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Managerial Effectiveness in the Implementation of Quick Response Manufacturing (QRM) to Increase Business Agility

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Abstract:

Purpose: *The competitive and variable business environment forces organizations not only to flexibly adapt to changes, but also to predict them. A desirable capability of an organization is agility, understood as the ease and speed with which companies can reconfigure, redesign and adapt their processes in order to respond to the needs, threats and opportunities. QRM is a management concept that focuses on time as the key factor in competitive manufacturing. The objective of this article is to analyze the effect of QRM implementation on key business agility characteristics.*
Design/Methodology/Approach: *The research methods used to accomplish this goal are literature studies and questionnaire surveys using the agility attributes matrix. Based on literature studies as well as the conducted interviews, a model of the effect of QRM implementation has been developed.*
Findings: *The results obtained show that QRM implementation definitely has an impact on all areas of the company's agility.*
Practical Implications: *The article brings several valuable pieces of information and provides practical tips. The results may be taken advantage of by entrepreneurs. They constitute indications for selecting competition instruments during the crises.*
Originality/Value: *The previous studies on Quick Response Manufacturing (QRM) were conducted in various dimensions, while there is no research linking this method to business agility. It is the first such research.*

Keywords: *Quick Response Manufacturing, QRM, agile, agile production.*

JEL classification: *M10, M40.*

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1. Introduction

Agility and unpredictability are perhaps the most commonly mentioned characteristics of the modern world - and therefore of the environment of business organizations. In order, in the era of these dynamic and multifaceted changes obtain, but then maintain the competitive advantage businesses must be agile so as to adapt to (Vazques-Bustelo, Avella, and Fernandez 2007):

- unpredictable changes in the environment (high dynamics),
- competitive markets with critical and scarce resources (strong competition/enmity),
- close linkages between the enterprise, suppliers, distributors, customers and competitors (high complexity),
- diversification of types of operations; diversification of: products, customers (high diversity).

Among the mentioned characteristics of the turbulent environment, the dynamics and competition are defined in the literature as the main factors enforcing the agile approach to production (Coronado *et al.*, 2002; Vazques-Bustelo, Avella, and Fernandez, 2007). It seems that choice of the right strategy in the production area may considerably contribute to improving the agile capabilities of the business. One of such strategies is Quick Response Manufacturing (QRM). Literature studies on QRM are conducted in various dimensions, while there is no research on the impact of implementation of this strategy on business agility.

Therefore, the objective of this article is to analyze the effect of the skills delivered together with the implementation of QRM on key business agility characteristics. Literature studies, conclusions from participatory observation and questionnaire surveys using the agility attributes have been used in the article. The structure of this study is as follows: in the beginning a theoretical framework is presented for business agility and QRM strategy. Then, a model of dependencies between the agile characteristics of the business and the attributes acquired as a result of implementing the four basic QRM concepts is presented. This article is an introduction to the field research currently being prepared on the impact of QRM implementation on business agility.

2. Literature Review

2.1 Business Agility as the Answer to Variability of the Environment

For the first time the "agility" concept, with a special accent on agile production, appeared in the report *21st century manufacturing enterprises strategy: An industry-led view* (1991) of scientists from the Iacocca Institute. Multifaceted and far-reaching research on agile manufacturing (Gunasecaran, 1999a; 1999b; Sharifi and Zhang,

2001; Yusuf *et al.,* 1999; Zhang, 2011) significantly affected research on agility in other areas of business operations. As a new model of production, agile manufacturing is the answer to variability in the business environment of enterprises (Yusuf *et al.,* 1999; Zhang and Sharifi, 2000; Ismail *et al.,* 2006). It is a combination of innovation in production, information and communication technologies and organizational changes as well as new marketing strategies. Gunasecaran (1999a; 1999b) also pays attention to the fact that agile production has a powerful potential for reducing production costs, increasing the market share, satisfying the needs of customers, shortening product lead times and increasing production competitiveness.

