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CONSTRAINTS IN PRINTING INDUSTRY

Patrycja ROGOWSKA

Bialystok University of Technology, Faculty of Engineering Management; p.rogowska@pb.edu.pl,
ORCID: 0000-0002-1156-5176

Purpose: The main objective of this paper is to identify typical constraints characteristic of the printing industry and to systematize them through quantitative research.
Design/methodology/approach: A literature review method and a quantitative survey conducted on a sample of 237 companies in the printing industry were used to solve the research problems. This study is both theoretical and empirical.
Findings: The answers obtained from the respondents, allowed the development of a systematic of constraints, and also helped to expand the knowledge of printing companies. A total of 26 constraints were included, which were divided into four categories: technical, market, social and organizational constraints. Also identified were the key constraints that companies of different sizes - small, medium and large - most often identify in their operations.
Research limitations/implications: The developed of a systematic of constraints applies only to the printing industry. It is a flexible tool, i.e., it must be regularly updated and adapted to changing market conditions and the specific needs of the organization, thus enabling effective identification and resolution of current problems.
Practical implications: The systematic of constraints is a practical tool that enables printing companies to understand what key constraining factors are affecting their operations and growth. The tool identifies and better understands the industry's major constraints, sensitizing companies to key issues that need to be addressed.
Originality/value: The value of the study lies in providing printing companies - regardless of their size - with a dynamic tool to identify the constraints blocking their growth. The article is aimed at industry professionals, managers and researchers who are looking for practical solutions and insights into current constraints affecting the printing sector.
Keywords: constraints, bottlenecks, printing industry, theory of constraints, TOC.
Category of the paper: research paper.

1. Introduction

In the printing industry, as in other industrial sectors, there are constraints that have a key impact on operational efficiency and the achievement of business goals. To identify these constraints, it is useful to ask a fundamental question: *what is preventing an organization from*

increasing the rate at which it achieves the purpose of its existence? Thus, a constraint can be defined as anything that prevents a system from performing better relative to the purpose of its existence (Scheinkopf, 2022) or anything that prevents a company from making more money and achieving a higher level of its goals (Azaria et al., 2023).

Constraints can take many forms. In the literature, there are many types of constraints that occur in companies (Goldratt, 1990; Cox, Spencer, 1998; McMullen, 1998; Reid, 2007; Woeppel, 2009; Lewandowski et al., 2018). Scheinkopf (2022) distinguishes between physical, organizational and mental constraints. Physical constraints, are resources that physically limit the system's ability to increase throughput. They can be located inside or outside the organization. An internal physical constraint occurs when an organization lacks the capacity or specific skills needed by the organization. External physical constraints include raw materials or the market. Another is organizational constraints, understood as rules that prevail in a company, but also measures that are used to evaluate the systems on which decisions, sometimes strategic ones, are made. Mental constraints are beliefs and assumptions that make us create and accept organizational constraints and adhere to them. Constraint is often confused with bottleneck, which is certainly an internal physical constraint. It may be defined as a resource whose capacity is less than required. It is worth noting that every bottleneck is a constraint, but not every constraint is a bottleneck. The presence of constraints significantly determines how effectively an enterprise can achieve its goals. Improper management of these constraints can lead to a number of consequences including downtime, built-up inventories, reduced productivity of the system as a whole (Urban, Rogowska, 2018), but most importantly, improper management of constraints distances us from a commercial company's main goal of making money today and in the future (Gupta et al., 2022; Cox et al., 2003; Cox, Spencer, 1998).

A concept that focuses on managing constraints in organizations is the Theory of Constraints (TOC) developed by Israeli physicist Eliyahua M. Goldratt. The methodology is not particularly new. Its origins can be traced back to the 1970s, when Goldratt and his team developed a production planning and control system, first called the Optimized Production Timetable (1979) and then, from 1982, as Optimized Production Technology (OPT) (Mabin and Balderstone, 2003). Introduced by E.M. Goldratt in the mid-1980s, a broad awareness and understanding of the TOC methodology was first achieved by people reading the book The Goal: A Process of Ongoing Improvement (Goldratt, Cox, 1984). The essence of TOC is to focus on the organization's most important goal and precisely identify the element that most blocks its achievement. Its basic premise is that the capacity of the entire organizational system is determined by the capacity of the constraint (Goldratt, 1990). An company can be compared to a chain that has a minimum of one link inhibiting its current potential and preventing it from increasing its performance. Thus, in any system, at any given time, there is only one area that limits the ability to achieve the intended goal. Otherwise, the company's activities would generate unlimited profits (Lewandowski et al., 2018). TOC is becoming popular among

