SILESIAN UNIVERSITY OF TECHNOLOGY PUBLISHING HOUSE

SCIENTIFIC PAPERS OF SILESIAN UNIVERSITY OF TECHNOLOGY 2024
ORGANIZATION AND MANAGEMENT SERIES NO. 197

USING THE THEORY OF CONSTRAINTS THINKING PROCESS TOOLS TO SOLVE CRITICAL PROBLEMS IN THE ORGANIZATION

Krzysztof KNOP

Czestochowa University of Technology, Faculty of Management; krzysztof.knop@wz.pcz.pl,
ORCID: 0000-0003-0842-9584

Purpose: The article aims to practically use the tools of the Theory of Constraints thinking process to eliminate critical problems in a selected subsystem of an enterprise in the automotive industry and, based on practical experience, to determine the strengths and weaknesses resulting from their use as well as external opportunities and threats, to indicate appropriate remedial actions that will enable managers of any organization to use thinking tools effectively.
Design/methodology/approach: The goals of the article were achieved through the practical application of selected thinking process tools from the Theory of Constraints to solve critical problems in the R&D department of the selected company from the automotive industry. Identifying the goals of the subsystem of the studied company, identifying key problems, solving an important conflict in the subsystem, determining ways to solve key problems, and practically applying one of the solutions using the whole TOC toolkits constituted the scope of the research. The research tools were the TOC thinking process tools, such as the Goal Tree, the Current Reality Tree, the Evaporating Cloud, the Future Reality Tree, the Prerequisite Tree, and the Transition Tree. An active SWOT analysis was used to indicate the strengths and weaknesses of thinking tools, based on the experience gained, and external opportunities and threats related to their use were identified. The research methodology was based on the use of qualitative analysis to develop thinking process tools through interviews and brainstorming with the key stakeholders of the studied organizational subsystem, interested in achieving specific goals for the analyzed subsystem and assessing the practical application of the thinking process tools.
Findings: It has been proven that the use of the Theory of Constraints thought process tools allows you to effectively solve critical problems in the subsystem of an automotive company. Using the tools of the thought process, key problems were identified in the analyzed organizational subsystem and actions were proposed to eliminate them. It will also identify the strengths and weaknesses of these improvement tools, as well as the opportunities and threats associated with their use by the organization. Research findings indicate that TOC thinking process tools enable a systematic approach to solving complex problems. Thanks to these tools, the analyzed company can combat internal constraints that limit its effectiveness, efficiency and competitiveness on the market. The condition for the effective use of thinking process tools is support from management, employees' knowledge of how to use them, using individual tools at a given time, the most important ones in the context of problem-solving, and effectively struggling with the weaknesses of these tools.

Research limitations/implications: The study concerned a single company from the automotive industry, which makes it impossible to generalize the results to the entire industry. The qualitative nature of the research methodology introduces subjectivity into the analysis. Future research will focus on conducting comparative studies to evaluate the effectiveness of thinking process tools in identifying the root cause of complex problems compared to other methods used to solve problems.
Practical implications: The research results indicate the effectiveness of the Theory of Constraints thinking process tools in solving critical problems. Other organizations can use this approach to streamline their processes, eliminate difficult systemic constraints, and more effectively achieve business goals. Thanks to thinking tools, companies can identify the root causes of their problems and indicate ways to solve them. By involving managers and employees from the organization interested in achieving the established goals in the process of creating thinking process tools and using their knowledge and experience, it is easier to properly identify the root causes of critical problems and then implement appropriate remedial actions. The SWOT analysis, based on the research and experience obtained, establishes the conditions for the effective use of TOC thinking process tools by other enterprises.
Originality/value: The article has cognitive and practical values. The research results can serve as a reference point, and benchmark for managers of various organizations in terms of the approach to eliminating critical problems in the organization and how to effectively use TOC thought process tools by empowering their strengths, eliminating their weaknesses, taking advantage of opportunities, and counteracting threats.
Keywords: Constraints, Constraints Management, Theory of Constraints, Thinking Process Tools, Root Cause Analysis, Active SWOT analysis, Improvement.
Category of the paper: research paper.

1. Introduction

Every system has constraints. A constraint is anything that stops a company from making more money and from achieving a higher level of its goal (Azara et al., 2023). Constraints determine the rate of growth, expansion of a system, or the extent to which a goal is achieved (Atwater, Chakravotry, 1995). Typically, the fastest and most effective way to improve a system's profitability is to focus efforts on eliminating or better exploiting the constraints present in the system (Blackstone, 2001; Cox et al., 2003). Constraints are internal, external to the system, or concerning the availability of resources. Internal constraints, i.e. everything that has something to do with the interior of the organization, regardless of what area it concerns, are the most common case of limitations occurring in the system (Cox, Schleier, 2010). An internal constraint may be a bottleneck, i.e. a resource in the system with a capacity less than or equal to the market demand, or some deficit of the management staff. Every bottleneck is a physical constraint, but not every constraint in the system is a bottleneck. A constraint is a broader term, it is any factor that limits the organization's performance and is an obstacle to its goal (Cox, Spencer, 1998). Research shows that lack of discipline in action, lack of communication and relationships between people, and lack of time and availability of

management staff are the three most common examples of constraints in organizations (Grupta, 2003).

Since every system has a "weakest link", a constraint that ultimately limits the success of the entire system, system managers should identify such a constraint and try to eliminate or significantly weaken it. This requires a thorough understanding of the current reality of the system, its purpose, and the magnitude and direction of the difference between the stated goal and the current level of achievement (Grupta, Boyd, 2008). Most negative effects, or problems, in the system are caused by a few critical root causes that are seldom superficially visible to managers (Ikeziri et al., 2019). These root causes are often perpetuated by hidden conflict (Grupta et al., 2011). Eliminating critical root causes results in a large degree of system improvement. This type of reasoning is the basis of the Theory of Constraints (TOC), a concept that deals with the elimination of constraints in organizations and their systems and processes. The Theory of Constraints (TOC) is a management method that aims to achieve long-term profits through appropriate management of constraints in the enterprise (Dettmer, 1997; Watson et al., 2007). TOC is a widely used method, especially in production, distribution, marketing, sales, project, and change management (Mabin, Balderstone, 1999). The implementation of the TOC concept has resulted in companies significantly increasing revenues and profits, improving quality, increasing on-time deliveries, reducing costs, inventories, and the production cycle (Dettmer, 1995; Dettmer, 1997; Cox, Schleier, 2010; Cox, Specnse, 1998). This method can be classified as a model of continuous improvement of the management system in production and service companies because it focuses on eliminating unproductivity and waste in the system while striving for perfection (Atwater, Chakravorty, 1995; Lacerda et al., 2010). TOC can be effectively integrated with other methods of quality and production improvement, such as Lean, and Six Sigma (Ehie, Sheu, 2005; Gupta et al., 2022).

Despite concerted efforts to address constraints, traditional problem-solving approaches often fail to provide lasting solutions. The complexity and interconnectedness of modern organizational systems require a more holistic and systematic approach to problem-solving. TOC provides tools that can eliminate complex problems, constraints or waste in organizations (Rahman, 1998). These tools are called thinking process tools or tools supporting systemic thinking (Kim et al., 2008). Thinking process tools are integrated problem-solving tools based on rigorous cause-and-effect logic (Dettmer, 1997). They enable the implementation of breakthrough solutions by identifying, challenging, and correcting unexamined assumptions (Cooper, Loe, 2000). Thinking process tools allow to create of effective solutions to very complex problems in the organization. Thanks to tools supporting systemic thinking, managers can better and faster understand the current reality of the company, its problems, and constraints (Dalci, Kosanm, 2012). They make decisions based on a systematic analysis of facts because it is clear which improvement activities and which areas are priorities. Thanks to them, managers

can systematically solve the company's unresolveKaid problems or conflicts and make better decisions (Hunink, 2001; Ulewicz et al., 2023). As a result, the owners of the organization achieve a significant improvement in the company's results and the effectiveness of their managers' actions (Scheinkopf, 2010).

The article aims to practically use specific Theory of Constraints thinking process tools to eliminate critical problems in a selected subsystem of a company in the automotive industry. By demonstrating the potential of TOC thinking process tools, this article aims to provide guidance to organizational leaders and practitioners on how to deal with complex problems, overcome conflicts, identify the necessary actions to achieve goals and implement necessary improvement actions step by step.

2. Methods

The examined facility was a branch of an automotive concern located in Poland dealing with the design and testing of modern car components. The subsystem examined was the research and development (R&D) department.

The scope of the research concerned the use of the Theory of Constraints thinking process tools to eliminate or reduce the impact of the most important constraints/problems on the goals identified for the examined organizational subsystem - the research and development (R&D) office.

The reasons why the company was selected were the company's lack of previous experience with thinking process tools and the knowledge of one of the people from this company about the Theory of Constraints and its thinking tools. There was therefore a need to investigate whether TOC thinking tools could effectively analyze and solve the relevant problems of the company under study. The basis for building thought trees was the knowledge of the employee mentioned above of the surveyed company about its current problems, supplemented by interviews conducted among employees.

The research part was based on the use of the thinking process toolkit of the Theory of Constraints. The thinking process toolkit provides a road map for making improvements or changes (Dettmer, 1997). Improving or changing using thinking process tools involves answering three questions: 1. What to change? 2. To what to change to? 3. How to cause the change? (Reid, 2007; Fredendall et al., 2002) By using a thinking process toolkit such as Current Reality Tree (CRT), Evaporating Cloud (EC), Future Reality Tree (FRT), Prerequisite Tree (PRT), and Transition Tree (TT) (Scheinkopf, 1999; Cattaneo, Bassni, 2016), these questions can be answered, which is shown by Fig. 1. Thinking process toolkit can help decision-makers answer these questions by facilitating the process of structuring the problem,

identifying the problem, building the solution, identifying barriers to overcome, and implementing the solution (Banerjee, Mukhopadhyay, 2016; Dat et al., 2024). The thinking process toolkit can be used to analyze, develop and implement solutions for the entire organization, its departments, groups of people or individuals, and to change operational strategies (Shoemaker, Reid, 2005; Pacheco et al., 2021). Thinking process tools are an example of improvement tools designed to analyze the root causes of problems (Wolniak, Grebski, 2023a, 2023b; Wolniak et al., 2023) to indicate appropriate corrective actions.

