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INVESTIGATING BARRIERS IN ADOPTION OF MASS CUSTOMIZATION IN CONSUMER ELECTRONICS SECTOR IN INDIAN PERSPECTIVE

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ABSTRACT Mass customization (MC) offers tailor-made services to customers and necessary for industries in current global competition. However, implementation of MC is at nascent stage particularly in consumer electronics. This study investigates barriers in adoption of MC in context with developing economies such as India. There are quite a few barriers which may affect implementation of MC. Through literature survey and experts' opinion 15 barriers has been identified. DEMATEL method was used to find cause-effect relationship between these barriers. Also most significant barriers has been identified as Lack of financial support, Lack of awareness of use of Information Technology in MC, Not availability of machines supporting MC, Lack of support from top management, and Lack of trained & skilled manpower. This study guides policy maker and managers in understanding the challenges in implementation of MC in emerging economies.

KEYWORDS : Mass Customization, Consumer Electronics Industries, Developing Economy, Manufacturing, Dematel

INTRODUCTION

Over the centuries, manufacturing processes has seen tremendous changes. Starting from handmade products, back before the first industrial revolution to the latest machine made, customised to satisfy individual customers tastes and needs [1]. The mass production has advantages such as production of large volume in less time and cost in reduced labors, uniformity good quality products [2, 3]. The limitations are lesser flexibility, lack of unique features of individual products, and higher inventory costs, to name a few. The tangible benefits of MC as an alternative such as improved customers' satisfaction, increased customers loyalty, improved inventory resulting into increased profits are visible [4, 5].

To implement MC, the top management needs to consider number of barriers. These barriers can be due technology, organization and environment [6, 7]. Before any manufacturer decides to implement MC strategy, it is worthwhile to identify the barriers which may affect significantly and concentrate on those barriers which will affect the most [8, 9, 10].

The organization of the paper is as follows: Section 2 gives list of barriers. Case implementation is given in section 3. Section 4 gives discussion on results followed by conclusion as section 5.

List Of Barriers

After interacting with the practitioners and excerpts from academia following barriers are identified. Each of these barriers would affect the other barriers to some extent. Refer Table 1 for details.

Table 1: Barriers affecting MC in consumer electronics industry

S. N.	Factor	Brief Description
1.	Lack of awareness of Government support and policy	Government is promoting usage of technology for MC
2.	Lack of Customer Satisfaction	Increased satisfaction seen through the large number of customer retainment
3.	Lack of implementation knowledge	Finding the right kind of people to implementation is difficult
4.	Lack of information sharing	The success stories of companies adapting MC are not published/ shared with others
5.	Lack of awareness of use of Information Technology in MC	There is a lack of awareness of technologies available among the practitioners on MC and its effects on production
6.	Lack of implementation of modern information technology in manufacturing	No or minuscule knowledge of trending technologies which can be used to adopt MC
7.	Lack of trained & skilled manpower	Lack of skilled manpower to handle and understand the advanced technology
8.	Resistance to change the organization culture to support MC	Top management is unwilling to try alternative approach of manufacturing than traditional
9.	Lack of Customers' involvement	Involvement of customer in designing the final product
10.	Lack of financial support	Changing the setup requires huge amount of investment
11.	IT support for infrastructure	The modifications needed to support usage of IT in MC requires proper infrastructure such as high bandwidth, uninterrupted power supply, automated / robotic machines etc.
12.	Cost of Production using MC	Increased compared to mass production
13.	Lack of support from top management	Top management's support is vital for implementing MC. Management should be ready to invest in hardware/ software and machines used in manufacturing
14.	Not availability of machines supporting MC	The machines which could be used in reconfigurable mode to support MC are uncommon, hence not easily available

15.	Concerns of job loss	Some opportunities will be lost due to reconfiguration or changed production processes

To understand the barriers influencing implantation of MC in Consumer Electronics Industry, a survey was conducted. Based on the inputs received from the practitioners and academicians, DEMATEL approach was used to identify the level to which each of these barriers influences the other barriers.

