

## INTEGRATED COMMERCIALIZATION MODEL OF RESEARCH AND DEVELOPMENT PROJECT RESULTS

*Małgorzata MALEC, Lilianna STAŃCZAK  
KOMAG Institute of Mining Technology*

*Brian RICKETTS  
EURACOAL (European Association for Coal and Lignite)*

### Abstract:

The need to undertake research work on the commercialization of results from scientific research and development projects emerged from the Author's professional experience as well as the incomprehensive literature on the role of Polish research institutes in the process of technology transfer and commercialization of innovative solutions, in particular in the case of mining machinery and equipment. From the available literature, the commercialization of research results and technology transfer are analyzed from the perspectives of academia and entrepreneurs, but there is no analysis of this challenge from the perspective of the research institutes which create the majority of innovative solutions implemented in Poland. The research results presented in this article identify and highlight not only the main factors which facilitate knowledge transfer in the widest sense, but also the barriers which should be overcome. An integrated commercialization model of research results, developed by the Author, is described in the article. Some examples of other models, used to assess innovative technology transfer processes, i.e. Transfer model of the Cracow University of Technology, Jolly's model, United model (science + market), Trzmielak's linear – subsequent model, Network – interactive model and IpOp model, are also presented. Special attention is paid to the process of generating innovative ideas and to the area of efficient project management. Based on the integrated model, practical management recommendations for the successful commercialization of innovative solutions are given. It is highlighted that the integrated model can be treated as a diagnostic tool, enabling an efficient assessment of the transfer of research results and commercialization of innovative solutions.

**Key words:** *commercialization, innovation, integrated model, research institute, technology transfer*

### INTRODUCTION

The article aims at a presentation of a research problem, identified by the Author, consisting in an investigation of commercialization process components in the case of research and development projects' results, realized by a research institute. The scientific problem, under consideration, concerned a construction, a description and an analysis of a commercialization model in the aspect of research work efficiency. The article fits in the scope of "Production Engineering" because the discussed "Engineering of Innovations" is a sort of a challenge for "Production Engineering", understood as a technical dimension of implementing innovative solutions in the economy. It is worth mentioning that a management of a transfer process of innovative solutions is an essential element of "Production Engineering", bearing in mind that engineering is an activity consisting in a cost-effective designing, constructing, modification and maintenance of practical solutions

of problems with use of scientific knowledge. It is important to remind the fact that engineering enables to use properties of matter, energy as well as abstract objects for a generation of machines and products to be used for an execution of required functions or a solution of a given problem. Thus it can be assumed that engineering is the area of creative technosphere, which takes into account the requirements of the ecosphere. It includes activities aimed at an efficient realization of the process from the moment of a need recognition till its full satisfaction. The Author's scientific contribution concerns an identification of a research problem, a construction of the own model of research results' commercialization in the field of mining machines and equipment, basing on procedures as well as an elaboration of guidelines enabling a dissemination of knowledge, facilitating a practical use of this model. The added value incorporates legal, economic, financial and organizational mechanisms, which speed up a

transformation of research results into innovative solutions of business character.

The Integrated Commercialization Model (ICM) reflects collaborative relationships among three partners in the process: a research institute, a producer of mining machines and equipment as well as an end-user of these machines, representing producers of minerals.

The information and the activities, presented in the article, enable a practical use of verified, efficient transfer methods of innovative solutions and of a commercialization of research results. Assuming that a transfer of innovative solutions means an implementation of research projects' results into economic practice, i.e. to be commercially used as an applied project, so the results of a research project and of an applied project can form the basis for an assessment of an implementation process correctness.

So far the relationships among the elements of the commercialization process of research and development projects' results, realized on the base of the Integrated Commercialization Model (ICM), developed by the Author have not been presented in detail. This model describes a collaboration of a research institute with industrial partners. The ICM is not a simple re-creation of the reality, but it is an intentional transformation, presenting the properties, which, in the Author's opinion, seem to be most important. The model was used for testing the commercialization of scientific and development projects' results, realized at the KOMAG Institute of Mining Technology in the years 2006-2011. For an elaboration of the model case-studies of three projects which ended with a success and of three projects which ended with a failure were analyzed very thoroughly. The article concentrates on management of innovative solutions transfer process. Basing on the conducted research, a scientific problem, consisting in a specification of relations among the elements of commercialization processes of research and development projects' results, carried out according to the integrated model of collaboration between a research institute and an industrial partner, was identified. The scientific and research problem concerned a construction, a description and an analysis of such a model in the aspect of effectiveness of the projects realized by a research institute. The method of "case studies" was applied for an analysis of three research projects which were successful and of three projects which failed. The terms "innovation" and "innovativeness" often appear in everyday language, but for an entrepreneur and for a researcher a practical dimension of innovations plays a crucial role. Innovations are created due to a collaboration between science and business. An indispensable source of innovations is a transfer of research and development projects' results and their adaptation for an industrial implementation. The research work, described in the article, was oriented onto phenomena, events and processes in the transfer channels of research results between a creator of innovative solutions, i.e. research institute and their users, i.e. producers of mining machines and equipment and mines of minerals [39]. Such an approach enabled to identify the

factors fostering a transfer of knowledge and innovative solutions as well as the factors which impede this transfer.

