# THESIS

## Summary

# RESEARCH ON THE APPLICATION OF STRATEGIC ENGINEERING IN THE ACTIVITY OF SMALL AND MEDIUM-SIZED ENTERPRISES. GEROM PETROSANI CASE STUDY

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The work includes an introduction, seven chapters, bibliography and appendices.

In the Introduction, the choice of the theme is motivated, this paper addresses aspects related to the use of strategic engineering in the field of activity of small and medium-sized enterprises. Based on experimental research in the field of technological processes of manufacturing mining equipment, the aspects related to the monitoring of parameters are taken into account technological influence on the performance of mining equipment.

In the first chapter entitled "Peculiarities of small and medium enterprises" the particularities of small and medium enterprises are identified. For this purpose, small and medium enterprises are defined and their role in the economy is identified. Small and medium-sized enterprises are not just scaled-down versions of large firms, and therefore the management methods and techniques applied in large firms will not work in small firms as well. Thus, the need to study and identify the distinctive characteristics of SMEs is supported in order to establish functional managerial methods for them.

Small and medium-sized enterprises contribute to economic development in various ways: by creating jobs in both rural and urban environments, by ensuring the sustainable development of the economy, representing at the same time the main source of innovation. SMEs have a significant effect on the distribution of social income, fiscal income, and employment, the efficient use of resources.The existence of small firms is strongly influenced by the personality of the owner/manager and his behavioral characteristics. Small business culture is marked by close and familiar contact between owners and employees, the business as a whole being close to the outside world, customers or suppliers. This type of company is especially characterized by a small size that leads to the specialization of the companies, to the concentration on a single market or a small number of markets, having a small share and therefore practically being unable to influence the price level. The limited resources at their disposal and the lack of the possibility of risk dispersion determine a major problem for small and medium-sized companies, namely the difficulties they encounter in attracting financing funds. The level of environmental uncertainty is much higher for these companies, both entering and exiting the market bringing them a series of obstacles.

It also presents the forms of organization, fields of activity, value structure, evaluation methods and the impact of managerial culture that contribute to the success or failure of small businesses.

Small and medium-sized companies enjoy a series of advantages: they are flexible, adaptable to change, their small size favors the speed of decision-making and their implementation, the working environment within SMEs is a better one, with closer relations both between employees as well as between employees and managers/owners. The SME sector is an extremely dynamic one, characterized by high initiation and bankruptcy rates. Among the factors that most frequently determine the failure of small and medium-sized companies are: the characteristics of the entrepreneur, his lack of managerial skills, the external environment, the company's resources, the lack of strategy and unclear objectives, the faulty concept of the service or product, insufficient study of consumers.

Introducing S.C. GEROM INTERNATIONAL S.A. Petroșani which is a company that manufactures a wide range of machinery and mining equipment. For this company, the interdependence between managerial culture and internal and external characteristics is analyzed.

In the second chapter entitled "Strategic engineering of small and medium-sized enterprises" the main aspects of strategic engineering are presented, highlighting the need for the application of strategic engineering, the importance of economic strategies, typologies of economic strategies and the development of economic strategies for small and medium-sized enterprises.

The economic strategy represents a complex concept that defines the set of objectives that the management of an economic unit aims to achieve, objectives established on the basis of studies, scientific research and forecasts, actions that must be taken over different time horizons and the way of allocating resources in in order to maintain competitiveness and future development.The central objective of strategic management is to ensure the company's long-term success. The task of strategic management can be divided into three components: strategic planning, implementation of strategies and strategic control (evaluation).The absence of strategies in the sector of small and medium enterprises can be translated by the following aspects:a lack of cash flow forecasting and cost control;an inadequate response to market realities;too rapid growth, with the appearance of a series of crises within the company (managerial, financial, etc.) or too slow, not taking sufficient advantage of internal and external opportunities;a lack of substantiation of the objectives;an improper allocation of the organization's resources;an insufficient definition of the scope of the enterprise's activity, accompanied by a partial understanding of the respective business concept.

Thus, we can conclude that strategic management is a necessity for small and medium enterprises, their survival and growth being threatened.

Regarding the issue of strategy and strategic management in small and medium enterprises, the following can be concluded:o in many small and medium enterprises there are intuitive or empirical strategies that are not outlined in a written form;o the personality of the owner/manager leaves its mark on the strategy, there being similarities between his objectives and those of the strategy;o there is a rejection and indifference in the use of strategic management which is mainly due to the lack of knowledge in this field both of the owners/managers and of the employees;o the strategic horizon is more limited, especially due to the higher uncertainty faced by these companies;a strategy must be more flexible in small and medium-sized companies to allow rapid adaptation to environmental changes.

The specialized literature suggests the idea that the type of planning used by small and medium-sized enterprises depends on the stage of development of the company, this type of activity evolving towards a greater degree of formalization and sophistication with the succession of stages in the life cycle of the companies. Also, as the complexity of activities and functional areas increases, strategic management will evolve from the stage of simple financial plans and budgets towards forecasting and outward-looking planning. In this last stage managers will begin to think strategically, using formal strategic management techniques. The progress towards strategic orientation and the use of more sophisticated tools specific to strategic management must be achieve with the development of companies to ensure their long-term survival and success.