managers because of its simplicity, which can be pointed out as: find the limitation of your system and improve its throughput, thus improving the performance of the whole system. This methodology of focusing exclusively on key constraints is extremely attractive - as it promises high efficiency and great results with the least possible expense (Urban, 2019). The TOC systems approach requires that you first understand the system, its goal, and measurements. Then you can apply the Five Focusing Steps (Cox, Schleier, 2010):

1. Identify the constraint(s).
2. Decide how to exploit the constraint(s).
3. Subordinate/synchronize everything else to the constraint(s).
4. If needed, elevate the system's constraint.
5. If the constraint has been broken, go back to step one. Do not let inertia become the constraint.

Properly identifying the key constraint (step 1) is the foundation of this concept, as it allows resources and activities to be focused on the areas that have the greatest impact on achieving the desired results. By accurately identifying these constraints, companies are able to direct their efforts to eliminate or mitigate these factors, leading to significant improvements in the overall system. Identifying constraints is essential for process improvement and achieving operational excellence, enabling organizations to operate effectively and make sound decisions to increase efficiency and accomplish strategic goals (Urban, Rogowska, 2020). Therefore, it is important to develop a systematic of constraints tailored to the specific characteristics of various industries. Each sector has its constraints. A systematic of constraints would allow organizations to direct resources more precisely to where their impact would bring the greatest benefits for operational efficiency.

The main objective of this paper is to identify typical constraints characteristic of the printing industry and to systematize them through quantitative research. The following research problem were formulated: what constraints exist in the printing industry in Poland? The literature review method and quantitative research were used to address the scientific problem. This study is both theoretical and empirical. The theoretical part presents the importance of identifying key constraints within an enterprise. The practical part then discusses the results of a study conducted on a Polish sample of 237 companies from the printing industry. The study concludes with a discussion of the results and conclusions.

2. Own research methodology

The aim of this study is to identify the typical constraints of the printing industry. For this purpose, two research methods were used: literature review and survey. The paper covers a fragment of a broader study in which the research tool was a survey questionnaire

consisting of 13 questions of a closed. The closed questions included a Likert scale. The survey was developed based on an extensive literature review aimed at identifying the constraints (their types) occurring in enterprises. The analysis considered not only the perspective of the production system but also the entire enterprise and its environment. The main technique used for the research process was the CAWI method. The electronic questionnaire was made available on the profitest.pl website. The survey was anonymous. The study was conducted from May to July 2022. A complete return of fully filled-in questionnaires was obtained. The research results are presented in the subsequent part of the scientific article.

3. Characteristics of the research sample

The subject of the conducted research were enterprises operating in the printing sector, involved in the production of various products. These enterprises represent an important research area due to their specific requirements, diverse production flows, and their economic significance in the economy. The study, conducted in 2022, included 237 respondents, each representing one enterprise. The survey covered companies from all over Poland, encompassing all provinces. The structure of the surveyed enterprises is presented in the figure 1.

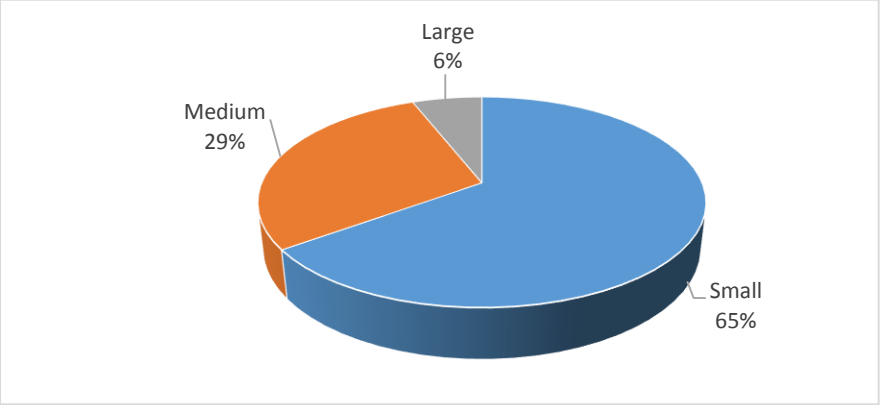

Figure 1. The structure of the surveyed enterprises.

