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LINKING GREEN MANAGEMENT AND MASS CUSTOMIZATION

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Abstract. *The need to bridge mass customization (MC) with green management (GM) is starting to be recognized in literature. To date, this emerging discussion has been almost exclusively conceptual or simulation-based. To contribute to the empirical grounding of this discussion, we present the preliminary results of a longitudinal case study in a company faced with the twofold challenge of MC and GM. We identify the key organizational capabilities associated with these two strategies in the company. Then, we discuss some positive linkages between MC capabilities and GM capabilities that emerged from a preliminary analysis of the empirical evidence.*

Key Words: Mass Customization, Green Management, Longitudinal Case Study

1. INTRODUCTION

Two increasingly important challenges are reshaping the competitive environment of a growing number of companies. On one hand, many firms need to combine high product variety and customization with operational performance levels that are comparable to those of a mass producer: this challenge has been named in literature as mass customization (MC) [1-3]. These companies are pushed to offer more customization and variety by many factors, such as the increasing heterogeneity of customers' demands or the fall of barriers to international trade [2, 4, 5]. At the same time, they are also forced by the intensifying competition to develop, produce and deliver their products with greater rapidity, lower costs and higher quality [6].

On the other hand, regulatory pressure and customers' environmental consciousness are encouraging companies to increasingly integrate sustainability principles into their businesses [7, 8], and this trend is confirmed by large-scale surveys of worldwide executives [9].The first companies to modify their strategies were the large ones, given their availability of information and resources to invest in green management [10], but also SMEs are now trying to ensure effective green management (GM) [11].

Academe has promptly reacted to the growing importance of MC and GM to the business community, multiplying the research initiatives on these topics [12, 13]. In particular, previous studies have identified a number of organizational capabilities supporting GM [14, 15], which we refer to as GM capabilities (GMCs), and a number of organizational capabilities supporting MC [16-18], which we denote as MC capabilities (MCCs).

However, the existing literature provides very limited support to the growing number of companies that face the twofold challenge of implementing both MC and GM [19, 20]. The few, very recent and mostly conceptual papers that have attempted to address this gap implicitly suggest there may be linkages between MCCs and GMCs, but empirical studies specifically focused on these linkages are still lacking. Accordingly, the present paper explores the relationships between MCCs and GMCs through a longitudinal case study within the context of a large manufacturing company strongly committed to implementing both MC and GM.

2. LITERATURE REVIEW

Most of the few studies addressing the linkage between MC and GM belong to the research stream on MC. Niinimäki [21] and Black [22] propose that MC can have a positive effect on sustainability because the emotional bond, which users experience with a product tailored on their needs, can extend product life time. Badurdeen and Liyanage [23] advance a list of possible benefits of MC from a sustainability perspective. For example, if companies are able to produce customized products on a to-order basis within the customer expected delivery lead times, they also manage to eliminate the risk of having inventories of obsolete products and, therefore, reduce waste. Nielsen et al. [24] suggest that the ability to modularize products can support the firm capacity to minimize the environmental impact of mass customized goods during the pre-use, use, and after use phases. For example the increased similarity in production technology will have a positive impact on energy and resource consumption because of higher potential for optimizing processes. Pedrazzoli et al., [25] and Chin and Smithwick [26] estimate, mainly with qualitative data, the product life-cycle of two particular products (footwear and a men's dress shirt) and find that the mass customized version is more energy and resource efficient than the mass produced version. Thuesen and Jespersen [27] and Wijekoon and Badurdeen [28] suggest that the product configuration process could be the place for estimating the environmental impact of various product choices and,

therefore, for making the customer understand the impact of their selections. Petersen et al. [20] argue that MC can have both positive and negative impacts on multiple dimensions of environmental performance. For example, direct delivery of customized products may require more packaging and energy as compared to similar standard products which are packaged and distributed in high volumes. But at the same time the product does not have to travel through multiple tiers of wholesalers/retailers to reach the customer and, therefore, the CO2 emission of logistics may be lower. This work concludes that the global effect will depend entirely on the particular type of product that is customized.

In the GM literature, relationships between MC and GM, though not explicitly addressed, are sometimes implicitly suggested. For instance the ability to reduce pollution is often coincident with the ability to reduce waste [29]. For example when a company reutilizes the process scrap to limit pollution, that company simultaneously reduces waste as well. Waste reduction clearly means better operational performance and this help implement MC by improving compatibility between high levels of product customization and high levels of operational performance [30].

In conclusion, the research on the relationships between MC and GM is still underdeveloped and, notably, lacks empirical evidence supporting the few linkages that have been conjectured so far. In particular, while implicitly suggesting that MCCs and GMCs may impact on each other, previous research lacks any empirical study addressing the following research questions: How do GMCs influence MCCs and why is it so? How do MCCs influence GMCs and why is it so?.