Regarding the process of strategic management in small and medium-sized enterprises, a dynamic model of strategic management is necessary that has at its center the creation of value for customers consisting of four phases:an awareness

- understanding of the strategic situation;o strategy formulation
- preparation of appropriate strategies;o implementation of the strategy
- realization of the determined strategy and o control and evaluation of the strategy
- review and learning for future development.

The strategies, policies and competitive advantages of small and medium enterprises in Romania were analyzed for the year 2019 and partially for 2020, taking into account the economic and social situation, the provisions of the Government program, the EU Strategy 2020, the EU funding program 2014-2020, the Package especially for EU funding 2020-2027 for countering the current pandemic, the Small Business Act and the last half-yearly evaluations carried out by the European Union Commission, strategic documents that mark the major evolution of SMEs in Europe and implicitly in Romania.

In 2020, we distinguish the following significant directions of evolution: the increase in the incidence of concerns for the amplification of marketing activity, the acquisition of new technology, the intensive training of the workforce, building constructions and the computerization of activities, the replacement of machinery, managerial restructuring and modernization, the introduction of modern systems of quality management and pollution control/limitation; decreasing the weight of managerial options aimed at: other managerial priorities.

In the third chapter entitled "The systemic approach to technological processes and equipment in the construction of mining equipment" the production system is described, the logical-methodological problems of systemic research, the study of production systems, the optimal systems with and without variables as well as the technological process of manufacturing mining equipment at GEROM Petroșani as a complex production system. The place of the manufacturing process in the whole GEROM Petroșani as a system was highlighted as well as the characterization of the technological process as a system.

The technological process of manufacturing mining equipment from GEROM Petroșani is considered a complex production system with reverse connection that ensures the transmission of information from the execution level to the decision level in order to adapt it to actual situations. The company's manufacturing system includes three basic subsystems: the technological subsystem (ST), the informational-decisional subsystem (SD), the human structures subsystem (SU). Thus the idea emerges from here that the problems of commercial society as a system are not economic problems, but technical and economic ones.

If we consider the technological process of manufacturing mining equipment as a system, then it is characterized by the three essential elements specific to any system: purpose, organization and planned flow.Continuing the research of systems belonging, it is necessary to define from this point of view the basic technological process system with the help of an iconic-schematic model.

Within the production process, different technological processes are distinguished: basic, auxiliary, service technological processes, etc., according to the criterion regarding the participation in the realization of the finished product.

At the commercial company that builds mining equipment, the basic technological processes include: the development of semi-finished products (casting, pressing, welding, forging, etc.), processing on machine tools, assembly, testing, finishing. Auxiliary and service activities ensure the realization of the basic technological processes including: production processes of the various forms of energy used, maintenance of the technological equipment and the S.D.V.-istic equipment, etc.With these specifications, the iconic-schematic model of the production process reflects the interaction of the auxiliary and service processes with the basic technological processes.

The iconoc-schematic model allows the discussion of the purpose problem for the commercial company system and for the component subsystems.The production process as a system consists of the subsystem of the basic technological processes and the two subsystems of the auxiliary and service processes, respectively.

Continuing the research on the belonging of the systems, we arrive at the need to define from this point of view the basic technological process system with the help of an iconic-schematic model consisting of the subsystems: technological processes for the development of semi-finished products (PTsf), mechanical processing (PTpm), assembly (PTm), tests/trials (PRi) and finishing (PTf). The entry into the system consists of: materials, raw materials, energy, information and the exit from the system consists of: the objectified categorical goal identical to that of the production process and therefore to that of the commercial company as a system.

For a given finished product, the serial connection of the systems of the basic technological processes gives the image of a vector summation of the objective goals of the component processes. A matrix of purpose coefficients can be associated with the basic technological process. From the matrix of purpose coefficients it is found that:o column summation obliges the introduction of a benchmark objective and the conversion of each quality from the objective goals into the benchmark quality;summation on the lines does not generally raise special problems, except for the quantity characteristic of the objectified goal, when it is not possible to make an algebraic summation of some partial quantities from which the final quantity results.

The existence on the one hand of several objective goals, or more simply, objectives and the impossibility of optimizing a system only in relation to an objective, and on the other hand the possibility of considering different groupings of technological process systems, leads to the need to apply the theory of contraction of the criteria or treating the objectives as making up a system of objectives to establish the unique objectified categorical goal in relation to which to optimize the technological process system.

However, the systemic treatment requires the research of the interdependence of the elements, showing the necessity of grouping the elements according to certain criteria, for example - the criterion of precision.

The technological functionalism that cannot be separated from the structure, and the organization of the technological process system is the starting point in the optimization of this process and in this way, obtaining some "outputs" from this system that will constitute the "inputs" in the organization and management activities of the society commercial manufacturers of mining equipment, as a system.

Knowing the purpose and structure of the technological process as a system, it remains to specify the problem of flows present in this complex system. Taking into account the clarifications made regarding the localization of the technological process, in certain commercial companies, it follows the existence of three flows in the technological process: the flow of materials, the flow of energy, the flow of information.