#### LITERATURE REVIEW

From the conducted literature review it could be concluded that it lacked a comprehensive analysis and a description identifying an impact of factors ensuring a successful realization of technology transfer methods and of a commercialization of research results realized at research institutes. According to Cadenhead G. [6] it is important to concentrate on the future impact of an innovative solution calling this activity a snapshot of the future. However, Drucker P. [14] stated that an innovation is a particular tool of entrepreneurs, used for changes enabling to undertake a new economic activity or render new services. The activities connected with a transfer of innovative solutions are a measure of technical progress, and their intensification has a decisive impact on a product business attractiveness and ensures a market supremacy [1, 4, 5, 12, 28, 42]. For an entrepreneur and for a scientist a practical dimension of an innovation is essential. It is generated in the result of collaboration between science and industry. The presented model of collaboration between a research institute and an industrial partner has not only research-cognitive objectives but also a utilitarian objective, i.e. it is a tool enabling a complex, comprehensive assessment of commercialization process of scientific and development projects' results. It can also be used as a recommendation for stakeholders of transfer processes of innovative solutions. The results of innovative projects are usually in a form of products and changes but the results of research projects can be patent-letters, know-how, technical knowledge and expertise, technical equipment and tools, generated due to an application of an innovative method but also technical services and scientific publications. Schumpeter J. [37] believes that innovations concern a product, a manufacturing process and an organization. To forecast the efficiency of innovative processes it is necessary to take the following actions:

- to conduct a risk analysis before starting a realization of the project and during its realization period,
- to define exactly all the tasks in the project management process, determining the scope of duties and responsibilities,
- to assess an advisability of the project continuation (the projects which lost their grounds should be interrupted irrespective of the costs borne so far).

A decision about the project advisability can be facilitated by a use of the QuickLook method which consists in the market research, an identification of potential end-users' needs, an analysis of a technology competitive supremacy and in an assessment of barriers. An efficiency analysis can be made using technological road-mapping, which supports a generation of a market strategy. A realization of a successful process of a development and commercialization of an innovative technical solution is not possible without a regular assessment of the project progress. It should be accompanied by an analysis of different scenarios which enables a long term planning of activities [8, 10,

13, 15]. It also helps to determine development paths, taking into consideration uncertainty areas and their impact on competitor's activities. The process of constructing scenarios enables an efficient use of knowledge in the scope of trends and factors having an impact on future changes. This process enables to identify all the parameters and factors which should be monitored, i.e. factors of success and barriers. It should be highlighted that in general the reasons of projects' failures are not of technical nature, but they are caused by an incorrect assessment of the reasons of experienced problems [3]. From the tests, conducted by the Bono [3, 9, 16, 18, 23], it can be concluded that 90% of mistakes result from the mistakes of perception and only 10% of them are caused by incorrect reasoning. The transfer efficiency of innovative solutions and of commercialization processes of research and development projects' results depends on the kind and scope of collaborative relationships between a research institute and an industrial partner. The article concentrates on a description of relationships among a research institute, conducting scientific, development and technical projects of applied research character in the scope of mining machines and equipment with particular attention paid to man-machine-environment issues, producers of mining machines and equipment directly implementing innovative solutions developed by a research institute and mines of minerals as end-users of innovative solutions.

American experience, resulting from the university innovative entrepreneurship [17, 20, 44], gives some practical guidelines which can be used on a large scale. The same approach can be found in the aspect of the organization culture impact on innovations [21, 22, 45, 46].

Some companies innovate towards sustainability to improve their socio-environmental and economic performance [2]. The analyzed sample was obtained from the database of companies that make up the Global Reporting Initiative. After having conducted the quantitative content analysis it was concluded that the size of the company influences the supply chain and the financial elements of the business model.

An interesting approach to business opportunities is described by Costa S.F. et al [11]. Sometimes it is difficult to understand the reasons why some individuals, but not others, identify business opportunities. Most studies on opportunity identification rely either on retrospective data or on entrepreneurs' knowledge and experience. In the study it was concluded that individuals were more risk-averse in the business reformulation opportunity than in the entrepreneurial opportunity.

Innovators have a natural bias to conceal key information because such knowledge can make a competitor's second-generation invention and patent more powerful. A key case study of a radical innovation such as the four-stroke engine [25, 35] gives a lot of information about new insights on issues related to full (or lack thereof) patent disclosure.

Sanz Llopis J. and Ostermann M. [36] suggest a new conceptual model that redefines innovation challenges. The Innovation Challenge Canvas (ICC) was generated on the basis of seven in-depth interviews with innovation directors. Its usefulness was tested in three case studies. An innovative approach, focusing on redefining a challenge instead of proposing solutions to a problem, fosters creative thinking and encourages innovative proposals. The ICC provides a better means enabling to manage projects that embody high uncertainty, while helping to generate more innovative solutions.

An interesting case study on learning communities as a support for a knowledge and innovation management system is presented by Gutierrez A. et al [19].

In China there are continuous debates on innovations [24] and on how to conduct innovative research projects in future.

The user is a critical factor in design and innovation [26, 29, 31]. Companies experiment with different approaches to involving the user in design processes, which result in new forms of intra- and extra-organizational collaboration. Such an approach is included in the KOMAG marketing strategy.

Intellectual and conceptual structure of creativity and innovation is a very good inspiration for all the researchers oriented onto an industrial implementation of novel solutions [32, 34]. Future topics and innovation development paths are of special interest and importance.

Analyzing a complex system of generating and implementing innovative solutions, some financial aspects of this process can have a decisive impact on its successful realization [33, 40, 41, 43].