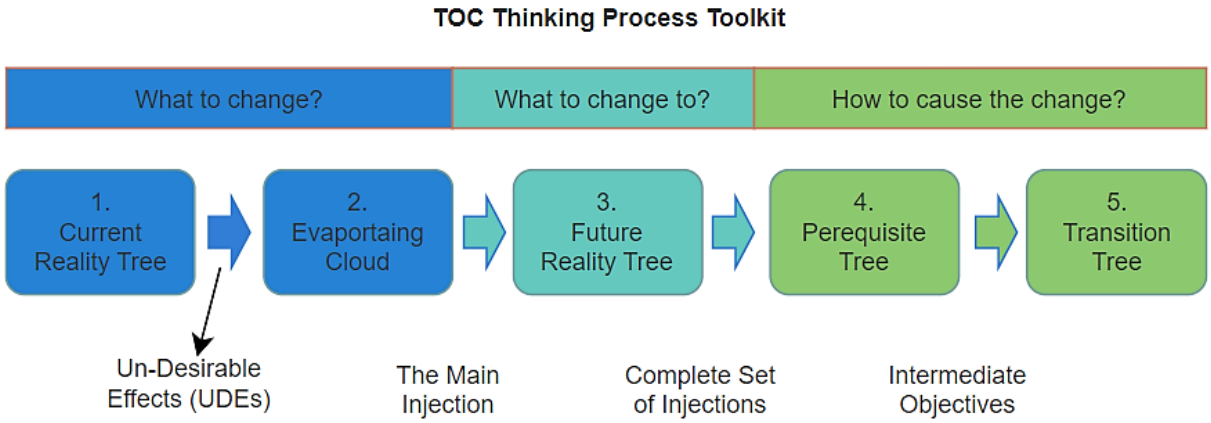


Figure 1. How do thinking process tools help answer the three most important questions on the path to improvement or change?

Source: own study based on: (Prerequisite Tree…, 2021).

Thinking process tools that were used to identify and solve problems within the analyzed subsystem of the company branch were the Goal Tree (GT), Current Reality Tree (CRT), Evaporating Cloud (EC), Future Reality Tree (FRT), Prerequisite Tree (PRT) and Transition Tree (TT). The procedure for using subsequent TOC thinking tools as part of the research part is presented in Fig. 2. Principles of constructing the TOC thinking process tools are presented in Fig. 3.

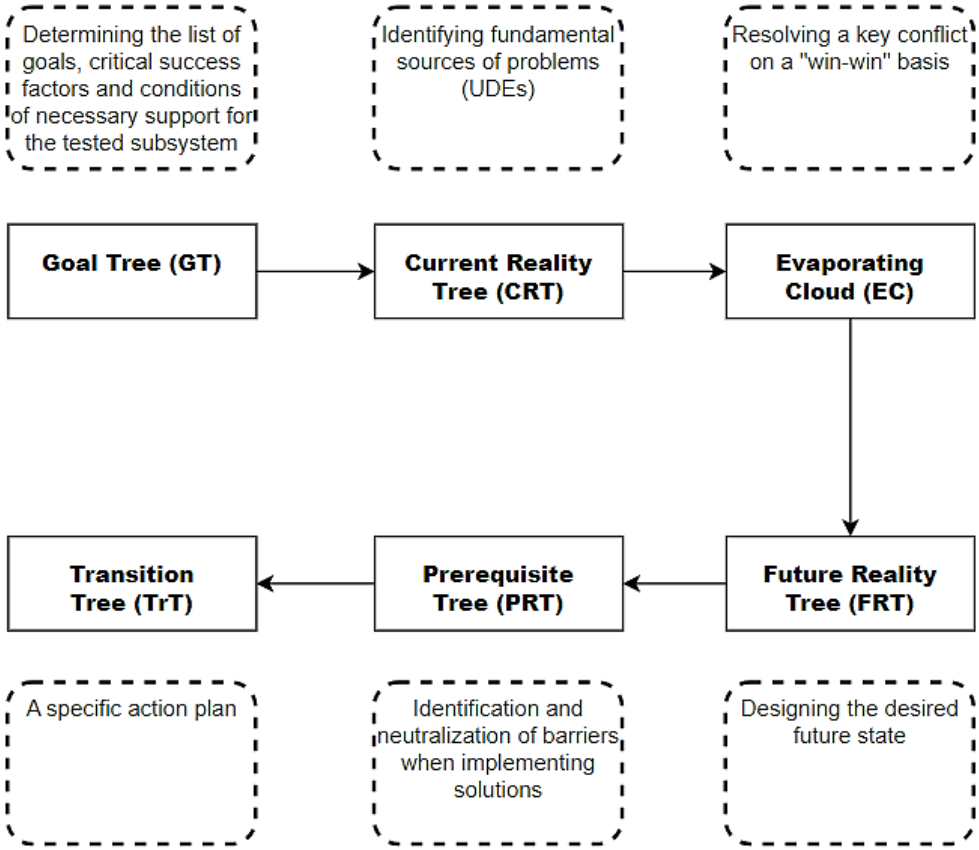
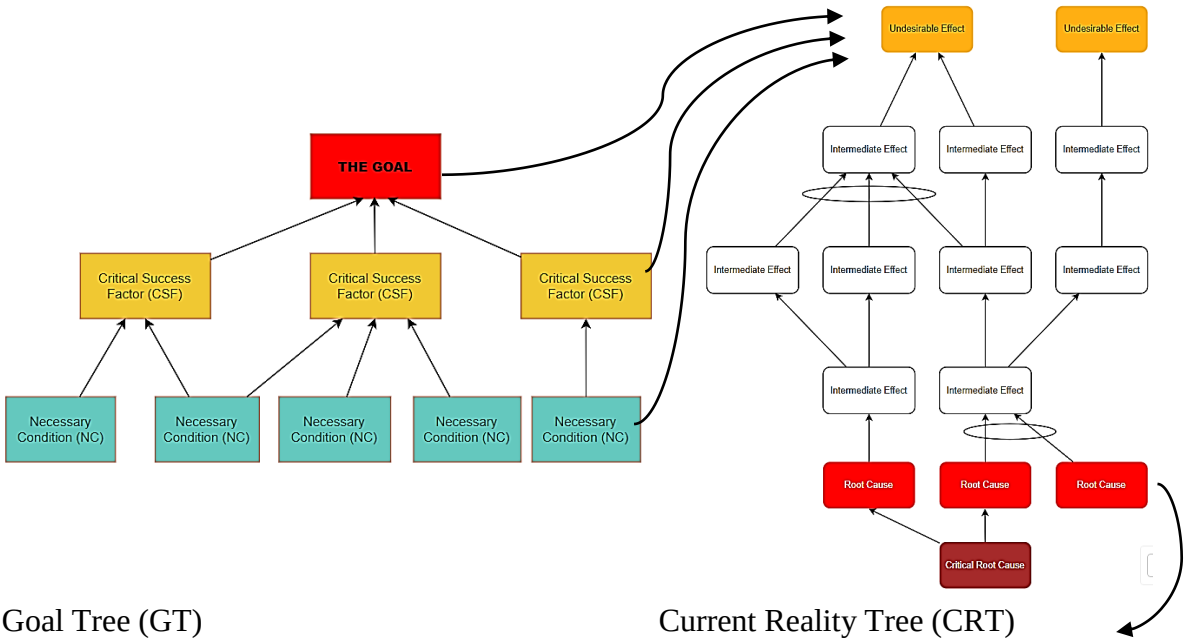


Figure 2. The procedure for using subsequent TOC thinking tools in the research part.
Source: own study based on: (Scheinkopf, 1999).



Goal Tree (GT) Current Reality Tree (CRT)