Source: Own elaboration based on the research results.

The vast majority of respondents participating in the study were from the small enterprise sector, employing between 10 and 50 employees (154 entities). The smallest group consisted of large enterprises with more than 250 employees (15 entities). However, given that in 2020 there were only 18 representatives of this group in the printing industry market, it can be considered the most well-recognized group of surveyed entities. The last analyzed group consisted of 68 respondents, who were representatives of medium-sized enterprises employing between 50 and 249 employees. The presented structure of the surveyed enterprises reflects the share of company sizes in the printing industry, where the small enterprise sector

clearly dominates. The survey conducted did not include the microenterprise sector, employing fewer than 10 employees, due to the low technological advancement of these entities.

4. Analysis of research results

A broad literature review identified 16 constraints that may occur both within and outside the enterprise. These include: the scale of demand for products, applicable legal regulations, a limited number (monopoly) of suppliers, conflicts between different departments, improper flow of information, lack of synchronization between the sales and production departments, insufficient production space, the company's development policy, excessive product assortment variety, machine capability, outdated technology, mismatched technology, production planning system, delays in material delivery to the production station, problems with raw material deliveries from suppliers, and unavailability of workers.

Respondents were tasked with evaluating each constraint from the list using a five-point Likert scale, where the assigned values represented: 1 – does not occur, 2 – rather does not occur, 3 – difficult to say, 4 – rather occurs, 5 – occurs. Respondents were also asked to provide other factors as potential constraints that were not included in the question but may be relevant to the issue being analyzed. Ten entities participating in the study provided their own responses. Respondents identified the following factors as potential constraints for the enterprise: quality of courier deliveries, insufficient warehouse space (for production materials and finished products), customer requirements, availability of courier services, a large number of changes between the calculation and the final product, employee incompetence, employee engagement in their work, delays in files from customers, the business owner, and high capital intensity. The responses obtained from the respondents allowed for the development of a systematic of constraints and expanded the knowledge about enterprises in the printing industry. It is worth noting that a constraint is understood as a factor that blocks the development of an enterprise within the framework of the TOC. The systematic of constraints is a way of categorizing and grouping different types of constraints that may occur within an enterprise. The development of a constraint systematic is directly related to the TOC, as it can serve as one of its key tools.

Table 1 presents the systematic of constraints in the printing industry. These constraints have been divided into four categories: technical, market, social, and organizational constraints. A total of 26 constraints were considered, taking into account both the constraints from the list and the responses provided by the respondents. Each group contains between 4 and 8 items. The constraints were organized according to the number of responses rated as 5 – occurs for each, starting with the most frequent and ending with the least frequent. This division allows for a more detailed identification and understanding of the factors influencing the development of printing enterprises.

Table 1.
The systematics of constraints in the printing industry

SYSTEMATICS OF CONSTRAINTS IN THE PRINTING INDUSTRY	
Technical	- machine capability - insufficient production space - delays in material delivery to the production station - excessive product assortment variety - outdated technology - mismatched technology - quality of subcontracted logistics services - insufficient warehouse space (for production materials and finished products)
Market	- scale of demand for products - applicable legal regulations - limited number (monopoly) of suppliers - customer requirements - availability of courier services - a large number of changes between the calculation and the final product
Social	- unavailability of workers - conflicts between differentia departments - employee incompetence - employee engagement in their work
Organizational	- problems with raw material deliveries from suppliers - production planning system - lack of synchronization between the sales and production departments - the company's development policy - improper flow of information - delays in files from customers - the business owner - high capital intensity

Source: own study.

The first group – *technical constraints* – refers to barriers that occur, especially where technology plays a key role in the production process. These constraints hinder the proper functioning of production processes, resulting from imperfections in the technologies and equipment used, as well as from insufficient space and infrastructure. They can affect both the production process itself and management or transportation systems.

