Mass Customization Cycle (MCC) through ETLC System Dynamics Modeling: A Case Study in Consay Company

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***Abstract*—This paper examines MC enabling technologies and their impact on the success of MC systems in Cosay Company by using System Dynamics analyzing. It also demonstrated the effect of technology on the level of customization and production volume. This paper shows how technology contributes in the handling of the customers, the realization of the product or service, and the coordination between those two sides, which is a vital element to the success of an MC system.**

It has been found from the system dynamics model that the company's information system plays a major role in linking and coordinating the different sides of the MC cycle and also has a valuable input in market research and development.

***Index Terms*—Mass customization cycle, system dynamic, case study.**

I. Introduction

Mass customization was first conceived in the 1970's as a system that integrates the customer into the production process where the customer becomes the "prosumer", that is the customer and producer [1,2]. However, this concept has not really been practiced until the mid 1990's, when it was further developed by Pine (1993) in his book Mass Customization. Mass customization can also be described as integrating the customer into the production process, also defined as "co-creation", in which the customer has a direct input in the design of his/her unique variant (final product) [3,4,5,6]. The producer faces a great challenge in establishing a reliable and reusable production or service system that can realize the individualized needs of the customer in a quick and cost-effective manner. This cost of complexity is directly proportional to the extent of features and components that are customizable. That is, the higher the level of customization, the greater the cost of attainment.

We have presented a typical MC cycle starting from the customer order all the way to delivery. For this cycle to be effective, it is important to adequately coordinate the three aforementioned components [7, 8, 9]. A weakness in any part of the MC cycle could jeopardize the success of the entire system. The information system structure is the backbone of the MC cycle; it keeps track and coordinates all of the customers' database, procurement database, suppliers' database, production database, and marketing database [10, 11, 12, 13, 14]. Unlike other mass production systems an MC system, without the need for customer survey or questionnaires, has access to the exact demands, tastes and background of customers on an individual basis. This direct information is considered a valuable asset for market research and analysis. It offers the means to better understand the voice of customer and promote continuous improvement, which helps better serve the customer while maintaining the efficiency of production.

The paper is structured as follows. In the second section we present research objective we also describe the mass customization technologies in the third section. the fourth section explain about the company case study . The Model description will be described in the fifth section. The paper finishes with conclusion and list of references.

II. Research Objectives

There are four main objectives for the research. First, to build a SD model for ETLC. Second, to identify the Production value in ETLC. Third technology contributions on handling of the customers. Finally, to understand the role that the SD2 play in MC.

III. Mass Customization Technologies

There are three technology sides for MC. We will first start with the customer's side and then describe the Interface Level technologies. Finally explain the technology at the Producer's Side.

A. *Technology at the Customer's Side*

There are many Mass Customization services in the market and there is a necessary to educate the customers of the new system (For example, online services, CRM3, SFA4). For an MC system to be successful it needs to offer a user-friendly and self-explanatory media for the customer. The customer is not expected to be knowledgeable about the product component details and the nature of the system.

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The effect of technology on the level of customization.

Consay Company Discount Store (in Poland) stocks socks in its warehouse and sells them through an adjoining showroom. The store keeps several brands and styles of socks in the stock; however, its biggest seller is Super socks marketing

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[2] system dynamics
[3] customer relationship management
[4] Sales Force Automation systems

B. Technology at the Interface5 Level

The interface refers to the link between customer's order and the ability of the current system to comply with those needs. The advances in information technology (IT) can allow this process to operate on a real-time basis, serving a large number of users[15].

C. Technology at the Producer's Side

In this side to achieve a successful MC, it is important to have supporting software and manufacturing technologies. It is important that producer use the up-to-date technologies in this regard. Figure 1 show the MC technologies in a simpler form:

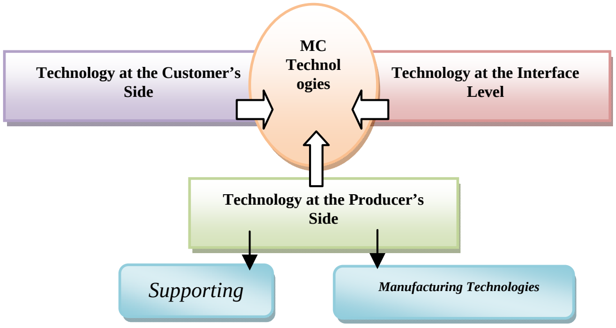

Fig. 1. MC technologies.

In the mass customization strategy the "process technology feasibility" is the third pillar[16,17,18]. If the customers do care about customization, how much process change would be required to customize at low cost? That is the most important question[19,20]. In Figure 2 shows the old paradigm comparing by the mass customization paradigm .