Case Implementation

The questionnaire was shared with number of practitioners and academic experts. Industry personnel were from consumer electronics industry. All the academic experts were well experienced in this field. They were asked to assign numbers 1- 5 for the identified barriers in terms of influence on the other barriers; (1 for No influence while 5 for maximum influence); based on their experience. The process of DEMATEL was used to understand the relationship between these barriers and also to find out the top barriers influencing the MC The responses from all individuals were compiled in an average net direct relation matrix as presented in equation 1.

The average matrix based on inputs from all experts is given in Table 2.

Table 2: Average matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	0	3	3	2	0	4	2	3	3	1	3	3	2	2	2
2	0	0	1	1	0	1	1	1	1	0	2	2	1	0	0
3	0	2	0	1	1	2	0	1	2	0	2	2	0	1	2
4	2	4	4	0	0	3	1	3	2	2	2	2	2	1	2
5	2	1	4	3	0	4	2	3	3	2	2	2	3	3	4
6	1	0	1	2	1	0	1	1	0	1	0	1	2	1	1
7	2	2	3	3	0	2	0	2	2	2	3	2	2	3	2
8	1	4	3	2	0	2	1	0	3	1	3	3	2	1	2
9	0	2	0	1	1	1	0	1	0	0	2	2	0	0	0
10	4	4	4	3	2	3	3	3	4	0	3	4	3	2	3
11	0	1	1	0	0	0	0	1	1	1	0	1	0	0	0
12	0	3	0	1	1	1	0	1	2	1	2	0	1	0	1
13	4	4	3	3	2	2	2	3	4	2	4	4	0	2	2
14	4	1	3	2	3	3	3	2	1	1	2	1	3	0	2
15	0	0	2	1	1	2	0	1	0	1	0	1	2	0	0

The normalized direct relationship matrix (Refer Table 3) is calculated using equation 2

$X = k . A$ where

Table 3: Normalized Matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	0	0.0666	0.0666	0.0444	0	0.0888	0.0444	0.0666	0.0666	0.0222	0.0666	0.0666	0.0444	0.0444	0.0444
2	0	0	0.0222	0.0222	0	0.0222	0.0222	0.0222	0.0222	0	0.0444	0.0444	0.0222	0	0
3	0	0.0444	0	0.0222	0.0222	0.0444	0	0.0222	0.0444	0	0.0444	0.0444	0	0.0222	0.0444
4	0.0444	0.0888	0.0888	0	0	0.0666	0.0222	0.0666	0.0444	0.0444	0.0444	0.0444	0.0444	0.0222	0.0444
5	0.0444	0.0222	0.0888	0.0666	0	0.0888	0.0444	0.0666	0.0666	0.0444	0.0444	0.0444	0.0666	0.0666	0.0888
6	0.0222	0	0.0222	0.0444	0.0222	0	0.0222	0.0222	0	0.0222	0	0.0222	0.0444	0.0222	0.0222
7	0.0444	0.0444	0.0666	0.0666	0	0.0444	0	0.0444	0.0444	0.0444	0.0666	0.0444	0.0444	0.0666	0.0444
8	0.0222	0.0888	0.0666	0.0444	0	0.0444	0.0222	0	0.0666	0.0222	0.0666	0.0666	0.0444	0.0222	0.0444
9	0	0.0444	0	0.0222	0.0222	0.0222	0	0.0222	0	0	0.0444	0.0444	0	0	0
10	0.0888	0.0888	0.0888	0.0666	0.0444	0.0666	0.0666	0.0666	0.0888	0	0.0666	0.0888	0.0666	0.0444	0.0666
11	0	0.0222	0.0222	0	0	0	0	0.0222	0.0222	0.0222	0	0.0222	0	0	0
12	0	0.0666	0	0.0222	0.0222	0.0222	0	0.0222	0.0444	0.0222	0.0444	0	0.0222	0	0.0222
13	0.0888	0.0888	0.0666	0.0666	0.0444	0.0444	0.0444	0.0666	0.0888	0.0444	0.0888	0.0888	0	0.0444	0.0444
14	0.0888	0.0222	0.0666	0.0444	0.0666	0.0666	0.0666	0.0444	0.0222	0.0222	0.0444	0.0222	0.0666	0	0.0444
15	0	0	0.0444	0.0222	0.0222	0.0444	0	0.0222	0	0.0222	0	0.0222	0.0444	0	0

