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METRICS SYSTEM FOR EVALUATION OF THE INDUSTRIAL ENTERPRISES ADAPTABILITY DURING THE IMPLEMENTATION OF MASS CUSTOMIZATION

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ABSTRACT: Currently, the Bulgarian market is rather limited for the Bulgarian industry. Therefore, most of the middle range industrial enterprises in Bulgaria are export orientated. These enterprises are units in various international supply chains and they implement different forms of mass customization.
The supply chain flexibility is main instrument to cope with the increasing uncertainty and competition in the market place. The requirements for strong flexibility of the supply chains set correspondingly high requirements for the adaptability of the separate units in the supply chain.
In this work is presented a model of metrics system for evaluation of the adaptability of middle range enterprises implementing a strategy for mass customization.
The model comprises three groups of metrics: adaptability of the products' design, adaptability of the business system of the enterprise, adaptability of the business processes in the enterprise.
KEYWORDS: Mass Customization, Supply Chain Management, Responsive Manufacturing Systems, Flexibility, Small and Medium Enterprises

❖ INTRODUCTION

The transition from industrial to informational society requires fundamental changes of the manner in which are manufactured the industrial products, as well as the structure of the production systems. There are many theorists in management [1], [2], etc. who accept that the information society is characterized by development of global competition, change in the consumers requirements, increasing market diversity and rapid development of the production and information technologies.

In the core of this changes are the consumer's requirements which acquire an ever stronger importance [1]. The conception of customer driven manufacturing becomes more popular in the beginning of 90s and compels the manufacturers, while keeping the low prices to create customized products.

Manufacturing firms started to search for different ways to implement the conception of the so called "Mass customization", which rationale is in the ability to design, produce and deliver fast and at low prices products which satisfy specific needs of the customers.

The conception of Mass Customization requires the achievement customer responsiveness and at the same time high volume production. This is achieved through various time based manufacturing practices. From a marketing standpoint the notion of „Mass Customization" is proposed first by Kotler [3]. Pine [4] introduces the notion into the sphere of production and operations management. He defines Mass Customization as a strategy for low cost, high quality, large volume delivery of initially customized goods.

Nowadays, by Mass Customization is meant the knowledge of the companies how to produce customized products on a large scale at a cost comparable to non customized products [3], [5]. The Capabilities of the organizations to apply Mass Customization is determined by their ability to produce differentiated products with cost effectiveness, volume effectiveness and responsiveness.

The companies can achieve this ability through various technical and managerial innovations, which are combined in the so called „Time based Manufacturing Practices" [6]. Time based Manufacturing Practices have the following sub-dimensions [6]: shop floor employee involvement; reengineering setup; cellular manufacturing; preventive maintenance; quality improvement effort; dependable suppliers; pull production.

❖ SUPPLY CHAINS FOR REALIZATION OF THE MASS CUSTOMIZATION CONCEPTION

The main characteristic of the contemporary business is the fact that the competing agents are not different companies but supply chains and the successful functioning of the supply chains is determined by the end consumer [7].

The delivery of the exact product at the exact moment for each consumer at present is crucial not only for the competitive success, but also for the survival of each business organization.

Therefore, the satisfaction of each customer and the knowledge of the global markets are key factors which should be taken into consideration for the development of a supply chain strategy. The conception of Mass Customization is the main tool for creation and development of successful supply chain strategy.

The supply chain is a chain which connects all the elements of the value chain from customer and supplier through manufacturing and services so that the flow of materials, money and information can be effectively managed to meet business requirement [8]. The performance of the supply chain determines to what extent it is responsive to the needs of the market. The performance of the supply chain has four dimensions [9]: Market sensitiveness; Information driver; Process integration; Flexibility. The crucial one among these characteristics is flexibility.

In order to implement the conception of Mass Customization the supply chain should possess before all the quality "Agility". Agility is business wide capability that embraces organizational structures, information systems, logistic processes and particular mindsets [10]. Initially it has been suggested that Agility can be achieved through automation to enable rapid changeovers. Currently, though, the manufacturing flexibility covers wider business context and is based on two capabilities: speed and degree to which a firm can adjust its supply chain speed, destinations and volumes [11].

In order to achieve Agility of the Supply chains, first it should be achieved agility of each of the units in their structure. The main characteristic of the agile organizations is their flexibility. Any firm supply chain agility is determined by how its physical components are configured to incorporate speed and flexibility.

In the present work the flexibility of the industrial enterprises, which are parts of logistic chains, is viewed as a function of three indicators: Flexibility of the product groups manufactured by the enterprises; Flexibility of the components and relations of the business system of the enterprises; Flexibility of the business processes, by means of which the enterprises manufacture their products.

