Make-to-order manufacturing – new approach to management of manufacturing processes

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Abstract. Strategic management must now be closely linked to the management at the operational level, because only in such a situation the company can be flexible and can quickly respond to emerging opportunities and pursue ever-changing strategic objectives. In these conditions industrial enterprises seek constantly new methods, tools and solutions which help to achieve competitive advantage. They are beginning to pay more attention to cost management, economic effectiveness and performance of business processes. In the article characteristics of make-to-order systems (MTO) and needs associated with managing such systems is identified based on the literature analysis. The main aim of this article is to present the results of research related to the development of a new solution dedicated to small and medium enterprises manufacture products solely on the basis of production orders (make-to-order systems). A set of indicators to enable continuous monitoring and control of key strategic areas this type of company is proposed. A presented solution includes the main assumptions of the following concepts: the Performance Management (PM), the Balanced Scorecard (BSC) and a combination of strategic management with the implementation of operational management. The main benefits of proposed solution are to increase effectiveness of MTO manufacturing company management.

1. Introduction

Strong competition in the market and technological advances mean that customer requirements regarding products are very high. Customers expect a wide range of high quality products, the frequent introduction of new models and attractive prices of goods. For this reason a number of significant trends in the market are observed. The most important ones include: shortening product life cycles, strong pressure to reduce costs, increase production efficiency, increase quality of products, etc. The products are more and more increasingly complex and technologically advanced, what leads to manufacture products in networks included small, medium and large enterprises characterized by high specialization of production and creating complex supply chains. Nowadays more flexibility is needed to customize the products to the specific needs and requirements of individual customers. A manufacturing of complex products require the creation of supply chains in which a number of specialized usually small and medium-sized enterprises produce only the elements of the final product. As a result, this situation has led to an increase of the make-to-order manufacturing (MTO).

Meeting customer needs associated with the development and production of small series of products according to customer orders is associated with problems with quick and precise planning,
execution and performance of orders. At the same time, industrial companies must take care of its own development and constantly adapt strategy to very quickly changing market conditions to stay in business. Strategic management must now be closely linked to the management at the operational level, because only in such a situation the company can be flexible and can quickly respond to emerging opportunities and pursue ever-changing strategic objectives. In these conditions industrial enterprises seek constantly new methods, tools and solutions which help to achieve competitive advantage [1]. They are beginning to pay more attention to cost management, economic effectiveness and performance of business processes.

In the article characteristics of make-to-order systems and needs associated with managing such systems is identified based on the literature analysis. The main aim of this article is to present the results of research related to the development of a new solution dedicated to small and medium-sized enterprises manufacture products solely on the basis of production orders (make-to-order systems). A set of indicators to enable continuous monitoring and control of key strategic areas this type of company is proposed. A presented solution includes the main assumptions of the following concepts: the Performance Management (PM), the Balanced Scorecard (BSC) and a combination of strategic management with the implementation of operational management.

2. Characteristic of make-to-order systems

Make-to-order is an term referring to companies that produce bespoke and customized products to particular customer specifications but not repeated on a regular basis or in a predictable manner [2]. In the MTO sector, some or all of the production takes place after the customer order has been received. MTO companies have few standard products and difficult-to-predict, volatile demand. The significant and essential features of the make-to-order systems are presented in table 1.

| Criterion                  | Features of make-to-order systems                                                                 |
|---------------------------|--------------------------------------------------------------------------------------------------|
| Type of products          | bespoke, high-variety, customized to customer specifications                                   |
| Production                | not repeated on a regular basis, only few standard products                                      |
| Key problems              | dealing properly with enquiries                                                               |
| Key strengths             | flexibility, quick decision making, effective cooperation from employees                      |
| Weaknesses                | lack of technical superiority, lack of infrastructural facilities, lack of financial resources |
| Competitive factors       | price, technical expertise, delivery time, reliability in meeting, due dates                   |
| Crucial factors in winning the order | realistic and currently competitive delivery dates, realistic and currently competitive prices, reputation for technical skill, reputation for quality, financing package, archiving and retrieval of product data, assessment of available design, product skills and facilities, estimation of lead times, costs, profit margins, effective communication and coordination between all departments |