The total relation matrix is calculated using equation 3

$T = X (I- X)^{-1}$ Where I is identity matrix (3)

Table 4 represents the total relationship matrix

Table 4: Total Relationship Matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	ri
1	0.031	0.123	0.116	0.087	0.023	0.135	0.068	0.109	0.113	0.048	0.120	0.120	0.082	0.068	0.080	1.323
2	0.009	0.021	0.037	0.035	0.006	0.036	0.028	0.036	0.039	0.010	0.062	0.061	0.033	0.008	0.012	0.453
3	0.011	0.066	0.022	0.040	0.012	0.065	0.010	0.040	0.062	0.012	0.005	0.066	0.018	0.030	0.058	0.507
4	0.071	0.142	0.134	0.041	0.021	0.112	0.048	0.106	0.091	0.066	0.096	0.097	0.079	0.045	0.078	1.225
5	0.087	0.096	0.157	0.121	0.030	0.154	0.077	0.123	0.127	0.078	0.112	0.114	0.116	0.099	0.137	1.629
6	0.043	0.033	0.054	0.068	0.034	0.030	0.038	0.048	0.029	0.038	0.031	0.052	0.066	0.038	0.045	0.646
7	0.077	0.103	0.119	0.107	0.024	0.095	0.027	0.089	0.093	0.069	0.120	0.098	0.082	0.089	0.082	1.279
8	0.045	0.134	0.105	0.077	0.018	0.083	0.041	0.030	0.104	0.042	0.110	0.110	0.072	0.040	0.072	1.090
9	0.007	0.060	0.014	0.033	0.026	0.034	0.006	0.034	0.014	0.008	0.058	0.058	0.011	0.006	0.010	0.379
10	0.130	0.171	0.163	0.128	0.074	0.140	0.102	0.131	0.159	0.099	0.146	0.167	0.120	0.081	0.121	1.871
11	0.005	0.034	0.030	0.008	0.004	0.009	0.004	0.029	0.012	0.025	0.011	0.010	0.006	0.004	0.007	0.243
12	0.013	0.089	0.023	0.040	0.030	0.042	0.011	0.041	0.064	0.013	0.067	0.025	0.038	0.010	0.036	0.560
13	0.124	0.164	0.134	0.120	0.070	0.112	0.077	0.124	0.152	0.077	0.159	0.158	0.051	0.076	0.093	1.691
14	0.124	0.086	0.129	0.095	0.088	0.126	0.096	0.097	0.080	0.054	0.105	0.085	0.110	0.035	0.091	1.403
15	0.016	0.026	0.067	0.041	0.032	0.065	0.012	0.041	0.023	0.034	0.023	0.046	0.060	0.013	0.019	0.516
cj	0.700	1.349	1.305	1.038	0.511	1.239	0.644	1.086	1.183	0.634	1.285	1.290	0.943	0.641	0.941	14.878

To formulate interdependency matrix from the total Table 4, alpha () value is calculated, which is 0.066. Table 5 shows the interdependency matrix where values less than are eliminated from Table 4.

Table 5: Interdependency matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1		0.123	0.116	0.087	0.023	0.135	0.068	0.109	0.113	0.048	0.120	0.120	0.082	0.068	0.080
2															
3		0.066													
4	0.071	0.142	0.134			0.112		0.106	0.091		0.096	0.097	0.079		0.078
5	0.087	0.096	0.157	0.121		0.154	0.077	0.123	0.127	0.078	0.112	0.114	0.116	0.099	0.137
6				0.068											
7	0.077	0.103	0.119	0.107		0.095		0.089	0.093	0.069	0.120	0.098	0.082	0.089	0.082
8		0.134	0.105	0.077		0.083							0.072		0.072
9															
10	0.130	0.171	0.163	0.128	0.074	0.140	0.102	0.131	0.159		0.146	0.167	0.120	0.081	0.121
11															
12		0.089									0.067				
13	0.124	0.164	0.134	0.120	0.070	0.112	0.077	0.124	0.152	0.077	0.159	0.158		0.076	0.093
14	0.124	0.086	0.129	0.095	0.088	0.126	0.096	0.097	0.080		0.105	0.085	0.110		0.091
15			0.067												

DISCUSSION ON RESULTS

Based on the Table 4, the cause barriers and effect barriers ar determined. The cause barriers are the barriers for which (ri - cj) is positive, whereas barriers which (ri-cj) is negative are termed as effect barriers.