❖ FLEXIBILITY OF THE PRODUCT GROUPS

The conception for mass customization, aiming to satisfy the individual needs of each customer and at the same time to keep the high efficiency of the mass production processes, raises serious problems for the creation and distribution of the products components. The problems are connected mainly with a significant increase in the different categories of components which the particular industrial enterprise should produce or supply in order to realize the intended product groups.

Undoubtedly, the standardization of the components is a solution of this problem but it is also the main factor reducing the opportunities for manufacturing of personified products.

In the contemporary practice this problem is resolved by creation of product groups. The application of this approach reduces considerably the efforts and expenses for manufacturing of personified products.

While the question for the benefit from the product groups is well analyzed in theoretical as well as in practical aspect, the process of creating the most useful product groups for the organization is still unclear. This vagueness stems from the fact that on one side, it should be achieved variety of product components that keeps the products attractive over a long period of time, but on the other side, the variability shouldn't cause unacceptable expenses.

In short, a balance should be achieved between the variability of the manufactured products and the complexity of the business processes for their manufacturing.

Basing on this data for the particular industrial enterprise, an optimum compromise can be achieved between the processes of standardization and variability of components for products and processes.

❖ FLEXIBILITY OF THE PRODUCTION SYSTEMS

The construction of customer-centered production systems is result of the development of the conception for customers-orientated organizations.

The processes are high flexibility of the production system. The implementation of the conception for mass customization is achieved through creating opportunities for high-speed reconfiguration of operations, business processes, business contacts, etc. On the one hand, the aim

here is the most profitable satisfaction of the individual requirements of every consumer in the organization. On the other hand, the dynamic requirements of the production system should also be satisfied. The process of constant reconfiguration of operations, processes and connections is crucial for achieving the objectives of the contemporary industrial enterprises.

For a sustainable competitive advantage in the current conditions, the production systems and industrial enterprises should be flexible enough so that they can come up with all customers' requirements even for low-series orders. Main purpose is achieving a balance between the standardization of business.

❖ FLEXIBILITY OF THE BUSINESS PROCESSES

The business processes for manufacturing the products in the contemporary industrial enterprises should be characterized by high flexibility and dynamics so that the advantages of the current flexible production systems can be used at a maximum.

Therefore, these processes are saturated with information technologies which are enriching over time. The entire process of manufacturing of the modern products in the industrial enterprises encompasses a large scale of processes (600 – 800), which have to do with appreciation, interaction and integration of a broad spectrum of modern technologies. In order to ensure gradual and incessant development of the business processes in the contemporary industrial enterprises, it is necessary to take into an account all aspects of the organizational activity and all characteristics of the business systems and the products manufactured by them.

❖ MODEL OF A SYSTEM FOR EVALUATION OF THE ADAPTABILITY OF INDUSTRIAL ENTERPRISES

The author's ambition is that the suggested system for evaluation of the adaptability of industrial enterprises renders an account of all main characteristics and needs for the implementation of Mass Customization.

The main aspiration of the model is achievement of the highest level of simplicity of the evaluation and highest level of automation in the processing of the results, the purpose of which is facilitated usage of the system in all medium industrial enterprises.

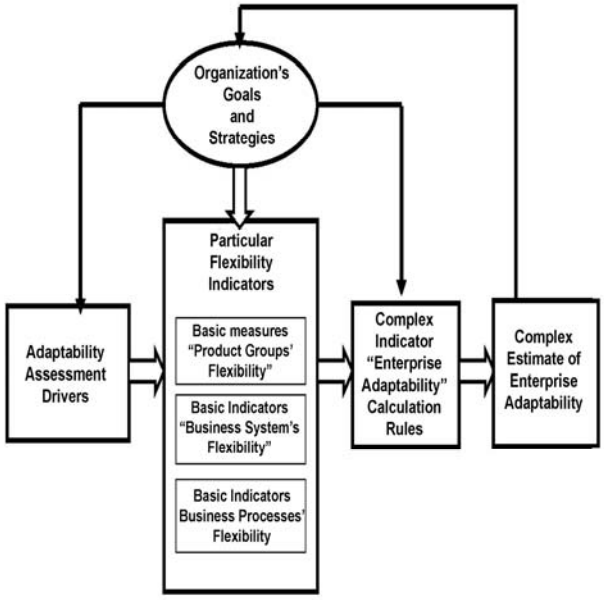

Fig.1. Model of a system for evaluation of the adaptability of industrial enterprises

The main objective with the creation of the model is, on the one hand, recognizing the differences between the various industries where the industrial enterprises operate and, on the other hand, integration of the interests of all stakeholders in the realization of the conception of Mass Customization. These two opposing requirements are harmonized in the developed model (Fig. 1).