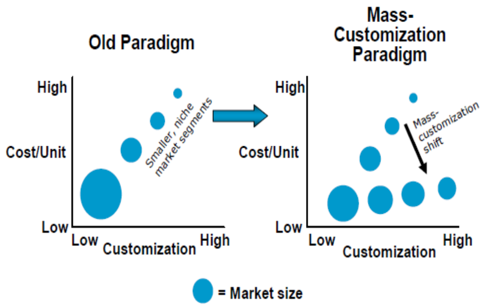

Fig. 2. MC paradigm

In Consay company, for example our case study , would likely need to start with a new product and radically change its processes and culture. All they needed was the key process technology--an information system capable of creating a guest-history database--that would enable them to become a mass customizer [21,22,23,24,25]. To gauge the process technology feasibility, consider the questions like Does the technology exist to allow to customize products and services to individual customers? What would be the impact of new technology on variable costs? Fixed costs? in our paper we analyze these questions and add these variables to our ETLC model . in the next section we try to summarize the case study detail.

[5] It is not the virtual dialogue between the customer and the system.

IV. Case Study (The Polish Consay Company)

The SD model is not limited to special state in every modeling stage. Although the model can be used in various cases, it has been established to examine the Consay Company's situation in this study. In order to study and examine the present situation of the company, suggest future production strategies, and verify and validate the model, the activities of this company will be described here. The domain of this company's activities is production of different types of sock with the participation and investment of internal and external corporations and incorporations.

Some companies have a point out about mass customization that the cost would become high , according to previous research it was showed that a mass-customizer are too high only if mass customizing competitors are unlikely to take company customers[26,27,28,29,30]. Consider the magnitude of change required to acquire the competencies needed to become a mass-customizer. Would be need to start with a green-field site, or does the firm already possesses mass-customization capabilities that can serve as the foundation for migrating to a full-scale, explicit mass-customization strategy? Many firms already possess such capabilities, but do not view them in the context of mass customization. Further consider which emerging technologies should be monitored most closely in the business by identifying the key areas in which new process technology would make mass customization possible. Viewing consay company through the mass-customization lens brings focus and urgency to the search for new process-technology. Combining Customization Sensitivity, Improvement Potential and Process Technology Feasibility Figure 3 is a matrix that illustrates the relationships between customer-customization sensitivity, performance improvement potential and process technology feasibility[31]. Using a comprehensive assessment approach, your company's position on the matrix can be plotted.

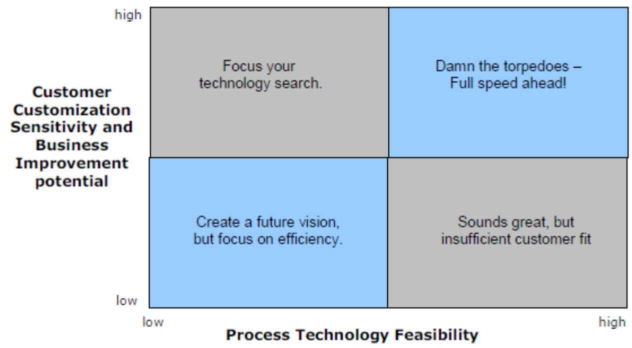

Fig. 3. MC paradigm matrix that illustrates the relationships.

V. Model Description

The development of an appropriate model for the effect of the technology on the level of the customization in RMS, which incorporates different parameters involved in that process, is an essential step. Appendix (1) shows a system dynamic model for the effect of technology on the level of customization.

The model expresses the production value as a stock level controlled by other parameters. In addition, it incorporates the technology contribution on handling of the customers, production value, demand, order rate, total value sales orders, production per customer, minimum cycle time, order delay, information system , technology . In this study, a continuous-time model is used because it provides an acceptable, approximation of the continuous process in RMS. Finally, similar dynamic characteristics can be obtained using discrete-time models . Deterministic data are used in the analysis to provide a simple and yet effective comparison among the various scenarios.

VI. Mathematical Models Description

Any attempt to design a system must begin with a prediction of its performance before the system itself can be designed in detail or actually built. Such prediction is based on a mathematical description of the system's dynamic characteristic. This mathematical description is called a "mathematical model", which is classified into linear and nonlinear differential equations. The linear differential equations (LDE) may be classified as linear time-invariant differential equations and linear time varying differential equations[32].

VII. Model Nomenclature

* Order = Interval of time or period between the placing (which means the act of finding a single buyer or a group of institutional buyers for a large number of shares in a new company or a company that is going public) of one set of orders and the next. * PV(t) = production value, * OR (t) = order rate, * PPC(t) = production per customer, * OD(t) = order delay, *Cu (t) = customers, *Ed =demand, *Or=order,* IS=information system,* CTmin=Minimum Cycle Time, *TVS= Total value sales.