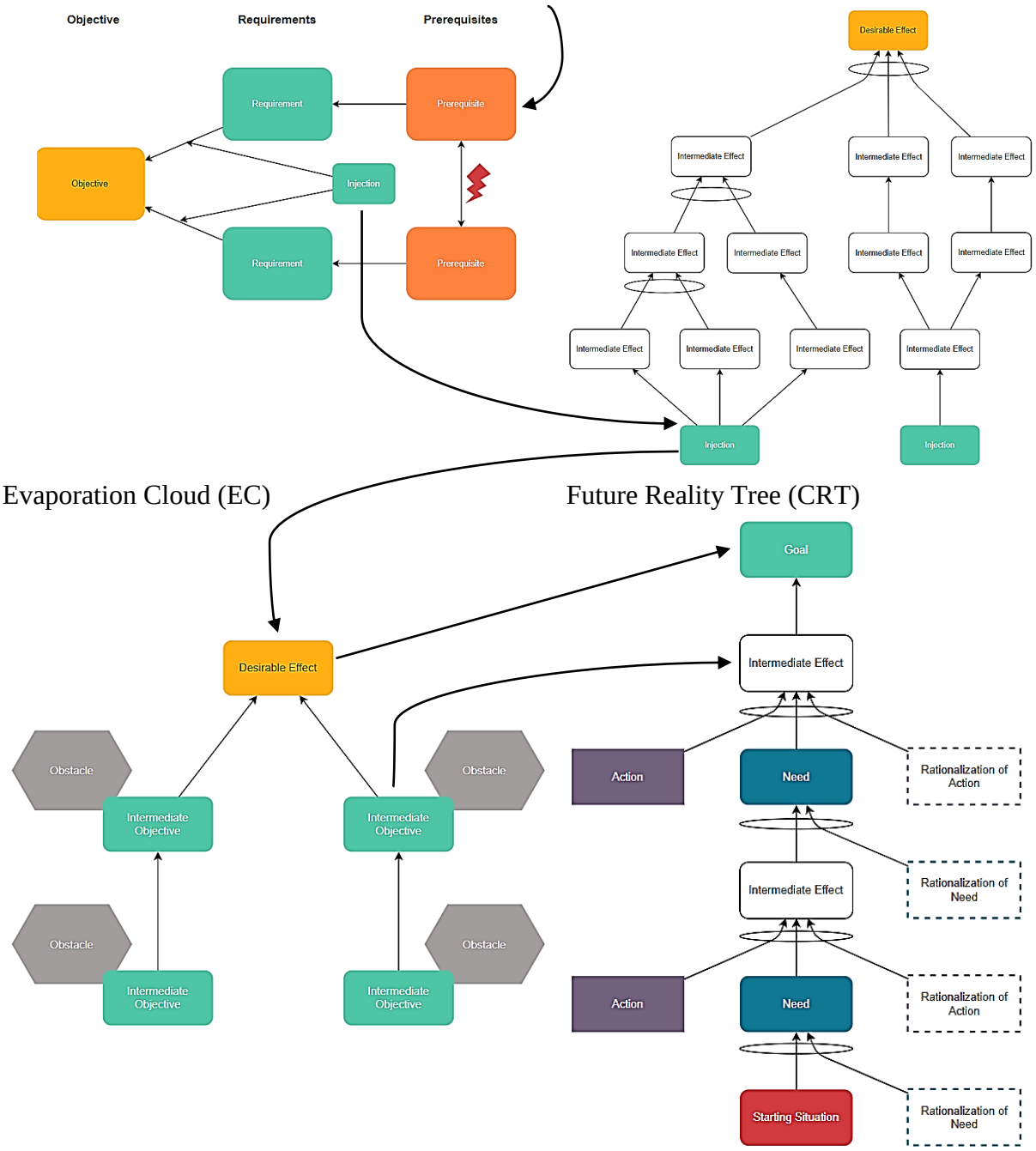


Figure 3. Principles of constructing the TOC thinking process tools.

Note: **GT:** *Goal* - the primary objective or the desired outcome, *CSF* - essential milestones needed to achieve the goal, *NC* - specific tasks or actions that must be met to achieve the CSFs, **CRT:** *UDE* - represent unwanted outcomes that are caused by other events or conditions; *Intermediate Effect* - represent outcomes that aren't necessarily good or bad and too are caused by other events or conditions, *Root Causes* - are the fundamental underlying factors or conditions that contribute to the existence of undesirable effects (UDEs) or problems within an organization; *Critical Root Cause* - is a specific root cause that has a significant impact on the occurrence or persistence of multiple undesirable effects or problems within the organization, **FRT:** *Desirable Effects* - are the desired states or conditions that the organization aims to realize as a result of implementing changes or initiatives, *Injections* - are the means by which an organization plans to bring about the desired future state envisioned in the FRT, **EC:** *Perequisites* - the wants of each party to the conflict understood as the edge of the conflict, *Requirement* - the needs of each side of the conflict, in other words, the reasons why each side wants what it wants, *Objective* - common goal of the conflict, if there was no common goal there would be no conflict, **PRT:** *Obstacle* - refer to the factors or conditions that stand in the way of achieving the intermediate objectives, *Intermediate Objective* -

are steps to implement the change or steps to overcome obstacles, **TT:** *Action* - refer to specific steps or interventions that need to be undertaken to facilitate the transition from the current state to the desired future state, *Need* - denote the requirements or conditions that must be met to enable the successful execution of the planned actions, *Intermediate Effect* - denote the interim or intermediate outcomes that result from the implementation of the actions and contribute to progress towards achieving the ultimate goals (Scheinkopf, 1999; Scheinkopf, 2010).

Source: own study based on Visual Paradigm Online.

Each thinking process tool has a purpose, but all tools can be used independently (). In the research part, they were used together, following the principles of their application and sequence, to ensure the synergy effect and maximize the benefits of their combined use.

Goal Tree (GT) was used to define all the necessary components to achieve the desired, chosen goal of the subsystem, from objectives called Critical Success Factors (CSFs) to its Necessary Conditions (NCs). Current Reality Tree (CRT) was used to visually map the cause-and-effect relationships underlying the identified root issues (UDEs) in the subsystem to discover the underlying/fundamental causes of these issues. Evaporative Cloud (EC) was used to identify and resolve specific conflict in the subsystem; thanks to it, the basic assumptions of the conflict were discovered and its creative solution was found on a "win-win" basis. Future Future Tree (FRT) was used to develop a vision of the desired future state of the subsystem; necessary changes and actions are presented to achieve the desired results. Prerequisite Tree (PRT) helped identify the necessary conditions to be met to achieve the desired goal. Transition Tree (TT) outlined the specific steps needed to transition from the current reality to the desired future reality and helped develop a roadmap for implementing changes and achieving subsystem goals (Taylor, Poyner, 2008; Scheinkopf, 1999; Scheinkopf, 2010).

First, the constraints in the analyzed subsystem were identified and classified, as well as the three most important ones, along with the justification for their selection. Then, the most important goals of the analyzed subsystem were identified and one was selected to build the Goal Tree. Next, the most important UDEs in the subsystem were selected and the Current Reality Tree was developed to indicate fundamental root causes. A hidden conflict in the subsystem was identified and, using the Evaporating Cloud, an attempt was made to solve the conflict using the "win-win" method. Subsequently, it was proposed to implement actions that will contribute to the elimination of UDEs using the Future Reality Tree. In the last step, one of the corrective actions was selected to indicate the necessary steps for its effective implementation by eliminating potential obstacles during implementation. For this purpose, the Prerequisite Tree was used.

Finally, to indicate the strengths and weaknesses of TOC thinking tools as well as opportunities and threats, an active SWOT analysis was carried out based on the collected experience and literature on the subject. Based on the identified factors, actions were proposed that will allow each organization to use thinking tools more effectively.

3. Results and Discussion

The constraints functioning in the examined subsystem of the automotive industry company - the research and development (R&D) department - were identified. The identification and classification of constraints in the analyzed subsystem are presented in Table 1.

Table 1.
Identification and classification of constraints in the organization's subsystem

No.	Constraints name/description	Constraint area [internal/market/ resource availability*]	Constraint type [physical/political/ paradigm**]	Comments
1	Lack of clear procedures for the WC11 system	internal	political	N/A
2	Lack of qualified employees to replace people who leave	resource availability	physical + political	Lack of employees due to a reduction in the number of vacancies
3	Lack of adequate efficiency in the prototyping department	resource availability	physical + political	There are no people to work, the company's internal arrangements allow only one unit to create prototypes
4	**Project delays**	internal	political	N/A
5	Duplicating activities related to the design of new products	internal	paradigm	N/A
6	**Lack of appropriate methodology for implementing new employees**	internal	political	N/A
7	A large number of projects carried out simultaneously	internal	political + paradigm	Suspension of employment due to disruptions related to COVID-19 and the belief that the more projects are completed, the better (with an impact on the quality of the service)
8	**Problems in the supply chain**	resource availability	physical + political	Lack of materials needed to produce the component caused by state policies (e.g. lockdowns, quarantines).
9	Delays in testing new products	internal	political	N/A

Note: * *internal* - it's everything that has something to do with the inside of the organization, regardless of what area it concerns; *market* - it's anything that has to do with the customer and the market and its limitations; *resource availability* - is everything that has to do with procurement (suppliers) and resources (materials, raw materials, machines, technologies, people). ** *physical* - e.g., the least efficient machine, person, or department; *political/procedural* - various policies and procedures imposed by corporations, enforced by law, required by superiors, as well as informal work rules in the company; *paradigms* - deep beliefs about reality from which the vast mass is completely unconscious to us.

Source: own study.

The most important goals for the analyzed subsystem were indicated, which include:

1. Eliminate delays on the latest projects within 2 years.
2. Introduce a uniform system for inducting new employees throughout the year.
3. Increasing the number of suppliers from 3 to 5 per production method within 5 years to minimize problems in the supply chain.

Delays in project preparation affect the future of the product. Such delays affect not only the R&D department itself, but also cooperation with suppliers, prototyping, validation and verification, and production and quality departments. Delays at such an early stage affect the entire subsequent implementation and production process, which may also affect the end customer who is obliged to meet their deadlines. Lack of product availability negatively affects not only the customer but also the company's reputation. Project delays can occur due to various problems, such as lack of availability of materials, personnel, insufficient information flow or system delays.

The lack of an appropriate methodology for onboarding new employees proves that new employees are not effectively integrated into the team and do not quickly achieve full productivity in the new work environment. The lack of clear procedures for onboarding a new employee means that new employees need more time to learn and assimilate, and this leads to a feeling of lack of support from new employees, which contributes to lowering their productivity and level of commitment. It also leads to people leaving the company quickly, which increases the employee turnover rate. Employees also feel underappreciated and dissatisfied with their jobs, which reduces their loyalty to the company. As a result, an incorrect methodology for implementing new employees results in reduced work efficiency and productivity, increased costs, and the loss of valuable staff.

Having more suppliers increases supply diversity and diversification of supply sources, which allows for greater flexibility in responding to changing market conditions and customer demand. In case of problems with one or two suppliers, other suppliers can ensure continuity of production at the appropriate quality level. More suppliers will reduce downtime caused by supply chain issues, which will increase a company's operational efficiency. The consequence of a larger number of suppliers is increased supply chain management costs related to the need for better coordination, monitoring and management of relationships with a larger number of business partners.

The goal of building the goal tree was to eliminate delays in the latest projects within 2 years. This goal has a very large impact on the process of introducing a new product into production. Delays in the design and implementation stages of documentation have a significant impact on the remaining stages of implementation. Delays generated at this stage affect all other production and distribution links. Eliminating delays will reduce the costs associated with changing priorities of both suppliers and internal production, minimize the risk of penalties, and stabilize the department's position as a reliable unit worth investing in. This is a goal that will be possible to achieve if most of the restrictions that apply to the examined subsystem of the company are eliminated.

The result of constructing a goal tree to indicate the necessary actions to achieve the goal - eliminate delays in the latest projects within 2 years, at three levels of detail is shown in Fig. 4.