When defining business agility, the subject literature specifies many attributes that are assigned to the term, stressing them with varying intensity. Thus business agility is the ability to effectively respond in a short time to (unexpected) market changes (Brown and Bessant, 2003), to meet the varying customer requirements for price, specification, quality and quantity of supplies (Prince and Kay, 2003). Agility is also reflected in the ability of the company to produce and supply new products in a cost-effective manner (Swafford *et al.,* 2006; Tsourveloudi and Valavanis, 2002). According to Trzcieliński, business agility is expressed by its ability to quickly perceive market opportunities and hazards from the environment (Trzcieliński, 2005). Kidd claims that agility can be reached by integration of the organization, highly qualified and experienced people and advanced technologies (Kidd, 1994). Business agility is characterized by (Yusuf *et al.*,1999):

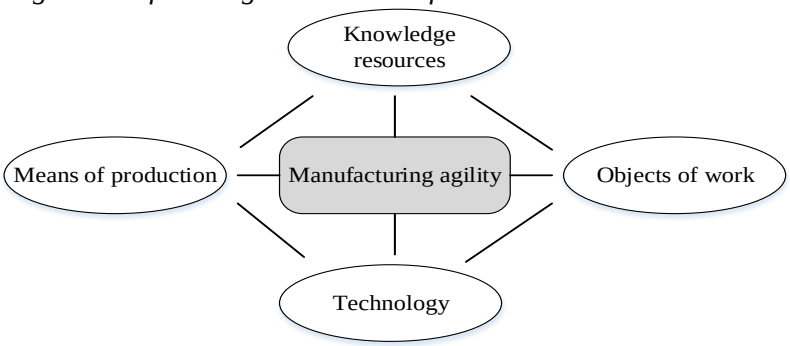
- speed and flexibility,
- response to changes and uncertainty,
- strongly customized high-quality products,
- high value added products and services,
- mobilization in the area of key competences,
- response to social and environmental problems,
- synthesis of different technologies,
- integration within the company and among businesses.

The skills of agile organizations were organized by Sharifi and Zanga (2000). These researchers proposed four mutually dependent areas of agile capabilities: ability to react, competence, flexibility and speed. They have assigned the corresponding skills to each area. Sharifi and Zanga also proposed a model of agility implementation based on: agility driving forces, agile skills (features) and agility providers. The driving forces behind agility are changes in the environment and the pressure exerted on the organization, forcing the company to seek new ways to gain a competitive advantage.

Agile skills allow the organization to react quickly enough to changes (also in search of opportunities to capture). In turn, agility suppliers (practices, methods and tools) are supported by the right organization, technology, people and innovation, enabling them to acquire and maintain proper agile skills.

According to Niewiadomski and Nogalski, the variability of the environment manifesting itself through technological progress and variability in the behavior of buyers and competitors puts pressure on organizations to focus on deepening their competences and their focus on the development and introduction of new products to the market. In addition, the company in order to increase the chances of success of the implementation strategy, should concentrate on the mechanisms and elements that build competitive advantage. (Nogalski and Niewiadomski, 2012). These researchers form a new paradigm for the business which assumes that central to the value of the company are technology, means of production, objects of work, knowledge, resources and intellectual capabilities in the form of the qualified staff (Figure 1), since these factors, in the opinion of the authors, determine agile manufacturing, and the level of these characteristics implies the perception of market opportunities resulting in the possibility to quickly implement the finished product.

Figure 1. *Agile manufacturing as a resource function*



Source: *Nogalski, Niewiadomski, 2012, p. 318.*

Moreover, Meade and Sarkis (1999) pay attention to the fact that integration of three resources: technology, management and workforce into a coordinated, interdependent system, creates an adaptable, competitive, and innovative organization.

For Stefan Trzcieliński (2011), the agile characteristics and skills represented by reactions to emerging opportunities were the foundation for a different definition of an organization's agile areas. These are:

- acuity – expressed by the ability of the business to find potential market opportunities in a turbulent environment;
- flexibility – understood as the ability to transform potential market opportunities into resourcefully available market opportunities,
- intelligence – namely the skill of noticing market opportunities by the business
- cleverness - the organization's capacity of using the available opportunities.

Here, the role of one more factor should be considered - time. In the quoted definitions, the speed of reaction is each time regarded as equal to other agility characteristics.