As it can be seen on the figure, the model for evaluation of the adaptability of industrial enterprises is based on three main components: Factors which instigate the need for evaluation of the adaptability of industrial enterprises; Indicators for evaluation of the adaptability of industrial enterprises; Rules for comprehensive evaluation of the adaptability of industrial enterprises.

The factors which instigate the need for evaluation of the adaptability of industrial enterprises give expression to the circumstances which stimulate for evaluation of the adaptability at the present moment. Included here are conceptions like: the conception of Mass Customization; characteristics of the contemporary supply chains; the conception of the so called „Customer-centered organizations"; the conception of the so called „Extended enterprises"; the conception of the so called „Virtual organizations" etc.

The Indicators for evaluation of the adaptability of industrial enterprises are designed in a manner that they reflect the viewpoint of all stakeholders in the process of implementation of the conception of Mass Customization: end consumers of customized products; the enterprises which produce customized products; the participants (units) in the supply chain which places the customized products at disposal.

In accordance with the model are developed three particular indicators: particular indicator for flexibility assessment of the groups of products manufactured by the enterprises; particular indicator

for flexibility assessment of the business system, through which are manufactured the product groups; particular indicator for flexibility assessment of the business processes, through which are manufactured the product groups;

The Particular indicator for flexibility assessment of the product groups manufactured by the enterprises is formed by five measures: number of the product groups; number of products in the most important product group; levels in the hierarchy structure of the most complicated product; number of the components in the most complicated product; platform availability for the most complicated product.

The Particular indicator for **flexibility assessment of the business system**, through which are manufactured the product groups is formed by two basic indicators: flexibility of the technical sub-system and flexibility of the social sub-system. Each of the basic indicators is formed by group of indexes.

The Flexibility of the technical sub-system is evaluated through six basic measures: percentage of the computer controlled machines (CNC); percentage of the computer controlled machines and automatic tools change (working centers); possibility for change of the production capacity; percentage of the operations in which acceleration is achievable (shortening of the operative time); capability of the business system to cope with unforeseen situations (% of working centers); insensitiveness of the business system during optimizations of various business processes (% working centers).

The Flexibility of the social sub-system is evaluated through three basic measures: competence of the employees to operate on more than one working place; competence of the employees to operate with non-standard tasks; adequacy of the reactions in case of introducing new products and processes.

The Particular indicator for evaluation of the flexibility of business processes, through which are created product groups is formed by three basic indicators: basic indicator for operative flexibility of business processes; basic indicator for tactical flexibility of business processes; basic indicator for strategic flexibility of business processes.

The Operative Flexibility of the business processes is evaluated through seven basic measures: Capability of changing the processes for manufacturing of different products; Capability of changing and rearranging the priorities in the customers' orders; Availability of alternative technological routes for the predominant product group; Capability of changing the sequence of technological operations in the predominant product group (% of the operations); insensitiveness of the business processes to changes in the production scale and the size of the shipments (% of the business processes in manufacturing the predominant product group); Possibility of shortening the business cycle (lead time); Possibility of changing the technological equipment with duration under 10 minutes (% of the operations in manufacturing the predominant product group).

The Tactical Flexibility of the business processes is evaluated through three basic measures: Possibilities for change in the scope of the product groups; Possibilities for introducing of new products and modification of products; Possibilities for introducing of new business processes or modification of actual business processes.

The Strategic Flexibility of the business processes is also evaluated through three basic measures: Capabilities for designing new product groups (product innovations); Capabilities of designing new processes for products manufacturing (process innovations); Capabilities of implementing organizational changes (organizational innovations).

❖ DETERMINATION OF THE WEIGHT FACTORS, FIXING THE INFLUENCE OF PARAMETERS ON THE ADAPTABILITY OF INDUSTRIAL ENTERPRISES

In the multi-criteria decision making there are various procedures for ranging of indicators in terms of importance. The methods have different origin and are connected with different decisions taken in the business. Undoubtedly, a perfect aggregation of indicators cannot exist. Therefore, some reasonable procedures for ranging should be discovered.

In the current work is suggested that the ranking of the importance of the influence on the adaptability of the industrial enterprises**,** which is caused by different factors, is implemented through the Borda method [12]. Under this method the procedure for evaluation should render account on the opinion of all respondents, not only on these determining the first places of the ranked indicators. Not only should the preferences of the majority be taken into consideration, but also the elements which are disliked.

In this sense, according to the rule of the Borda [12], if N measures, are ranked, the measure ranked on last place doesn't gain any scores. The last but one Measure gains one score. The process of grading continues until the conferring of N-1 scores to the measure which takes the first place. According to the Borda rule [12], most important is the measure with the highest total number of scores.