VIII. Model Logic

In Consay Company orders from the client for a feasible sock needs from the system to check the current availability of resources, component inventory, suppliers' readiness, and schedule restraints before getting back to the customer. Production value has been calculate depend on (1) .

$$PV = f(X1, X2, X3,..., Xn) \quad (1)$$

In case of using the Built-to-order systems, typically require a large number of differentiated components inventory to fulfill the personalized needs of the client. so in order to calculate the demand Ed we depend on (2).

$$E_d = \frac{\%\ \text{change in quantity demanded}}{\%\ \text{change in price}} = \frac{\Delta Q_d / Q_d}{\Delta P / P} \quad (2)$$

In all cases, the company or supplier strives to keep the components inventory level at a minimum. Having an MC system that is a pure push system (on demand - not depending on forecast) and that operates on a just-in-time basis throughout the supply chain would be the ultimate goal from a logistics standpoint. Total value sales could be calculated upon the (3):

Unit market share (%) = 100 * Unit sales (#) / Total Market Unit Sales (3)

For minimum cycle time Eq 4 has been used as shown below :

$$CT_{min} = \max_{j = 1, M}\{\tau_j\} \quad (4)$$

Recently, custom socks has been an ambition; especially in e-commerce, where customers can access the company's website and select a style fabric, color and measurements range, and then the customized garment would be home delivered in a few days at a price comparative to retail alternatives. There would be no more need for mall shopping in a quest to find clothes that best fit the unique shape and contours of the shopper.

Tailoring 3D 6 Body Scanning has also played an important role in custom clothing. This technology offers a competitive advantage by maximizing the customer satisfaction while minimizing finished goods inventory (FGI) storage costs and display expenses.

IX. Numerical Simulation Results and Analysis

In order to illustrate the dynamic behavior and performance of theeffect of technology on the level of customization , the SD Model demonstrates a sudden step change in the demand to give a dramatic shock to the system and represents cyclic demand fluctuating scenarios for which RMSs are designed. Policy differs from rules or law. While law can compel or prohibit behaviors, while policy merely guides actions toward achieve a desired outcome. Policies also refer to the process of making important organizational decisions. It is typically described as a principle to guide decisions and achieve rational outcome(s).Tow policies are selected for the assessment of SD model:

Policy1: The Effect of the technology on the level of customization:

The first policy is based on technology to measure the level of customization. Fig. 4 shows the first pattern that demonstrates a sudden step change in products per customer to give a dramatic shock to the system. The system responds well to such change.

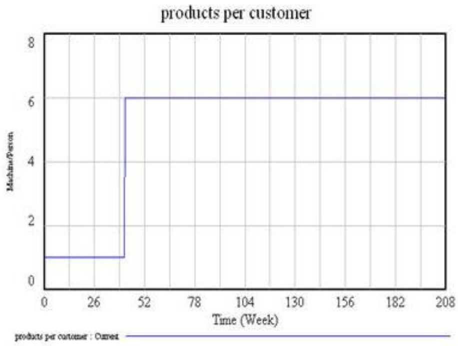

Fig. 4. Products per customer graph for sudden change scenario.

[6] Examples of companies that ventured into this technology are Levi Strauss, Land's End, Smart Body Scanning Kiosks and Madison Avenue store.

Dynamic modeling was performed for the Consay Company and the simulated results were obtained by Vensim software. The correct prediction of system behavior as a result of dominant policy is changed by preceding efficient policies to utilize the facilities toward stable development and dominant policy is changed by making reasonable changes in the parameters' values or the equations formulation.

By setting the order and demand to 1 the order rate immediately responds to the customer order rate and new customers shock by increasing the customer level to 5% Fig. 5.

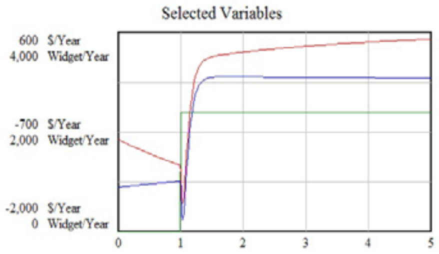

Fig. 5. Customer order rate.

The increasing in the production value could from the increase according to order rate and production per customer and the increasing in total value sales order Fig. 6.

Fig. 5 production value effects from other Variable.

Policy 2: Total value sales and order delay:

The success and progress in mass customization is based on technological advances at the customer side, producer side and the interface between both sides. It is not the manufacturing and production technology alone that plays a role in the success of an MC system, but it is also the sophistication of the customer interface, which is the ability to convey the client's exact needs. The fig 6 shows that there is decreasing in the order delay that effected from the increasing in mini cycle time and the total value sales.

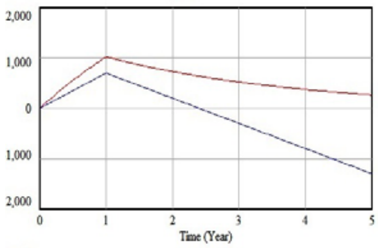

Fig. 6. Order delay.

X. Conclusion

It has been found from the system dynamics model that the company's information system plays a major role in linking and coordinating the different sides of the MC cycle and also has a valuable input in market research and development.

A summary of different applications for MC enabling technologies has been presented in various industries. Some of those technologies were serving the customer interaction, the product manufacturing, or the link between both. Those applications demonstrate the impact of technological advances in various areas on the achievement and success of MC. Now firms venturing into MC can be profitable at elevated levels of customization and higher production volumes.

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