On the grounds of the literature review a selection of the following research methods was chosen:

- analyses of texts representing Polish and foreign publications enabled to formulate a research problem which has already been described in the Introduction,
- method of multiple case study which was used for a description of three research projects which were successful and of three projects which failed,
- heuristic method which enabled to detect new facts and relationships among them, in particular the transposition method, being one of the heuristic methods, was used for conducting detailed analyses of the research projects,
- method of diagnostic survey (questionnaires) enabled to get knowledge about the users of innovative solutions offered by the research institute (a degree of satisfaction, critical opinions, expectations),
- method of mathematical statistics enabled to obtain useful, general information about meeting the industrial partners' expectations and requirements as well as to draw conclusions concerning all the set of industrial partners on the base of a tested sample.

In the result of the literature review and of the analyses of research methods, a research model was constructed.

### TRANSFER MODELS OF INNOVATIVE TECHNOLOGICAL SOLUTIONS AND OF COMMERCIALIZATION OF RESEARCH AND DEVELOPMENT PROJECT RESULTS

At present several transfer models of innovative technological solutions are commonly used for an assessment of commercialization processes.

They are as follows:

- Transfer model of the Cracow University of Technology.
- Jolly's model.
- United model (science + market).
- Trzmielak's linear – sequent model.
- Network – interactive model.
- IpOp model.

#### Transfer model of the Cracow University of Technology

This model combines many aspects of a composed innovation transfer process. It includes a company technological strategy and demand of new technologies as well as their assessment from the point of view of the determined selection criteria. After having obtained a positive technology assessment, the company starts to negotiate a contract. The model, presented in Fig. 1, reflects a typical transfer process of innovative solutions and of a commercialization process of research results realized by universities which offer ready-made technical and technological innovative solutions.

#### Jolly's model of commercialization of research results

- Jolly's technology commercialization model consists of five stages:
- IDEA – an awareness of potential and of technology innovativeness.
- INCUBATION – a determination of technology commercialization potential, a verification of property rights, a preparation of commercialization business-plan, obtaining external financial support for the technology commercialization.
- DEMONSTRATION – a preparation of the product/service for its introduction to the market.
- PROMOTION – a presentation of the product on the market, a collection of information about the product from customers and users.
- MAINTENANCE – an expansion and keeping the product on the market, full use of technology commercialization capabilities.

Jolly's model (Fig. 2) presents an innovation transfer process exclusively from the point of view of an entrepreneur. It does not include the role of scientific organizations as creators of innovative solutions. It also contains a financial aspect as regards means for a demonstration and for the product maintenance.

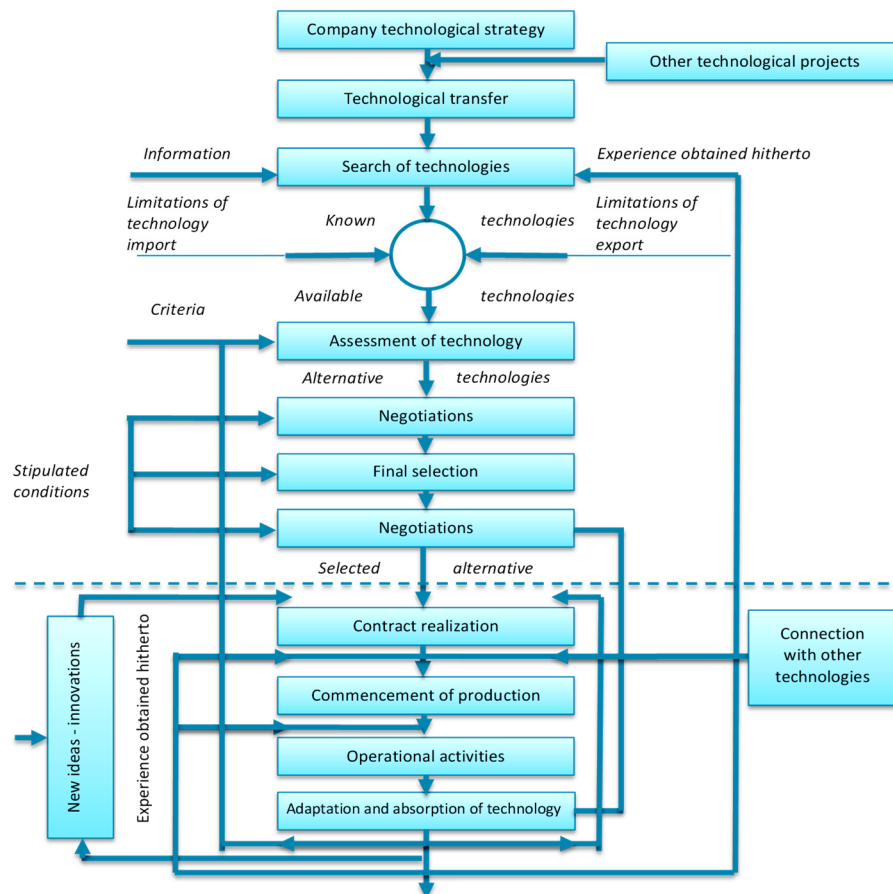
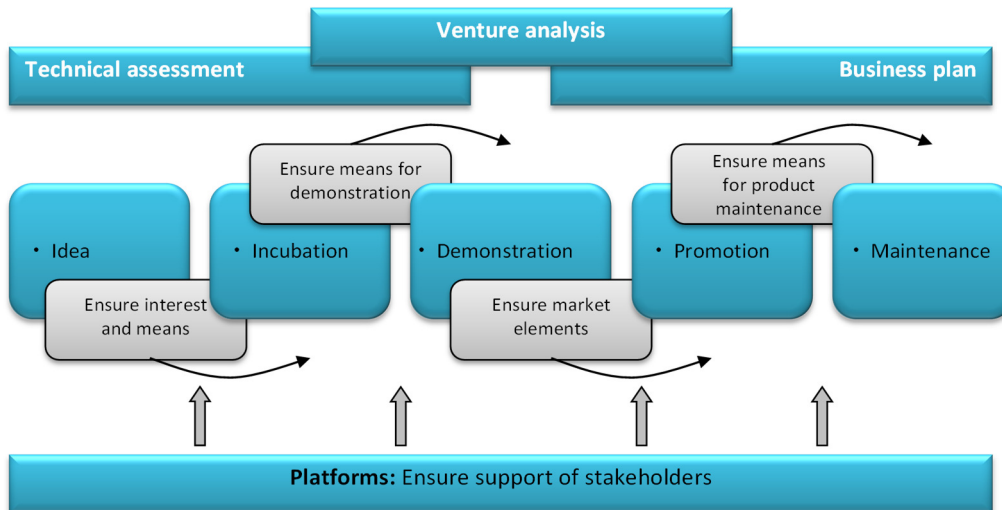