They usually manufacture products based on the customer specification [3]. Many MTO enterprises are small and medium sized companies (SME’s) [4].
From a manufacturing strategy point of view, the key strengths of SME’s are flexibility, quick decision making and cooperation from employees, whereas weaknesses are the lack of technical superiority, infrastructural facilities and financial resources [5], [6]. A key problem of MTO companies is dealing properly with enquiries. These enterprises are in competition with other companies on the basis of price, technical expertise, delivery time and reliability in meeting due dates. The bid has to contain realistic and currently competitive delivery dates (DD) and prices, which are crucial factors in winning the order, although aspects such as the enterprise’s reputation for technical skill, quality, or the financing package can also be significant. In MTO systems, each order may be different. When a customer provides a request for invitation-to-tender for a particular product, he requires due date and the determination of price. Therefore, these decisions require: the archiving and retrieval of product data; the assessment of available design, product skills and facilities; the estimation of lead times, costs, profit margins; and effective communication and coordination between all departments involved in the activities [3], [7], [8], [9].

3. New challenges in manufacturing company management

Nowadays, manufacturing enterprises must constantly seek competitive advantage in the market. Modern companies no longer have permanent structures, and the development of management methods in order to gain competitive advantage lies in combining new technologies and organizations. A multi-faceted strategic management is developing, which is focused on human capital and knowledge. A characteristic feature of this process of adaptation and learning to adapt new behaviors is a very short period of time counted in months or often even days. The social side is as important as the technical and economic functioning of the company. Strategic Management combines all levels of management, i.e. technical management (coordination of information technology, human resources and financial) management subsystem of the social (human resource management, power) and cultural management (creating and maintaining a collection of commonly shared values, assumptions, views, which have impact on the behavior of employees of the organization). In attempting to adapt to existing conditions, companies are introducing many solutions that can help them successfully compete in the market, including:

- Value Based Management (VBM),
- Strategic Management,
- Performance Management,
- Business Process Management (BPM),
- Business Process Reengineering,
- Benchmarking,
- Total Quality Management (TQM) and Six Sigma,
- Just-in-time (JIT) and Kanban,
- Activity-Based Management,
- Lean Management, etc.

Implementation of these solutions has significantly improved business in many cases, and has ensured the success of many companies [16]. However, many cases where they have not produced the expected results can also be observed. The most common causes of failures should be noted as: fragmentary treatment of improving the efficiency and the lack of its connection with the company's strategy or to the achievement of specific economic and financial objectives. Significant changes in the system of the management and measurement of enterprise results to improve the efficiency of activity should be made [17].

Nowadays built strategies should aim to use methods and techniques that allow the processing of vision, mission and strategy into operational objectives. Maintaining a long-term competitive advantage allows the decision making process in the company to be simultaneously based on strategy,
risk management processes and information [12]. The decision support system requires the following significant features to be included [18]:

- effective mechanisms to generate alternative due date plans and pricing to deal with customer enquiries;
- a need for aggregate, dynamic planning and control which takes unconfirmed bids into consideration;
- effective capacity planning and control;
- flexibility to be able to document aspects of product development throughout the order processing cycle;
- incorporation of a job release decision point in planning;
- a need to enable a high level of coordination amongst departments playing a critical role in MTO planning.

Organizations are moving away from standardization in favour of diversity and flexibility. Standard production of identical products is being replaced by the production of short and medium-sized series of products made to individual customer orders. Companies involved in make-to-order manufacturing are designed not only to fulfill production orders according to customer requirements, but also to take care of their own development. To stay in business, they must be flexible and able to quickly identify and respond to emerging opportunities and threats, which mean frequent change of strategy.

Along with the rapid globalization of markets, there is also a trend in technological globalization, manifesting itself in new products and research capabilities. Constantly improving information technologies allow quick, easy and affordable access to information and knowledge resources, which has not only significantly increased the pace of technological changes, but has also become the basis for increased efficiency and productivity. The management of an enterprise manufacturing products solely on the basis of production orders requires very careful planning, based on current, accurate information and a thorough inspection and monitoring of the implementation of the approved plans. A key role in such organizations is played by the process of gathering information and planning of the order, verification of orders and decisions concerning order acceptance. Therefore, there is a strong need to create measurement and evaluation systems, dedicated to small and medium industrial enterprises in the make-to-order sector, that help to implement the strategy quickly and effectively and to control and monitor its realization. Enterprises need implementation and improvement of innovative management systems. Comprehensive measurement and assessment of enterprise activity play a significant role in these conditions.

