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PHD THESIS

SUMMARY

Solutions for revitalizing the activity at a company producing mining machines and equipment. Case study

PHD SUPERVISOR:
PROF. UNIV. DR. ENG. ILIAȘ NICOLAE

PHD STUDENT:
TULPAN MARIOARA

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SELECTIVE CONTENTS

INTRODUCTION

The Romanian industry has gone through in the last three decades a process of unrest and restructuring with economic and social consequences, changes in the industrial landscape, loss of skills and intellectual property, phenomena that the official statistical data do not highlight by using established indicators.

Within this framework, the Romanian industrial machinery manufacturing has also suffered, during this period, a sinuous route whose characteristics can be subsumed to the syntagma deindustrialization.

The same was happened in the case of the industry producing machinery, equipment and installations for the extractive industry, known generically as **mining machinery and equipment**, an industrial sub-branch that is closely related to the evolution of the extractive industry.

As in Romania, in recent decades, a process of downsizing or even liquidation of the mining industry has been carried out, it goes without saying that the industry producing machinery and machines dedicated to these industries has also suffered.

This process has led to the loss of almost all of the internal market, to the drastic reduction of demand, which, in conjunction with other constraints and difficulties, has endangered the very existence of numerous specialized firms.

A common feature of the countless projects and strategies for the industrial reconversion of mining areas, launched over time, some left on paper, others bogged down due to lack of resources or administrative capacity was their segmental character, being focused only on some components, not always the essential ones, of the social economic life of the areas in question.

For example, most of them concerned only the reconversion of the redundant workforce, the problem of unemployment and very few on the essential axes of sustainable development, such as the creation of industrial alternatives, investments that create added value, the revival of existing firms dependent on mining activity, the provision of human resources for sustainable development in the future, maintaining the urban status of the affected localities and others.

All the more so, as the very existence of these areas as human settlements was endangered, because the forced deindustrialization of the last 30 years, which has not carried out any dominant industrial activity of substitution, may shortly lead to a massive depopulation of these localities.

The unprecedented industrial transformation of the second half of the twentieth century, followed by a galloping, multi-wave population increase of the areas that later became disadvantaged, was the natural result of a mono-industrial development based on the exploitation of mineral and energy resources.

The mono-industrial character implies that, in addition to the basic industrial activity - mining - associated with the direct beneficiaries, the manufacturing industry, the steel industry and the thermal power engineering, there is a whole industry - value chain - of industrial activities subsumed to the basic industry.

The territorial thematic concentration, in the period to which we refer, was dictated by considerations of promptness of the response to the requirements of economic development and by the availability of the products supplied.

The various economic activities of production and services related to mining, maintenance, rail and road transport, and, last but not least, the manufacture of machinery and equipment for mining, have also followed an accelerated dynamic.

Not by chance, in the post-war period, the representative enterprises from the branch producing machinery and equipment for mining were located in the large mining centres, Jiu Valley, Brad Area, Deva, Gorj County, Baia Mare area, or the areas bordering them, as well as in areas with a strong pre-existing tradition in the field of machine building, such as Timisoara or Satu Mare.

If in the next period, of downward dynamics of the extractive industry, the outsourcing of related services by mining enterprises was considered a commendable managerial decision, in the subsequent period their internalization represents a solution for completing and controlling the value chain of the finished product, in this sense the new characteris, namely servicing being a motivating and dynamic factor.

A return to internalization is easily felt even nowadays, with a tendency to accentuate, worldwide, by concentrating the production of mining machines and equipment in several large multinational companies in the field, through the merging and /or acquisition processes, and the transition from product orientation to customer orientation, emphasizing the servicing of production, flexibility of the activity that proves

to be beneficial both for producers and beneficiaries.

Due to their character of high specificity of the products, of typological diversity and uniqueness dictated by the high unit value, unlike the mass or large series production, the companies specialized in the production of mining machines and equipment, had from the beginning a native flexibility, reflected in the way of organizing the production, which ensured them an advantage in the adaptation process specific to a reconfigurable production system, a trend that is being felt more and more strongly in the manufacturing industry, worldwide.