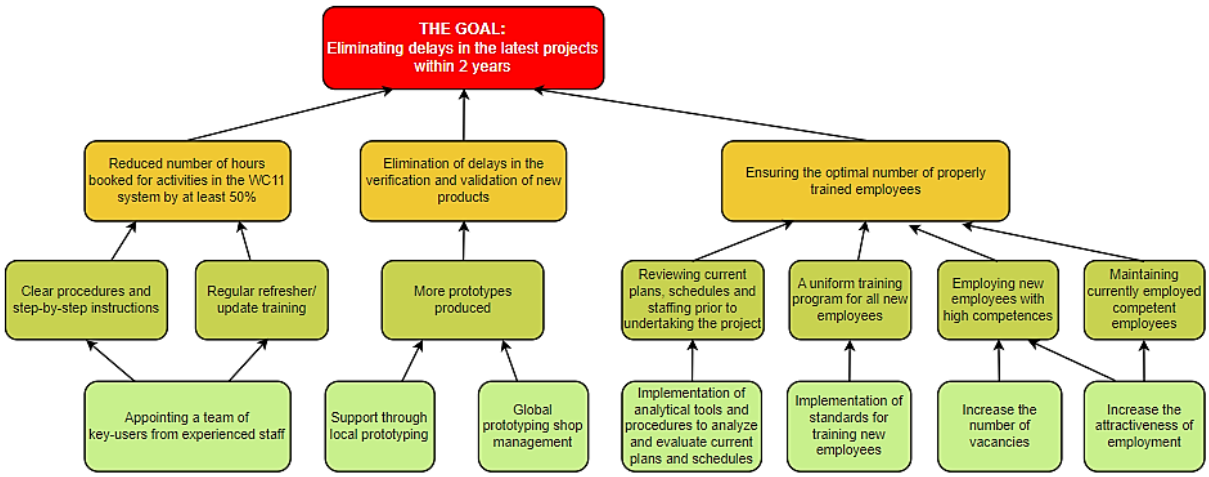


Figure 4. Goal Tree (GT).

Source: own study based on Visual Paradigm Online.

Analysis using the Goal Tree showed that to eliminate time slippages in the latest projects within 2 years, management of the subsystem should focus in particular on reducing the number of hours booked for activity in the WC11 system by at least 50%, eliminating delays in the verification and validation of new products and ensure the optimal number of trained employees. These are the so-called "Critical Success Factors (CSF)", "means", and "levers" of great importance, without which the main goal cannot be achieved. Key Necessary Conditions (NC) were also identified, at two levels of detail, needed to implement the CSF. These are elements supporting each CSF, "building blocks" without which each CSF cannot be implemented, having a functional (operational) nature.

The three key problems in the examined subsystem were indicated based on the Goal Tree (Fig. 5): 1. Too much time spent on the documentation processing system, 2. Too few well-trained employees, 3. Delays in the validation of new products.

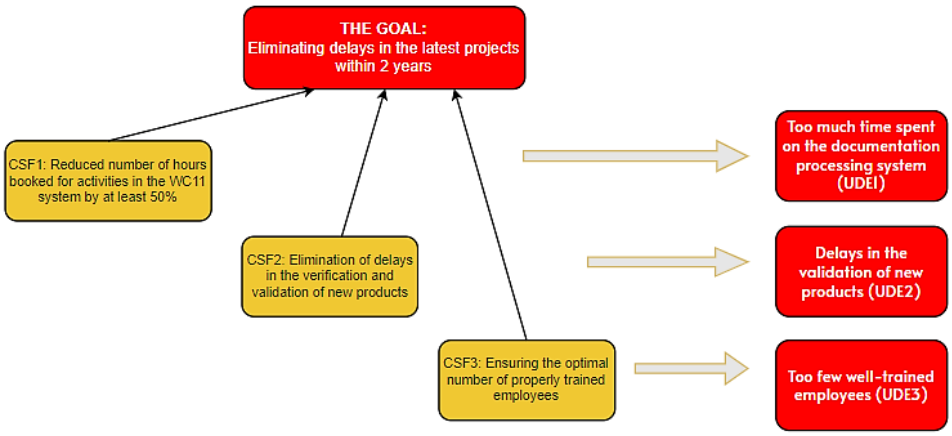


Figure 5. Identification of basic Undesirable Effects (UDEs) based on the Goal Tree (GT).

Source: own study based on Visual Paradigm Online.

These problems were treated as UDEs, i.e. symptoms and side effects of existing constraints in the analysed subsystem. The indicated UDEs are discrepancies from the set goal for the subsystem and its critical success factors - CSFs conditioning the achievement of this goal, i.e. "constraints" in the examined subsystem that prevent it from achieving better results about the main goal. It was concluded that these three UDEs require the most urgent attention and it is necessary to take action to eliminate them. The Current Reality Tree (CRT) (Fig. 6) was used to identify the root causes of these UDEs (marked with red fills) and point out the fundamental or critical root causes (marked with burgundy fills).

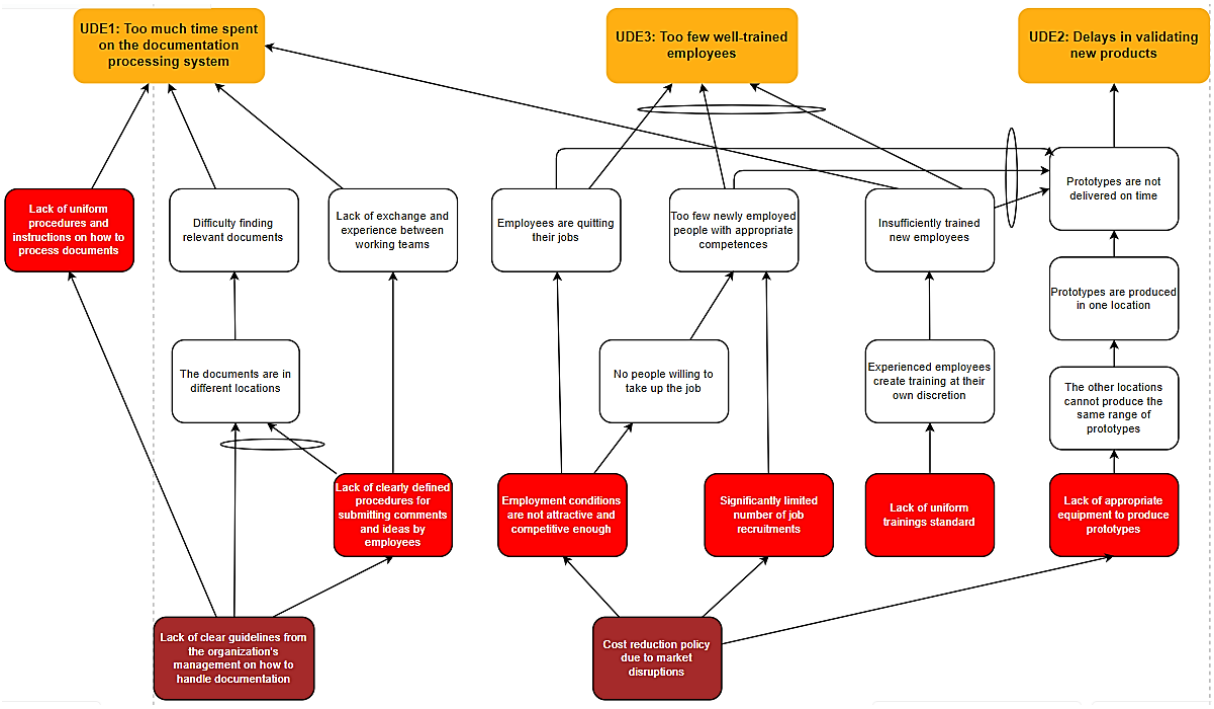


Figure 6. Current Reality Tree (CRT).

Source: own study based on Visual Paradigm Online.

Six major root causes were found for the UDEs studied. The lack of uniform procedures and instructions on how to process documents and the lack of procedures for submitting comments and ideas by employees in this regard are the root causes found for UDE1. The critical root cause of UDE1 was the lack of clear guidelines from the management regarding the implemented project documentation management system. Introducing a document management system in a large enterprise is a very difficult, time- and energy-consuming job. The matter becomes more complicated when this system is to replace several different systems that have been used in the enterprise for years and implemented at a time when the amount of information was much smaller. The introduction of the WC11 system without clear documentation processing procedures, standardization of procedures, regulation of nomenclature, delays in updating existing documentation, etc. generated a lot of additional and unnecessary work. This significantly increased the time needed to take action and the quality of work performed by employees, as well as delaying the entire process of approving

and validating documentation. The root cause of this state of affairs was identified as errors made by management during the implementation of the WC11 system in the enterprise.

The root cause of UDE2 was identified as the lack of adequate equipment to produce the same range of prototypes in different locations. In turn, the unattractive employment conditions, limited number of recruitments, and lack of a uniform training standard were indicated as the root causes of UDE3. The fundamental root cause for UDE2 and UDE3 was the cost reduction policy due to market disruptions resulting from the COVID-19 pandemic. The COVID-19 pandemic has caused serious problems for many companies and made it much more difficult to achieve their intended strategic goals (Gajdzik et al., 2024). The cost reduction policy resulted in a lack of investment in equipment for the production and validation of prototypes, made it difficult to retain competent employees and recruit new employees with similar competencies in their place, as well as conduct effective internal training, which resulted in the lack of an appropriate number of competent staff in the company's departments (including R&D department) and also as a result of delays in the validation of new products.

The problem that the examined company is struggling with is the problem related to the high employee turnover rate, which is caused by many circumstances, including lack of support during the employee induction process, insufficient professional development opportunities (Marszowski, Michalska, 2023), company policy related to cost reduction resulting in insufficient remuneration or lack of appropriate motivational measures (Putra et al., 2024; Szmyd, 2024). An intragroup conflict appeared in the examined subsystem: the R&D department, in which the team leader wants to give raises to his team to increase morale in the group and thus show employees that they are appreciated. Appreciating an employee is supposed to keep him in the company and increase his efficiency. In turn, the company's financial management team and general management do not want to give raises because the department must pursue a policy of savings and cost reduction due to disruptions and losses related to the COVID-19 epidemic. It was decided to analyze this conflict and find a solution that would satisfy both sides of the conflict. Evaporating Cloud (EC) was used for this purpose. The result of applying EC is shown in Fig. 7.