Thus, the schematic model of an information block (pass, phase, operation, process) can be represented, which highlights the degree of processing and the degree of use of information with different functions in the organization of the information flow in the technological process as a system.

Looking at the technological process as a system, the following flows were highlighted: material (FM), energetic (FE) and informational (FI), but it must be specified that all these flows interact planned or programmed, not by themselves, but due to the active presence of man.

In general, the human system (SU) intervenes, leads, supervises each flow: FM, FE, FI or group of flows by means of machine tools, tools, devices, parts, etc., which form the technological system (STE).

With this specification, by technological process as a system, in the construction of machines, we mean an ordered sequence of subsystems man-machine or SU-STE with a well-defined objective through the technical-economic function and with a planned flow of materials, energy and information .

In the fourth chapter entitled "Strategic engineering in small and medium enterprises. Case study at GEROM Petroșani" presents the evolution of the concept of technological design, starting from the traditional, linear conception to parallel or simultaneous engineering, taking into account the life cycle of the product and the need to eliminate the linear, sequential process, by facilitating the intervention of the various professions that they seek to make work in parallel in order to obtain a faster convergence of the results of their work.

Currently, the notion of integrated or parallel design covers several meanings:o integration consists in taking into account the events that must occur, sooner or later, in the manufacture, commissioning, use or destruction of the product, right from the design phase. There must therefore be a link between the designer and the product's life cycle. A product is not necessarily made for a normal use phase, but has an origin, an end, needs for repair, destruction and recycling;o integration consists in the possibility of imagining solutions depending on the context in which the product must evolve. Of course, this is already directly related to the life cycle presented in the first approach, but the use of the product is strongly related to the environment in which it evolves or will be evaluated. The environment is seen here in a broad sense, being both the social and the physical environment of the product, both in the design phase and in the manufacturing or use phase. Also, integration is related to the integration of trades because the consideration of specific manufacturing restrictions will depend on the existence of the means available to make the product. Unusual usage solutions can be considered, in other words, a little forced, the provision of the unpredictable;o integration is seen under the participative aspect of different professional bodies during the design. It has already been pointed out that in the current industrial context, in which SMEs profiled on technical executions must be able to produce products at the lowest possible costs, of the highest quality and with the shortest possible deadlines. By integrating professional skills, taking into account the requirements of professionals from each specialty that compete to make the product, leads to an evolution of the processes in acceptable directions by eliminating irreversibilities in the design process as quickly as possible, reducing to the maximum the inputs-outputs between the different actors of different professions caused by incompatibilities of the works already performed.

Currently, integration regroups all three meanings, taking into account the life cycle of the product placed in its development and use environment, through the intervention during the development of the design of the different actors who sooner or later have to deal with the product.

The main connections between the design parameters and the different aspects of the manufacturing of a mining equipment within GEROM Petroşani, under the aspect of the basic model of dispositions and decisions at different levels, the design for production (DFM) was imposed, which consists in the necessity of concordance between the design data and the possibilities of manufacturing throughout the development of the product and its realization.

Design for Assembly (DFA) is a technical assessment used to measure the ease with which a product can be assembled. Because all products are assembled from many components and assembly takes time, this is a strong incentive to make mining machinery and equipment as easy to assemble as possible. The methods developed to measure assembly efficiency imply that the product design is quite complex before they to be applied. The ease of assembly is directly proportional to the number of components that need to be assembled.

A product is measured in terms of the efficiency of the whole assembly and the ease with which each component can be rebuilt, handled and assembled. A product with a high assembly efficiency will have several components that will be easy to handle and will slide together during assembly so that the labor yield is obvious and in addition, it represents an economy in invented and handled components.

With regard to design for costs (DTC), the timely identification of costs in all phases of development and design as well as in work planning thus becomes particularly important for meeting target costs. By juxtaposing the fixed (determined) and actual (realized) costs, the preponderant responsibility of the design in the final cost of the product is emphasized. In the majority of cases, the final expenses are fixed by choosing the operating principle and constructive form, choosing the manufacturing process, establishing the semi-finished product (metal materials) and defining the technological process. The structure of this distribution shows that most of the final expenses depend on the solutions adopted at this stage. Neglecting this relationship and taking into account in the design and planning departments only personnel expenses, aiming for small savings, leads to much higher expenses in the production sphere. In conclusion, much greater investments in conception and design through a global approach to the product throughout its life cycle, lead to a high responsibility for the final results of these activities. The quantification of this aspect requires estimating the costs of the products before they are fully detailed, involving estimation procedures that provide criteria for choosing between different design solutions.