The transition from small or unique series equipment to turnkey technological solutions for large mining projects is an element that changes the centre of gravity from the actual manufacture, from product orientation to customer orientation, to consulting activity, innovation-based design and development at company level, subsumed to the phrase servitization (servicing). This trend is present in the analysed field, along with the concentration of firms through merging and acquisition.

Thus, ultra-specialized companies in the field, such as Eickhoff, Tamrock, SSCM, Hemscheidt, Klockner, which have since become branches of multinational giants, retaining their prestigious brand, but becoming components of a more comprehensive and resistant system in a market, which, paradoxically, has become more competitive although the number of competitors has decreased.

Interesting, from this point of view is the further evolution of the big producers, DBT, Bucyrus, CAT, Joy, Demag, Robbins, etc., which dominates the world market.

In eastern European countries, as in Romania, the evolution of companies producing mining machines and equipment, after the change of the political regime and the transition to the market economy, given that the restriction of the domestic mining activity led to a drastic downsizing of the traditional internal market, followed similar trajectories.

From repair, maintenance and spare parts production enterprises for imported machines and installations, located in mining areas, they have turned into productive enterprises of mining equipment.

Like the mining enterprises for which they provided products and services, they were owned by the state, operating in the system of the planned economy, their production, quantity and assortment being correlated with the requirements of the beneficiaries.

The machines produced were either of their own conception, adapted to the geologic-mining conditions and minerals to which they were dedicated, or assimilated after imported machines and equipment that had proved to be adaptable to the existing geologic-mining conditions.

Some products were even developed through cooperation with the manufacturers of the imported equipment, mainly from Eastern Europe but also from the Western one.

Most of them then entered the process of privatization, in the forms and methods specific to each post-communist country. Some subsequently entered, through various forms of acquisition or merging into the composition of specific companies in Western Europe, others were faced with difficulties that led, most of the times, to extinction.

For those that have remained viable, the problem arises of revitalization, based on solutions that ensure their adaptation to the increasingly changing conditions in the field of exploitation of mineral resources.

The present thesis tries to identify and scientifically substantiate some solutions possible to apply, following several directions of action and factors of influence that have emerged from the experience of a company on which the case study and the world trends in the field are grafted.

THESIS OUTLINE

CHAPTER 1 Characteristics of mining machinery and equipment

In this chapter, I intended to present, from the point of view of the subject and objectives of the thesis, the defining elements of the product of the manufacturing industry of machines and mining installations, elements that are useful in understanding and developing the analysis that follows.

Thus, I have pointed out that, unlike other industrial products, the equipment, installations, machinery for the mining industry are small series products with accentuated specificity and which meet specific requirements, characteristic of the environment in which they operate.

The current, structural and assortment configuration of these equipment is the result of a sinuous and conjectural technological evolution, dictated by the constructive complexity and accentuated specificity, imposed by the technological operating environment characterized by a variability of conditions and an accentuated aggressiveness that generated special difficulties on manufacturability.

Since this equipment has common, but also distinctive constructive, functional and usefulness aspects, the classification criteria derive from them, and serve to guide the manufacturer and the user in identifying them.

In this regard, I have proposed a systematized classification scheme by destination, working process and functionality, which offers a better categorization of them than the classification used in commercial environments and market studies.

In order to be competitive, a company producing mining machinery and equipment must take into account, in planning and drawing the future production strategy, the evolving trends of these equipment, in order to be able to anticipate the expectations of the beneficiaries in order to satisfy them.

That is why, based on an analysis of the specialized literature, I have made a synthesis of the main trends, which are manifested in the field of construction of installations, machinery and equipment for mining as a result of technological mutations in the sphere of extractive industry.

I have highlighted that, some of these trends are common to all machines, regardless of their type and destination, and others are specific to one or another of the groups of machines.

Compared to the general characteristic of industrial markets in general, the market of mining equipment has specific characteristics, which must be taken into account when developing strategies for the future development of manufacturing firms.