3. METHOD

To answer these questions, the present research deploys the method of exploratory longitudinal case study. The case study was considered a fruitful strategy for this work, given the initial stage of the research on the topic [31]. Case studies are also particularly suited for answering how and the why questions [32], such as those addressed in this paper. Finally, case study research, when also relying on direct observation, is a particularly useful method for observing organizational routines [33], which are widely acknowledged as the microfoundations of capabilities [34]. For example, Dosi et al. (2008: 1167) consider organizational routines "the building blocks" of capabilities, [e.g. 35] and Cohen et al. (1996) refer to them as primitive concepts in the definition of capabilities [33]. Organizational routines [36] are repetitive "chunks" of coordinated activity [37], which underlie organizational capabilities (Teece, 2007), meant as the replicable capacity of an organization to bring about an intended action (Dosi et al., 2000).

We chose to conduct a longitudinal case study which has the potential for increasing the internal validity of results by facilitating the identification of cause-effect relationships [38], and relieves the risk that participants do not recall relevant events or that their recollection is subject to bias [39]. While allowing for in-depth observation of causal relationships inside organizations, longitudinal case studies are also very time and resources consuming [40]. Consequently, for this study we chose to conduct a single case study due to reasons of time constraints.

Consistent with previous studies on organizational capabilities [41], our unit of analysis, or case, is the business unit. The case was selected following the "extreme situation" decision rule [42:275]: to limit the shortcomings of having only one case, it is important to choose a case where the phenomena of interest are more likely to be transparently observable. The chosen case provided such opportunity because the selected business unit was far from having high MCCs and GMCs but it was strongly committed to developing them.

The selected business unit belongs to a large manufacturing firm, which has been producing wash units for every type of vehicle for over 50 years: cars, buses, tankers, trains, streetcars, underground trains and military vehicles. Today, it is present in over 60 countries and through a strong distribution network offers a complete service to business customers, from the design up until the final installation and start-up phases. The business unit that was selected for this study was the car-wash unit.

Regarding MC, at the beginning of 2009 the company was offering thousands of product variants that scarcely met the market requirements: many of those products had never been asked by customers and, at the same time, clients often requested variants that were not included in the solution space. Therefore, the company often had to respond to the customer's requirements according to an engineer-to-order approach, with the subsequent negative implications on delivery lead-times, costs and quality (since in these cases the product was tested for the first time by the customer him/herself). Moreover, it was not unusual to accept customer orders that were incomplete or incorrect, and this further impaired performance. In 2008, the company perceived that this was a problem and started to analyze the implications of variety and customization on its processes. At the end of 2008, it became clear that it was necessary to work simultaneously on product development, production, sales and post sales processes to reduce the negative effects of product variety and customization. Between the end of 2008 and the beginning of 2009, the company launched an ambitious project aimed to redesign all the above mentioned processes. This included the adoption of a product configurator capable of supporting both sales specification and the generation of the product data needed to fulfill customer orders, the reorganization of the inventory management and production planning and control systems, the redefinition of the production cycles and layout and the adjustment of the new product development process to make it more coherent with a strategy of MC.

As regards GM, before the beginning of our study environmental issues were scarcely considered by the firm, even though that business was characterized by high resource consumption (water, energy, chemicals) and potentially severe water pollution during product usage. Starting from 2008, after a change of the company ownership and management, a new strategy was launched, aiming to revitalize the brand and differentiate it from competitors' through the achievement of green corporate reputation. In early 2009, the company's mission and vision were formally aligned with this objective and the top management chose to apply for an Environmental Product Declaration

(EPD®) so as to concretely demonstrate the new strategy to the shareholders. We considered this choice as a sign of true dedication to environmental issues, since EPD® offers more transparency, quantification, and verification compared to the other standards, labels or certifications concerning GM [43].

4. RESULTS

4.1 MCCs improvement

From January 2009 the company took many steps on the way of achieving MC. The firm improved its operational performance without sacrificing product customization: costs decreased because of both reduced working capital and increased labor productivity; order-to-delivery lead times shortened, product quality improved as a result of higher reliability and serviceability; process quality rose thanks to fewer errors in the sales specification process.

All these achievements are the result of the improvement of a number of MCCs during the period of observation. A crucial role was played by the enhanced capacity to understand market demand heterogeneity, which we term "market heterogeneity scanning capability". In 2010, the capability increased thanks to the establishment of a routine to systematically analyze new product functionalities in terms of price positioning, and thanks to the creation of a dedicated marketing office in november 2010, guided by a long experienced marketing manager. This office was in charge of evaluating the differentiation of the company offer from competitors and estimating the market success for new product or product features. For example, at the end of 2011 a market research was carried out to sense how a large sample of the company customers normally used the product, which problems they had and which were their most or least preferred optional or functionalities.