GEROM Petroșani uses for the evaluation of the manufacturing costs/prices (quotes) of the individual mechanical parts a software designed and developed internally, software based on preset graphics that were built considering the following aspects (the designed software starts from to preparation-finish time, unit time, service time, machine loads, required material cost, unit/piece cost, total cost per batch/order):

o Type of material;

o Material quality;

o Number of pieces/lots;

o Experience accumulated over time;

o The size of the piece, calculated both in kilograms and volumetrically;

o Energy consumption of the machines involved in processing;

o Typology of the piece to be made;

o The need for qualified personnel involved in making the piece or the various intermediate stages;

o The order of operations to be performed on it;

o The number of operations to be performed on the raw material until it becomes a semi-finished or finished product;

o The number of personnel required to be involved simultaneously;

o The cost of the necessary materials is constantly updated, being the responsibility of the procurement department, which is in permanent contact with the specific market of the necessary materials, with its trends and with the possible evolution in the next period;o An important element of determining the cost and, respectively, the production price is the cost of transporting the materials both to the factory gate and the necessary cost to the beneficiary, if this delivery condition is negotiated with him; o When evaluating the price, in some cases where the beneficiary also wants assembly or commissioning for various products, when preparing the estimate, the time required to travel the technical team necessary to achieve this objective is also taken into account;o The experience accumulated over time is a factor, also determined, which was taken into account when developing the computer program used to determine the estimates drawn up for establishing the price/cost.

In a case study for the design of a flexible cell, the problem arises of achieving an optimum between the set of parts to be manufactured and the set of machines and peripherals capable of ensuring the best manufacturing. Also, it is useful to have at this level a design methodology showing the optimal way to follow, so that, starting from the components, you can arrive at the definition of a flexible cell. Such a methodology requires four main stages: i) production analysis; ii) determination of possible cells offering the possibility of knowing more parameters; iii) the dynamic stimulation that allows the appreciation of the coherence of the previous parameters, determining the production behavior of a flexible cell; iv) economic analysis of the project.

In approaching the problem of evaluating the costs of implementing a processing center (CP), the following assumptions are made:

o how much should a processing/rectification machine cost?

how much should a tool change cost?

o how much should automation cost?

o how much does it cost compared to countries with cheap labor?

The functions offered by an economic simulation program of the model which is based on the comparison of the operation of the machine with the numerical command served by an operator with the same machine integrated in an automated cell are: the calculation of the adjusted value per piece depending on the lot size; establishing comparative profitability areas on each of the two systems; calculation of the amortization time of the investment.

In the fifth chapter entitled "The mathematical model for the optimization of the technological process within GEROM Petroșani" the characteristics of the global mathematical model of the problem of optimizing the technological process, the directions for optimizing the technological processes as well as the limits and perspectives of mathematical modeling are presented. The calculation methods, in order to better understand the real processes, have created a calculation algorithm with limited applicability. This very characteristic highlights some of the limits implied by the connection between mathematical modeling and practice. In this direction, the following limits of mathematical modeling, used within GEROM Petroşani, can be mentioned:o calculation techniques and methods are applied in a finite field of concrete problems and the optimization of the entire technological process, in its entirety, still remains at the stage of only some attempts without a general solution being determined;o the decisions that are sometimes taken, in important issues, cannot be based on measurable quantitative factors. Until the moment when these factors can be expressed in quantitative form, a limitation of the field of mathematical modeling can be observed, because the establishment of the optimal decision, in such cases, is based on non-quantitative evaluations;few mathematical modeling methods have wide applicability. With the exception of mathematical programming and the critical path method, the other mathematical modeling methods have limited possibilities of application. In the case of operational calculation methods, there is not even a general algorithm, in the category of which the dynamic programming method also falls;o narrowing the scope of mathematical modeling methods for optimizing solutions, in the scope of concerns in the paper refers to the fact that the optimization of technological processes is also imposed by the type of manufacturing.

On economic grounds, optimization is applicable, with effectiveness, in large series and mass production; o the training gap that currently exists between the manager, in this case the technologist engineer and the computer scientist specialized in mathematical modeling. Mathematical demonstration can be very interesting, but a manager of a production process will not appreciate it if the information obtained is not useful to his activity. Thus, better collaboration and coordination between engineers, economists and computer scientists is necessary.

The importance of the uncertainty coefficients of the results of mathematical modeling for the establishment of decisions must be emphasized;o solving complex problems involves the use of electronic computers, which contributes to raising the cost of products. The use of appropriate mathematical models and the use of electronic computers can ensure the establishment of optimal solutions under certain conditions, in small time intervals, with important effects on the productivity and economy of work.

The problem of obtaining an optimal technological process (PTO) must be approached step by step in a logical sequence of the stages of the optimization process. The system of the optimization process within GEROM Petroşani includes the stages: o Information activity stage. During this stage, the technological system specialist informs himself in order to make decisions in the following decision-making stages, the necessary information is stored on different types of media: documentation, problem files, magnetic tapes or discs, memory sticks, microfilms, VCRs, etc. , organized into three major categories: requirements (C); possibilities (P) and knowledge (Cu) according to a structure that corresponds to the structure of the operational technological system in the manufacturing of mining equipment.