2.2 Quick Response Manufacturing as a Strategy based on Reduction in the Manufacturing Time

The problem of lead time reduction is not new. This topic was dealt with by various researchers (Womack and Jones, 2003; Suri, 2010; Sutherland *et al.*, 2014). Many methods have been prepared, taking account of time as a significant factor determining both the level of costs and business competitiveness, e.g.: six sigma, lean production, concurrent engineering, SCRUM, QRM, etc.

QRM - namely Quick Response Manufacturing (Suri, 1998) originates from the paradigm of competition based on time and is "a comprehensive strategy for reducing lead times. It encompasses all aspects of the company's operations, both internal and external" (Suri, 2013). QRM is the organization's strategy the most important objective of which is to constantly shorten lead times in all business areas. This approach is particularly recommended in entities that manufacture individual products (to order) or in small series (high mix/low volume model). With regard to these companies the large variability is exceptionally visible, and at most times customers expect comparatively short contract lead times. The QRM approach is based on 10 principles proposed by Suri (1998):

1. Focus on minimizing lead time.
2. Action with the optimal use of critical resources, which means the pursuit of obtaining flexibility and agility, instead of maximizing the use of the owned potential (70%- 80% efficiency in the case of critical resources).
3. Establishing the measurement of the shortened lead time as the basic efficiency meter.
4. Stick to measuring and rewarding reduction of lead times.
5. New approach to material planning and controlling the flow of orders (use of MRP (Material Requirements Planning) only on the top level of planning production and materials).
6. Motivating the suppliers to implement QRM (organization of the supply chain on the basis of the QRM principle - stressing the essence of shortened operation lead times).
7. Cooperation with customers based on QRM principles - negotiations of smaller batches without changing the price.
8. Extension of QRM principles into non-production areas (e.g. functioning of offices).
9. Leads to a truly productive company with a more secure future (the main reason for implementing QRM is the need to obtain long-term time-based competitive advantage).

10. The highest obstacle to QRM is not technology (or rather the lack of it), but the traditional focus on cost and efficiency (change in the method of thinking requires improvement in awareness and training).

To better reflect the above presented 10 key principles, Suri (2013) reduced them down to four key concepts:

1. Power of time - replacing traditional cost-based goals with the primary goal being shortened lead time.
2. Organizational structure - the business structure should support the efforts to reduce lead time; the main objective of this change is to ensure the transition from the functional structure to a structure based on cells (QRM – cells).
3. Understanding and Exploiting System Dynamics: understand the relationship between the shop-floor variables that have effects on the lead time, and therefore give better guidance to the improvement efforts in these variables to maximize their effects on the reduction of lead time.
4. Complex implementation - reduction in lead time should be implemented in all business areas, also offices, sales, engineering and product development departments.

In addition, Suri (2013) each time emphasizes that QRM is a complementary approach to lean manufacturing in that it transfers the "burden" from production cost optimization to the time of performing the tasks.

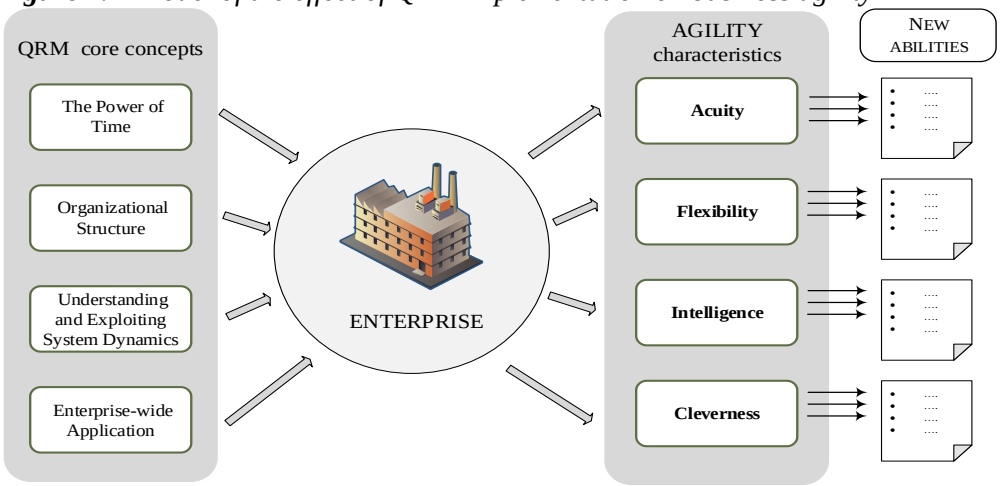
QRM is not just a shop floor strategy, it extends across your whole enterprise including material planning and control, supply management, office operations, and new product introduction (Suri, 2010). A Companywide Approach to Reducing Lead Times requires fundamental structural changes, cardinally transforming the company to a cellular organization.