As far as socio-economic development is concerned, a relative decline in the importance of "hard" resources (assets) can be observed in favour of an increase in the importance of "soft" assets (competencies, standards and cultural values, relationships, and attitudes). Contemporary knowledge is becoming an essential strategic resource, which builds up an advantage in competitive markets, while strategic management is becoming one of the most important areas of enterprise management. Alongside soft-assets, an increased significance of non-financial performance measures can also be observed, mainly in view of the growing importance of elements which will bring future performance and cannot be measured by financial indicators (e.g. innovative products, technologies, human resource management, supply-chain relationships, etc.) [13], [14], [15].

On the basis of the analysis of literature and manufacturing practices, two important conclusions can be formulated for the management of modern enterprises. Firstly, companies need management methods and tools that will ensure their long-term existence on the market. For this reason, strategy is of increasing importance in the company and there is strong pressure to use solutions that enable rapid strategy implementation, monitoring and control of its realization. Secondly, modern management methods are primarily focused on increasing company value, the efficiency of processes and resources used and their continuous improvement, which raises the need for continuous monitoring and control of enterprise results and the application of new methods of measuring the performance of an
enterprise. Performance measurement systems are needed to measure the effects of both the activities of the company as a whole and the individual processes that are implemented within.

4. The proposed solution
The rapid changes in the market cause the need for frequent changes or updates strategy. Manufacturing companies in particular need tools that assist in rapid implementation of the strategy in practice. Monitoring and control of all areas of enterprise activity is not possible in this turbulent environment, because market conditions change often faster than the time needed to analyze precise data. There are therefore questions:

- What are the strategic objectives of enterprises MTO most important?
- What areas of MTO companies should be subjected to constant control?
- What method will ensure rapid implementation of frequently changing strategy?

Therefore, solutions are being sought, which allow for quick implementation of frequently changing strategies through the monitoring and control of only the most important strategic goals of the company. The main aim of conducted research was to develop a new solution dedicated to small and medium-sized enterprises manufacture products solely on the basis of production orders (make-to-order systems). A set of indicators to enable continuous monitoring and control of key strategic areas in this type of companies is proposed. A presented solution includes the main assumptions of the following concepts: the Performance Management (PM), the Balanced Scorecard (BSC) and a combination of strategic management with the implementation of operational management.

The research consisted of two phases. In the first stage, the main areas in which special attention should be paid in make-to-order systems were identified [19]. These include:

- customer satisfaction;
- manufacture of products according to customer requirements, as specified in the order;
- improving quality of customer service;
- shortening order realization time;
- shortening response time to customer inquiries about the possibilities and conditions of the order realization (quick decision-making to accept orders);
- increasing effectiveness of production planning of new submitted orders;
- maintaining cash flow (the result of limited financial resources);
- increasing revenues;
- improving the order verification process;
- increasing the number of customers;
- employee satisfaction;
- increasing return on investments;
- reduction of production waste; etc.

Some strategic objectives do not require the creation of a system of measurement, as related to the activities in which only the total effect can be measured. Based on this information four main areas of that should be subject to monitoring and control were identified:

1) customer satisfaction,
2) enterprise flexibility,
3) maintaining cash flow,
4) employee satisfaction.

The second stage a suitable system for measuring the implementation of the strategy objectives was built which based on checking the key strategic objectives through using Key Performance Indicators provides monitoring and control of the corporate strategy realization for each area (see table 2-5).
### Table 2. The proposed strategic objectives and Key Performance Indicator system for make-to-order small and medium enterprises within area customer satisfaction.

| Strategic objective                                      | Key Performance Indicators                                                                 |
|----------------------------------------------------------|------------------------------------------------------------------------------------------|
| Reduction of incompatibilities with customer requirements| KPI<sub>1</sub> – percentage of products manufactured correctly due to customer requirements |
|                                                          | KPI<sub>2</sub> - percentage of measured products                                        |
| Shorten time of order realization                        | KPI<sub>3</sub> - percentage of time of order preparation to manufacture and expectations  |
| Improvement of reliable due date                         | KPI<sub>4</sub> - percentage of orders with the same planned and actual due date           |
| Improvement of reliable cost estimation                  | KPI<sub>5</sub> - percentage of orders with the same planned and actual cost               |
| Shorten duration of decision-making process              | KPI<sub>6</sub> - percentage of planning time of an order                                 |