There is therefore the need to create some technological data banks, with a certain specific architecture, which allows both manual and automatic access, the information can be stored both in the operating cloud computing, but especially in coded form, much more accessible to automatic processing of information. In the field of computers and informatics, cloud computing is a modern concept that represents a distributed set of computing services, applications, information access and data storage, without the user needing to know the location and the physical configuration of the systems that provide these services.o The stage of the sequential decision-making activity in which the technological system specialist solves in a certain sequence decision nodes arranged on certain decision levels Ni (i = 1,2, ... ,n), for example: semi-finished product, nature and order of operations , technological equipment, regimes and norms, etc., establishing for each decision-making level, possible and technically and economically acceptable variants. In the ideal situation and, therefore, with a practically very small probability, a single optimal variant would be obtained at each decision level, the third optimization stage being practically cancelled, the optimal technological process being obtained within the second stage, satisfying the principle of Bellman's optimization.o The global optimization decision-making activity stage. This stage appears as a natural consequence of obtaining several acceptable variants for each level of the second activity and therefore of a matrix. The existence of several technological process variants for the same given theme, called possible technological processes (PT-P), naturally calls for their selection based on technical criteria (C-T) to obtain possible and acceptable technological process variants (PT-PA) and then selecting them based on some economic criteria (C-E) in order to obtain the possible, technically and economically acceptable technological process, a process that actually represents the optimal technological process sought (PTO).

Depending on the techniques and procedures used, as well as the equipment that the technological system specialist has, the level of treatment of the activities in the three stages is very different, from the level of manual-mental treatment to the fully automated level.

In the sixth chapter entitled "The possibility of expanding strategic engineering within GEROM Petroșani to the economic-social systems of small and medium-sized enterprises" I carried out an analysis of the factors that influence the activity of small and medium-sized enterprises, and based on a case study carried out at GEROM Petroșani regarding the application of subtle sets in value engineering, the solutions that can be applied to other small and medium-sized enterprises were highlighted. The application of subtle sets in value engineering requires the deepening of analogies from nature and the discovery of the most unexpected and unpredictable relationships between phenomena. That is why the concept of value engineering modeling must be adapted to the methods derived from the theory of utility and the theory of vague sets. Also, taking into account the current trends in modeling, the use of subtle sets is proposed because they present the advantage of operating in a unitary conception with deterministic, fuzzy and random quantities. To define a possible solution to a value engineering problem, one or more functions that the end user pursues, as well as the restrictions that must be satisfied (technical, ecological, psychological, etc.) are considered. Next, the cost restrictions are imposed, and in this sense the ratio between the utility of the benchmarks that satisfy both the required functions and the restrictions is estimated and is related to the total cost.

To develop the mathematical model of the fuzzy analysis method for multi-attribute decision-making problems, the following steps are followed: formulation of the problem (construction of the performance matrix of the variants and the vector of importance coefficients for the decision-making criteria), generation of the vector of fuzzy multi-attribute analysis performances.

The case study concerns the application of the fuzzy multi-attribute analysis procedure for the selection of a construction variant of the scraper conveyor mining machine for the mining industry within GEROM Petroşani. The following constructive types of mining equipment are taken into account:

- Variant V1: SAM – T: transport capacity: 20 ... 250 t/h; chain speed equipped with scrapers: 0.8 m/s; electric motor drive power: 45 kW; conveyor length: 60 m; weight: 17.5 tons;

- Variant V2: TR – 3 with an electric drive motor: transport capacity: 150 t/h; chain speed equipped with scrapers: 0.8 m/s; electric motor drive power: 22 kW; conveyor length: 60/120 m;

- V3 variant: TR – 3 with two electric drive motors: transport capacity: 150 t/h; chain speed equipped with scrapers: 0.8 m/s; electric motor drive power: 2 × 22 kW; conveyor length: 60/120 m;

- V4 variant: TR-2: transport capacity: 40 ... 65 t/h; chain speed equipped with scrapers: 0.5 m/s; driving power of the electric motor: 15 kW; conveyor length: 60 m; weight: 6.56 tons.

The decision criteria are: C1 - mining equipment maintenance; C2 - functional correlation with the machines in the slaughterhouse; C3 - the correlation from the point of view of the transport capacity with the machines in the slaughterhouse; C4 - the cost of the mining equipment; C5 - technical-mining characteristics of the abattoir; C6 - technical characteristics of the subassemblies used to make the equipment.

By ranking the variants in descending order of their performance index Pi, it follows that variant V1 can be considered for the manufacture of a scraper conveyor for the mining industry. We mention the fact that selecting the most appropriate decision option from a finite set of options requires consistent subjective judgments based on experience and intuition.The analyzed method allows the decision-maker to choose the most appropriate linguistic terms to express his reasoning and preferences regarding the decision criteria and the performance of the variants in relation to each criterion.

The application of the theory of fuzzy sets, however, requires the association of fuzzy numbers with linguistic terms. These numbers can be obtained from experts and incorporated into a knowledge base of a decision support system that would include multi-attribute analysis methods based on fuzzy set theory.The proposed procedure can be accepted as an easy-to-apply method for substantiating managerial decisions.Starting from the recognition of the fact that the product can be considered a system, and value analysis was applied to this system, obtaining important results, the question arises: Can the method of value analysis (value engineering) be applied to other systems as well?