CHAPTER 2 Situation of the mining machinery and equipment manufacturing industry worldwide

Making an analysis of the current state and trend of evolution of the industrial machinery and equipment manufacturing industry worldwide, I have highlighted that the demand for mining machinery and related components is correlated with the demand for mineral resources, which is also in continuous dynamics, both quantitatively and as typological diversity.

This is due to the change in time of the use of mineral raw materials, both for energy purposes and as a raw material for various industries. The dynamic change in the value scale for mineral raw materials, with repercussions on the quantities and market value of different mineral substances, has also had an impact on the demand – in terms of volume and diversity of machinery and equipment for the extractive industry.

The mining machinery, plant and equipment manufacturing industry is highly

concentrated – with the 7 largest manufacturers in the world accounting for 43% of the global value of mining equipment produced and sold.

The increasing technical complexity of new generation equipment makes it increasingly difficult for small companies to compete with those that have larger financial and technical resources, which will lead to an increase in the degree of concentration.

The demand for mining equipment, globally and in most mature markets around the world is characterized by a rather high cyclicality. Another important feature of the market of machinery and equipment for the mining industry is the territorial division.

I presented the evolution after the change of the political regime and the transition to the market economy, of some companies in eastern Europe, confronted with the same problems as those in Romania, given that the downsizing of the local mining activity led to a drastic reduction of the traditional internal market, an evolution that can offer models of solutions for the revitalization of Romanian enterprises in similar situations.

CHAPTER 3 Situation of the mining machinery and equipment manufacturing industry in Romania

I have made a historical retrospective of the development of the Mining Machinery and Equipment Manufacturing Industry in Romania after the Second World War until now.

I have revealed that the current situation of the mining machinery and equipment manufacturing industry is the disastrous effect of the chaotic and unprofessional privatization process.

This was a natural consequence of the extensive industrial restructuring process that it has gone through in Romania over the last three decades, which has resulted in the decrease in domestic production and the operational closure of most of the mines.

The result was, with some delay, an involution and, in some cases, even leading to the disappearance of domestic suppliers of mining machinery and equipment.

Few companies in the field have resisted after 1990, most of them suppliers of machinery and maintenance services for lignite open pit coal mining, the solely remained mining activity.

However, some companies, including GEROM SA and ROMINEX-SA, have managed to survive, and are looking for revitalization solutions.

As coal mining has collapsed towards liquidation, its demand for new equipment has become increasingly reduced.

Even in the previous period, foreign competition on the internal market, fostered by the liberalisation of intra-Community trade and the difficulty of approaching the external market, were elements faced by this sector.

The next chapter presents in detail the current situation and the results that led to keeping GEROM INTERNATIONAL afloat, as a starting point for the analysis that will outline the future solutions for revitalization.

Chapter 4. Presentation of GEROM International SA

The difficulties created by the modification of the external economic environment have been overcome due to the decision to diversify the production towards areas collateral to mining, but which use similar equipment, for the internal and external market, by resuming the collaboration with traditional partners, but also through new partnerships and collaborations.

The exceptional technical endowment and the structural and organizational flexibility of the company allowed the capitalization of this opportunity.

The efficient management contributed to the passage of this period of economic turbulence, the company managing to advance in the new coordinates of the market

economy.

Protecting intellectual property was another means of maintaining the firm's ability to survive in times of crisis. The entire portfolio of products for which there is documentation, manufacturing technology and technological preparation has been registered as a trademark or patent.

Servicing, or the transition from product orientation to customer orientation, by offering product-related service packages, is a viable solution to revitalize the activity, which is part of the trend felt globally and nationally in the field of industrial equipment manufacturing, including those for mining and construction.

CHAPTER 5 Solutions for revitalizing the activity of companies producing mining machinery and equipment

This chapter is dedicated to presenting conclusions, contributions to the modelling of solutions for revitalizing production, as theoretical support and scientifically based demonstration of proposals for solutions for revitalization of a company producing mining machines and machinery.

The models are largely based on data from GEROM INTERNATIONAL S.A.

At the beginning of the chapter, I presented theoretical considerations regarding the modernization of production systems, this being considered the main lever for revitalizing a firm in difficulty, including companies producing mining machines and equipment.

The activity of modernization of production systems has certain specific features, which give it advantages over other methods of increasing economic efficiency.