A crucial role was also played by the enhanced capacity to design product families that integrate the point of views of marketing, R&D and operations, which we term "design for MC capability". In summer 2009, the company started to use a novel procedure for developing new products: the R&D and operations managers were required to evaluate the multiple technical solutions that could be used to provide the product functionalities asked by the salespersons. This procedure helped to eliminate redundant product modules and minimized the use of design solutions that were problematic for the operations. Moreover, in October 2010, the director manager formalized a procedure for the modification of the product space, so that every change had to be approved by the top management, in order to prevent salespeople from keeping on offering "special" products that were problematic for other functions.

Another MCC that improved during the period of observation was the capability to efficiently identify the product variant that best matches the customer's requirements among the solutions offered by the company. We term this capacity "efficient and effective customer-company interaction capability". This capability highly increased in 2009, when the company started to segment customers into homogeneous groups asking for similar product solutions: these data were given to the salesmen to teach them how to direct the customer towards the most typical product for his/her segment. In mid 2010, the new product configurator started to be used for guiding the customer in progressively defining the characteristics of the most suitable product in the product space offered by the company. This was achieved through a sequence of questions, supported by images and descriptions of the product options, to communicate both the advantages (performance and functionalities provided) and the costs (impact on the total price of the product) of the possible choices. With this system salespersons were able to create a complete and correct product configuration, choosing from the updated solutions space, and provide to the customer a full description of the variant ordered, with also a 3D graphical representation.

Another MCC that improved during the period of observation was the capability to shape the supplier base so that it delivers product mix and volume flexibility, which we term "supplier flexibilization capability". At the beginning of 2010, the company created a procedure, , for the evaluation of suppliers, based on a set of performances, included responsiveness. This procedure allowed the company to identify a set of suppliers to be dismissed and a set of suppliers with whom to develop closer relations. The decreased number of suppliers allowed the firm to focus more resources on some selected companies. The relationship with a supplier of structural components was, for example, reconfigured to implement just-in-time supply: the company agreed to increase the total number of components purchased per year, in exchange for a sharp reduction of the minimum lot size, thus decreasing its supply coverage from four months to two weeks.

Another MCC that improved during the period of observation was the capability to move customer order information through all the production stages so that the right product variant ultimately reaches each customer, which we term "logistics for MC capability" [16]. This was achieved mainly through the implementation of a technical product configurator, which enabled the company, starting from middle 2011, to automatically generate the information needed to manufacture the product variant requested by the customer. This helped to eliminate any errors in the creation of the bills of materials and subsequent risk of delivering a product solution different from the one ordered by the customer.

Between 2009 and 2011 the company also increased its capability to continuously generate a stream of incremental innovations to reduce the negative operational implications of product customization, that we term "continuous improvement for MC capability". This capacity was achieved by assigning clear process ownership and giving him/her the power and the resources to enact the improvement suggestions. Moreover in 2010 the organization started to collaborate with an international management consulting company to develop some instruments supporting the continuous improvement. Examples of these instruments are visual management, kaizen journal or the use of blackboards for tracking the activity progresses.

Crucial to the improvement of operational performance was, finally, the capacity to reduce the unneeded variance in the operational processes, which we term "process variance control capability". This capacity was improved when the company adopted the product configurator as the only way for entering orders

into the production system. This drove the salespersons towards accepting only orders that belonged to the predefined solution space, thus limiting the ad-hoc development of "special" products, which created instability in the internal operations of the firm. Furthermore the company adopted in 2011 a planning system to freeze the product and process specification in the last part of the order fulfillment: no changes could be done to the product or the processes that could harm the material flow close to the due date.

4.2 GMCs improvement

From January 2009 the company greatly reduced the environmental impact of its operations and products. In January 2010, the special wastes created during the product testing process were almost eliminated. Then, a part of the production process was changed to replace dangerous phosphate-based consumables with nanotechnology-based materials, way less dangerous for the environment. In addition, the paint used in the manufacturing process was substituted with a more eco-friendly one (water-based paint) and its consumption was reduced through the use of photocells to activate the painting system only when needed. By November 2010, the company also reduced the pollution created during product usage and disposal (e.g. more energy efficient engines, minimized decoration plastics, etc.). Following all these achievements and a life cycle environmental impact assessment, in February 2011 their new product families were awarded the EPD® and this event was reported by local and national journals, drawing the attention of some big multinational firms interested in "going green".