❖ THE CALCULATION RULES OF THE COMPLEX INDICATOR

The calculation rules of the complex indicator evaluating the adaptability of industrial enterprises are used to estimate the influence of all particular indicators in relation to the relative weight of each of them.

By means of these rules will be formed the so called "complex index of adaptability of the industrial enterprise". In compliance with the developed model this indicator is calculated with the formula:

$$I_{aie} = w_{fpr}.I_{fpr} + w_{fbs}.I_{fbs} + w_{fbp}.I_{fbp} \quad (1)$$

where: I_{aie} – complex indicator for evaluation of the adaptability of the industrial enterprise;
I_{fpr} – particular indicator for flexibility assessment of the product groups manufactured by the enterprise;
I_{fbs} – particular indicator for flexibility assessment of the business system, through which are manufactured the product groups;
I_{fbp} – particular indicator for flexibility assessment of the business processes, through which are manufactured product groups;
w_{fpr}, w_{fbs}, w_{fbp} – weighting factors respectively of the particular indicators I_{apr}, I_{abs}, I_{abp}.

The Particular indicator for flexibility assessment of the product groups manufactured by the enterprise is calculated with the formula:

$$I_{fpr} = \frac{\sum_{i=1}^{5} M_{fpri}}{5} \quad (2)$$

where: I_{fpr} - particular indicator for flexibility assessment of the product groups manufactured by the enterprise;
M_{fpri} - values of the basic measures, which form the particular indicator I_{fpr};

The Particular indicator for flexibility assessment of the business system, through which the product groups are created, is calculated with the formula:

$$I_{fbs} = w_{ftbs}.I_{ftbs} + w_{fsbs}.I_{fsbs} \quad (3)$$

where:
I_{fbs} – particular indicator for flexibility assessment of the business system, through which are created product groups;
I_{ftbs} – basic indicator for flexibility assessment of the technical sub-system;
I_{fsbs} – basic indicator for flexibility assessment of the social sub-system;
w_{ftbs}, w_{fsbs} – weighting factors respectively of the basic indicators I_{ftbs} and I_{fsbs}.

Basic indicators, for evaluation of the flexibility of the business system, through which are created the product groups are calculated with the formula:

$$I_{xx} = \frac{\sum_{i=1}^{N} M_{xxi}}{N} \quad (4)$$

where: I_{xx} - basic indicators, through which is evaluated the flexibility of the business system, on which the product groups are created;
M_{xxi} - value of the basic measures, which form the basic indicators I_{xx};
N - number of the basic measures.

The Particular indicator for flexibility assessment of the business processes, through which are created product groups is calculated with the formula:

$$I_{fbp} = w_{ofbp}.I_{ofbp} + w_{tfbp}.I_{tfbp} + w_{sfbp}.I_{sfbp} \quad (5)$$

where: I_{fbp} – particular indicator for flexibility assessment of the business processes, through which are created product groups;
I_{ofbp} – basic indicator for operative flexibility assessment of the business processes;
I_{tfbp} – basic indicator for tactic flexibility assessment of the business processes;
I_{sfbp} – basic indicator for strategic flexibility assessment of the business processes;
w_{ofbp}, w_{tfbp}, w_{sfbp} – weighting factors respectively for the basic indicators I_{ofbp}, I_{tfbp}, I_{sfbp}.

Basic indicators, evaluating the flexibility of the business processes, through which are created product groups are calculated with the formula:

$$I_{xx} = \frac{\sum_{i=1}^{N} M_{xxi}}{N} \quad (6)$$

where: I_{xx} - basic indicators, for evaluation of the flexibility of the business processes, through which are created product groups
M_{xxi} - values of the basic measures, which form the basic indicators I_{xx};
N - number of the basic measures.

❖ PROCESS FOR CALCULATION OF THE COMPLEX INDICATOR EVALUATING THE ADAPTABILITY OF THE INDUSTRIAL ENTERPRISES

In order to achieve maximum simplicity in the determination of the adaptability of the industrial enterprises, the evaluation of all flexibility aspects is accomplished through one indicator – I_{aie}.

The scheme of the process is presented on Figure 2.