The value of (ri + cj) indicates prominence of the factor. Ranking can be done based on (ri +cj) or (ri-cj). Many researchers [11, 12] argued about ranking based (rj-cj) value. In this study, the ranking of barriers is done based on (ri-cj) value. Table 6 gives cause-effect category along with the rank.

Table 6: Causes-effect category and rank

Barrier	ri-cj	Category	Rank
B10	1.237	Cause	1
B5	1.117	Cause	2
B14	0.762	Cause	3
B13	0.748	Cause	4
B7	0.630	Cause	5
B1	0.533	Cause	6
B4	0.186	Cause	7
B8	0.004	Cause	8
B15	-0.425	Effect	9
B6	-0.593	Effect	10
B3	-0.708	Effect	11
B12	-0.730	Effect	12
B9	-0.804	Effect	13
B2	-0.916	Effect	14
B11	-1.042	Effect	15

Cause-effect diagram is drawn where the Y axis represents (r_i-c_j) and the X axis represents (r_i+c_j) The cause barrier are above the X axis, whereas effect barriers are below the X axis.

Referring to Table 5, arrows are marked between the barriers. There are two types of arrows, single direction ( ) and bidirectional ( ). Single directional arrow is used when barrier Bi is affecting B_j, whereas B_j has no effect on B_i. Bidirectional arrow represents barriers B_i and B_j are affecting each other. Figure 1 represents cause-effect diagram of barriers affecting MC

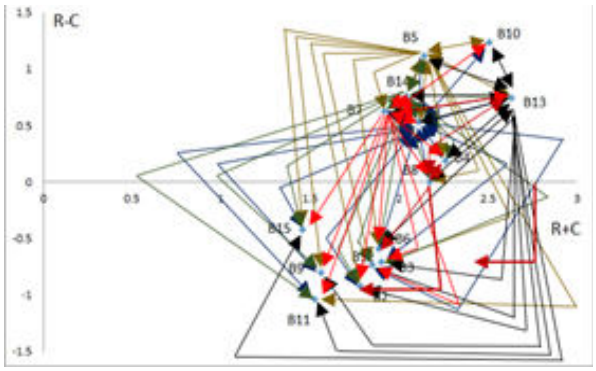

Figure 1: Cause -Effect diagram of barriers affecting MC

The top 5 significant barriers as per their ranks are as follows:

Lack of financial support (B10), Lack of awareness of use of Information Technology in MC (B5) , Not availability of machines supporting MC (B14), Lack of support from top management (B13), Lack of trained & skilled manpower (B7).

CONCLUSIONS

The basic purpose of this study was to identify the barriers of adoption of Mass Customization in consumer electronics sector in India. It could be noticed that the Indian manufacturers are required to be educated and informed about importance of mass customization to improve customers' satisfaction by supplying what they actually need at the minimal increased cost. The manufacturers will also be benefitted by producing products in demand, reducing inventory cost; thus, increasing the profit. The modern trending Information Technology can be used in various stages of manufacturing. The effect of use these technologies will provide a win-win situation for both; the customers and the manufacturers.

Implications of the study

Mass Customization (MC) manufacturing strategy has many advantages of the other approaches. Swift, efficient production process from start to finish, customers' involvement from design phase improves higher customer retention, products have options which satisfies personal tastes, closeness to the customers' choice at reduced process compared to tailored products, are a few worth mention.

The Government of India has come out with various schemes, such as make in India, to support manufacturing, skill India, to provide competent and skilled manpower. The top management, when aware of benefits of MC, would support wholeheartedly. It is expected to rearrange and reconfigure production line, to support manufacturing of different variants. The level of automation and use of robots, machines which are IoT enabled would be of great help.

Limitations and future scope

In this study barriers were identified based on literature survey and some of the barriers may be missed out. Inputs for DEMATEL received from experts may be biased. As this study was conducted in Indian context, the obtained results can be compared with similar kind of study in emerging economy. Results can be validated using quantitative analysis such as factor analysis.

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