

Jolanta Łopatowska*

Improving the production planning and control process

Introduction

Maintaining and improving the competitive edge of an enterprise requires continuous improvement in all areas of its activities. In order that the anticipated effects are actually attained, the improvement line should be consistent with the strategy adopted by the business. In the case of producers, the strategy of competing in the global market is based on three factors: quality, time, and costs. The factors are interrelated, which implies that a change on any one of them may trigger a change in the others. An effective strategy is geared at attaining a maximum change on one of the factors whilst reaching an acceptable level of the others [Trojanowska, Koliński, 2011, p. 227–231].

Focus on a quality-based strategy translates to the orientation on meeting the customer expectations. This corresponds with the so-called European concept of quality which says that quality is the function of the market needs and customer-taken decisions [Skrzypek, 2014, p. 136]. The latter are determined by the complete market value of the product, that is meeting the expectations related to both the product itself, the process and terms of its delivery, and the post-sale support. Hence, for producers and manufacturers pursuing the strategy it is beneficial to take care of the product quality on the one hand, and the quality of the service related to the delivery of the product on the other hand. This is conditional on the other key factors of the strategy adopted by a producer, that is the time and costs (e.g. tailoring the financial terms, timely deliveries, delivery size or flexibility to the customer needs). Pursuance of such strategy calls for adequate improvement actions geared on the factors in each area of the production business, including the process of production planning and control. To get the improvements properly oriented, it is important to translate customers' expectations to the requirements imposed on the process and the objectives correlated with the strategy. Improvement of

* Ph.D. Eng., Department of Engineering of Operational Management, Faculty of Management and Economics, Gdańsk University of Technology, Narutowicza 11/12, 80-233 Gdansk, jolanta.lopatoewska@zie.pg.gda.pl

production planning and control contributes to improving customer satisfaction and efficiency of the implementation of the production process.

Hence, this article carries out a discourse on improving the production planning and control process related to meeting the customer expectations. The aim of this article is identification of the process objectives seen from the perspective of the internal (production process) and external customers and their expectations, the major problems hindering effective execution of the steps involved, and, consequently, the directions of improvement.

Research methods such as analysis of the literature sources, logical inference and observation were used to prepare this article.

1. The process of production planning and control, and the related objectives

The process of production planning and control plays a vital role in coordination of the flow of materials and information between customers and suppliers and the businesses determining the product value stream. It is a component of the global process of strategic, tactical, and operational planning in a business [Brzeziński, 2002, p. 347]. It manages the flow of material, the utilization of employees and equipment, and it responds to customer expectations [Gustavsson, Wänström, 2009, p. 327]. Its purpose is to harmonise the sale of products and services with the demand therefore from the customers [Slack et al., 2007, p. 288]. Hence, it plays a major role in meeting customer expectations. The process fulfils its function in actions which may be grouped as follows [Chapman, 2005, p. 12; Hadaś et al., 2011, p. 46–48; Jacobs et al., 2011, p. 3–6; Jonson, Mattsson, 2003, p. 875–877; Łopatowska, 2014, p. 825]:

- demand forecasting and demand management,
- production plan building, from the production plans connected with the operations strategy, through Sales and Operations Planning S&OP, quantity and assortment plan, Master Production Schedule MPS, Material Requirements Plan MRP, and up to the operative plan,
- production resource and capacity planning, to comprise Resource Requirements Planning RRP, Capacity Requirements Planning CRP, and Rough Cut Capacity Planning RCCP,
- control: purchasing control, manufacturing process control and distribution control.