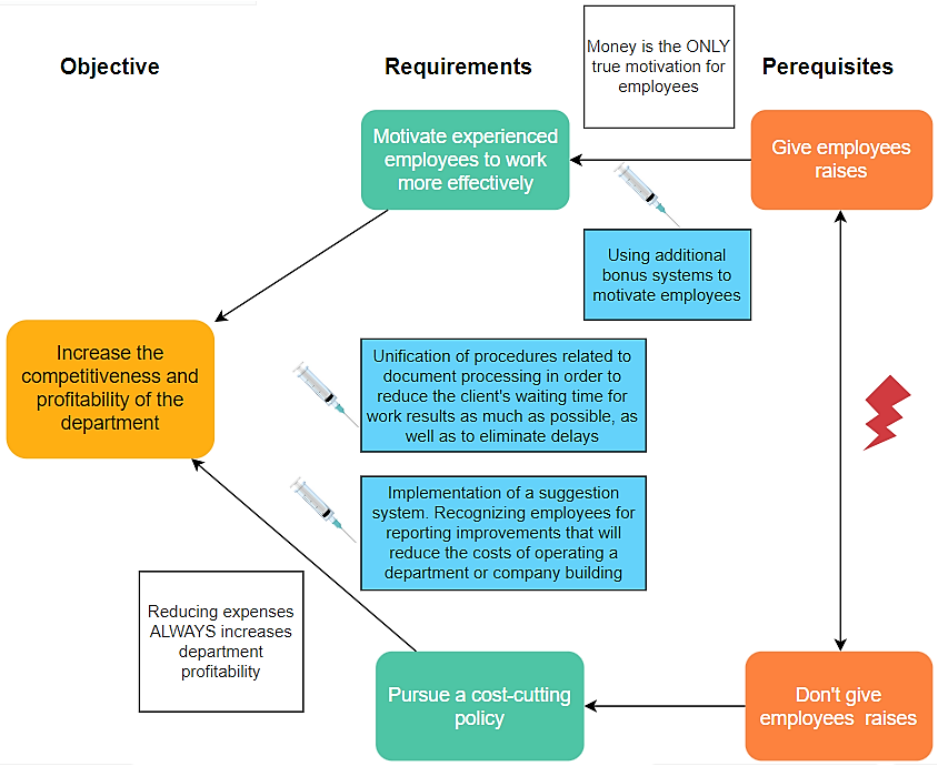


Figure 7. Evaporating Cloud (EC).

Source: own study based on Visual Paradigm Online.

The assumptions that lie behind each path of existing logical connections of statements are pointed out to find the incorrect assumption. Incorrect assumptions are marked with a white filling of the box. The incorrect assumptions included that "reducing expenses ALWAYS increases the profitability of the department" and "money is the ONLY right motivation for an employee." For these incorrect assumptions, "injections" were used, i.e. proposals for ways to resolve the conflict on a WIN-WIN basis, or in other words: ideas for "disarming" invalid assumptions. The implementation of an employee suggestion system, the unification of procedures related to document processing, and the introduction of additional bonus systems for employees were considered actions that would ultimately bring benefits to both sides of the conflict. An analysis was carried out for and against the implementation of the above-mentioned injections to eliminate the conflict. The result of this analysis is presented in Table 2.

As Table 2 shows, the list of benefits resulting from the implementation of the above-mentioned solutions is longer than the potential disadvantages, which supports the implementation of these improvement activities.

Table 2.
Analysis of pros and cons of implementing injections to eliminate invalid conflict assumptions

Incjections	Pros	Cons
Implementation of a suggestion system. Recognizing employees for reporting improvements that will reduce the costs of operating a department or company building	• The ability to demonstrate savings in areas of waste will contribute to cost optimization. • Encouraging company managers to invest in infrastructure will increase operational efficiency. • Motivating employees to get involved in the life of the company will bring tangible benefits. • Employees can be concretely shown that even small changes can bring big savings. • Demonstrating savings in other areas can prevent employee wages from stagnating.	• Some of them will require financial outlay. • The methodology of selecting the distinguished person may increase conflicts. • Some investments will have a long payback period. • It will be necessary to hire an additional person to manage this system or add responsibilities to a current employee.
Unification of procedures related to document processing to reduce the client's waiting time for work results as much as possible, as well as to eliminate delays	• Making working with documentation easier. • Reducing time wasted searching for solutions and procedures. • Elimination of errors, minimizing the time for finding and repairing them. • Reducing the likelihood of project delays. • Reduction of working time on projects. • Greater customer satisfaction. • Increasing team efficiency. • Reducing employee frustration.	• Lack of people to collect all the information and create procedures. • Creating or updating current procedures will be a time-consuming activity. • It will take a very long time to check the procedures. • The procedures are not infallible and cannot determine every case.
Using additional bonus systems to motivate employees	• Greater motivation of employees to do their job. • The job will be done faster and better. • Elimination of unjustified sick leave. • An employee who receives a bonus will feel more appreciated. • Greater fairness in rewards - an inefficient employee will earn less.	• It requires an outlay of money, which is not saving money. • It is not known whether the additional bonuses will pay off in the form of higher efficiency. • Bonus rules in the R&D department are difficult to define. • For fear of losing the allowance, an employee may work while sick.

Source: own study.

A future Reality Tree (FRT) was built to plan the implementation of changes aimed at eliminating the symptoms of constraints (UDEs) and achieving the intended goals (Fig. 8). FRT showed why changes are needed and what the benefits may be for the analyzed subsystem. Green boxes indicate injections that are closely related to the desired changes. Effective implementation of injections will enable cause-and-effect logic to achieve the desired changes.

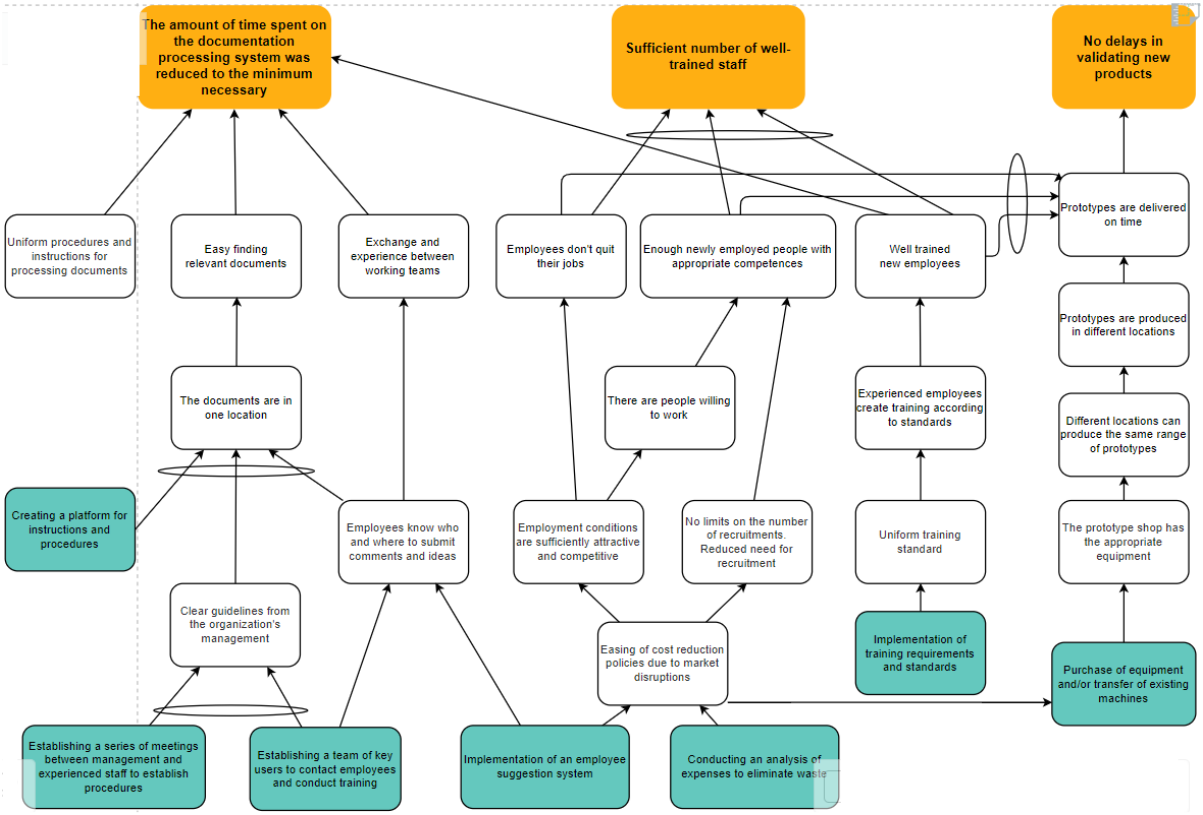


Figure 8. Future Reality Tree (FRT).

Source: own study based on Visual Paradigm Online.

To reduce the amount of time devoted to the documentation processing system, it is planned to create an Internet platform for storing instructions and procedures, create a series of meetings between management and experienced staff to establish and update necessary procedures, establish a team of key users to contact employees and conduct training, and introduction of an employee suggestion system to submit comments and ideas for improvement by employees.

To increase the number of well-trained employees, the basic actions included the implementation of training requirements and standards, the introduction of an award-winning employee suggestion system, carrying out an analysis of expenses to eliminate waste, and the transfer of funds for bonuses for employees (including those conducting training) to increasing crew morale.

To eliminate delays in the validation of new products, first of all, the necessary equipment for the production of prototypes or the transfer of existing machines should be purchased, which will mean that each prototyping plant in various locations will have the necessary equipment and will be able to produce prototypes so that the prototypes will always be delivered on time.

Actions were planned, starting from the current state to the desired future state, in connection with implementing one of the solutions: the implementation of training requirements and standards. Obstacles to achieving the main goal were also identified. The Prerequisite Tree was used for this purpose (Fig. 9).