### Table 3. The proposed strategic objectives and Key Performance Indicator system for make-to-order small and medium enterprises within area enterprise flexibility.

| Strategic objective                                      | Key Performance Indicators                                                                 |
|----------------------------------------------------------|------------------------------------------------------------------------------------------|
| Increasing the ability to change the order of the processes| KPI<sub>7</sub> - percentage of orders for which an order can be changed                   |
| Increasing the flexibility of employees                  | KPI<sub>8</sub> - percentage of employees who can operate more than one workstation       |

### Table 4. The proposed strategic objectives and Key Performance Indicator system for make-to-order small and medium enterprises within area maintain cash flow.

| Strategic objective                                      | Key Performance Indicators                                                                 |
|----------------------------------------------------------|------------------------------------------------------------------------------------------|
| Increasing the role of the Just-in-time method           | KPI<sub>9</sub> - percentage of suppliers supporting the Just-in-time method              |
| Increasing the system of customer advance payments       | KPI<sub>10</sub> - percentage of value of production orders financed from customer advances |
| Lowering the value of bank credits to finance order realization | KPI<sub>11</sub> - percentage of value of production orders financed from bank credit     |
The company should measure and control only what confirms their efforts and its strategic direction. KPI’s should be very clearly linked to business strategy and relate to the key areas. The main objective of determining the KPI is to show the workers why the strategy is important and help in understanding these areas. The indicators are used for organizational learning and development and presentation of the strategic direction of the company in a more understandable manner, and above all the use of indicators to improve working and correction operations, allowing organizations to refocus their efforts in the fight for results. KPI’s allow enterprises to determine the stage of development at which the organization is to determine whether the adopted goal is achieved in an appropriate manner and to indicate when it will be achieved [20]. The essence of KPI’s is to select the most important indicators to rationalize and simplify decision-making, paying attention to the strategically most important areas of the organization. KPI’s, which should be selected on the stage of identifying key areas and strategic objectives of the company, help an organization to define and measure progress toward organizational goals and make the management of enterprise easier.

KPI’s not only relate to items that are easy to measure (e.g. participation, number, frequency, etc.), but also allow areas which are difficult to measure (such as organizational culture, the potential for cooperation, quality of relationships with customers, etc.) to be controlled. These activities cannot be measured, but can be evaluated using any scale (e.g. the description of KPI’s in the form of number of activities, that relate to intangible assets). KPI’s should be treated more as “indicators”, rather than a specific measure.

It should be underlined that the developed strategic objectives, operational initiatives and measures should be systematically checked for accuracy, and the effects they bring. This phase should be an "early warning system" that requires quick changes and adjustments, if there are any irregularities or if it is found that a proposed solution does not produce the desired results.

5. Conclusions
For many years a need of strategy in company is highlighted. Strong competition causes that manufacturing enterprises have to look for competitive advantage to continue their existence and business activity in the market. For this reason there is strong pressure for well designed, properly updated and quickly implemented strategy. Manufacturing companies in particular need tools that assist in rapid implementation of the strategy in practice.

The new Key Performance Indicators system to monitor and control a strategy realization is proposed in the article which is dedicated to the MTO sector of small and medium manufacturing enterprises. Based on survey research of MTO sector in the west of Poland the main areas of special control was identified and a set of Key Performance Indicators was design for each area: customer satisfaction, enterprise flexibility, maintaining cash flow and employee satisfaction.

The design of KPI system exactly according to the significant needs of such type of manufacturing companies and taking into account their special characteristics help to manage of them in practice. The monitoring and control of the proposed areas has a very strong influence on the financial results of companies and significant strategy financial objectives indicated in the research.