Fig. 1 Commercialization model of research results suggested by the Cracow University of Technology

Source: [7].



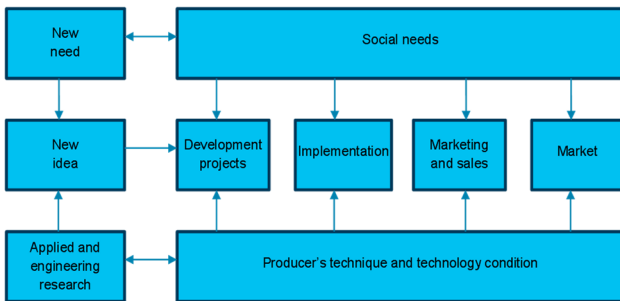
**Fig. 2 Jolly's commercialization model of research results**  
Source: [21].

**United model (science + market)**

Analyzing commercialization models, it is worth taking into consideration the united model recommended by the Harvard Business School. There are three types of this model:

- the model “pushed” by market, consisting in using the results of fundamental research,
- the model “pulled” by market, consisting in using the results of applied research,
- the “united” model, combining both above given models, i.e. an impact of science and market.

A scheme of the united model is shown in Fig. 3.

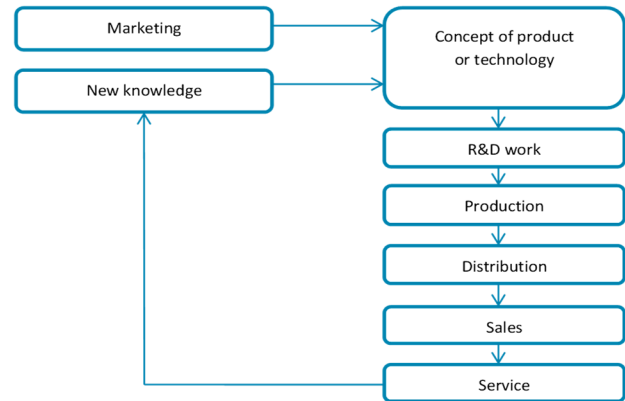


**Fig. 3 United model (science + market)**  
Source: [21].

This model is commonly used by advanced technology centres, technological platforms and clusters.

**Trzmielak's linear – sequent model**

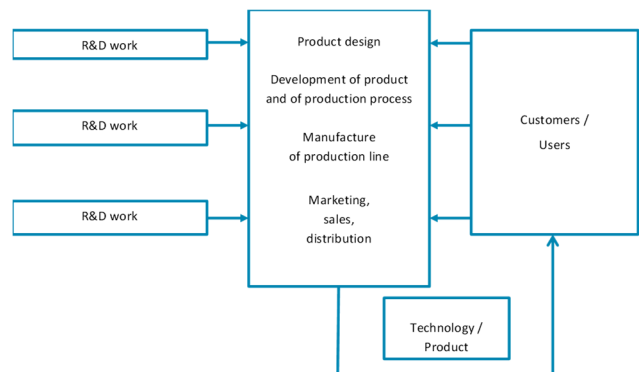
This model presents a traditional approach in which individual commercialization stages of research results are realized linearly and an initiative concerning research and development work is taken by a research institution (Fig. 4).



**Fig. 4 Linear – sequent model of product or technology commercialization**  
Source: [38].

**Network - interactive model of product/technology innovation**

In the case of the model, shown in Fig. 5, the processes are realized in parallel and the producers are engaged in the work on the product/technology creation from the very beginning of the commercialization process.