Regarding the possibilities of extending the application of the principles of value analysis to the economic-social systems of small and medium-sized enterprises, starting from the case study, for the design of a new enterprise, a nomenclature of functions is proposed, which it should fulfill. The basic functions proposed for the enterprise in general and for SMEs in particular are:

o To ensure the needs of the market and of internal or external consumers, with functional, quality products at affordable prices;

o To ensure the appropriate technical and technological endowment for the realization of products/services;

o To ensure environmental protection;

o To ensure the judicious use of human resources and an appropriate motivational system;

o Create mechanisms for relations with stakeholders, both internal and external, that are significantly more balanced;

o To promote and support creativity and innovation in the enterprise, both at the level of products and management;

o To ensure an organizational climate and culture corresponding to increasing the efficiency and effectiveness of the enterprise;

o To ensure the transfer of international managerial know-how.

In the seventh chapter entitled "Final conclusions, personal contributions and research directions" I highlighted the general conclusions, regarding the current state of the research carried out regarding small and medium-sized enterprises operating in the field of machine construction, the influence of external factors on manufacturing flows, the influence of simulation modeling on the supply chain, original contributions and future directions for study.

At the end of the thesis, I highlighted the original contributions, the final conclusions and identified the future prospects for capitalizing and developing the results of the research carried out.Regarding the final conclusions we present the aspects below.

Currently, SMEs play an essential role in the economy of many countries in the world as well as in Romania, and therefore the issues related to the strategic evaluation of the work performance of SMEs highlight that it is quite important from a conceptual point of view and is in agreement with the research carried out.

The summary of the general conclusions is as follows:

1) Small and medium-sized enterprises (SMEs) represent the most important sources of economic development in many countries. Small and medium-sized enterprises contribute to economic development in various ways: by creating jobs (both in rural and urban areas), they ensure the sustainable development of the economy, they are also the main source of innovation, a large number of people rely on on small and medium-sized enterprises directly or indirectly, have a significant effect on the distribution of social incomes, fiscal incomes, and employment, the efficient use of resources and the stability of family incomes.

2) The existence of small and medium enterprises is strongly influenced by the personality of the owner/manager and his behavioral characteristics. The culture of small and medium enterprises is marked by close and familiar contact between owners and employees, the business as a whole being close to the outside world, customers, neighbors or suppliers. 3) The characteristic of small and medium enterprises to be small in size, determines the specialization of companies, the concentration only on a single market or a small number of markets, having a small market share and therefore practically unable to influence the level of prices.

4) The limited resources available to small and medium-sized enterprises and the lack of the possibility of risk dispersion determine a major problem for them, namely the difficulties they encounter in attracting financial funds for financing. The level of uncertainty of the external environment is much higher for these companies, so that entry and exit from the market are determined by a series of obstacles.

5) Small and medium-sized enterprises are characterized by a series of advantages, among which we mention: the company's flexibility, adaptability to change, the small size that favors the rapid adoption of decisions and their implementation; the working environment within SMEs is a better one with closer relations both between employees and between employees and managers/owners.

6) The SME sector is an extremely dynamic one, characterized by high initiation and bankruptcy rates. The factors that most frequently determine the failure of small and medium-sized enterprises are: the characteristics and lack of managerial skills of the entrepreneur/manager, the external environment, the company's resources, the lack of strategy and unclear objectives, the faulty service or product concept, the insufficient study of consumers.

7) The conducted research shows that among the owner/manager of small and medium-sized enterprises there is both a rejection and an indifference towards the use of strategic management, this is mainly due to the lack of knowledge in this field both of the owner/manager and of employees. A first argument of the owner/manager is that they do not need strategic planning, this being specific to large enterprises or, having a short-term oriented activity, they do not need planning, or formalized planning limits, constrains and reduces the flexibility of the company.

8) Competitiveness for SMEs is the result of a complex of factors internal and external to the company, whose influence can be negative or positive. An important step towards the Single Market can be made by consolidating and achieving success on the Romanian market. Romanian SMEs must contribute to the configuration of a favorable business environment that assimilates business culture and European good practices.

9) The economic gap between Romania and the majority of EU member states represents a major impediment in ensuring the competitiveness of Romanian SMEs on the European market. The most reliable solutions to overcome this problem are: the adoption of new technologies, orientation towards innovative solutions in the company's activity, access to national and international business facilitation networks and last but not least, the use of information and communication technology (ICT) in all activities , including in marketing and promotion.

10) If the increasingly strong action of the main influencing factors is taken into account, then the role of the economic strategy is to define, through objectives as precise as possible, the directions of the activity of the small and medium-sized enterprise, so that it achieves an increase in competitiveness .

11) The strategy involves monitoring the implementation of the proposed actions and measures as well as updating them and, as the case may be, supporting the promotion of new initiatives in accordance with the SME Development Strategy. The guarantee of the success of the implementation of the Strategy for supporting the development of SMEs is the effective cooperation and the general consensus between the decision-makers and the representatives of the SME communities. The monitoring system will measure the relevance, efficiency, effectiveness, impact and sustainability of the measures and actions according to the established indicators. The information resulting from the monitoring will be entered into a management information system that will be developed by GEROM Petroșani and that will be used as a basis for the preparation of annual reports and the mid-term and ex-post evaluations of the strategy.