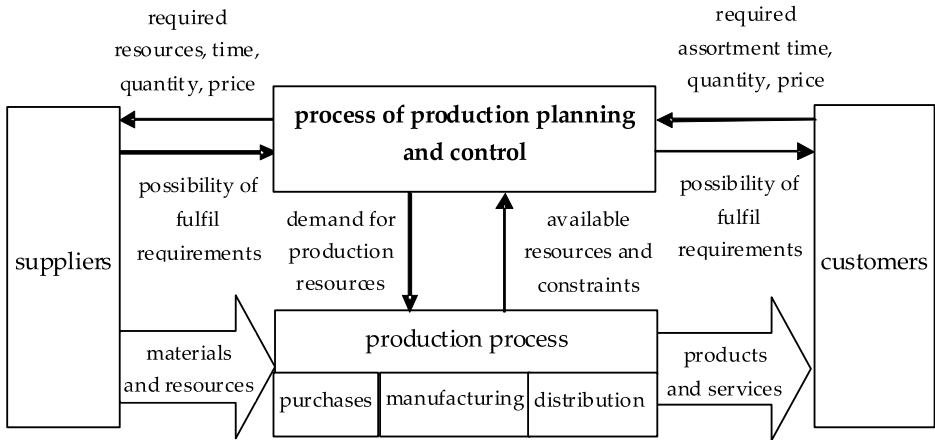
Execution of the actions entailed in the production planning and control process requires identification of the external customer's needs (regarding, among others, assortment, quantity, timing and terms of delivery), followed by their translation into the demand for the products and their components, as well as the means of labour, work, and knowledge. The subsequent step entails confrontation of the needs with the potential and limitations of the production process, and the production resources available in the market (e.g. materials, production resources). Ultimately, the time comes for building plans that will combine the assortment and its quantities with the time, production site, and the demand for resources. These actions are carried out over different periods, and in recognition of the plans built at a higher management level. They might call for the decision it is necessary to reconfigure the producer network so as to e.g. include a new supplier of materials, or engage new work resources, or reorganize the production processes whenever the volume of the demand for individual products changes. In effect, the potential of meeting the customer requirements is identified. Production control plays an executive role with respect to the plans. Here, the task is to coordinate the flow of materials and information, and monitor and correct the running purchase, production, and shipment orders [Szatkowski, 2014, p. 372–374] so that the adopted plans are attained. The general flow of information and materials between the production planning and control process and the actual production process, customers and suppliers is outlined on figure 1. Production planning and control process is concerned with planning and controlling all aspects of production process and coordinating suppliers with key customers [Jacobs et al., 2011, p. 23]. The view corresponds with the broad definition of the production process, which sees the latter as made up of the following component processes: production preparation, manufacturing, and product distribution [Durlík, 2007, p. 54–55; Pająk, p. 85–86].

Improvement of the production planning and control process, being an integral component of the quality strategy of a producer, requires identification of the process client and the objectives defined for the process, vital to meet the client's needs. From the perspective of the production planning and control process, one can consider:

- the external client, i.e. the recipient of the final outcomes of the production process, or the enterprise where the outcomes of the production process are subject to further transformation,

- the internal client, i.e. the production process in the broad sense contains purchases, manufacturing and distribution.

Figure 1. The general flow of information and material within the production system and between the production system and the market



Source: Own elaboration.

Production process is the internal client because the production control system must be compatible with the production system [Fernandes et al., 2008, p. 685]. Furthermore the effectiveness of production planning depends on the information coming from the production process which are related, among others with operations time and manufacturing sequence [Mo et al., 2009, p. 98].

Apart from the actions focused on the product and its features, the business's orientation on the external client entails actions oriented on the service connected with the physically existing product and the logistic services provided to the customer [Bendkowski, 2013, p. 9; Goldtratt, 2007, p. 146–147]. Hence, from the perspective meeting the expectations of the external customer, the goal of the production planning and control process is to deliver to him the products he requires at the place, time, and in the quantity he requires, and to ensure flexible change of the delivery terms. This makes it imperative for the production planning process to identify the clients' needs, construct flexible plans matching the needs, secure the resources that will enable execution of the adopted plans. Production control should be implemented so that the customers' orders, including their potential alterations by the clients, can be performed within the

required time span. The key operating measures connected with that goals are: the time spent on performing the customer's order and its timely completion, the time it takes to respond to a change in the needs, the time it takes to build the plan, or the minimum size of the delivery, plus the financial measure: the product price. Actions taken to reduce the numerical value of the measures raise the customers' satisfaction.

The objectives relating to the internal client (specified by managers of production process) are of the following nature:

- organisational, connected with the translation of the steps taken in the process of production planning to the organisation and flow of the production process, the effects of which are reflected in the parameters of the production process such as e.g. the lead time, production cycle, delivery cycle, inventory level, process flexibility, level of capacity utilisation,
- financial, connected with the cost of the funds engaged in execution of the production process (to name e.g. the costs of the inventory, labour, machines) to the adopted plan,
- social, connected with the efforts taken to keep the employee workload balanced and the work pace steady, and to avoid arduous and stressful working conditions.