Thus, I also presented the particularities of the projects for the modernization of the technological systems, highlighting the fact that the modernization ensures a more judicious distribution of the expenses, in the sense that they are oriented with priority for the construction, adaptation or structural improvement of the active fixed capital.

Regarding the company adopted for the case study, I showed that the technical endowment and the structural and organizational flexibility specific to the basic activity of the company allowed the capitalization of the opportunities offered by the modernization.

In the following subchapters I dealt with different models, based on theoretical assertions and methods of mathematical optimization applicable to the studied issues.

Thus, I made a model of the space economy applied to the study of the mining equipment market. Starting from the finding that the market of machinery and mining equipment, which is the subject of the present work, is a dispersed market, in the sense that both producers (suppliers) and consumers (customers) are unevenly distributed territorially in space, which makes the sale-purchase-supply process, to take place in time and space.

This is true both globally and nationally or regionally. The generality of the model I made and applied is not an impediment, on the contrary it can be used for the situation of a company or a consortium of companies, with a similar profile, with products identical in typology, which supply the products to consumers – dispersed mining enterprises.

From the point of view of relevance to the theme of the thesis, knowing the spatial aspects in expanding or restricting the search areas of the markets can represent a solution to revitalize the company producing mining machines.

The spatial economy methods, unlike the classical ones for establishing the supply-demand balance, take into account spatiality and assume that the development of the supply-procurement process does not take place instantly, and the aspects of transport costs are treated together with the dynamics of supply and demand.

Classical models are based on the "punctuality" hypothesis of the economy and

usually ignore the aspect of the geographical location of agents and markets. In this approach, the essential problems of economic analysis, such as the assortment of products, the production technology, the beneficiaries - the users of the products, are studied without taking into account the distances, transport costs or other shortcomings generated by the spatial dimension of the market.

In this thesis I have applied the model based on field theory to the analysis of the global market of equipment for the extractive industry, which are as a similar destination and functionality, regardless of the manufacturer, marketed at relatively equal prices, resulting from a natural balancing of demand - long-term supply, but the mix of production and consumption by geographical areas is different.

I proposed to divide the analysis space into 6 geographical areas that characterize the global mining machinery market, each containing, in different proportions, both manufacturers and users.

I have determined, using Mathcad applications, the product flows and the lines of separation between the zones of influence, and the results obtained are in line with the data presented in the market studies published by prestigious agencies, available to us.

The opportunity of the applied method and model for the global analysis of the markets of high-specific products, such as mining machines from industrially developed regions, where they occur to the emerging areas where the mineral resources exploitation activity is carried out, where the beneficiaries are located.

In the next subchapter I analysed the issue of sustainable development at the firm level as a status indicator and revival lever.

Sustainability, beyond its component focused on environment and resources, translated at company level involves setting long-term objectives correlated with those in the medium and short term, as well as compliance with a set of principles and criteria, which we have identified and formalized, among which the overall process improvement, effective use of resources, focus on financially critical areas, creating opportunities for innovation and technological progress, perfecting the supply mechanism, continuous evaluation of the organization and technological trends, analysis of the market potential and the field of competences, etc.

In summary, the permanent activation of innovation processes, increasing competitiveness at all stages of production by decreasing the consumption of material, energy and human resources used in the manufacture of products, are ways of reviving the activity of industrial production enterprises subsumed to the idea of sustainability.

At the end of the subchapter, I proposed relationships to calculate the economic effect of the various measures to increase sustainability.

The next subchapter is dedicated to shaping the economic impact of servicing in the mining machine manufacturing industry. Servicing production is a concept according to which companies that produce tangible goods not only to sell them as such but to sell their use or functionality.

This economic concept, called "product servicization" (servitization of products), is related to the concept of business based on "product-service systems" (product-service systems: PSS).

A product-service system (PSS) can be defined as a system of products, services, as well as partner networks and support infrastructure, which make the company more competitive because it is able to meet the specific needs of customers.

From this point of view, PSS is naturally the attribute of companies that are producing machines, equipment and mining installations.