**Fig. 5 Network – interactive model of product/technology innovation**  
Source: [38].

**The IpOp commercialization model of innovative solutions**

This model (Fig. 6) incorporates the process from the idea to the cash in the bank. It reflects expectations, needs and requirements of stakeholders, participating in a transfer process of research and development work results. Prof. Cohen from the Geneva University is its creator. The model, apart from a realization of the main tasks, also takes into consideration the environment of science and business. The IpOp model, understood as an innovation resulting from taking advantage of opportunity/possibility/chance (I – innovation, p – per, Op – opportunity), enables an optimization of the process realization from the point of view of risks caused by all the stakeholders’ decisions. Its advantage consists in a possibility of analyzing individual components of the IpOp model, considering an individual approach of the stakeholders, whose expectations and aspirations should be taken into account. For some of them costs will be a crucial criterion, whereas for others a possibility of gaining market supremacy or potential profits

may be decisive. Potential barriers and side effects should also be considered. It is worth analyzing unknown factors which may sound as a paradox, because it seems hardly possible to analyze an impact of unknown factors. However, the IpOp model takes into consideration an impact of unknown factors of technical and technological character as well as of market and organizational character. According to Prof. Cohen 20% of information is sufficient for taking 80% of correct decisions. The unknown factors are included in the column concerning the environment/surroundings, but they are also in the column of stakeholders. The IpOp model reflects a dynamic process. A change in one of its components causes changes in the others, so for each project of an innovative character it is worth conducting an analysis from the top to the bottom and from the bottom to the top. A mistake, which is made most often, consists in concentrating on trying to solve a problem instead of concentrating on understanding the reasons of such a problem.

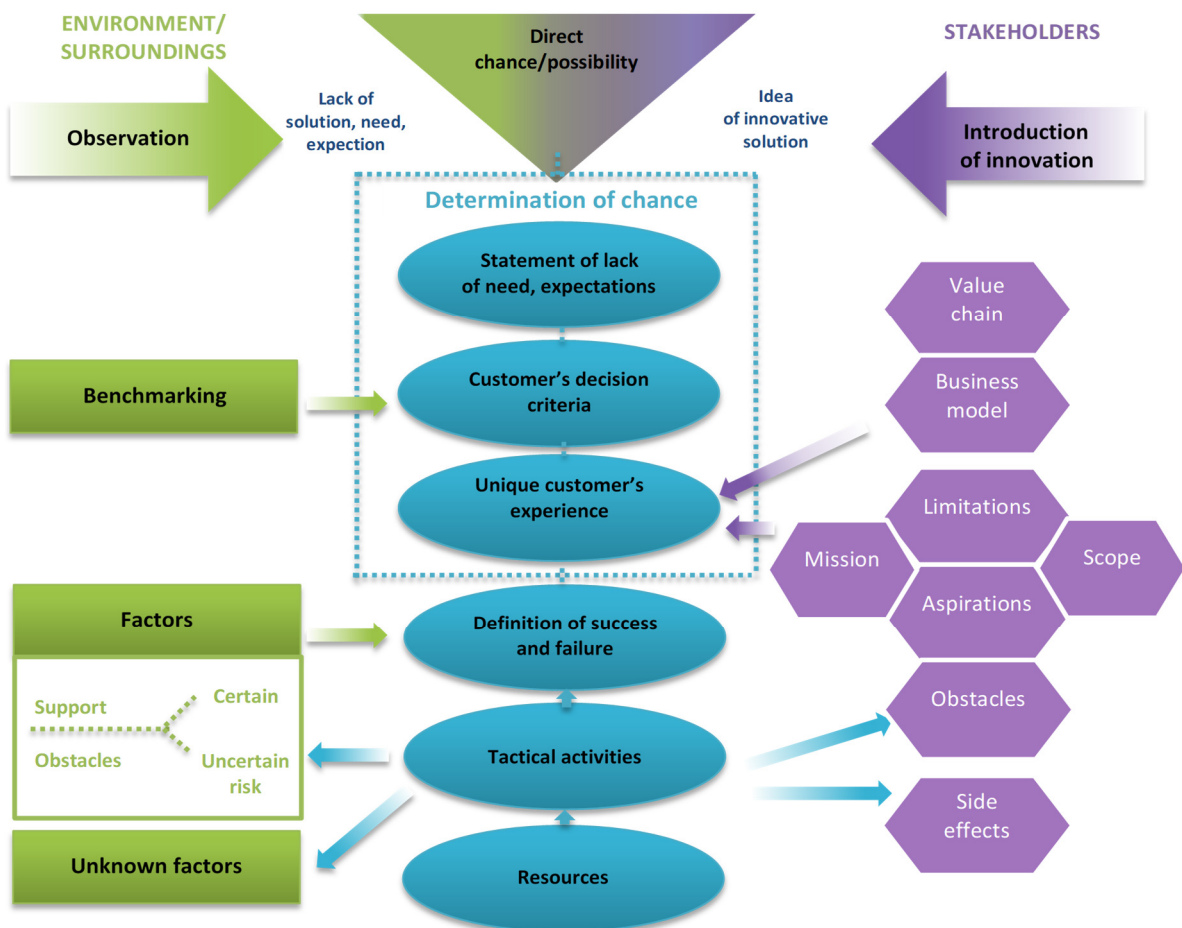


Fig. 6 IpOp model developed by R. Cohen  
Source: [11].