3. Research Method

Based on literature studies, a model has been developed of the effect of QRM implementation on the areas and potentials for internal adjustment in the organization (Figure 2). In order to evaluate the effect of QRM implementation on business agility, the focus was put on agility properties and their indicators proposed first of all in Trzcielecki's studies (2011), but also in other related studies (Włodarkiewicz-Klimek and Kałkowska, 2012; Włodarkiewicz-Klimek and Antczak, 2015).

It has been assumed that the four agility properties, i.e.: acuity, flexibility, intelligence and cleverness are exemplified by the attributes that result from implementing the four basic QRM concepts. On the basis of the research by Godinho Filho, Marchesini *et al.* (2016; 2017), the list of attributes was determined (often these are new skills) that are a result of QRM implementation.

Figure 2. *A model of the effect of QRM implementation on business agility*



Source: *Own study.*

For the purposes of the research, two lists were drawn up:

- agility properties along with the indicators assigned to them,
- of the attributes/skills that result from QRM implementation.

The list of the characteristics along with the indicators assigned to them and the list of the attributes was presented to the employees of the company being studied. The choice of company dealing with the case was intentional - the selected company intensively implements QRM. It is a family production company, operating in a competitive environment. Through the years, the company was transformed from a small to an average one. In the face of the continuously growing scale of operations, the owners realized that the management methods used so far, which had been perfectly fine and allowed the company to expand, ceased to be effective. As a result, problems and restrictions were becoming increasingly apparent, such as related to excessive machine occupancy, ineffective internal communication, shrinking profitability in certain areas and insufficient amount of data from manufacturing processes, which would allow appropriate decisions to be made and ensure further growth. Therefore, it was decided to implement QRM.

5 persons took part in the first stage of the research, who were directly responsible for implementing QRM in the company (two co-owners, financial director, production director, supply specialist). During brainstorming, they were asked to:

- familiarize with information on what indicators define a given agility property (list no. 1),
- and then assign the attributes/skills resulting from the QRM implementation (from list no. 2) to the indicators earlier assigned to the characteristics.

It was assumed that in the first stage the aim was to determine the possible (and expected) effects of QRM implementation in the area of agility, but without referring to the experience from the surveyed enterprise (i.e., the state: "how it should be"). In addition, the study author interviewed 3 persons implementing the QRM method in other companies to acquire their opinion as to the obtained results.

As a result of this operation, dependency matrices have been created (Tables 1-4) of the agile characteristics of the business translated into the indicators and the attributes assigned to these indicators. It is necessary to emphasize that important are these attributes/skills that the enterprise may acquire as a result of QRM implementation (or enhance as a result of the implementation).

Table 1. *The effect of QRM implementation on "Acuity" of the business*

Agility property: Acuity (A)			
Property characteristics		**Attributes of the indicator/skill being studied, resulting from QRM implementation or strengthened thereby**	
organization's ability to configure events and phenomena taking place in the environment into opportunities	A1	Strategic decisions are quickly passed on to relevant work groups	A1. 1
		Communication between different levels in hierarchy is easy	A1. 2
organization's ability to assess opportunities in a comprehensive manner in terms of its value and risks	A2	Various disciplines are involved/integrated into product development/engineering	A2. 1
shortened life cycle of opportunities (growth in short-term contracts, growth in the diversity of contracts change in the value of an individual contract)	A3	We use tools and techniques to cut decision-making time	A3. 1
		We followed an upfront planning and phased development plan (stage-gate model)	A3. 2
ability to search for alternative solutions	A4	We have written rules and procedures that guide quality improving and creative problem-solving	A4. 4