In this subchapter I proposed an original model, which analyses the competition

between two business flows (models). One refers to a firm that offers separately goods (physical products) as well as associated services, possibly provided by a specialized firm, and the other refers to a firm that provides services goods, in which the tangible component is included in a whole inseparable with the associated services. I considered two critical parameters for the explicit competition between the two flows:

(1) dependence on services – which indicates the degree of dependence of physical goods on services and
(2) substitutability of flow – which indicates the degree of substitution between a conventional flow - product associated with services - and a serviced one.

The study, based on original equations and modelling in Mathcad, revealed that the servicing strategy is a better choice for a manufacturer who only sells physical goods when the goods require a higher level of services (i.e., they have a high dependence on services) and when the competition between the two strategies is more pronounced (that is, a high substitution of flows).

The next subchapter, also achieved through modelling, aims to demonstrate the idea that the process of creating and assimilating new products and services, introducing modern technologies, progressive methods of organizing work and production within an enterprise require a methodology for evaluating innovations, which is accessible and scientifically based.

In the first part of the subchapter, starting from the simplified equation of the Cobb Douglas production function, proposed by Solow, which highlights the role of the technological factor in the economic efficiency of the company, we made, based on the statistical data, the evaluation by regression of the contribution of the technical progress factor on the results, to three industrial fields of Hunedoara County.

Through this approach we have demonstrated the rationality of the idea of restructuring through technological development, respectively, a substantial economic growth can be achieved rather through investments in innovation, innovative business development, which produce a ...

Next, we turned to Forrester's System Dynamics modelling, which provides a more complete picture of the impact of technological innovation in the business environment.

Through the presented model, and realized with the Any Logic application, we considered the impact of two events with a shock effect in the evolution of a company, namely the layoff of 20% of the workforce at the time of t1 and the increase of the technological level through refurbishment, at the time of t2.

It turned out that in an industry with high personnel expenses and a low reinvestment rate, the reengineering, based on innovation and technology transfer, is the only one that ensures both the growth of production and an economic recovery in the mining machine manufacturing industry that is fit for the absorption of factors of progress, based on innovative technologies.

In the last subchapter we treated the theoretical substantiation of revitalization solutions based on econometric models.

Based on the economic and financial data of GEROM INTERNATIONAL SA from 2005 to 2021, I found that the company has gone through at least three stages regarding turnover, net profit, capital and personnel (average number of employees).

For the three stages of evolution, namely the periods 2005-2009, 2009- 2016, 2016-2021, I determined, by nonlinear regression, the production functions, using the method of the smallest squares in Mathcad.

In order to highlight the three stages of evolution, we made the correlations between the aforementioned time series. By analysing the production functions in the three stages and over the entire period, one can conclude the dominant factor of production,

and the beneficial effect of the investments in technology on the specific results.

Chapter 6 Final conclusions, original contributions, future directions of research

Final conclusions and original contributions were marked before, so I will present only:

Directions of future research and dissemination of research results

The field on which this thesis is focused refers to enterprises producing equipment for the extractive industry, which are small series products, some even unique, with high value, whose service life is long (from a few years to several decades, which are addressed to specialized beneficiaries (users) and for which they represent important elements of body capital.

The research carried out so far, accessible in the literature, is relatively small in number, in most of them punctual, based mostly on surveys among users or beneficiaries.

There is a lack of in-depth, scientifically based, theoretical analysis in the literature to analyse various factors of influence of the market-beneficiary-producer relationship. In this sense, as future directions of research I foresee the expansion of the approach based on mathematical modelling to capitalize on data provided by the case study subject.

The beneficiary– mining companies – producer – companies' relationship in the field is a field still unexplored from the point of view of industrial engineering.

The implementation of analyses involving the aspects of cyclicity, territorial fragmentation, with the use of modern methods of mathematical modelling is still fertile ground for further scientific approach.

Last but not least, the analysis of the favourable factors that lead to the revitalization of some companies in the field, the ways and the substantiation of the decisions that ensure a favourable dynamic of them, with modern analysis tools represent a way forward for future research.

Creating a database and information that creates the premises for a dedicated expert system is another challenge for future research.

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