The objectives relating to the internal client are mutually interrelated; for instance: reduction of the inventory or shortening of the production cycle will translate to reduced demand for funds, and the balancing of the process and steady work pace will pertain to the shortening of the lead time. Moreover, the internal objectives are correlated with the external goals (table 1). Hence, striving towards the objectives translates to the possibility of adjusting the delivery terms flexibly and meeting the expectations of the external client. For instance, the flexibility of the production process translates to the flexibility of the delivery terms offered to the customers and the time for completion of the customer's order, and the amount of the funds engaged in the production process has an impact on the product price.

Table 1. Exemplary external goals of the production control process and the related internal objectives

External goal	Internal objective
Improving or keeping the flexibility of the delivery terms	Improving or maintaining flexibility of the production process, reducing the size of the production batch and transport batch, current monitoring of the production process status
Improving or keeping the timeliness of the deliveries	Shortening or retaining the length of the production cycle, balancing the operations, improving availability of the materials, aiming at making the maximum use of the production system throughput
Keeping or reducing the price	Shortening of the production cycle and the material lead time (L/T), improving the resource utilization level, reducing the inventory

Source: Own elaboration.

Striving at the attainment of the goal set for the production planning and control process requires selection and employment of an adequate strategy (push or pull), monitoring system, and swift response to changes in and diversions from execution of the plan, as well as a set of tools properly selected to the planning environment for all actions comprising the process. Furthermore, it is indispensable to integrate the process vertically (in between individual levels of planning and control), and horizontally (in between individual types of actions, i.e. management of the demand, construction of the plans and management of the production resources and capacity) within the entire product value stream, as well as to coordinate the flow of information and materials. This enables keeping the process flexible and the time of response to the changing operating conditions short. Moreover, since management of knowledge and competencies is a major element contributing to the improved competitive position in the supply chain [Miocevic, 2008, p. 73–83; Kayakutlu, Büyüközkan, 2010, p. 130–132], the internal objectives of the production planning and control process should also focus on this aspect of the business, if the actions are to be effective. Acquiring knowledge and developing skills opens an opportunity to build the production plans that will be better aligned with the

planning conditions and to control the production process more effectively.

2. Problems faced in executing the steps, and the directions of improving the production planning and control process

The production planning and control process is prone to numerous disturbances which make it difficult to attain effectiveness of the actions taken. The major problems which affect execution of the tasks and attainment of the objectives of production planning and control identified based on the analysis of literature sources and observations which were made include e.g.:

- incorrect identification of the customers' needs in terms of the product assortment and their delivery terms, which may result from e.g. uncertainty of the forecasts,
- no coordination or incorrect coordination of the information flow, both between the client and the enterprise, and between the production process and the production planning and control process,
- no integration or improper horizontal and vertical integration of individual process actions in the entire value stream,
- incorrectly defined planning environment, and a mismatch between the production planning and control methods and the planning environment,
- a high rate of changes in the customer demands (in terms of the kind, quantity of the products, or their delivery terms), which entails variable and increased demand for resources and funds, and a time gap between the moment the demand for a resource arises and the moment it becomes available,
- dynamic changes in the market conditions, e.g. in terms of availability of the materials and other resources,
- shifting constraints in the continually reconfigured supply chain,
- high fluctuation in the resources used in the production process (the headcount, jobs, types and quantities of the materials), which translates to process instability.

The problems indicated above result in disturbances in the flow of information and materials between the client and the resource market on the one hand, and the production process and the production planning and control process on the other hand. These translate to a mismatch between the effects of the production process and the customers' needs,