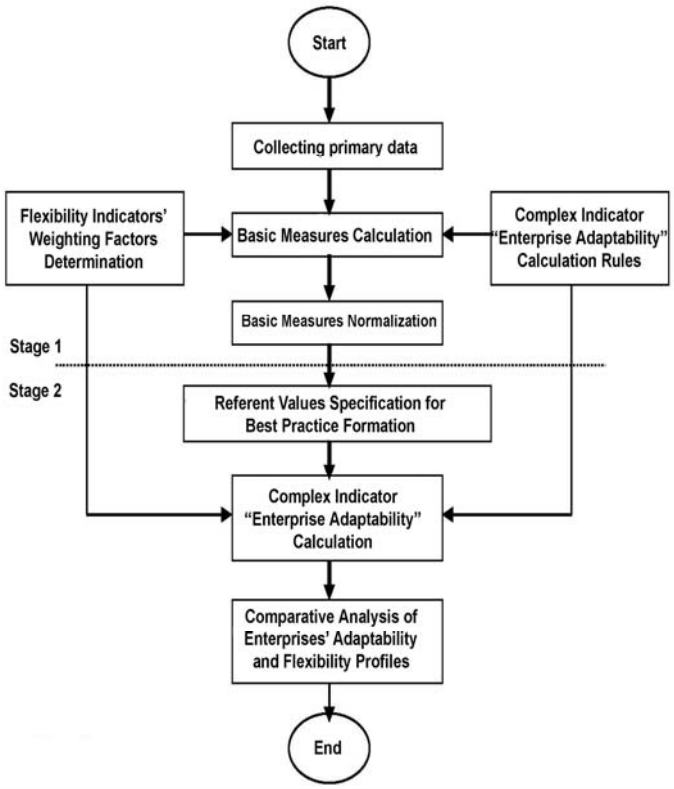

Fig. 2. Process for calculation of the complex indicator for evaluation of the industrial enterprises adaptability

❖ APPROBATION OF THE MODEL FOR ADAPTABILITY EVALUATION OF INDUSTRIAL ENTERPRISES

The approbation of the model is based on the author's research of 16 Bulgarian medium and small enterprises which are units in international supply chains. These enterprises are part of four industries: apparel; lighting; furniture; printing. [13].

Before the determination of the flexibility indicators the author has investigated in details the characteristics of the researched objects with respect to the parameters of the product groups created by them, the parameters of their business systems and the business processes taking place in the organizations. The purpose of this investigation is to select the quantitative parameters, which correspond to each of the five degrees of the planned examination marks.

The assessment of the flexibility indicators is implemented through questionnaire. By means of five-degree scale, the questions in it evaluate in the most precise manner the current state of the flexibility parameters. The examination marks from 1 to 5 stand for the flexibility level of each of the researched industrial enterprises in relation to the parameters of products, business processes and characteristics of the business system.

In the end of the questionnaire the respondents should range the importance of the different groups of indicators. This is necessary in order to form weighting factors of the particular indicators for evaluation of the adaptability of the industrial enterprises.

The calculation of the basic measures and basic indicators for evaluation of the adaptability of the industrial enterprises includes five main stages:

- ☐ processing of the data for basic measures, which form the basic indicators I_{ftbs} , I_{fsb},.I_{ofbp}, I_{tfbp}, I_{sfbp};
- ☐ normalization of the values of the basic measures;
- ☐ weighting factors calculation, of the basic indicators and particular indicators - w_{fpr}, w_{fbs}, w_{fbp}, w_{ftbs}, w_{fsbs}, w_{ofbp}, w_{tfbp}, w_{sfbp};
- ☐ calculation of the values of the basic indicators I_{ftbs} , I_{fsb},.I_{ofbp}, I_{tfbp}, I_{sfbp};
- ☐ calculation of the values of particular indicators for assessment of the adaptability of the industrial enterprises I_{fpr}, I_{fbs}, I_{fbp}
- ☐ calculation of the complex indicator for assessment of adaptability of the industrial enterprses I_{aie}.

The Basic measures, forming basic indicators I_{ftbs} , I_{fsb},.I_{ofbp}, I_{tfbp}, I_{sfbp} are calculated for each of the researched enterprises according to the developed model for evaluation of the adaptability of industrial enterprises.

The weighting factors for basic indicators w_{fpr}, w_{fbs}, w_{fbp}, w_{ftbs}, w_{fsbs}, w_{ofbp}, w_{tfbp}, w_{sfbp} are calculated on the basis of the ranks specified by the respondents in the questionnaires of the researched enterprises and is presented in table 1.

The data for the basic indicators, particular indicators and complex indicator calculated in accordance with the developed model for each of the researched industrial enterprises are presented in Table 3.