Source: *Own study.*

Table 2. *The effect of QRM implementation on "Flexibility" of the business*

Agility property: Flexibility (B)			
Property characteristics		**Attributes of the indicator/skill being studied, resulting from QRM implementation or strengthened thereby**	
ability to adopt fast changes in employee teams	B1	In our organization employees are cross-trained so that they can take over tasks from other employees if necessary	B1.1
		Shop-floor employees are key to problem-solving teams	B1.2
		Our work teams have control over their job	B1.3
		Our supervisors or middle managers are supportive of the decisions made by our work teams	B1.4

ability to change in the scope of processing orders	B2	We are able to quickly introduce a new product	B2.1
		We are able to rapidly adjust the capacity	B2.2
		Production is "pulled" by visual/virtual cards or bins	B2.3
		Production at stations is "pulled" by the current demand or available capacity of the next stations	B2.4
ability to subordinate work to market conditions,	B3	We offer a large number of product features or options	B3.1
		During development/engineering, we are still able to execute customers feedback	B3.2
		We have rapid prototyping techniques	B3.3
ability to adjust the offer	B4	Our (new) product development/engineering process is flexible so that we can quickly response to customer specific product wishes	B4.1
		During development/engineering, we have the ability to make changes, without being too disruptive	B4.2
		We measure time-to-market from the last change in requirements until the product is delivered	B4.3
		We use a "pull" or combinations of "push" and "pull" production system	B4.4
		Production is "pulled" by the shipment of finished goods	B4.5
increased flexibility of the organizational structure (change in role and number of task force and design teams, number of hierarchical levels, decentralization, specialization, flow of information).	B5	Decentralized decision-making	B5.1
		Our workers have the authority to correct problems when they occur	B5.2
		Our tasks are done through cross-functional teams	B5.3
		Our managers are assigned to lead various cross-functional teams	B5.4
		W e can handle "rush orders" without disturbing our average delivery time	B5.5
		We do not aim for maximum utilization so that we gain flexibility/robustness	B5.6

Source: Own study.

Table 3. *The effect of QRM implementation on "Intelligence" of the business*

Agility property: Intelligence (C)			
Property characteristics		**Attributes of the indicator/skill being studied, resulting from QRM implementation or strengthened thereby**	
ability to develop the intellectual potential of human teams and saturate the management system with well qualified staff	C1	In our organization, the workers are specialized and learn to perform a few or only one job/task	C1.1
		We have written rules and procedures that show howworkers can make suggestions	C1.2
		Our workers have their own space and time to experiment with their job	C1.3

		We encourage workers to be creative in dealing withproblems at work	C1.4
		We have written rules and procedures that show howworkers can make suggestions	C1.5
ability to skillfully assemble employee teams	C2	In our organization employees receive training to perform multiple tasks	C2.1
		We have written rules and procedures that guide quality improving and creative problem-solving	C2.2
ability to search for new areas of operation	C3	Shop-floor employees lead product/process improvement efforts	C3.1
		During problem-solving sessions, we make an effort to get all team members opinions and ideas before making a decision	C3.3
ability to automate and standardize information and decision-making processes	C4	Products are classified into groups with similar processing or routing requirements	C4.1
		Our processes are located close together so that material handling and part storage are minimized	C4.2
		Families of products determine our factory layout	C4.3

