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Co-Definition of Product Structure and Production Network for Frugal Innovation Perspectives: Towards a Modular-based Approach

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Abstract

Frugal innovation theory is proposed to help companies rethinking their current product design and production strategies facing competitive challenges. Co-evolution of product and production systems is required to reach frugality goals. The success of the co-evolution strategy should be based on robust models ensuring the global consistency of the whole development process. Modular-based models are a good solution for such problematics since they provide a common semantic for the representation of the physical product structure as well as the organizational structure of the production system through the definition of interfaces between elements and the hierarchical decomposition of a system into different elements.

This paper proposes a conceptual modular-based approach dealing with the selection of product modules influencing the selection of suppliers and the allocation of orders in a global production network. The indirect linking of the customer to production is also discussed in terms of the timewise restrictions in selecting product modules offering the customer a maximum degree of flexibility in product specification.

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1. Introduction

In the new vision of the industry of the future, companies should adopt new flexible strategies to deal with the huge varieties of competitive markets and complex needs of customers, correlated by specific cultural, social, political and economic specificities. This implies the development of new products and services for several markets (i.e. emerging markets) with acceptable quality and optimal cost regarding the socio-economic context of the targeted market.

Indeed, the high growth rates, huge market size and workforce in emerging countries have ensured sufficient focus on "winning in emerging markets" through region appropriate strategies [1]. Hence, the traditional products and services with complex features and functions sold in western markets

should be modified to obtain attractiveness according to frugal criteria [2]. Some products or services even should be developed from scratch by involving regional R&D in local regions to capture the regional market needs and features [3].

In this new challenged context, frugal innovation theory seems to be an efficient solution to cope with these issues by providing experts a set of technical and managerial tools helping them with the identification of the exact customer needs in specific markets but also rethinking their current development processes to answer these needs with affordable cost and best quality.

Thus, creating new frugal products or services for regional markets can be obtained through the definition of new product features or the adaptation of existing products regarding the constraints of the targeted context.

However, the (re-)design of the product structure is not already sufficient to reach the frugality goals. Additionally, the (re-)definition of the production network structure and processes based on heterogeneous capabilities can contribute to the optimization of the final solution in terms of cost, quality and time to market.

This paper discusses the potential of using a modular-based approach as a kernel methodology to reach the frugal innovation objectives by supporting the co-evolution of product structure and production strategy. The application of such an approach is discussed through some inputs from real use cases about how the selection of product modules influences the selection of suppliers in a global production network and the allocation of orders in such a network.

The next section focusses on the main characteristics of the frugal innovation theory and the co-evolution strategy as main pillar of this theory. The third section describes the foundations of modular approach method and its advantages to support frugality. The last section presents the utility of the proposed approach from a practical point of view.

2. Co-evolution for frugality perspectives

Frugal innovation theory is introduced to explain new market trends and to propose new solutions supporting these evolutions [3]. For Tiwari and Herstatt [4], frugal innovation refers to innovative products and services that “seek to minimize the use of material and financial resources in the complete value chain (from development to disposal) with the objective of reducing the cost of ownership while fulfilling or even exceeding certain pre-defined criteria of acceptable quality standards”.

In general, five main directions for frugal innovation are identified as efficient levers to develop frugal products for specific markets with optimal costs and quality:

- Develop new products from scratch in local R&D centers.
- Develop frugal products as an adaptation of existing solution for local markets, by:
 - ✓ Replacing current materials with cheaper but functional ones;
 - ✓ Removing non-essential product and service features from current products and services;
- Re-design the production network by increasing the proportion of regional suppliers;
- Modify current production processes and strategies to reduce manufacturing and logistic costs.

According to these directions, the co-evolution of product, processes and production systems and the consideration of their reciprocal influences with the strategic decisions of the company are often required to reach economic and social sustainability in the frugal context. Herein, the change propagation behaves as a cause-effect wave across the enterprise, spanning all product, process and production system dimensions. According to Tolio et al., [5] the term “co-evolution” represents the ability to strategically and operationally manage the propagation of engineering changes to gain competitive advantage from the resulting market and regulatory dynamics.

The co-evolution of the production system is usually extended to the production network level that aims to create several collaborative relations between OEM and supplier companies for a better management of their distinctive skills and resources in the whole production process. Supplier selection and evaluation are among the main factors to be resolved at the earlier stage to guarantee successful results from any OEM-Supplier collaboration [6].

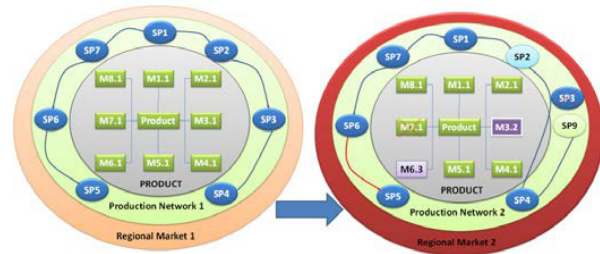


Fig. 1. Frugal Innovation: adaptation of existing product to new market

The co-evolution of product structure and production systems to adapt an existing product to a new market can be summarized in figure 1 as follows: some of the current product features are modified in order to fit the regional customers’ needs. These features surely belong to some modules (Mx.y), composing the architecture of the product. Accordingly, the production network consisting of a set of production systems, i.e. plants, and/or suppliers (SP) may be changed to support the new modification. Even, deeply, the product’s production with its realization systems and technologies are also affected. Additionally, the design may also be modified when there is a need to redesign some features or develop new product modules of the current product for the adaptation. Therefore, to realize frugal innovation along this direction, a couple of key problems should be dealt with, such as:

- How to identify the right product modules, features or functions to be removed, modified or even renewed?
- How to integrate the customers into the modification and/or development process?
- How to adapt the current production to the modified product features for the new regional markets?
- How to re-design the supplier network for this adaptation?
- How to reuse the knowledge of regional product development in the future?

The success of any co-evolution strategy should be based on robust models ensuring the global consistency between all development stages (from product design to production network configuration) and supporting the propagation of decisions through all managerial levels. The power of modularity for such problematics is clearly laid out in the literature [7] since it consists of decomposing complex systems into independent but interconnected parts that can be treated as conceptual, logical or physical units as well as organizational units [8].

The next section discusses the main advantages of the concept of modularity to address the above questions for the implementation of the frugal innovation approach.

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