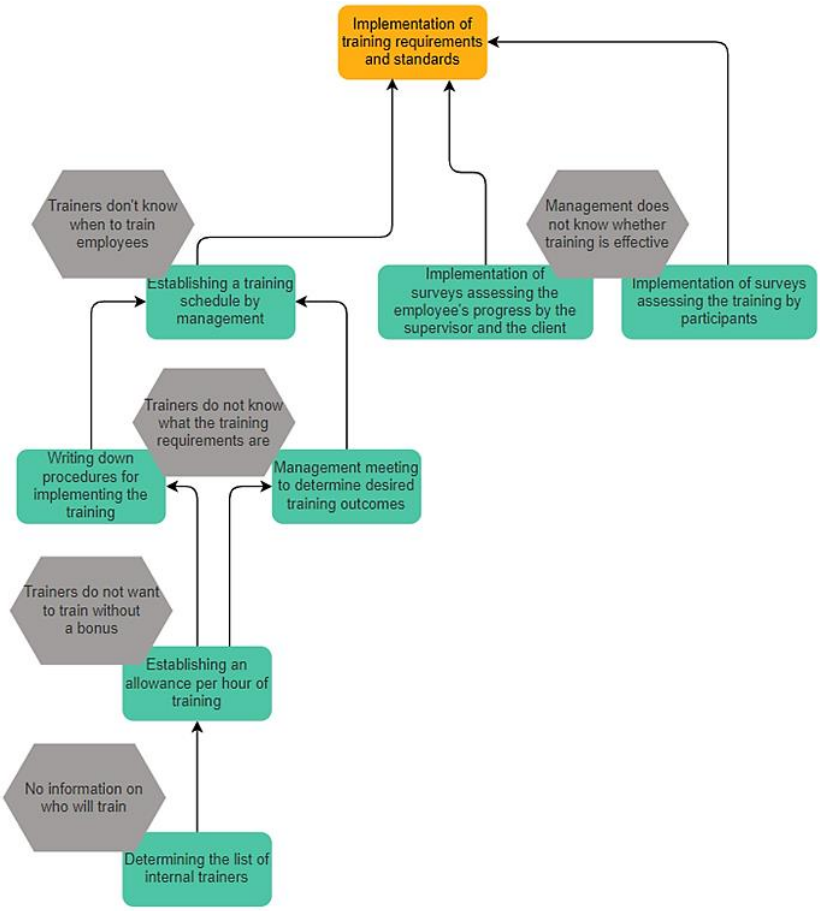


Figure 9. Prerequisite Tree (PT).

Source: own study based on Visual Paradigm Online.

The PRT is a plan for implementing training requirements and standards to which the organization's management should assign time frames, duties, and responsibilities. The management should eliminate all identified obstacles because they make it difficult to achieve the main goal and prevent the effective implementation of the analyzed solution. For this purpose, it was proposed to create intermediate goals, which should either eliminate a given obstacle or neutralize it, making it irrelevant to achieving the main goal. It was indicated that to effectively implement a system of training requirements and standards, it is necessary to start by creating a list of internal trainers from experienced staff, establishing an allowance per hour of training, determining the desired measurable effects of training, documenting training procedures, developing surveys assessing the employee's progress after training and surveys. assessing the training itself by employees and finally establishing a training schedule.

The main purpose (injection) of the PRT was chosen to convey a precise procedure for implementing training requirements and standards, which was done using a Transition Tree (TT) (Fig. 10). Thanks to the TT, the actions taken on the way to the goal (left side), the validity of the logic of actions on the way to the goal (why the actions are necessary - right side) and the resulting changes in reality (middle part - white field) and the needs to be satisfied (middle part - teal color field) have been defined.

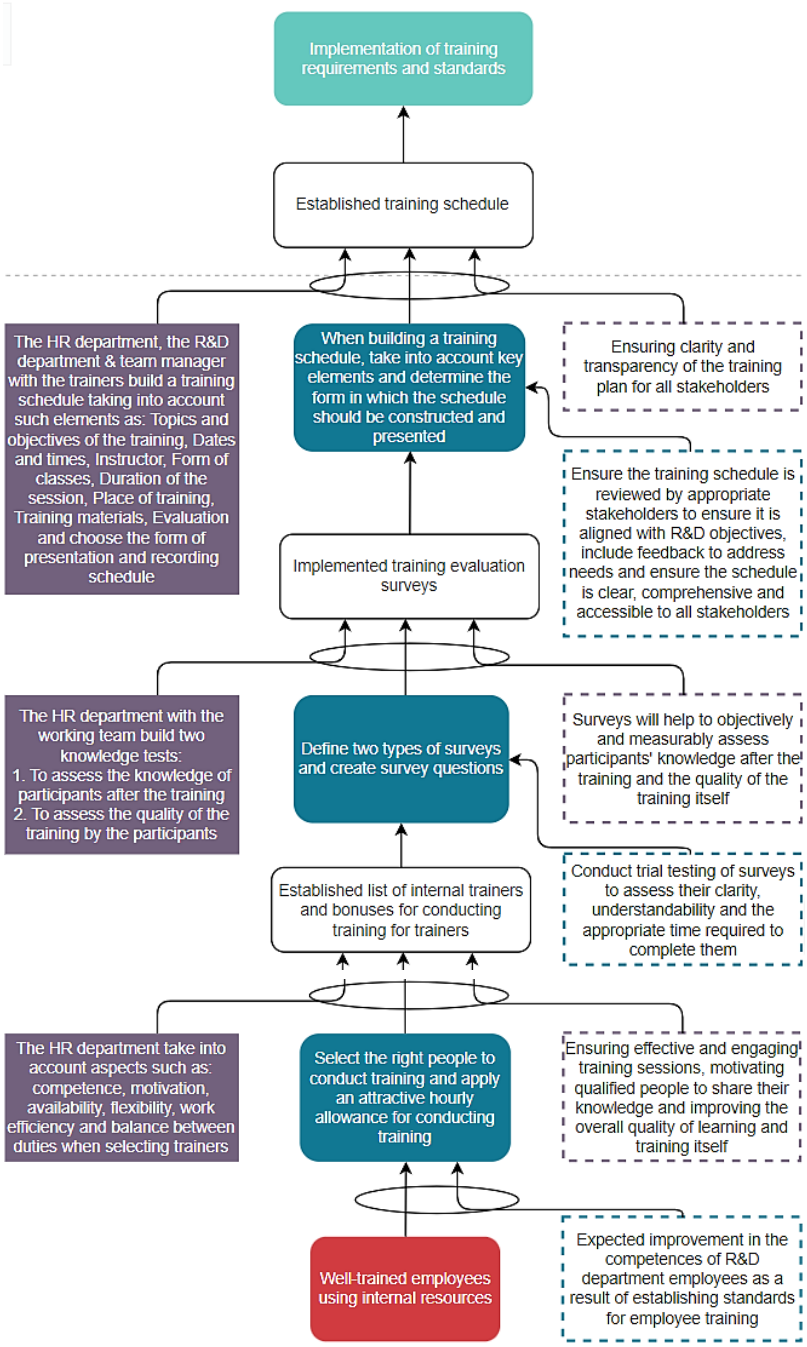


Figure 10. Transition Tree (TT).

Source: own study based on Visual Paradigm Online.

SWOT analysis was used in an active approach to determine the strengths and weaknesses, opportunities and threats related to the use of thinking process tools, and to propose reactive actions based on the identified factors. This analysis was made based on the experience gained from the use of thinking process tools in the examined enterprise. The tips contained in the SWOT analysis constitute an element of the risk analysis related to the use of thinking process tools and will allow managers of other companies to use thinking process tools more effectively in their organizations. The result of the SWOT analysis is presented in Table 3.

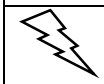
Table 3.
Active SWOT analysis for the effective use of Theory of Constraints (TOC) thinking process tools based on experience from the analyzed company

Factor no.	Factor name	Reaction to a factor
	**Strengths/Benefits/Advantages**	**How to use these advantages in any company's reality?**
1	They enable solving complex problems at various organizational levels	Establishing cross-functional problem-solving teams that utilize TOC thinking process tools to tackle complex issues that span multiple departments or organizational levels
2	They enable breakthrough solutions by identifying, challenging, and correcting unexamined assumptions	Conducting regular workshops or training sessions to encourage employees to challenge assumptions underlying existing processes and procedures, leading to innovative solutions and improvements
3	They help resolve hidden conflicts in the organization on a win-win basis, which often cause harmful symptoms that are confused with the problem itself	Facilitating open and constructive dialogue among stakeholders to identify and address underlying conflicts, fostering a collaborative environment focused on mutual understanding and resolution
4	They are versatile tools that can be used in any business situation, as well as to improve the competencies of a group of employees or management staff	Integrating TOC thinking process tools into various aspects of organizational development, such as strategic planning sessions, process improvement initiatives, and leadership development programs
5	They help achieve the goals set for individual organizational units, contributing to increasing the effectiveness and efficiency (profitability) of the organization	Aligning the goals of individual departments or units with the broader organizational objectives, utilizing TOC thinking process tools to identify and prioritize actions that drive towards common goals
6	They allow you to prioritize improvement activities based on current constraints in the system	Conducting regular assessments of organizational constraints and using TOC thinking process tools to prioritize improvement initiatives that address the most critical limitations, ensuring maximum impact on the company's profitability
7	They provide a focused approach to creating rapid improvements at various organizational levels	Implementing targeted improvement projects guided by TOC thinking process tools, allowing the organization to quickly address key challenges and achieve tangible results within specific areas or departments
8	They provide a framework that makes it easier to find what is slowing down the growth of the entire organization and enable continuous improvement	Establishing a culture of continuous improvement where TOC thinking process tools are regularly used to identify and address bottlenecks that hinder organizational growth, facilitating ongoing adaptation and enhancement of processes and systems
9	They help staff better focus on improvements that will have the most positive impact on the company's bottom line	Encouraging employees to use TOC thinking process tools to identify improvement opportunities that directly contribute to KPIs, promoting a results-oriented approach to problem-solving and decision-making

Cont. table 3.