The second group – *market constraints* – refers to barriers that arise from the conditions prevailing in the market (external factors). They hinder the proper functioning of a business due to variations in demand for products, legal regulations, availability of logistics services, customer requirements, and the number of suppliers in the market. These constraints can affect various aspects of the business, such as production, distribution, or sales. Market constraints often force businesses to adapt to new conditions.

The next group – *social constraints* – refers to barriers related to employees or the workforce that can hinder work and lead to irregularities in the functioning of the organization. These constraints are usually related to interpersonal relationships, employee engagement in their work, and their competencies.

The last group – *organizational constraints* – refers to barriers that arise from management issues within the company or due to the improper functioning of its organizational structures. These constraints hinder the proper functioning of the unit, resulting from imperfections in

internal processes. They can affect aspects such as planning, coordination, and control of activities.

The results of the research allowed for the observation of interesting relationships between entities. Table 2 presents the key constraints that companies of different sizes – small, medium, and large – most often identify in their operations.

Table 2.
The size of the company and the type of potential constraints

The size of the company	Constraints	Percentage of indications
small	applicable legal regulations	60%
	scale of demand for products	58%
	machine capability	48%
medium	the scale of demand for products	57%
	machine capability	54%
	problems with raw material deliveries from suppliers	53%
large	machine capability	80%
	scale of demand for products	60%
	applicable legal regulations	60%
	limited number (monopoly) of suppliers	60%

Source: own study.

The scale of demand for products and machine capability were identified as key constraints by all respondent groups, highlighting their fundamental importance in the context of business operations regardless of company size. In the case of small company, 60% of respondents highlight applicable legal regulations as key constraints affecting their operations. Additionally, 58% point to the scale of demand for products, and 48% to machine capability. These data suggest that small businesses should pay particular attention to changes in applicable legal regulations and the efficiency of their technology. Adapting to these requirements may involve significant costs and require substantial time investments, which ultimately affects their ability to respond quickly to changing market conditions. For medium-sized businesses, the scale of demand for products (57%) and machine capability (54%) are the dominant constraints. This indicates the need for greater flexibility in managing production processes and the necessity of closely monitoring market demand. Additionally, 53% of respondents from this group point to problems with raw material deliveries from suppliers, which also affects production stability. In large businesses, machine capability is a key constraint highlighted by 80% of respondents. Large companies often specialize in printing specific types of products, which may be linked to higher customer demands and quality standards. This can affect the execution of a larger number of complex orders that require diverse and more advanced processes, as well as coordination of multiple machines and workers. This means there is a higher frequency of machine setup changes, which consequently extends downtime and impacts overall machine performance. Despite having greater financial resources that allow for investment in modern machinery, these factors can still affect the efficiency of production processes. The scale of demand for products, applicable legal regulations, and limited number

(monopoly) of suppliers (60% each) also play a role, indicating that these companies must manage complex operational processes and ensure the efficiency of their production technology.

5. Discussion and conclusions

The printing industry faces numerous constraints that significantly impact the efficiency and growth potential of businesses. Precise identification and analysis of these constraints are essential for companies to fully leverage their potential and achieve their set goals. The developed systematics of constraints enables the identification and resolution of various issues that affect the functioning of businesses. It is a tool that allows organizations to better understand which internal and external factors may hinder their operations. As a result, businesses can analyze what actions should be taken to eliminate these constraints or at least minimize their impact.

It is important for printing companies to treat the systematics of constraints not as a set of rigid rules, but as a flexible tool for identifying and solving current problems. This systematics should be understood as a dynamic process that requires regular updates and adjustments to changing market conditions and the internal needs of the organization. By implementing TOC, printing companies should adopt an approach based on continuous improvement, where they constantly identify and eliminate constraints. This enables the systematic increase of efficiency and operational effectiveness, contributing to their long-term growth and competitiveness.

The systematics of constraints thus becomes a practical tool that allows printing companies to understand which key limiting factors affect their operations and development. This tool helps identify and better understand the main constraints in the industry, sensitizing companies to the key issues that need to be addressed. The systematics of constraints is important in the context of TOC because it enables more precise identification of constraints within the company and the development of strategies that will allow for their elimination or reduction.

It is important to emphasize that, according to the principles of TOC, the systematics of constraints allows companies to focus resources on key areas that can bring the greatest benefits. With more targeted management, organizations can operate more efficiently and respond more quickly to new challenges.

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