12) The strategic management process for small and medium-sized enterprises is dynamic, focused on creating value both for customers, owner/manager and other stakeholders, and consists of four stages:

a strategic analysis that requires an analysis of the internal environment in order to identify the potential sources of competitive advantages but also the company's vulnerable points, the analysis of the external environment in order to identify opportunities and especially threats (given the vulnerability of this type of enterprise in the face of unfavorable changes) but and an analysis of the industry and competitors in order to assess the position of the enterprise within the industry in which it operates;

o the formulation of the strategy which consists in the preparation of suitable strategies in accordance with the context in which the enterprise carries out its activity, with the strategic objectives and with the resources at its disposal;

o the implementation of the strategy which consists in the realization of the determined strategy, this requiring the construction of an organization capable of successfully using the strategy, to realize the modeling of the organizational culture to match the chosen strategy;

o control and evaluation of the strategy that involves review and learning for the future development of the enterprise.

13) As a result of a systemic analysis regarding the formulation and solving of strategic engineering problems, in general, and those related to the manufacturing process of mining equipment at Gerom Petroșani, in particular, a series of shortcomings can be highlighted:an optimization scope does not cover the entire life cycle of the optimized object. When this object is the manufacturing process, the life cycle is between the ordering of the products (by the customer) and the delivery of the product (to the customer); the goal of optimization is unilaterally/narrowly defined, referring only to the best solution of the optimization problem, according to a predefined criterion/set of criteria. Conventional optimization is not sufficiently adapted to the specific requirements of manufacturing processes, because: i) although a process must be optimized in its entirety, often this is not feasible from the very beginning, decisions having to be made at successive levels throughout the process, ii) the tasks performed during a manufacturing process have different natures, as well as different requirements, iii) the effect variables that should be used to describe the performance of a certain manufacturing task, are not precisely specified, iv) the causal relationships either between the descriptive variables or between a set of descriptive variables and an effect variable, not known a priori; the existence of an often large number of manufacturing tasks that must be performed to obtain a product leads to a very large number of variables that must be monitored, the dimensionality of the optimization problem being, thus, too large for the computational resources currently available at the SME level the

14) Using the method of structural identification of the manufacturing process allows the structuring of the main activities that make up a manufacturing process, at all its levels (contracting, production planning, product design, process planning and product processing), by: i) developing the activity tree specific, highlighting the relationships between the stages of the manufacturing process and the related information circuit, ii) the identification of variants of the manufacturing process at the level of each manufacturing activity, iii) the selection of the best variants according to different optimization criteria (example: the cost , processing time, power consumption, other critical resource consumption, or combinations thereof). By applying the structural identification method, integrated with holistic optimization method, the number of potential activities to be evaluated can be significantly reduced.

15) The research of the manufacturing flows of mining machines and equipment at Gerom Petroșani aimed to meet the criteria of the quality triangle: optimal quality, delivery cost and delivery terms as short as possible. The main characteristics followed in the process of developing the manufacturing flows of mining machines and equipment in order to optimize were:

o the large volume of manipulations, interoperational transport, waiting, storage, the duration of which can represent up to 70-80% of the duration of the manufacturing cycle, determines costs that have a weight of 20-30% of the manufacturing cost. These characteristics can lead to production flow blockages, their discontinuity, non-productive times as well as non-value;

o manufacturing flows are relatively long;

o the transfer of semi-finished products and parts between operations have a low degree of mechanization and automation and as a result these operations are predominantly manual;

o the modification of the product nomenclature, or the technical endowment sometimes causes incompatibilities between the design of the manufacturing flow and the production objectives, an aspect that requires periodic redesigns and reorganizations of the manufacturing flows;

o the reorganization of manufacturing flows requires a relatively small technical and economic effort in relation to other industrial branches.

16) Other characteristics of the manufacturing flows identified in the case of the manufacturing of mining machines and equipment, which require solutions to reduce manufacturing times and costs are:

a high degree of constructive and technological complexity of related products and services;

o the heterogeneity of the economic destination of the products;

a spatial dispersion of the equipment and the production process;

a great complexity of management problems.

17) Another factor that influences the manufacturing flows of mining machinery and equipment is represented by assembly lines and logistics networks, including the implementation of automation technologies and IP networks (these include IP cameras and video servers that convert analog video signal to digital signal). . A percentage of 65-85% of the duration of a production cycle is represented by the non-technological operations of transport, handling, waiting or storage. These operations do not contribute to the creation of use value, but represent 30% of the value of a product.

18) All phenomena that accompany the operation of production systems are carried out according to laws of a random nature. The duration of machine operation between two failures MTBF (Mean Time Between Good Operation) and the duration of their repair depend on a large number of factors, and the overlap of their effects leads to a resultant whose description is most correctly done by a random function. Also, a key element in manufacturing flows is equipment reliability.

19) Optimizing the times required for manipulations can be achieved by placing the workstations as efficiently as possible, in this way a regular flow of materials and operations that are necessary for the production of the parts is ensured.

The following original contributions can be identified within the doctoral thesis:

1) Following the study of specialized literature, scientific works and other doctoral theses in this field, the documentation of the current state of approaches to the problems of applying strategic engineering to manufacturing processes in small and medium-sized enterprises was carried out.