	**Weaknesses/Disadvantages**	**How to protect from these weaknesses in any company's reality?**
1	Complex use requiring employees to have very good knowledge of all thinking tools	Investing in comprehensive training programs that provide employees with in-depth knowledge and practical experience through different case-studies in using TOC thinking process tools effectively
2	Time-consuming use requiring a lot of time to put all the thinking tools into practice	Focusing on applying the most important thinking tools to solving a given problem (i.e. CRT, EC, FRT, not all at once), by practically applying only one tool in one workgroup meeting, providing employees with enough time for this.
3	Cost-intensive use involving expensive training of employees in the practical use of thinking process tools (use of external training companies, training not very popular, niche, expensive)	Developing internal training opportunities and materials on TOC thinking tools, leveraging the internal expertise of a single person within the company professionally trained to deliver training, or exploring cost-effective multi-employee online training options to equip employees with the necessary skills in using TOC thinking tools
4	Niche use in other companies, hence the lack of benchmarking possibilities	Establishing collaboration with organizations that have successfully implemented TOC thinking process tools, enabling knowledge sharing and exchange of best practices
5	Difficult to assess the effectiveness of thinking process tools with other root cause analysis methods (Kaizen, 5WHY, HERCA, Ishikawa diagram)	Integrating TOC thinking process tools with additional analysis methods such as 5WHY or the Ishikawa diagram, enabling a holistic approach to problem-solving and improving profitability
6	Their use may lead to the generation of new conflicts in the system, interpersonal or intrapersonal	Proactively manage potential conflicts by fostering a culture of open communication, transparency and collaboration within the organization and ensuring that any conflicts that arise are resolved quickly and constructively
7	The success of their use depends largely on the correct identification of constraints in the system, because if inappropriate constraints are identified and optimized, the overall performance of the system may not improve and may even deteriorate	Reduce the risk of misidentifying constraints by conducting thorough analyses, assessments and interviews to accurately identify them, leveraging data and insights from cross-functional teams
8	Excessive focus on constraints and their elimination using thinking process tools may lead to the neglect of other important areas in the system (ex. motivation system, organizational culture)	Adopting a balanced approach to improvement initiatives, taking into account factors such as incentive systems, organizational culture and employee engagement, as well as constraints management efforts
9	The need to constantly update constraints in the system due to their dynamics over time and the need to devote large amounts of resources to this	Remain agile and respond to changing constraints by implementing regular reviews and assessments of the organizational system, using feedback and KPIs to identify current emerging constraints
10	The effectiveness of using thinking process tools depends on the organizational context, organizational culture and the way the tools are implemented by the people responsible for them	Promoting an organizational culture that values continuous improvement and cooperation between departments, as well as providing continuous support from management staff and creating tangible incentives to motivate the use of TOC thinking process tools

Cont. table 3.

	**Opportunities**	**How to take advantage of these opportunities in any company's reality?**
1	Availability of free online software for faster-using thinking process tools (e.g. Visual Paradigm Online)	Integrating free online software tools into troubleshooting processes. Using Visual Paradigm Online to enhance the application of TOC thinking process tools to increase the effectiveness of problem-solving initiatives
2	Availability of free training materials (lectures, articles, websites) devoted to the TOC and thinking process tools, containing numerous examples of the practical use of thinking process tools	Organizing internal workshops where employees can analyze various case studies related to the use of thinking tools, encouraging continuous learning and improvement of processes and systems in the organization
3	Gaining knowledge about TOC and thinking tools by employees by finding and participating in free or low-cost symposia, trainings, and conferences devoted to TOC and thinking tools	By sponsoring participation in appropriate events, organizations enable employees to expand their knowledge and skills, which ultimately contributes to initiating improvement activities by employees and more effective problem-solving in the company.
4	Acquiring knowledge by employees during studies (fully or partially sponsored by the employer) about thinking tools and using it by leading and implementing improvement projects in the company or writing a diploma thesis devoted in the research part to thinking tools (condition for sponsoring studies)	Offering financial support to employees pursuing relevant courses or study programs related to topics related to TOC and thinking tools. Employees can use their newly acquired knowledge and skills to conduct improvement projects connected with utilizing thinking process tools, driving continuous company improvement.
	**Threats**	**How to avoid these threats in any company's reality?**
1	High pressure to achieve short-term results forcing the implementation and use of quick and simple production improvement methods	Educating senior management about the long-term benefits of TOC compared to quick-improvement methods by demonstrating the potential for profitability with TOC to build support for TOC and thinking process tools implementation
2	Lack of competent employees on the market with knowledge of methods and tools for improvement and problem-solving, including TOC tools	Investing in training and development programs to build internal expertise in TOC tools by organizing workshops, seminars and certification programs for employees to gain by knowledge in TOC tools
3	Market disruptions forcing cost cutting and limited investments in employee training, including TOC tools	Prioritizing investment in employee TOC training by demonstrating TOC's potential to increase productivity, reduce costs and increase competitiveness
4	Limitation of the organization's ability to experiment with new production improvement methods such as TOC as a result of intensified competitive activities	Supporting a culture of continuous development and improvement by implementing proven manufacturing improvement methods such as TOC, providing resources for pilot projects related to the implementation of TOC tools, which can help the organization stay ahead of the competition

Source: own study.

By applying these actions, any company can effectively protect itself against the weaknesses of TOC thinking process tools and maximize the benefits of their use in improving the efficiency and profitability of the organization. It will make the best use of various market opportunities at the same time and protect itself against threats that prevent the effective use of these tools. Active SWOT analysis allowed us to create conditions for the effective implementation of TOC thinking process tools.

4. Summary

Enterprises must learn to use effective tools to solve complex problems. Sometimes, a few problems significantly limit a company's ability to generate more profits. By eliminating such problems a company can increase its profitability and competitiveness in the market. The use of appropriate problem-solving tools and teamwork on complex problems are prerequisites for successfully dealing with problems. The literature, as well as the results of the conducted analysis, indicate that thinking process tools from the Theory of Constraints concept can be effectively used to eliminate complex problems in an organization.

The use of thinking process tools in the studied automotive company, in the subsystem of this company - the R&D department, allowed to define the main goal for this department and critical success factors that were the basis for identifying key constraints: too much time devoted to the documentation processing system, delays in validation of new products and too few well-trained employees. These three constraints were subjected to deeper analysis using thinking process tools, which showed that the critical root causes of their occurrence were the lack of clear guidelines from management and the cost reduction policy due to market petrification. The indicated root causes can be described as systemic, procedural, political, and market constraints. The key intragroup, internal conflict was analyzed in which two parties: the team leader in R&D wants to give a raise to employees to improve the staff's morale, while management refrains from giving a raise due to pressure from top management to cut costs. It was proposed to implement solutions to this conflict: introducing a system of employee suggestions that will reduce the costs associated with operating the department or company building, standardizing procedures related to document processing, and introducing additional bonus systems, e.g. annual awards for special achievements for the company. Using subsequent thinking tools, remedial actions were identified that will help overcome constraints in the R&D department and the company itself, obstacles to the implementation of one of these remedial actions - the implementation of training requirements and standards - were identified, and how to overcome them was determined. A detailed action plan for implementing this solution was then presented, along with a justification for the actions taken. Using the active SWOT analysis, the strengths and weaknesses of the thinking process tools were analyzed, and external opportunities and threats related to the use of thinking tools were identified, thanks to which reactionary actions were indicated that will allow each organization to effectively use TOC tools.

In summary, the following benefits were achieved from the use of thinking process tools in the following categories:

- clear goal definition: the thinking process tools helped in defining a clear main goal for the subsystem, aligning its efforts towards a common objective,
- identification of critical constraints: by using these tools, the organization identified key constraints hindering productivity and profitability, allowing for targeted problem-solving efforts,
- root cause analysis: thinking process tools facilitated a deeper understanding of the root causes behind constraints, enabling the organization to address underlying issues rather than surface symptoms,
- conflict resolution: the tools aided in identifying and resolving internal conflicts,
- solution identification: through the application of these tools, the organization generated feasible solutions to overcome constraints, ensuring a systematic approach to problem-solving,
- action planning: the tools facilitated the development of detailed action plans for implementing solutions, providing a roadmap for addressing identified issues effectively,
- continuous improvement: by utilizing thinking process tools, the organization established a framework for the implementation of new standards (Pawlak et al., 2023) and ongoing improvement,
- "recognize strengths, turn weaknesses into strengths, take advantage of opportunities, and counteract threats": like any other improvement tool, thinking process tools have their strengths and weaknesses. Skillful use of the strengths of TOC tools and an attempt to mitigate the weaknesses by the organization's management will enable the effective use of these tools, providing the organization with the intended benefits. The use of external opportunities in the context of the effective use of thinking tools and an attempt to counteract external threats is an important element of the risk analysis related to the practical use of TOC tools.

The effective use of thinking process tools requires good knowledge of them and the ability to apply them in the conditions of the organizational culture of a given enterprise, is related to appropriate training by employees, which is difficult to access (Polish conditions) and often time- and cost-consuming, the involvement of appropriate human resources, and most importantly primarily support from management, which may not understand that something cannot be done simpler and cheaper. These are important limitations related to the use of thinking tools, which may cause management to give up the desire to use them and use other root cause analysis methods (Ishikawa/4M, 5WHY, WHY-WHY, Kaizen, HERCA) (Wolniak, Grebski, 2023a, 2023b; Wolniak et al., 2023). These tools have been proven to provide lasting solutions to critical and complex organizational problems with multiple root causes. To shorten

the time associated with using TOC thinking tools, you can focus on utilizing specific tools that were created for analyzing complex problems, e.i. CRT, EC, and FRT, focus on their effective use, omitting using more time-consuming tools, e.i. PT, TT.

Further research will focus on attempting to specifically evaluate the effectiveness of using TOC thinking tools in comparison to other problem-solving methods and tools. This research will aim to establish recommendations and guidelines for the practical application of various problem-solving techniques for different types of problems and in different organizational contexts.