Table 1. Weighting factors for basic indicators

W. Factor	Value
W_{fpr}	0.21
W_{fbs}	0.37
W_{fbp}	0.42
W_{ftbs}	0,37
W_{fsbs}	0,44
W_{ofbp}	0,31
W_{tfbp}	0,25
W_{sfbp}	0,37

Table 2. Assessment of the flexibility measures [13]

		Apparel Average	Lighting Average	Furniture Average	Printing Average	All Average	Best practice
A	**Flexibility of the products**						
1	Number of the product groups	4,00	4,50	3,50	4	4,00	4,50
2	Number of products in the most important product group	3,25	2,75	2,83	3	2,96	3,25
3	Levels in the hierarchy structure of the most complicated product	2,75	2,25	2,17	1	2,04	2,75
4	Number of the components in the most complicated product	3,75	3,50	3,67	2	3,23	3,75
5	Platform availability for the most complicated product.	3,25	3,00	3,67	1	2,73	3,67
B	**Flexibility of the production system**						
B1	**Flexibility of the technical sub-system**						
6	Percentage of the computer controlled machines (CNC)	2,50	3,25	2,83	3	2,90	3,25
7	Percentage of the computer controlled machines and automatic tools change (working centers)	1,00	2,75	2,33	1	1,77	2,75
8	Possibility for change of the production capacity	2,50	3,00	2,50	2	2,50	3,00
9	Percentage of the operations in which acceleration is achievable (shortening of the operative time)	3,25	2,75	3,00	1	2,50	3,25
10	Capability of the business system to cope with unforeseen situations (% of working centers)	4,00	4,00	3,33	2,5	3,46	4,00
11	Insensitiveness of the business system during optimizations of various business processes (% working centers).	3,25	3,50	2,67	3	3,10	3,50
B2	**Flexibility of the social sub-system**						
12	Competence of the employees to operate on more than one working place	4,25	3,00	2,33	2,5	3,02	4,25
13	Competence of the employees to operate with non-standard tasks	4,75	4,50	2,50	5	4,19	5,00
14	Cdequacy of the reactions in case of introducing new products and processes.	4,00	3,75	2,83	4,5	3,77	4,50
C	**Flexibility of the business processes**						
C1	**Operative flexibility of the business processes**						
15	Capability of changing the processes for manufacturing of different products	3,25	2,25	3,00	1	2,38	3,25
16	Capability of changing and rearranging the priorities in the customers' orders	4,25	4,75	2,83	3,5	3,83	4,75
17	Availability of alternative technological routes for the predominant product group	2,00	2,50	2,17	1	1,92	2,50
18	Capability of changing the sequence of technological operations in the predominant product group (% of the operations)	3,50	3,50	2,67	1	2,67	3,50
19	insensitiveness of the business processes to changes in the production scale and the size of the shipments (% of the business processes in manufacturing the predominant product group)	3,50	3,00	2,67	2	2,79	3,50
20	Possibility of shortening the business cycle (lead time)	3,00	3,25	3,00	2,5	2,94	3,25
21	Possibility of changing the technological equipment with duration under 10 minutes (% of the operations in manufacturing the predominant product group).	2,00	2,25	2,17	1,5	1,98	2,25
C2	**Tactical flexibility of the business processes**						
22	Possibilities for change in the scope of the product groups	4,00	2,50	2,67	4	3,29	4,00
23	Possibilities for introducing of new products and modification of products	4,50	3,25	3,00	5	3,94	5,00
24	Possibilities for introducing of new business processes or modification of actual business processes.	2,75	3,00	1,83	1,5	2,27	3,00
C3	**Strategic flexibility of the business processes**						
25	Capabilities of designing new product groups (product innovations)	3,75	3,00	2,50	3,5	3,19	3,75
26	Capabilities of designing new processes for products manufacturing (process innovations)	2,25	2,50	2,00	1	1,94	2,50
27	Capabilities of implementing organizational changes (organizational innovations).	2,50	2,75	2,50	1,5	2,31	2,75

Table 3. Basic indicators, particular indicators and complex indicator calculated in accordance with the developed model