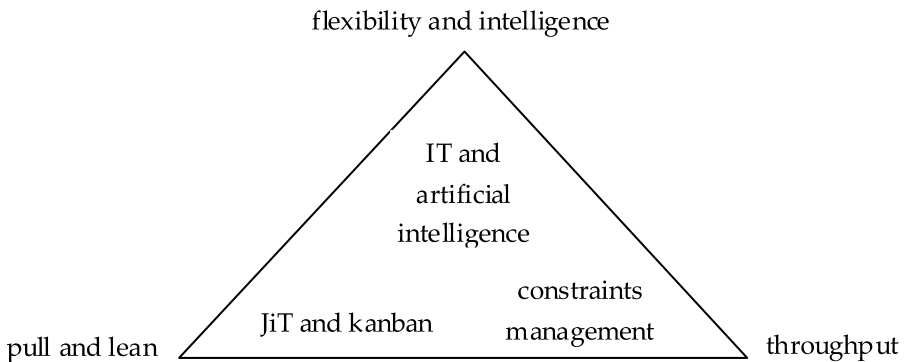
hence their lesser satisfaction and low effectiveness of the production process. Furthermore, because of mutual interrelations and feedback, minor disturbances compound in the bullwhip effect and grow to become substantial problems and discrepancies.

Efforts aimed at minimising the impact of disturbances and raising customer satisfaction requires continuous improvements of the production planning and control process. The efforts comprise the following actions (figure 2):

- adopting the orientation on care for improvement of the throughput of the production system,
- ensuring the possibility for the flow of information and materials to occur in accordance with the principles of the pull and lean management,
- aiming at flexibility and the corresponding meta-feature of intelligence.

Seeing to the maximum utilisation of the system throughput involves adequate management of the constraints and following the rules of the theory of constraints and drum-buffer-rope method. Planning and control of the production process in accordance with the rules allows for increasing the quantity of the output of the production system, i.e. the products the customer awaits, whilst limiting inventory cost, and operating expense [Corbett, 2007, p. 24–32; Goldratt, Cox, 2000, p. 79–80]. Application of the pull and lean principles relates to the use of the JiT and kanban system.

Figure 2. Directions of improving the production planning and control process



Source: Own elaboration.

This creates an opportunity to respond directly to the customers' needs, coordinate the flow of information and materials both in the very process of production planning and control, and in the supervised production process in the entire value stream. Moreover, it involves elimination of the muda and reduction of the financial resources engaged in the production process, employment of solutions which balance and level the production process, hence pertains to stabilisation of the demand for the resources and improved flexibility in meeting the customers' needs. Information technology contributes vitally to the coordination of the information flow; this can be exemplified by supporting the production planning and control process with systems of the Enterprise Resource Planning (ERP) class. Networked manufacturing requires additional coordination of information flow. The multi-layered coordination i.e. demand information coordination layer, production planning coordination and production control layer coordination can ensure the integration of production planning and control processes in all network [Chen, Li, 2013, p. 408–410].

Utilisation of artificial intelligence in the form of e.g. the expert system, fuzzy logic, or bioalgorithms (e.g. genetic algorithms, ant algorithms) in all areas of production planning and control makes it possible to manage the knowledge in the area and practical realization of the economic meta-feature of flexibility and the ensuing production intelligence [Zawadzka et al., 2012, p. 28–30]. Self-learning, self-adaptation, and self-development in the process of production planning and control in the environment of dynamic changes enables improvement in the degree to which the customers' expectations will be met.

Conclusion

Producers compete via factors connected with quality, time, and costs. From the perspective of meeting the customer's needs quality of the product is the important aspect; following suit in importance are: the terms of product delivery, and the possibility to alter them flexibly. The market value of the product is substantially determined by the process of production planning and control. It coordinates the flow of information and materials between the external client and the market on the one hand, and the internal client, i.e. the production process, on the other hand. The range of the actions in the process and the way they are performed translates to the value of the parameters of the production process, related to the time and costs, hence the degree to which the customer expectations

will be met. Consequently, the efforts to improve the production planning and control process are focused on improving the throughput of the production system, application of the pull and lean principles, and increase of flexibility through making use of the artificial intelligence solutions. These lines of action may be taken separate; however their coordination (e.g. by combining the lean principles with the theory of constraints, or using the pull strategy in the intelligent solutions) may magnify the ultimate effects in terms of e.g. shortening the order completion time, utilisation of the resources, or flexibility of the offer.