Source: *Own study.*

Table 4. *The effect of QRM implementation on "Cleverness" of the business*

Agility property: Cleverness (D)			
Property characteristics		**Attributes of the indicator/skill being studied, resulting from QRM implementation or strengthened thereby**	
the organization's ability to adapt to the environment it operates in	D1	We share our forecast/demand information with the supplier(s)	D1.1
		We frequently are in close contact with our supplier	D1.2
		Our customers give us feedback about our quality and delivery performance	D1.3
impact of the organizations on the environment for invoking favorable changes	D2	We regularly survey our customers/users' requirements	D2.1
		We encourage our customers to place frequently low volume orders	D2.2
intuitive adjustment of the informal structure to the dynamic of changes in the environment	D3	We are frequently in close contact with our clients/users	D3.1
		We strive to be highly responsive to our customers/users' needs	D3.2
		We apply tools and techniques that will shorten or integrate steps	D3.3
ability of the business to shape elements of the environment in a beneficial way for itself (e.g. relations with suppliers and with clients).	D4	We strive to be highly responsive to our customers/users' needs	D4.1
		We share our forecast/demand information with the client(s)	D4.2
		Our suppliers are involved in the early stages of product development/engineering	D4.3
		We make use of supplier expertise in the development/engineering of our product	D4.4

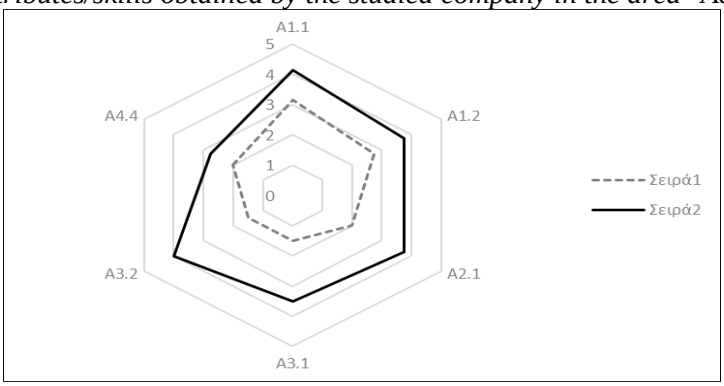
Source: *Own study.*

The matrix determined in the first stage is a certain type of an audit's tool of the agile characteristics that was utilized in further deliberations.

In the second stage of the study a survey was conducted among 32 operational employees creating Q-cells in the enterprise observed. They were presented with the matrices determined in the first stage and asked to determine in the five-stage Likert scale whether the implementation of QRM influenced the attribute/skill assigned to the agility characteristics index (in the studied company), where: 1 - strongly disagree, 2 - somewhat disagree, 3 – indifferent, 4 – somewhat agree, 5 – strongly agree. Then an arithmetic average of the detailed questions formed the indexes which were used as proxies of studied phenomena. First, however, each of the respondents had to determine to what extent a given attribute/skill characterized the company before implementation. The questionnaire survey seemed justified because it gives feedback with regard to the personnel's perception of the changes introduced, their suitability and adequacy compared to the expected outcomes.

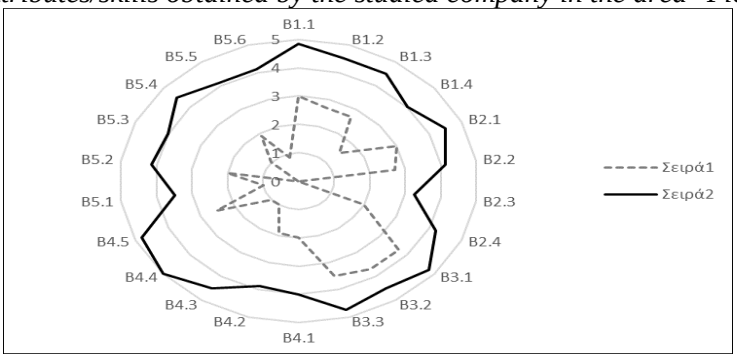
The objective of this operation was to determine to what extent the studied company has captured the opportunities for increasing its agility (in the assumed four areas) by implementing QRM. It should be highlighted that no time management or lean method tools were previously applied in this entity. The obtained results are shown on Charts 1-4. Series 1 applies to the answer about the pre-implementation state, series 2 are the results showing the state after the implementation.