	Adaptability indicators	Apparel					Lighting					Furniture							Printing			BG Industry	Best
		1	2	3	4	Average	5	6	7	8	Average	9	10	11	12	13	14	Average	15	16	Average	Average	practice
A	Particular indicator "Product Groups Flexibility"	3,80	3,40	4,20	2,20	3,40	3,60	2,80	2,20	4,20	3,20	2,20	4,60	2,40	2,80	3,20	3,80	3,17	2,80	1,60	2,20	2,99	4,60
B	Particular indicator "Business System Flexibility"	3,74	3,06	3,95	2,60	3,34	3,77	2,44	3,41	4,02	3,41	2,02	4,21	2,32	2,86	3,09	1,69	2,70	3,27	2,32	2,79	3,06	4,21
B1	Basic indicator "Tecnical Subsystem Flexibility"	3,00	2,50	3,33	2,17	2,75	3,83	2,50	2,67	3,83	3,21	1,83	4,33	2,50	3,17	3,33	1,50	2,78	2,83	1,33	2,08	2,70	4,33
B2	Basic indicator "Social Subsystem Flexibility"	5,00	4,00	5,00	3,33	4,33	3,67	2,33	4,67	4,33	3,75	2,33	4,00	2,00	2,33	2,67	2,00	2,56	4,00	4,00	4,00	3,66	5,00
C	Particular indicator "Business Processes Flexibility"	3,83	3,35	3,71	2,00	3,22	3,85	1,75	1,67	4,50	2,94	1,58	3,77	1,56	2,33	4,15	1,73	2,52	2,18	2,56	2,37	2,76	4,50
C1	Basic indicator "Operatonal Flexibility"	3,57	3,29	3,29	2,14	3,07	3,86	2,29	2,29	3,86	3,07	1,71	3,71	1,43	2,71	4,29	2,00	2,64	1,71	1,86	1,79	2,64	4,29
C2	Basic indicator "Tactic Flexibility"	4,33	4,00	4,33	2,33	3,75	4,00	1,33	1,33	5,00	2,92	1,33	3,67	1,67	2,33	4,33	1,67	2,50	3,00	4,00	3,50	3,17	5,00
C3	Basic indicator "Strategic Flexibility"	3,67	2,67	3,67	1,33	2,83	3,67	1,33	1,00	5,00	2,75	1,67	4,00	1,67	1,67	3,67	1,33	2,33	2,00	2,00	2,00	2,48	5,00
	Complex Indicator "Enterprise Adaptability"	3,79	3,25	3,90	2,26	3,30	3,77	2,23	2,42	4,26	3,17	1,87	4,11	2,02	2,63	3,56	2,15	2,72	2,71	2,27	2,49	2,92	4,41

In spite of the values of the basic indicators, particular indicators and complex indicator for the different enterprises, in the table are presented average values for each of the four branches (apparel; lighting; furniture; printing) and an average value for the Bulgarian industry as a whole. In the end of the table are calculated and presented the values of the so called "Best practice", which is estimated on the basis of the maximal scores of the basic measures and basic indicators of all researched enterprises. This Best practice demonstrates the potential of the Bulgarian industry in relation to its flexibility and adaptability.

❖ COMPARATIVE ANALYSIS OF THE ADAPTABILITY PARAMETERS OF THE INDUSTRIAL ENTERPRISES

The purpose of this analysis is to determine the discrepancy between the actual condition of the parameters and the adaptability of the industrial enterprises in relation to the potential of the Bulgarian industry towards the so called "Best Practice" which demonstrates the adaptability of the so called "Ideal enterprise".

The inconformity of every enterprise is evaluated in terms of the following factors: complex index of adaptability of the industrial enterprises; flexibility index of the created product groups; flexibility index of the business system on which are based the product groups; flexibility index of the business processes through which are created the product groups;

In virtue of the discrepancy results can be identified the directions in which should be improved the flexibility of each of the research enterprises.

The laggings behind which were found in relation to the indexes I_{ftbs} , I_{fsb},.I_{ofbp}, I_{tfbp}, I_{sfbp} are precondition for determination of the scale of measures that should be undertaken for reaching of the Bulgarian industry potential (acquiring of the so called "Best practice").

Meaningful information for the adaptability of the industrial enterprises can be obtained also from the inconformity of the complex index. This difference will determine the degree in which the Bulgarian industry as a whole lags behind the adaptability which could be achieved.

Due to restrictions for the volume of the present work, Figure 3 depicts through radar diagram the comparisons with the "best practice" of the profiles of the adaptability indexes for the four industries (apparel; lighting; furniture; printing) and the Bulgarian industry as a whole.

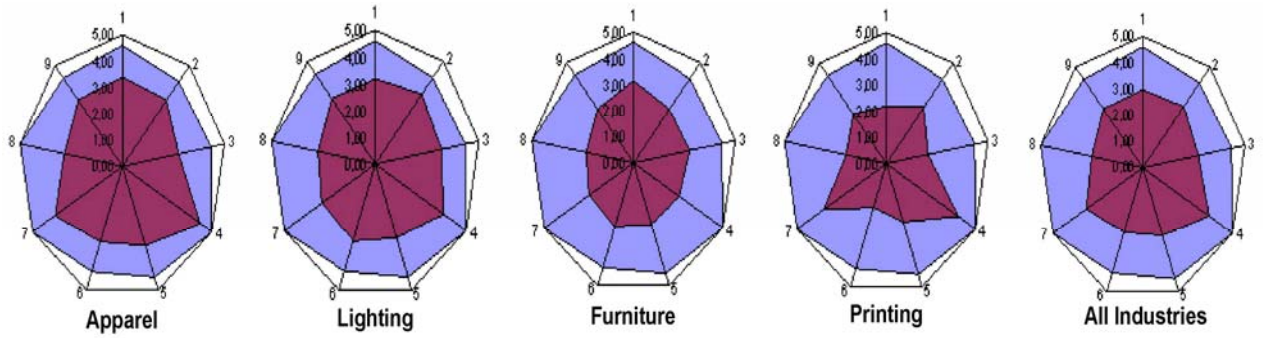

Fig. 3. Comparisons with the "best practice" of the profiles of the adaptability indexes for the four industries (apparel; lighting; furniture; printing) and the Bulgarian industry as a whole

