled stuff.

Fourth, to develop direct observation system to replace current telescope-lens watching system. A possible solution is to introduce an electronic system to show the thickness degrees directly. Another is to try to show the degrees/measurement results on the device body.

Fifth, different from the mining specialists, the target users of the non-mining device require a simple and easy way to manipulate the product. The product designers and developers should consider simplifying the lens-position adjustment procedure.

## **5. Conclusion**

We argue the framework that this study has proposed benefits designing and developing environmental friendly auxiliary product. The two core characteristics of auxiliary product, “being transferred from well-developed mainstream prototype product” and “being applied in a new and uncertain market”, suggest that, in promoting eco-innovation for auxiliary product, we need not spend much effort, time and fund to research an entirely original technology, but focus on fixing the problems to address the stakeholder environmental concern differences between the two application contexts. The case study exemplifies application of this

framework to a technology transferring to mining context to drink-making context. Through this framework, the new stakeholder environmental concerns are effectively spotted and constructive suggestions for eco-innovations are proposed.

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### **Conflicts of interest**

The author declares no conflict of interest.

### **References and Notes**

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