## RESEARCH METHODS AND OBTAINED RESULTS

Basing on the literature investigations the research problem was formulated, i.e. a construction of an integrated model of collaboration between a research institute and an industrial partner/partners in the scope of commercialization of research and development work results. For an elaboration of the model the case-study method was used for an analysis of three successful projects and of three failed ones. Then a comparative analysis was conducted and general conclusions were drawn, including some recommendations for stakeholders of technology transfer processes. The research work also included a verification of the integrated commercialization model against the examples from the KOMAG Institute of Mining Technology. The following research methods were used:

- an analysis of texts – studies of literature enabling to formulate the research problem,
- a multiple case-study for a description of three successful projects and of three failed ones,
- a heuristic method for a presentation of new facts and new relationships, in particular the transposition method was useful,
- a diagnostic survey enabling to gather information about structural and functional phenomena,
- mathematical statistics giving practical, general information about the commercialization process of research results in the aspect of meeting the industrial partners' requirements and expectations.

The comparative analysis of the projects included knowledge resources, a demand of innovations, a conception development, a preparation of offers, negotiations, financial sources, a preparation of project applications, contacts with partners and an assessment of project management.

The following activities, parameters and indicators were compared: a project initiator, a financing principle, an industrial partner/partners, an executor of research work, collaborating institutions, planned costs, scheduled work programme, contracts, reports, licence agreements, a number of implementations, licence fees.

In the result of the comparative analysis it could be concluded that the basic reasons of project failures are:

- Inaccurate formulations of contacts and agreements – lack of detailed specification of obligations and punishments for an improper realization of the contract obligations. Organizational and formal mistakes, lack of the market survey and an underestimation of the project costs are also the reasons of projects failures.
- Mistakes in project management – delays in a realization of the work scheduled programme, an incorrect communication among the project participants, causing misunderstandings, a deficit of current information, mistakes made by the project leader, basing his knowledge of the situation only on oral information without any in-situ check-up.
- Incorrect knowledge of industrial partners' needs and expectations as well as of legal and formal requirements.

The factors which have a decisive impact on a research project success are:

- Correct planning and a current analysis of the work progress.
- Establishment of the research project life cycle.
- Management of the research project life cycle.
- Management of the project team.
- Risk management.
- Quality management.
- Management of changes.
- Monitoring.
- Evaluation.
- Project closure.

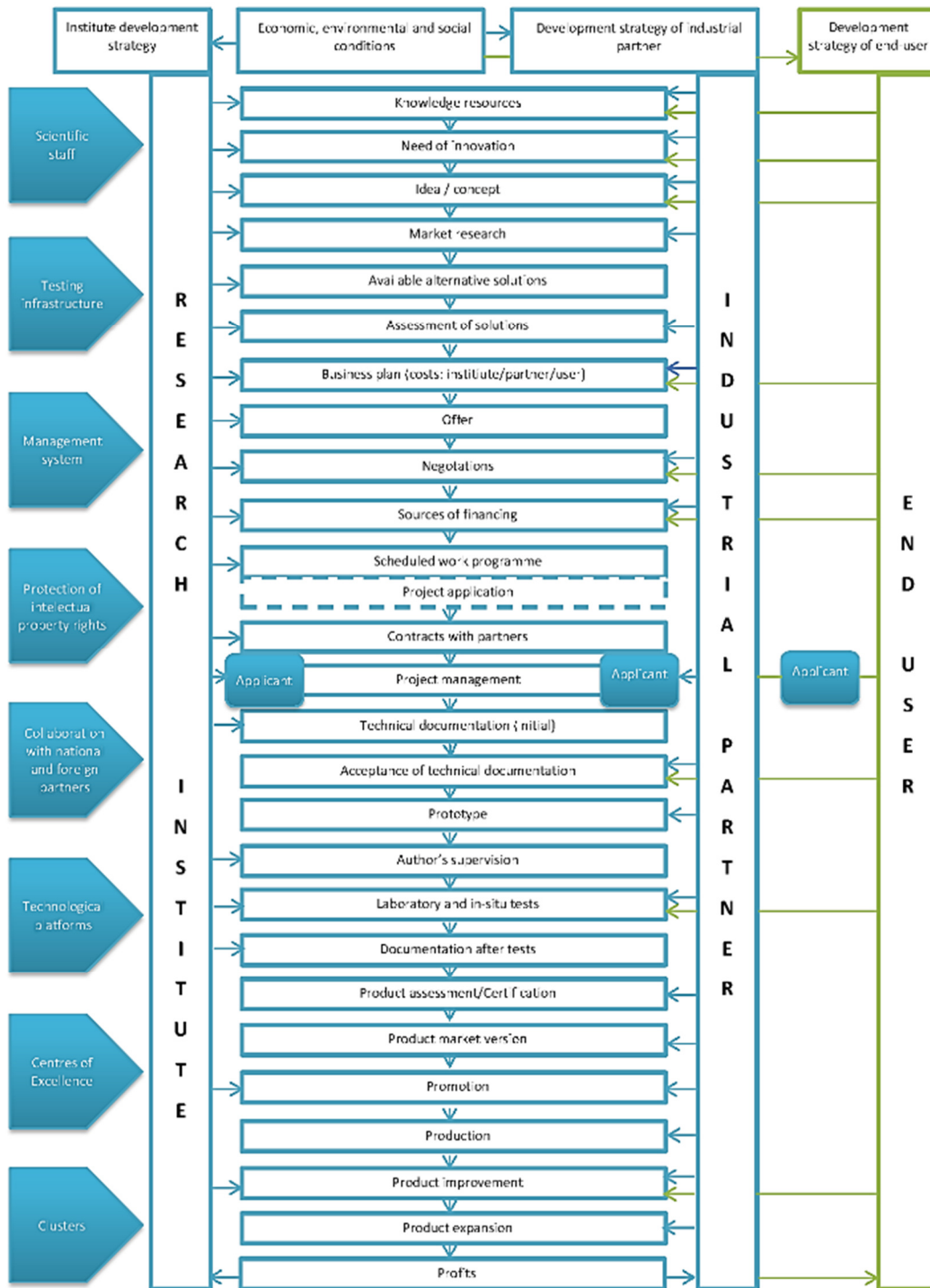
An incorrect realization of any of the above mentioned elements of the research project may cause a failure of the whole undertaking.