On the diagram rays from 1 to 9 are presented the respective average grades of indexes I_{fpr}, I_{fbs}, I_{ftbs} , I_{fsb}, I_{fbp}, I_{ofbp}, I_{tfbp}, I_{sfbp}, I_{aie}.

As the figure demonstrates the "Best practice" profile of the Bulgarian industry is very close to the maximal meanings of the indexes and in relation to indicators I_{fsb}, I_{ofbp}, I_{tfbp}, the indexes have values 5 at maximum. This means that the potential of the Bulgarian industry in terms of adaptability is very high.

Nevertheless, the actual situation of the industry as a whole is far away from the potential abilities. The complex index of adaptability I_{aie} is 2,92 and the particular indexes I_{fpr}, I_{fbs}, I_{ftbs} , I_{fsb}, I_{fbp}, I_{ofbp}, I_{tfbp}, I_{sfbp} are varying between 2,48 and 3,06. This demonstrates that as a whole the Bulgarian industry is not flexible enough in order to adapt to the contemporary supply chains. Lowest is the flexibility of the business processes.

If we analyze the profiles of the different industries (apparel; lighting; furniture; printing) it can be noticed that closest to the "Best practice" profile are the profiles of the apparel and lighting industries. These profiles are lagging almost symmetrically from the "Best practice" profile which means that the enterprises in these industries would manage with relatively small efforts to improve their adaptability parameters.

The situation is not similar for the enterprises of the furniture and printing industries. Here the lagging of the adaptability parameters from the "Best practice" profile is significant and unsymmetrical. This means that the enterprises in these industries in certain respects should make considerable efforts to improve the adaptability parameters.

If the adaptability is analyzed in an integrative manner through the complex indicator I_{aie}, it would be found that the index values for the enterprises of the four industries (apparel; lighting; furniture; printing) correspond to the lagging of the profiles in relation to the "Best practice" profile. Therefore, it can be concluded that with the help of the developed model and the defined complex indicator we can evaluate successfully the adaptability of the industrial enterprises which are units in supply chains.

❖ CONCLUSION

For the successful implementation of the conception of Mass Customization the contemporary Supply Chains should possess high flexibility. The conception of Mass Customization in Europe is realized through significant number of Supply Chains.

A high number of the Bulgarian Small and Medium Enterprises are units in European Supply Chains. In order to be competitive in the contemporary business environment and to remain units in the current flexible Supply Chains, the Bulgarian Small and Medium Enterprises should possess high adaptability.

The developed model allows simple but comprehensive evaluation of the adaptability of the Small and Medium Enterprises through one indicator – Complex evaluation indicator I_{aie}. The indicator presents three aspects of the adaptability of the industrial enterprises: flexibility of the created product groups; flexibility of the business system on which are based the product groups; flexibility of the business processes through which are created the product groups.

The approbation of the model which was held in 16 Bulgarian Small and Medium Enterprises from 4 industries (apparel; lighting; furniture; printing) shows that it evaluates adequately all parameters of the adaptability.

There are three important conclusions which can be made on the basis of the results from the approbation:

- The potential of the Bulgarian Small and Medium Enterprises to adapt to the European Supply Chains is high;
- Under the contemporary conditions the state of the adaptability of the Bulgarian Small and Medium Enterprises is satisfactory but insufficient for lasting participation in the European Supply Chains;
- The flexibility of the business processes in the Bulgarian Small and Medium Enterprises is the lowest.

Therefore, in order to strengthen the adaptability of the Bulgarian Small and Medium Enterprises the major efforts should be made for the increasing of the flexibility of the business processes.

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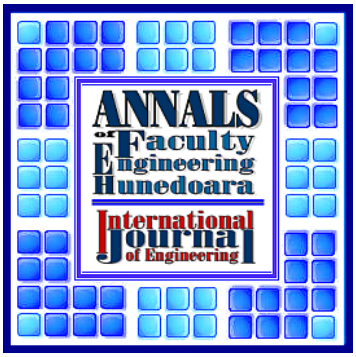

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