References

1. Bendkowski J. (2013), *Logistyka jako strategia zarządzania produkcją*, „Zeszyty Naukowe Politechniki Śląskiej”, seria Organizacja i Zarządzanie, z. 63.
2. Brzeziński M. (red.) (2002), *Organizacja i sterowanie produkcją*, Placet, Warszawa.
3. Chapman S. (2005), *Fundamentals of production planning and control*, Prentice Hall.
4. Chen Z., Li L. (2013), *Information support technologies of integrated production planning and control for OEM driven networked manufacturing*, „Journal of Enterprise Information Management”, Vol. 26, Issue 4.
5. Corbett T. (2007), *Finanse do góry nogami. Zdroworozsądkowa rewolucja w rachunkowości*, MINT Books, Warszawa.
6. Durlík I. (2007), *Inżynieria zarządzania*, cz. 1, Placet, Warszawa.
7. Fernandes F., Filho M. G., Bonney M. (2008), *A proposal for integrating production control and quality control*, „Industrial Management & Data Systems”, Vol. 109, Issue 5.
8. Goldratt E. M., Cox J. (2000), *Cel. Doskonałość w produkcji*, Werbel, Warszawa.
9. Goldratt E. M. (2007), *Cel II. To nie przypadek*, MINT Books, Warszawa.
10. Gustavsson M., Wänström C. (2009), *Assessing information quality in manufacturing planning and control processes*, „International Journal of Quality & Reliability Management”, Vol. 26, Issue 4.
11. Hadaś Ł., Fertsch M., Cyplik P. (2011), *Planowanie i sterowanie produkcją*, Wydawnictwo Politechniki Poznańskiej, Poznań.
12. Jacobs F. R., Berry W. L., Whybark D. C., Vollman D. C. (2011), *Manufacturing Planning and Control for Supply Chain Management*, McGraw Hill.

13. Jonsson P., Mattsson S. (2003), *The implications of fit between planning environments and manufacturing planning and control methods*, „International Journal of Operations & Production Management”, Vol. 23, Issue 8.
14. Kayakutlu G., Büyüközkan G. (2010), *Effective supply value chain based on competence success*, „Supply Chain Management”, Vol. 15.
15. Łopatowska J. (2014), *Realizacja zmiany procesu planowania i sterowania produkcją – aspekty metodyczne*, „Marketing i Rynek”, nr 5 (CD).
16. Miocevic D. (2008), *Organizational, buying effectiveness in supply chain environment: a conceptual framework*, „Journal of Business Market Management”, Vol. 2, No. 4.
17. Mo J., Sigit A., Myers K. (2009), *Development of product model for manufacturing planning and control in a made-to-order business*, „Journal of Manufacturing Technology Management”, Vol. 20, No. 1.
18. Pająk E. (2006), *Zarządzanie produkcją*, Wydawnictwo Naukowe PWN, Warszawa.
19. Skrzypek E. (2014), *Wpływ jakości na doskonalenie i dojrzałość organizacji*, w: *Innowacyjne i jakościowe aspekty w zarządzaniu operacyjnym*, Lis A. (red.), Zieliński G. (red.), Wydawnictwo Politechniki Gdańskiej, Gdańsk.
20. Slack N., Chambers S., Johnston R., (2007), *Operations Management*, Pearson Education Limited England.
21. Szatkowski K. (2014), *Nowoczesne zarządzanie produkcją. Ujęcie procesowe*, Wydawnictwo Naukowe PWN, Warszawa.
22. Trojanowska J., Koliński A. (2011), *Strategia efektywnego zarządzania przedsiębiorstwem poprzez adaptacyjne sterowanie produkcją*, „Zeszyty Naukowe Politechniki Poznańskiej”, nr 16.
23. Zawadzka L., Badurek J., Łopatowska J. (2012), *Inteligentne systemy produkcyjne. Algorytmy, koncepcje, zastosowania*, Wydawnictwo Politechniki Gdańskiej, Gdańsk.

Improving the production planning and control process (Summary)

Focusing the activities of a production business on the strategy based on quality entails orientation on meeting the expectations of the customers with respect to the product itself, and the terms of its delivery. The article notes the role of the production planning and control process in improving the quality of the business offer. It identifies the objectives set for the process from the perspective of meeting the expectations of both the external client and internal client, the latter

being the production process. The article points to the key problems which hinder meeting customers' expectations, and indicates the directions of perfecting the process, connected with improvement of the production system throughput, steps taken to attain the information and material flow according to the pull strategy and lean principles, and flexibility combined with production intelligence.

Keywords

production planning and control, production, improving