Table 5. The proposed strategic objectives and Key Performance Indicator system for make-to-order small and medium enterprises within area employee satisfaction.

| Strategic objective       | Key Performance Indicators                                   |
|---------------------------|--------------------------------------------------------------|
| Increase in staff training| KPI\textsubscript{12} – number of training courses per employee |
|                           | KPI\textsubscript{13} – percentage of employees without training |

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The presented solution includes the main assumptions of the following concepts: the Performance Management (PM), the Balanced Scorecard (BSC) and a combination of strategic management with the implementation of operational management. The proposed solutions allows the effectiveness of strategy realization to be controlled and increased in make-to-order systems. The main benefit is to increase effectiveness of MTO manufacturing company management.

6. References
[1] Jasiulewicz-Kaczmarek M Drożyner P 2011 Maintenance Management Initiatives towards Achieving Sustainable Development, [in:] P. Golinska et al. (eds.) Information Technologies in Environmental Engineering Environmental Science and Engineering, Springer - Verlag Berlin Heidelberg, pp. 707-721
[2] Hill T 2000 Operations Management: Strategic Context and Managerial Analysis, UK, Macmillan, Basingstoke
[3] Kingsman B Hendry L Mercer A de Souza A 1996 Responding to customer enquiries in make-to-order companies. Problems and solutions International Journal of Production Economics No 46-47 pp. 219-231
[4] Aslan B Stevenson M Hendry L C 2012 Enterprise Resource Planning systems: An assessment of applicability to Make-To-Order companies, Computers in Industry No 63 pp. 696
[5] Dangayach G S Deshmukh S G 2001 Manufacturing strategy. Literature review and some issues International Journal of Operations & Production Management No 21 (7) pp. 884-932
[6] Stevenson M Huang Y Hendry L C Soepenberg E 2011 The theory and practice of workload control: A research agenda and implementation strategy International Journal of Production Economics No 131 pp. 689-700
[7] Stevenson M 2006 Refining a workload control concept: a case study International Journal of Production Research No 44 (4) pp. 767-790
[8] Cakravastia A Nakamura N 2002 Model for negotiating the price and the due date for a single order with multiple suppliers in a make-to-order environment International Journal of Production Research No 40 (14) pp. 3425-3440
[9] Zorzini M Hendry L Stevenson M Pozzetti A 2008 Customer enquiry management and product customization: an empirical multi-case study analysis in the capital goods sector International Journal of Operations & Production Management No 28 (12) pp. 1186-1218
[10] Grando A Belvedere V 2006 District’s manufacturing performances: A comparison among large, small-to-medium-sized and district enterprises International Journal of Production Economics No 104 pp. 85-99
[11] Land M J Gaalman G J C 2009 Production planning and control in SMEs: Time for change, Production Planning and Control No 20 (7) pp. 548-558
[12] Świerk J 2009 Mapa strategii i strategiczna karta wyników w planowaniu działań przedsiębiorstwa. Studium teoretyczno-empiryczne, Wydawnictwo Uniwersytetu Marii Curie-Skłodowskiej, Lublin pp. 18.
[13] Chytas P Glykas M Valiris G 2011 A proactive balanced scorecard International Journal of Information Management No 31 pp. 460
[14] Świderska G K 2010 Controlling kosztów i rachunkowość zarządcza Difin Warszawa
[15] Fang-Mei Tseng Yu-Jing Chiu Ja-Shen Chen 2009 Measuring business performance in the high-tech manufacturing industry: A case study of Taiwan’s large-sized TFT-LCD panel companies The International Journal of Management Science No 37 pp. 686-697
[16] Jasiulewicz-Kaczmarek M 2012 Socio-technical integrity in maintenance activities Vink P. (eds.): Advances in Social and Organizational Factors CRC Press pp. 582–592
[17] Kaplan R S Norton D P 2001 Strategiczna karta wyników. Jak przelożyć strategię na działanie? Wydawnictwo Naukowe PWN Warszawa
[18] Kingsman B Hendry L 2002 The relative contributions of input and output controls on the performance of a workload control system in Make-To-Order companies Production Planning & Control No 13 pp. 579-590

[19] Saniuk A Gajdova Denisa 2015 Corporate strategy realization in industrial enterprises Aktualné problem podnikovej sfery 2015 Vydavatelstvo EKONOM Bratislava pp. 580-589

[20] Wieczorek A 2012 Metody i techniki prognozowania wartości kluczowych wskaźników efektywności dla potrzeb wprowadzania zmian w organizacji utrzymania ruchu Management Systems in Production Engineering Nr 1 (5) pp. 1