References

1. Atwater, J.B., Chakravorty, S. (1995). Using the theory of constraints to guide the implementation of quality improvement projects in manufacturing operations. *International Journal of Production Research, Vol. 33, No. 6*, pp. 1761-1784, doi: 10.1080/00207549508930240
2. Azaria, S., Ronen, B., Shamir, N. (2023). Justice in time: A theory of constraints approach. *Journal of Operations Management, Vol. 69, No. 7*, pp. 1202-1208, doi: 10.1002/joom.1234
3. Banerjee, A., Mukhopadhyay, S.K. (2016). A Contemporary TOC Innovative Thinking Process in the Backdrop of Leagile Supply Chain. *Journal of Enterprise Information Management, Vol. 29, No. 3*, pp. 400-431, doi: 10.1108/JEIM-08-2014-0086
4. Blackstone, J.H. (2001). Theory of constraints – A status report. *International Journal of Production Research, Vol. 39, No. 6*, pp. 1053-1080, doi: 10.1080/00207540010028119
5. Cattaneo, C., Bassani, G. (2016). The TOC Thinking Process: The Viability of Change. *Human Systems Management, Vol. 35, No. 4*, pp. 301-323, doi: 10.3233/HSM-161616
6. Cooper, M.J., Loe, T.W. (2000). Using the Theory of Constraints' Thinking Processes to Improve Problem-Solving Skills in Marketing, *Journal of Marketing Education, Vol. 22, No. 2*, pp. 137-146, doi: 10.1177/0273475300222008
7. Cox III, J.F., Schleier, J.G. (2010). *Theory of Constraints Handbook*. New York, NY: McGraw-Hill.
8. Cox, J.F., Blackstone, J.H., Schleier, J.G. (2003). *Managing operations: A focus on excellence*. Great Barrington, MA: North River Press.
9. Cox, J.F., Spencer, M.S. (1998). *The Constraints Management Handbook*. Boca Raton, FL: The St Lucie Press/APICS Series on Constraints Management.
10. Dalci, I., Kosan, L. (2012). Theory of Constraints Thinking-Process Tools Facilitate Goal Achievement for Hotel Management: A Case Study of Improving Customer Satisfaction. *Journal of Hospitality Marketing & Management, Vol. 21, No. 5*, pp. 541-568, doi: 10.1080/19368623.2012.626751

11. Datt, M., Gupta, A., Misra, S.K., Gupta, M. (2024). Theory of constraints in healthcare: a systematic literature review. *International Journal of Quality & Reliability Management,* Vol. 41, No. 6, doi: 10.1108/IJQRM-02-2022-0056
12. Dettmer, H.W. (1995). Quality and the Theory of Constraints. *Quality Progress, April*, pp. 77-81.
13. Dettmer, H.W. (1997). *Goldratt's Theory of Constraints: A Systems Approach to Continuous Improvement*. Milwaukee: ASQC Quality Press.
14. Dettmer, H.W. (2007). *The Logical Thinking Process: A Systems Approach to Complex Problem Solving*. Milwaukee: ASQ Quality Press.
15. Ehie, I., Sheu, C. (2005). Integrating Six Sigma and Theory of Constraints for Continuous Improvement: A Case Study. *Journal of Manufacturing Technology Management, Vol. 1, No. 5*, pp. 542-553, doi:10.1108/17410380510600518
16. Fredendall, L.D., Patterson, J.W., Lenhartz, C., Mitchell, B.C. (2002). What Should be Changed? *Quality Progress, Vol. 35, No. 1*, pp. 50-59.
17. Gajdzik, B., Wolniak, R., Grebski, W. (2024). Changes in the steel chain in Industry 4.0. Some results of survey on the Polish steel market. *Production Engineering Archives, Vol. 30, No. 1*, pp. 1-16, doi: 10.30657/pea.2024.30.1
18. Gupta, M. (2003). Constraints Management – Recent Advances and Practices. *International Journal of Production Research, Vol. 41, No. 4*, pp. 647-659, doi:10.1080/0020754031000065458.
19. Gupta, M., Boyd, L.H. (2008). Theory of Constraints: A Theory for Operations Management. *International Journal of Operations and Production Management, Vol. 28, No. 10*, pp. 991-1012, doi:10.1108/01443570810903122
20. Gupta, M., Digalwar, A., Gupta, A., Goyal, A. (2022). Integrating Theory of Constraints, Lean and Six Sigma: a framework development and its application. *Production Planning & Control, Vol. 35, No. 3*, pp. 238-261, doi: 10.1080/09537287.2022.2071351
21. Gupta, M.L., Boyd, H., Kuzmits, F. (2011). The Evaporating Cloud: A Tool for Resolving Workplace Conflict. *International Journal of Conflict Management, Vol.* 22, *No. 4*, pp. 394-412, doi: 10.1108/10444061111171387
22. Hunink, M.M. (2001). In Search of Tools to Aid Logical Thinking and Communicating About Medical Decision Making. *Medical Decision Making, Vol. 21, No. 4*, pp. 267-277, doi: 10.1177/0272989X0102100402
23. Ikeziri, L.M., Souza, F.B. de, Gupta, M.C., de Camargo Fiorini, P. (2019). Theory of constraints: review and bibliometric analysis. *International Journal of Production Research, Vol. 57, No. 15-16*, pp. 5068-5102, doi: 10.1080/00207543.2018.1518602
24. Kim, S., Mabin, V.J., Davies, J. (2008). The Theory of Constraints Thinking Processes: Retrospect and Prospect. *International Journal of Operations and Production Management, Vol. 28, No. 2*, pp. 155-184, doi:10.1108/01443570810846883

25. Lacerda, D.P., Cassel, R.A., Rodrigues, L.H. (2010). Service Process Analysis Using Process Engineering and the Theory of Constraints Thinking Process. *Business Process Management Journal, Vol. 16, No. 2*, pp. 264-281, doi: 10.1108/14637151011035598
26. Mabin, V.J., Balderstone, S.J. (1999). *The World of the Theory of Constraints. A Review of the International Literature*. Boca Raton: CRC Press.
27. Marszowski, R., Michalska, A. (2023). The importance of leadership styles in stimulating the development of organisations from the mining industry. *Scientific Papers of Silesian University of Technology. Organization and Management Series, No. 180*, pp. 427-442, doi: 10.29119/1641-3466.2023.180.21
28. Pacheco, D.A. de J., Antunes Junior, J.A.V., de Matos, C.A. (2021). The constraints of theory: What is the impact of the Theory of Constraints on Operations Strategy? *International Journal of Production Economics, Vol. 235, 107955*, doi: 10.1016/j.ijpe.2020.107955
29. Pawlak, Sz., Nowacki, K., Kania, H. (2023). Analysis of the impact of the 5S tool and Standardization on the duration of the production process - case study. *Production Engineering Archives, Vol. 29, No. 4*, pp. 421-427, doi: 10.30657/pea.2023.29.47
30. *Prerequisite Tree*. (2021). Theory of Constraints Institute. https://www.tocinstitute.org/prerequisite-tree.html
31. Putra, I.B.U., Kot, S., Ibrahim, A.H.H., Rajiani, I. (2024). Human Resource Productivity: Integrating Resilience Engineering, Motivation, and Health Safety. *Production Engineering Archives, Vol. 30, No. 1*, pp. 105-114, doi: 10.30657/pea.2024.30.10
32. Rahman, S. (1998). Theory of constraints: a review of the philosophy and its applications. *International Journal of Operations & Production Management, Vol. 18, No. 4*, pp. 336-355.
33. Reid, R.A. (2007). Applying the TOC five-step focusing process in the service sector. *Managing Service Quality: An International Journal, Vol. 17, No. 2*, pp. 209-234, doi: 10.1108/09604520710735209
34. Scheinkopf, L. (2010). Thinking Process Including S&T Trees. In: J.F. Cox III, J.G. Schleier (Eds.), *Theory of Constraints Handbook* (pp. 729-786). New York, NY: McGraw-Hill.
35. Scheinkopf, L.J. (1999). *Thinking for a change: Putting the TOC thinking processes to use*. Boca Raton, FL: St. Lucie Press.
36. Shoemaker, T.E., Reid, R.A. (2005). Applying the TOC Thinking Process: A Case Study in the Government Sector. *Human Systems Management, Vol. 24, No. 1*, pp. 21-37, doi: 10.3233/HSM-2005-24104
37. Szmyd, K. (2024). The role of training in motivating employees in public administration. *Scientific Papers of Silesian University of Technology. Organization and Management Series, No. 194*, pp. 505-521, doi: 10.29119/1641-3466.2024.194.30

38. Taylor III, L.J., Poyner, I. (2008). Goldratt's Thinking Process Applied to the Problems Associated with Trained Employee Retention in a Highly Competitive Labor Market. *Journal of European Industrial Training, Vol. 32, No. 7*, pp. 594-608, doi: 10.1108/03090590810899847
39. Ulewicz, R., Siwiec, D., Pacana, A. (2023). A New Model of Pro-Quality Decision Making in Terms of Products' Improvement Considering Customer Requirements. *Energies, Vol. 16, Iss. 11*, pp. 1-22, doi: 10.3390/en16114378
40. Watson, K.J., Blackstone, J.H., Gardiner, S.C. (2007). The evolution of a management philosophy: the theory of constraints. *Journal of Operations Management, Vol. 25, No. 2,* pp. 387-402, doi: 10.1016/j.jom.2006.04.004
41. Wolniak, R., Gajdzik, B., Grebski, W. (2023). The usage of Root Cause Analysis (RCA) in Industry 4.0 conditions. *Scientific Papers of Silesian University of Technology. Organization and Management Series, No. 190,* pp. 223-235, doi: 10.29119/1641-3466.2023.190.15
42. Wolniak, R., Grebski, W. (2023). The usage of 5 Why in Industry 4.0 conditions. *Scientific Papers of Silesian University of Technology. Organization and Management Series, No. 189*, pp. 735-745, doi: 10.29119/1641-3466.2023.189.46
43. Wolniak, R., Grebski, W. (2023). The usage of Kaizen in Industry 4.0 conditions. *Scientific Papers of Silesian University of Technology. Organization and Management Series, No. 188*, pp. 677-686, doi: 10.29119/1641-3466.2023.188.41