Chart 1. *Attributes/skills obtained by the studied company in the area "Acuity"*



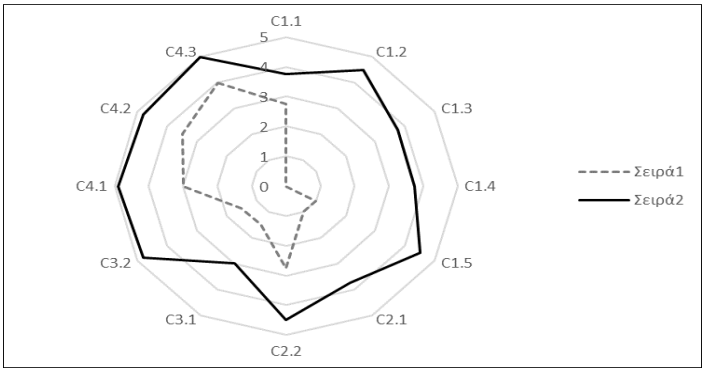
Source: *Own study.*

Chart 2. *Attributes/skills obtained by the studied company in the area "Flexibility"*



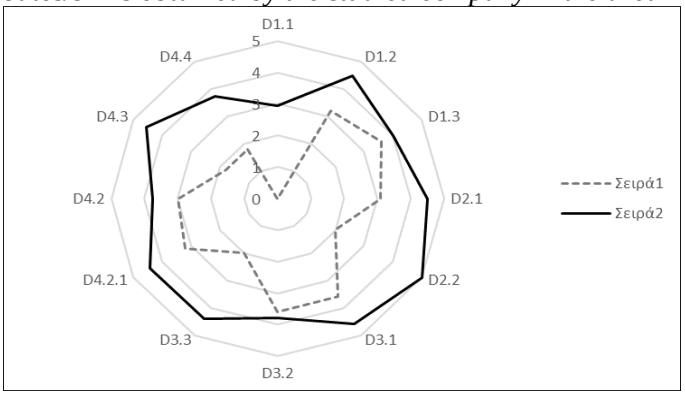
Source: *Own study.*

Chart 3. *Attributes/skills obtained by the studied company in the area "Intelligence"*



Source: *Own study.*

Chart 4*. Attributes/skills obtained by the studied company in the area " Cleverness"*



Source: *Own study.*

QRM implementation definitely affects all four business agility areas, strengthening acuity, flexibility, intelligence and cleverness. Taking account of the average

increase in a particular skill, the largest benefits from the implementation were obtained in the business intelligence area, and the smallest in its acuity. Referring to Trzcieliński's work (2011), who stated that a flexible, smart and clever - but not acute - enterprise will take advantage of the opportunities accidentally, it can be concluded that the QRM strategy does not increase capabilities of the business studied to discover potential market opportunities in a turbulent environment.

4. Conclusions

The management staff of the enterprise should ensure complete fulfillment of the assumed goals and ensure that as good results are achieved as possible. In order to make it possible, managers' activities must be focused on the achievement of maximum benefits from the resources involved in the operations at the same time rationalizing the costs. In other words, care should be taken of high effectiveness of the sustained costs. This is one of the most important tasks for persons who manage enterprises. The implementation of this task requires use of appropriate management methods.

Agile businesses achieve competitive advantage because they apply solutions in the area of organization and management, which are not applied by the competitors, among others take advantage of those concepts and management methods such as QRM. Business structures based on the solutions of this strategy featuring the ability to innovate, flexibility and fast adaptability in implementing new projects.

Before QRM found its place in enterprises as a management method, Goldman, writing about agility accented its dimensions (Goldman *et al.*, 1995):

- The first dimension, enriching the client, involves quick understanding of each customer's requirements and their prompt fulfillment.
- The second dimension includes cooperation in order to increase competitiveness and includes better cooperation outside and inside the organization (e.g. such as partnership with suppliers).
- The third dimension encompasses the organization in order to control changes and uncertainties, through the use of new organizational and management structures and technologies.
- The fourth dimension uses the effect of people and information, aswell acknowledges the importance of employees as the key asset for the company. Therefore, it puts particular emphasis on growth of the workforce through education, team work, training and position strengthening.

It's hard to resist the impression that the QRM method unambiguously responds to managers' demand for a management tool that notices this complexity. These results of the studies performed deliver guidelines for enterprises considering actions to be taken in order to increase their agility. Consideration should be given to conducting extensive field studies in Polish enterprises in order to confirm, using quantitative methods, the impact of QRM implementation on individual agility characteristics.

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