All these successes are the result of the improvement of a number of GMCs during the period of observation. A crucial role was played by the enhanced capacity to sustain manufacturing processes that met or exceeded environmental targets, which we term "manufacturing process environmental control capability". This capacity was developed starting from 2009, when the company began collaborating with a consultancy company, which subsequently engaged in the creation of the environmental manual with all the legal and operative prescriptions to be followed by the firm. In compliance with such prescriptions, in 2010 the company assigned a person the responsibility for the management of environmental emergencies in the plant, increased the frequency of environmental training, and started regularly monitoring the data on environmental emissions of processes. For example, chemicals are titrated twice a day, while previously that was done only once a week.

Another GMC that improved during the period of observation was the capability to minimize the environmental burdens caused by logistics, which we term "eco-adaptive logistics capability". In mid 2010, the warehouse was reorganized to reduce material handling operations (and therefore their emissions), especially for the dangerous chemicals that could cause severe environmental damage in case of improper handling. Additionally, in late 2011, packaging was redesigned to enable take back and reuse, and the company started to pool suppliers' shipments.

Another GMC that improved during the period of observation was the capability to continuously generate a stream of incremental innovations to reduce the environmental impact of internal processes, that we term "continuous environmental innovation capability" [15]. Since 2010, the company has been yearly visited by an external audit team and such audits have promoted a number of improvements: with the support of an external consultancy office, the company has created a roadmap of environmental improvement actions with formalized action plans and compliance indices.

Another GMC that improved during the period of observation was the capability to make the customer more environmentally conscious, which we term "greening the customer capability". This capacity increased in 2010, when the company started to extensively promote among its customers the use of particular chemicals that were less harmful for the environment. Additionally, the new products released at the end of 2011 were equipped with advanced control systems, monitoring the status of many environmental parameters: that was done in order to direct the customer's attention towards those dimensions of performance and help him/her realize that, for example, s/he is using too much car shampoo.

Another key aspect was the capacity to incorporate environmental concerns into product development, that we term "eco-design capability". This capacity was mainly developed through collaborations with external stakeholders: since 2009, the company started to collaborate with two universities and a research institute to develop greener products. Since the end of 2010, they also have had a partnership with a company specialized in the estimation of the life cycle impact of products, in order to guide the design of the new product families.

The supply chain was another key area for improving the environmental impact of the company's products. In particular, a GMC that improved during the period of observation was the ability to cooperate with the suppliers and motivate them to be more environmentally responsible, which we term "greening the supply chain capability". A mean for developing such capability was, since the end of 2010, to ask for the life cycle assessment of some supplied products. Since then, suppliers have started to propose more ecological solutions, sometimes developed ad hoc for the company.

Another GMC that improved during the period of observation was the capacity to monitor organizational, public, and regulatory priorities and stay abreast of competitive trends and future environmental legislation, which we term "environmental scanning for GM capability". In 2009, this capacity was obtained mainly through the participation to industry fairs and supplier fairs, or through informal personal contacts. In April 2011, it was improved through the creation of a marketing function in charge of monitoring competitor's product, market requirements and technological developments in the sector. For example, in summer 2011, the marketing function carried out a market research in order to sense how the customers normally use the product and what environmental problems they have.

5. PRELIMINARY FINDINGS AND CONCLUSION

This work adds empirical evidence to the emerging debate on the integration of MC and GM. To our knowledge, this is one of the first studies to empirically investigate the implementation of both strategies in the same company. We contribute to the literature by showing preliminary evidence of positive linkages between GMCs and MCCs. Specifically, two

relationships have emerged from the analyses conducted so far. The first is between environmental scanning for GM capability and market heterogeneity scanning capability. The ability to understand how each customer uses the product and how this use may change over time allows the firm to both identify unsatisfied needs to be exploited for proper product design [17] and, at the same time, to understand what green means in practice for the customer [c.f. 44] since different ways of using the product lead to different environmental impacts of the product in use. Therefore, the improvement of one of the two capabilities helped the other capability, by providing the necessary information it required. The other linkage is between design for MC capability and eco-design capability. What we observed is that the latter capability gave higher benefits when the former was more advanced. Thanks to the product modularization, which increased communalities and decreased the variety of technologies used by the company, eco-friendly innovations could be easily extended to a greater number of products within the company's offer. If the same product variety had been provided through pure customization, it would have been much more costly to apply the same eco-friendly solution across all the products of the company. Admittedly, our results are preliminary and must be further developed through the completion of the data analysis process. More empirical research is also necessary to test the emergent relationships on larger samples and thus enhance confidence in the validity of the proposed relationships.

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