## INTEGRATED COMMERCIALIZATION MODEL (ICM) OF RESEARCH AND DEVELOPMENT PROJECTS' RESULTS – RESULTS OF RESEARCH AND DISCUSSION

Basing on the available commercialization models and also on the Author's scientific and professional experience, resulting from a multi-year engagement in a management of national and international research projects, the Integrated Commercialization Model (ICM) has been developed. It reflects a process complexity and roles of all the stakeholders. The process components present the activities of the research institute and of the industrial partner, who in this case is a producer of machines and of also their end-user. It should be highlighted that this model shows a process, in which the research institute plays the crucial role. The institute takes an active part in all the process components, except for the production phase itself. This process will look different in the case of selling the research results by universities or institutes of the Polish Academy of Sciences. The integrated model (Fig. 7) enables to test a correctness of a commercialization process, but is limited only to the factors which have an essential impact on the analysis, so it includes only selected factors and only in a limited scope of changeability. It is an integrated model, which indicates that individual model components use a certain scope of knowledge from different domains, creating a frame structure.

Its big advantage is that it gives not only theoretical, but also utilitarian information to stakeholders.

Analyzing the integrated model, it can be stated that there is a clear impact of economic, environmental and social conditions on a development strategy of the research institute, industrial partner and end-user. In the research institute the strategy of innovativeness plays a strategic role. An important activity is an assessment process of an innovative solution to evaluate its market potential. An exact verification of this assessment enables to formulate an opinion whether an innovative solution will be accepted by the market or not.



**Fig. 7 Integrated model of innovative solution's transfer and of commercialization of research results**

Source: [10, 27]

The SWOT analysis, benchmarking or the method of awarding points can be used. The results of an innovative project should be treated as a potential investment, so it is required to analyze possibilities of its commercialization, chances for an implementation and maintaining on the market. Marketing activities are very important in this case. They include market research, its segmentation and activities on an innovation market. An active participation of an industrial partner in a realization of individual project phases enables to verify the results of research activities. A good, novel idea is a basic factor of success in the

process of research results' commercialization. A regular contact of researchers with representatives of the industry, discussions with producers as well as with end-users of mining machines and equipment deliver extremely valuable information, being a source of inspiration. Analyses of patent bases and a current studying of technical literature enable to check the present state of knowledge. After having confirmed the fact that an idea is of innovative character, it should be protected by the intellectual property rights, because only a properly protected idea has a



market value. An important step includes an initial selection of ideas and a decision concerning technical and technological capabilities, but also an assessment of market potential. Then a secondary selection is done and a decision about a development of an action plan is taken. In the process of generating new ideas and managing them three methods are used:

- Brain storming which enables a team generation of ideas. Its creator, Osborne A. [30] highlighted its advantage consisting in obtaining a big number of different ideas within a relatively short period of time enabling to solve a problem.
- Method of discussion enabling an exchange of views on a given subject. It helps to reach an agreement due to an exchange of arguments among opponents.
- Tree of decisions contains data, which are processed. A graphic form of the tree of decisions contains a description of the problem, a scope of possible solutions presented in a form of tree branches, a description of positive and negative results of a given decision in the aspect of the objective realization and of the final result, i.e. a finally taken decision.

Presenting the integrated model of innovative solutions' transfer and of commercialization of research results, special attention is paid to the project management process. The areas of an efficient project management are as follows:

- Management of the project scope, described in specifications, which includes a process verification and management of changes.
- Management of integration including correct planning and control.
- Time management consisting in an elaboration of the scheduled work programme and in a control of its realization.
- Budget management enabling a current monitoring of costs (personnel, equipment, materials).
- Quality management oriented onto meeting the quality requirements (internal and external audits).
- Risk management consisting in an identification, analysis and reaction to negative phenomena occurring in the project.
- Human resources management enabling to establish the executive team, to divide tasks and to determine duties.
- Management of orders incorporating a preparation of offers, an elaboration of contracts, a supervision of their realization and a termination of tasks.
- Communication management consisting in planning, a realization and a control of information flow to the project participants.

In the case of the projects which can be described as foreseeable the PRINCE 2 [30] methodology seems to be best. It includes a justification of the project realization, a description of organizational activities, plans with control

and risk management elements, quality requirements in the project environment, a configuration management and a control of changes.

A need for an innovation elaboration and implementation can appear both in the research institute as well as at the industrial partner's or end-user's. An incorrect assessment of the market potential may cause a project failure. An important task is an elaboration of a business plan, which requires a lot of knowledge and professional experience from the stakeholders. Then the research institute submits its offer and the parties start negotiations leading to a formulation of a contract. Monitoring of the project realization stages should be conducted in close collaboration with the industrial partner or the end-user.