2) From the analysis of the bibliography, according to the existing research, some shortcomings in the treatment of the problem of strategic engineering in the manufacturing process were highlighted, thus a reconsideration of the concept of strategic engineering of the manufacturing process was proposed through research directions and research objectives.

3) According to the concept of strategic manufacturing process engineering, a method for optimizing the manufacturing process was proposed.

4) Development of a structural identification method of the manufacturing process, a method that allows a structuring of the activities related to it, at all levels involved (contracting, production planning, product design, process planning and product processing), by elaborating the tree of specific activities ( highlighting the relationships between the stages of the manufacturing process

and the related information circuit) and identifying the variants of the manufacturing process at the level of each manufacturing activity.

5) Development of a method for identifying causal links, a method that allows providing multiple forms for one and the same causal relationship. The method was designed with the aim of being applied in the case of holistic optimization of the manufacturing process, before the comparative evaluation of the results of the activities that can be selected at the level of a decision point in the graph related to a manufacturing process. The method allows the identification of the most appropriate set of cause variables, based on which an effect variable can be evaluated, depending on the specific conditions of a certain manufacturing process. The purpose of applying the method is to elaborate the tree of causal links.

6) Development of a method for comparative evaluation of manufacturing process variants, a method that proposes an innovative approach in the analysis of potentially optimal solutions, based on their ranking. The comparative evaluation method was designed to assist in the selection of the optimal option to continue a manufacturing process, at a certain decision level. The application of the comparative evaluation method is done after the related causal identification, respectively after the adoption of a set of cause variables that describe the effect variable of interest at the current moment.

7) The work contributes to the optimization of manufacturing flows within the GEROM Petroșani company by analyzing the following aspects:

o the study of the particularities of the manufacturing flows of the components in the structure of mining equipment and machinery;

o highlighting the problems in the manufacturing process of mining equipment and machinery faced by the company;

o establishing the degree of efficiency regarding the implementation of production scheduling and tracking systems within the company;

an economic analysis of material and technological flow.

8) The objectives determined and pursued for the elaboration of this paper had as a starting point the need to introduce at the level of an industrial enterprise some production monitoring programs on the basis of which significant improvements can be made on the manufacturing cycles, thus contributing to the good operation of the enterprise and at the same time increasing the profit. For the manufacturing flows, the factors directly involved in the manufacturing processes that generated high costs and delivery times were identified and eliminated. Thus, for manufacturing processes, the productivity of existing manufacturing systems has been increased, consumption has been optimized and costs and inventories have been significantly reduced. The possibility of eliminating non-value elements was analyzed, these being discovered and eliminated through the application of manufacturing flow optimization methods, following which the production processes within the industrial enterprise correspond to the shortest delivery time and the highest productivity.

9) The work aims, in addition to the promotion of strategic engineering/strategic planning as a good practice among small and medium-sized enterprises, and a study on strategic planning activities carried out at GEROM Petroșani, which is located in the West development region, and

the examination, on the one part of the existence, nature and intensity of direct and indirect links, general and partial, between strategic planning, in general, and the components of this process, in particular, and on the other hand, the performance reflected by indicators related to turnover dynamics, the number of employees, meeting objectives.

10) The study highlighted both positive aspects regarding strategic planning and practices that must be corrected in order to increase the chances of success of small and medium-sized enterprises. The positive aspects regarding the strategic planning activities that resulted from the study are: the relatively high degree of formalization of the plans, the revision interval of the plans, the use of SWOT analysis and scenarios for pessimistic and optimistic situations (which indicates that there is an effort of thinking strategic among the company), formulating a mission and communicating it to employees and good communication within the company, the interest shown by the company's employees towards the needs of customers. However, the aspects that can be improved in the context of effective strategic planning are: long-term assessment of the impact of strengths and weaknesses, consideration of the long-term implications of opportunities and threats, concern for the long-term implications of the selected strategy, the existence of formal procedures for the assessment of opportunities and threats, the lack of knowledge of the strategic intentions of competitors, the allocation of appropriate resources for the implementation of strategies and the very existence of the stage of implementation of the selected strategy.

Future research directions are outlined below.

Considering the results of the research presented in the thesis, several future directions for capitalizing on them and deepening the research can be outlined, among which we mention:

1) Multi-modelling of a production line highlighting the specific characteristics for each modeling technique. Representing a system using different formalisms through multimodeling to observe the system from different angles.

2) Analysis of the possibilities of applying the strategic engineering method in all stages of the manufacturing process.

3) The application of statistical models in order to optimize the placement of machines within a production flow, highlighting some data and information that can contribute to improving the activity of small and medium-sized enterprises. The application of statistical models will allow the reduction of manufacturing times and costs through a more correct location of the machines. Also, by applying some statistical models, it will be proven that a bivalent location in an optimized form is the most indicated variant for the purpose of optimization.

4) Important for the company's success is the observance of some steps in the strategic planning process, but especially the content of the strategic plans. Thus, a potential future direction of research results from this: the content of strategic plans of SMEs through case studies among SMEs in the field of mechanical constructions, which will allow the formulation of directions for improving strategic management practices.The paper ends with a list of the bibliographic references used, as well as the works published and presented at scientific events by the doctoral student.