After a termination of the task, consisting in an elaboration of technical documentation, the industrial partner accepts it and then makes a prototype, which is subject to laboratory and quite often also to in-situ tests. Then the technical documentation is corrected by the research institute and submitted to the producer, who conducts the certification process or applies for a technical approval. Then a production of an innovative product can start. A process of the product improvement during its full life-cycle is important. The synergy effect plays a crucial role. It requires a close collaboration among the research institute, the industrial partner and the end-user.

A big advantage of the presented, integrated model consists in a possibility of conducting a detailed analysis of each transfer process of innovative solutions to check a correctness of realizing individual tasks. Bearing in mind significant roles of an industrial partner and the end-user, it is relatively easy to detect irregularities and undertake corrective measures immediately. The integrated model can be treated as a diagnostic tool enabling an efficiency assessment of innovative solutions' transfer and of research results' commercialization.

#### **RECOMMENDATIONS CONCERNING A SUCCESSFUL MANAGEMENT OF INNOVATIVE SOLUTIONS' TRANSFER AND COMMERCIALIZATION OF RESEARCH RESULTS**

Basing on the Integrated Commercialization Model (ICM) and on the Author's multi-year experience in the scope of innovative projects' management, the following recommendations for the stakeholders of the commercialization process can be specified:

- A good recognition of economic, environmental and social conditions.
- A good recognition of the industrial sector needs (knowledge resources, demand for innovations, information about competitors).
- A generation of ideas oriented onto innovative solutions (research and development projects conducted by the institute, analyses of customers' needs and expectations, analyses of competitors' products, suggestions made by producers, opinions of end-users, participation in conferences, seminars and fairs, analyses of patent bases, market research, close collaboration with scientific and industrial partners).

- A determination of the product market potential (available alternative products, assessment of the product from the point of view of its innovativeness, costs, manufacturing possibilities, etc.).
- A determination of barriers which can be of legislative, financial, organizational and institutional character.
- An establishment of scientific, research and business consortium.
- A preparation of business plan.
- An elaboration of offer.
- Negotiations – a big flexibility is recommended in the win-win system.
- A preparation of the contract including scheduled work programme and sources of financing. It is indispensable to establish duties and responsibilities of all the parties in detail to avoid misinterpretation or misunderstanding during the project realization. It is important to monitor a realization of the contract during its duration.
- Efficient and correct innovative project management should include a risk assessment and risk management.
- Marketing and promotional activities play a very important role in the commercialization process.
- Product improvement during its life-cycle (periodical customer's satisfaction survey can be useful).

These recommendations result from analyses of transfer processes of innovative solutions conducted on the base of the Integrated Commercialization Model (ICM).

## CONCLUSIONS

The article presents the results of research work, conducted by the Author, in the domain of commercializing technical, innovative solutions, obtained due to a realization of scientific and development projects at the KOMAG Institute of Mining Technology.

The Integrated Commercialization Model (ICM) describes collaborative relationships between the research institute and its industrial partners: producers of mining machines and equipment as well as the end users, i.e. mines of minerals. It should be highlighted that this model does not have only research-and-cognitive objectives but also utilitarian ones, which enable a comprehensive assessment of a commercialization process and undertaking corrective measures, when they turn out to be needed.

- There are different commercialization models of research and development projects' results.
- The integrated model, developed by the Author, presents the commercialization process from the point of view of the research institute and it can be used as a diagnostic tool enabling to assess the efficiency of technology transfer.
- A participation of industrial partners in a realization of innovative projects facilitates the management and contributes to their successful termination.

- Practical recommendations for stakeholders of innovative projects are oriented onto increasing the efficiency of these projects and ensuring market success. Basing on the available commercialization models of research results and also on the Author's scientific and professional experience, resulting from a multi-year engagement in a management of national and international research project, realized within the European Union Framework Programmes as well as within the Research Fund for Coal and Steel, the Integrated Commercialization Model (ICM) has been developed and verified. Due to this approach it was possible to identify the factors fostering a transfer of knowledge and of innovative solutions as well as the barriers which impede this transfer. It should be borne in mind that a successful transfer of innovative solutions is a measure of a technical progress and it ensures a market supremacy as it reflects a practical dimension of an innovation. It needs to be highlighted that an intellectual and conceptual structure of collaborative links among the technology transfer process stakeholders can be a good inspiration for all the researchers oriented onto an industrial implementation of innovative solutions, being the result of a collaboration between science and industry. A realization of a successful process of a development and a commercialization of innovative technical solutions is not possible without a regular assessment of the project progress, accompanied by an analysis of different scenarios, enabling a long-term planning of activities. The research work results, described in the article, are oriented onto the phenomena and relationship among three stakeholders of the technology transfer process conducted according to the Author's Integrated Commercialization Model, i.e. a research institute, conducting scientific, development and technical projects of an applied research character in the scope of mining machines and equipment, producers of these machines and by end-users from mines of minerals.

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**Małgorzata Malec**

ORCID ID: 0000-0002-6373-4568  
KOMAG Institute of Mining Technology,  
Pszczyńska 37, 44-101 Gliwice, Poland  
e-mail: mmalec@komag.eu

**Lilianna Stańczak**

ORCID ID: 0000-0002-5154-7693  
KOMAG Institute of Mining Technology,  
Pszczyńska 37, 44-101 Gliwice, Poland  
e-mail: lstanczak@komag.eu

**Brian Ricketts**

EURACOAL (European Association for Coal and Lignite)  
Rue de la Science 14b, 1040 Bruxelles, Belgium  
e-mail: ricketts@euracoal.eu